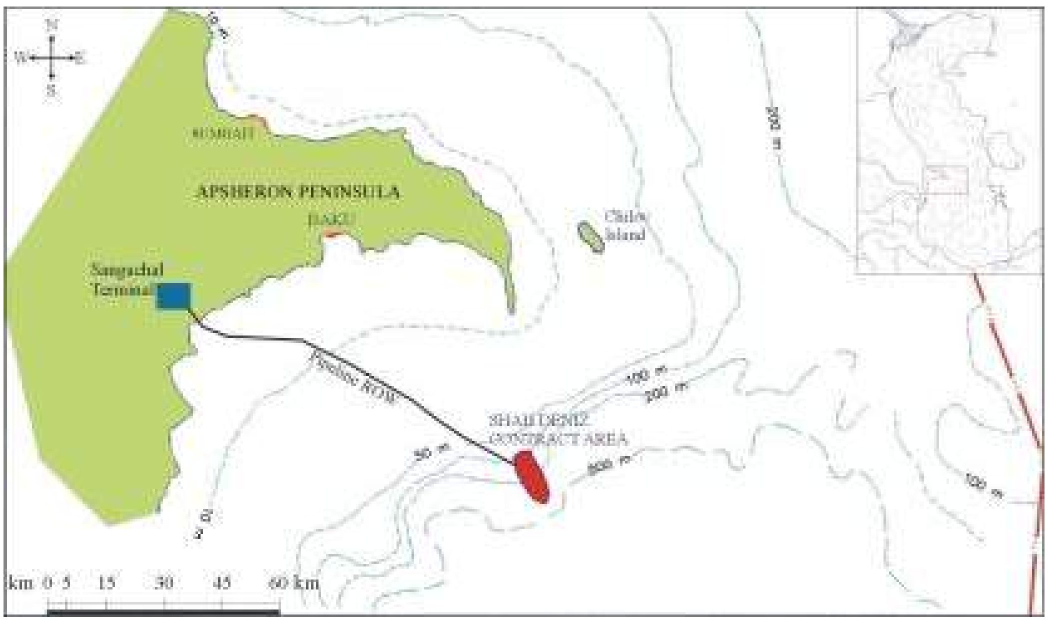
ES 1 Introduction

ES 1.1 Project outline

The Shah Deniz Stage 1 Project is the first stage in the development of the Shah Deniz gas field. The Stage 1 project comprises an "Upstream" component consisting of wells, drilling, offshore facilities, marine pipelines and onshore terminal and a "Midstream" component consisting of a sales gas pipeline system from the terminal to the Turkish-Georgian border. The Midstream component, known as the South Caucasus Pipeline (SCP) is part of the Azerbaijan-Georgia-Turkey (AGT) pipelines project that is also responsible for the Baku-Tbilisi-Ceyhan (BTC) oil pipeline. This Environmental Statement addresses the Upstream component of the Shah Deniz Gas Export Project Stage 1 Development.

The Shah Deniz Contract Area lies in the Azerbaijan sector of the Caspian Sea approximately 100 km south east of Baku (Figure ES.1) and covers an area of 858 km^2 in water depths ranging from 50 m to 500 m.

Figure ES.1 Shah Deniz Contract Area



A Production Sharing Agreement (PSA) between the State Oil Company of Azerbaijan Republic (SOCAR) and a number of Foreign Oil Companies (FOC) grants rights to the FOC to invest in and develop the Shah Deniz field to produce and market the hydrocarbons. BP has been appointed as operator on behalf of the other PSA Partners.

Early appraisal well drilling has indicated that the Shah Deniz field is a world-class gas-condensate discovery, the full potential of which requires further appraisal. The Stage 1 development will target approximately one third of the total potential resource in the Shah Deniz field, some 11.9 Tcf gas in place. Gas will be produced, conditioned and transported over the lifetime of the development that is estimated to be at least 30 years.

The Stage 1 offshore development will be in the Eastern Flank of the field where water depths range from 100 m to over 500 m, with drilling and production occurring at fixed facilities in some 100 m of water. To maintain gas production rates from the field, further development is anticipated several years after initial gas production from a subsea facility to be located some 4 km south of the fixed facilities in 350 m of water.

The project will require offshore drilling and production facilities. Gas and liquids will be separated offshore before transfer, via separate marine pipelines to a gas and condensate reception and processing facility onshore. The onshore reception and processing facilities will be located adjacent to the existing and planned future AIOC oil reception facilities at Sangachal 38 km to the southwest of Baku.

ES 1.2 Environmental assessment

This Environment Statement (ES) has been prepared following a detailed Environmental and Socio-economic Impact Assessment (ESIA) of the proposed Shah Deniz Stage 1 project. The ES has been prepared for submission to the Azerbaijan Ministry of Ecology and Natural Resources (MENR) to gain approval for the project and as such, has been conducted in accordance with the legal requirements and policies of Azerbaijan. The assessment has also been carried out in a manner that ensures it satisfies the international environmental and social guidelines as recommended by the International Finance Institutions (IFI) requirements and in the context of BP's Health, Safety and Environment (HSE) Policy.

This impact assessment represents the latest environmental work programme to be conducted and completed to date by BP in Azerbaijan. A full list of environmental and socio-economic programmes of work carried out by BP (and AIOC) to develop a knowledge and understanding of the environments in which their project developments occur, are outlined in Table ES.1. These studies have assisted BP in identifying and understanding the potential effects that its proposed activities may have on these environments, enabling the proposed programmes to be designed and planned in a manner that would minimise any adverse effects.

Table ES.1 Caspian environmental and social programmes undertaken to date by BP (and AIOC)

Environmental / Social Programmes Undertaken	Date
ACG Baseline Assessment	1995
Seismic Survey EIAs	1995
Appraisal Drilling EIAs for GCA Wells 5, 6	1996
Northern Route Export Pipeline EIA	1996
Western Route Export Pipeline EIA	1997
Supsa Terminal EIA	1997
EOP Environmental Impact Assessment	1997
Ongoing monitoring for EOP	1997 - present
ACG Phase 1 Baseline Assessments	1998, 2000 & 2001
Shah Deniz marine baseline assessment	1998
SDX1 post drilling marine survey	2000
SDX3 post drilling marine survey	2001
ACG FFD consultation with regulators and NGOs	2000 - ongoing
Early Template Well EIA for ACG Phase 1	2001
Sangachal Terminal, Early Civil Engineering Work Programme ESIA (ACG FFD Phase 1 and Shah Deniz Gas Export Stage 1)	2001
ACG Phase 1ESIA	2002

ES 1.3 Benefits of Shah Deniz FFD

The Shah Deniz Gas Export Project together with the linked investments including ACG Full Field Development and the AGT pipeline projects have the potential to deliver major economic benefits as well as a substantial injection of new resources to Azerbaijan.

The projects have the potential to either result in, or create the climate for, the following positive impacts.

- Assist the government in balancing the national budget assuming that spending remains restrained.
- Yield revenues that could be used for investment in the non-oil sector.
- Assist in the development and maintenance of a liberal trade regime by removing the need to raise revenues from import duties and by encouraging modernisation of customs procedures.
- Create an environment that is domestically more favourable to private sector investment and that sets an example making other private sector investors more open to invest. Current estimates suggest that between 10% and 30% of spend on oil and gas projects in Azerbaijan goes to local Azerbaijani firms. Similar figures are predicted for the Shah Deniz development despite the fact that full development of the local supply base will be difficult in the time frame of the project's rapid construction schedule.
- Add impetus to energy sector reform within Azerbaijan. This in turn should improve the population's access to energy (gas and electricity) and result in the wider use of cleaner fuels, better ambient and indoor air quality and reduced pressure on traditional sources of fuel (and hence forest products and therefore, biodiversity).
- Contribute to poverty alleviation and sustainable development via the revenues generated, assuming prudent revenue management.
- Continue to enhance public awareness and education in the environment.
- Create both direct and indirect employment opportunities.

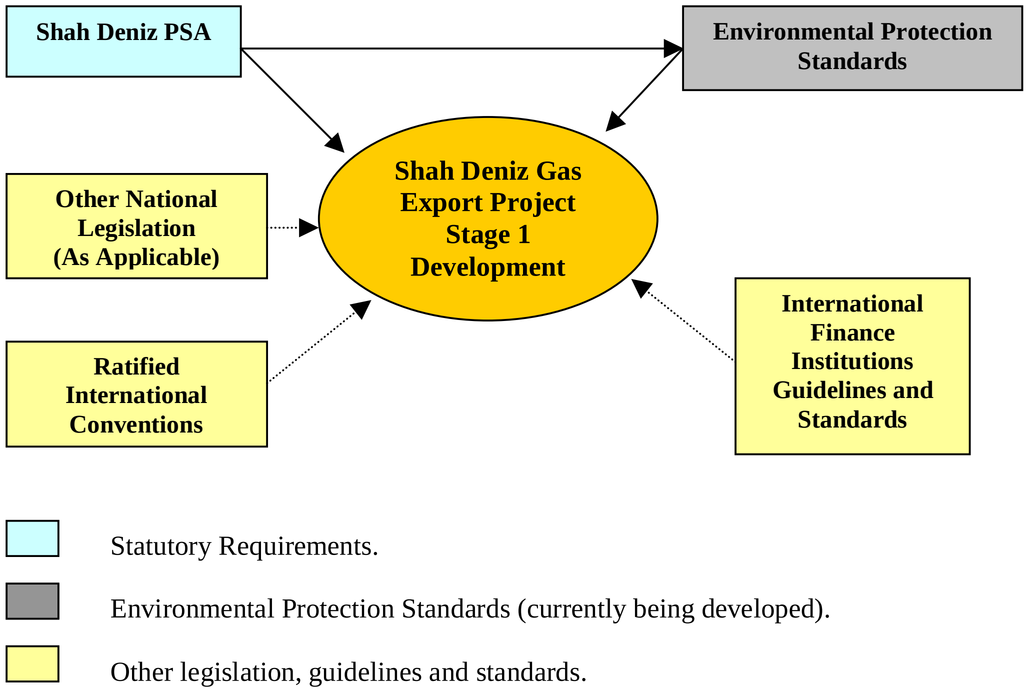
ES 2 Policy, legal and administrative framework

The Shah Deniz Stage 1 project is subject to the terms and conditions of the Shah Deniz PSA and the Partners are developing the Health, Safety & Environment (HSE) Design Standards for the project. These will be based on and will incorporate selected international standards where appropriate.

According to Article 26.4 of the PSA, the partners shall comply with the present and future Azerbaijani laws or regulations of general applicability with respect to public health, safety and protection and restoration of the environment to the extent that such laws and regulations are no more stringent than the Environmental Protection Standards.

Beyond the framework of the PSA and Stage 1 HSE standards, the project will also be undertaken with due regard to international conventions as ratified by the Azerbaijan government. Applicable national and international guidelines and standards, including the requirements of the IFI, have also been reviewed as part of this ESIA in order to ensure that the development is undertaken in a manner that is compliant with these guidelines and standards (Figure ES.2).

Figure ES.2 Legislative framework of Shah Deniz Stage1 project



ES 2.1 International Finance Institutions guidelines and standards

As Partners in the PSA may seek Bank finance for the project, the environmental and social standards, practices and guidelines set forth by the IFI have been used in the preparation of this ESIA. Potential IFI include:

- European Bank for Reconstruction and Development (EBRD);
- World Bank Group (WBG) including potentially the International Finance Corporation (IFC) and Multilateral Investment Guarantee Agency (MIGA);
- United States Export-Import Bank (US ExIm);
- Overseas Private Investment Corporation (OPIC);
- Other Multilateral Lending Agencies (MLAs); and
- Other Export Credit Agencies (ECAs).

ES 2.2 National legislation

In Azerbaijan, major private and public developments require the preparation of an ESIA. The objective of the ESIA process is to provide a means whereby adverse impacts can be identified and either avoided or minimised to acceptable levels.

The fundamental principle of the ESIA is applied by the Azerbaijan Ministry of Ecology and Natural Resources (MENR) using the *Law of the Azerbaijan Republic on Environmental Protection, August 1999* and the *Handbook for the Environmental Impact Assessment Process, 1996* published with the assistance of the United Nations Development Programme (UNDP). The handbook includes requirements for scientific expertise and public consultation in the ESIA process. Following submission to the MENR, the ESIA document is reviewed for up to three months by an expert panel including a one-month approval period.

ES 2.2.1 Azerbaijani regulatory agencies

The main environmental regulatory body is the MENR. This body is responsible for the following:

- development of draft environmental legislation for submission to the Parliament (Milli Mejlis);
- implementation of environmental policy;
- enforcement of standards and requirements for environmental protection;
- suspension or termination of activities not meeting set standards;
- advising on environmental issues; and
- expert review and approval of environmental documentation including EIAs.

In addition, the MENR has responsibility for the implementation of the requirements set out in international environmental conventions ratified by the Azerbaijan Republic.

ES 2.3 Ratified international conventions

The Azerbaijan Republic has entered into and ratified a number of international conventions, many within the last year. BP will endeavour to assist the government in meeting their obligations with respect to these conventions.

ES 3 Environmental and socio-economic impact assessment

The ESIA process incorporates a number of steps. A key element of the Shah Deniz Stage 1 ESIA process has been the on-going interaction between the environmental and engineering design teams with the objective of removing, or at a minimum, reducing as many of the potentially significant environmental impacts as practicable, while enhancing positive benefits of the project wherever possible. This has been achieved by assessing a wide range of options against numerous criteria including environmental and social impact, safety, technical feasibility, cost, ability to meet project commercial objectives and stakeholder concerns.

A critical element of the ESIA process is the public consultation and disclosure programme involving a wide range of stakeholders. The objectives of this process were to inform stakeholders about the project, allow stakeholders to raise key issues and concerns associated with the project, source accurate information, identify potential impacts and offer the opportunity for alternatives or objections to be raised by the potentially affected parties, non-governmental organisations, members of the public and other stakeholders.

The concluding steps of the ESIA process are the public disclosure of a draft ES for which comment is sought from the public and regulatory authorities. After the disclosure period of 60 days, the draft ES is revised and a final ES is submitted to the MENR. A decision, as to whether environmental approval shall be granted, should be forthcoming from the regulatory authority 30 days after submission.

ES 4 Options

A number of alternative engineering design options were considered for the Stage 1 development starting at a conceptual level and subsequently adding detail for each conceptual option through the design and planning process. Development concept options were identified and evaluated using a number of screening criteria. Non-viable options were rejected at an early stage in the process and potentially viable options were taken forward for further consideration. This process continues into Detailed Design, Construction and ultimately Operation.

In addition to the engineering design options for the project, the “no development option” has also been considered. No development would mean that the potentially significant benefits such as revenue, improved infrastructure and direct and indirect employment that would be created by the project would not be realised. The Shah Deniz Gas Export Project together with ACG Full Field Development and associated projects, particularly the AGT pipeline export projects, represents a unique opportunity for Azerbaijan to develop a stable economy, improve social equity and reduce levels of poverty. No other currently identified prospects offer this potential for the country.

Optimum design requirements were considered for each of the components of the project. Offshore this included facilities to provide a long-term centre for the drilling of development wells, the separation of gas and liquids, accommodation for personnel and the onward transportation of the produced hydrocarbons to shore. Several concepts were considered for these facilities and, although many were rejected early in the process, a technical ranking exercise against six key themes was used for the most viable concepts against the following criteria:

- Health, Safety and Environment (HSE);
- design and technical issues;
- project execution;
- drilling issues;
- operational aspects; and
- political issues.

In addition consideration of the availability of infrastructure and resources in Azerbaijan, as well as the wider Caspian region, were included in the review. In this respect, the possibility of schedule conflicts between the construction requirements of the Shah Deniz offshore facility with those of ACG Phases 1 and 2 were investigated.

Three of the concepts were considered to offer technically robust solutions for the facility, with very little difference between them. Overall, the Technip-GeoProduction 500 (TPG500), a proprietary purpose designed jack-up drilling and production platform consisting of all processing and drilling facilities, living quarters and utilities packages was finally selected. The TPG500 offered least risk to potential conflicts with other projects and a parallel investigation of the costs of the various concepts also concluded that this was the most attractive option. The TPG500 also provides some additional environmental benefits over the other options considered in that it allows the minimisation of offshore activity in both installation and commissioning phases in comparison to the installation requirements typically associated with the other offshore facility concepts considered. Further, it also readily facilitates future decommissioning.

Transfer of the produced liquid hydrocarbons to shore using shuttle tanker was discounted in favour of marine pipeline transfer early in the option evaluation process due to this option’s requirement for large offshore processing facility to process condensate to export quality as well as the lack of existing and appropriate tanker vessels within the Caspian Sea. In addition, it is considered that marine pipelines present significantly lower spill risks than offshore loading and shuttle tanker transportation as tanker transportation results in increased vessel movements and a consequent increased collision risk.

A multi-phase (gas and liquid combined) pipeline was considered during the pipeline selection process but was rejected due to the requirement to regularly remove wax build up thereby introducing operational difficulties relating to practicality and safety. Flow rate turndowns would be required during pigging. Subsequent increases to achieve required production rates would also introduce operational difficulties at the onshore terminal. The decision was made therefore, to select separate single-phase pipelines for gas and condensate. This option offers a higher degree of confidence with respect to operability as the underlying principles of the single-phase lines are better understood for gas transportation.

As the Shah Deniz development included the need for a gas-condensate processing terminal to be sited onshore, it was considered that benefits would result from siting the terminal alongside the ACG facilities at the Sangachal location as opposed to developing a new site at a different location. This siting option would lead to a reduction in environmental impacts (i.e. less total area effected). Further, benefits would be gained from the use of existing access and infrastructure at the site and from integrated operational control as well as combined maintenance and support services. In addition, potential synergy savings would be possible from combined engineering construction works as well as the advantage of developing a skilled workforce at one location.

In its assessment of the options available for the final design of project components and utilities required for the offshore and onshore facilities, the Shah Deniz project has implemented BP's Upstream Environmental Goals and Design Performance Guidelines for new projects. "Zero Environmental Damage" targets have been used as a starting point for the decision-making process and this, in turn, led to the development of project Environmental Goals which represent the environmental principles for Shah Deniz. Subsequent to defining project Environmental Goals, project Zero Damage Base Cases (ZDBC) for both offshore and onshore facilities were established. The ZDBC included the following steps:

- confirmation of environmental goals for the project;
- identification of options to attain the goals;
- emissions identification and quantification;
- assessment of options against standard criteria including:
  - technical feasibility;
  - safety screening;
  - environmental cost benefit analysis; and
- development of solutions and mitigation proposals;

The process focused on the identification of sources of and the potential for environmental damage of all potentially harmful emissions from the facilities and the identification of options available to eliminate or minimise each of the emissions identified. As such the areas mainly considered included:

- hydrocarbon emissions;
- combustion emissions;
- liquid discharges to sea; and
- energy efficiency.

The ZDBC was established early in the project design process with the initial objective of identifying potential zero damage base case solutions that meet the intent of each of the Environmental Goals established for the project. In cases where the environmental goals could not be attained, alternatives to the ZDBC were considered using some or all of the tools described above to justify the variance from the goal. This process will continue to be used for the evaluation of the project options throughout the project design through to operations.

ES 5 Project description

There are three main components to the Shah Deniz Stage 1 project, each significant engineering undertakings in their own right. These are:

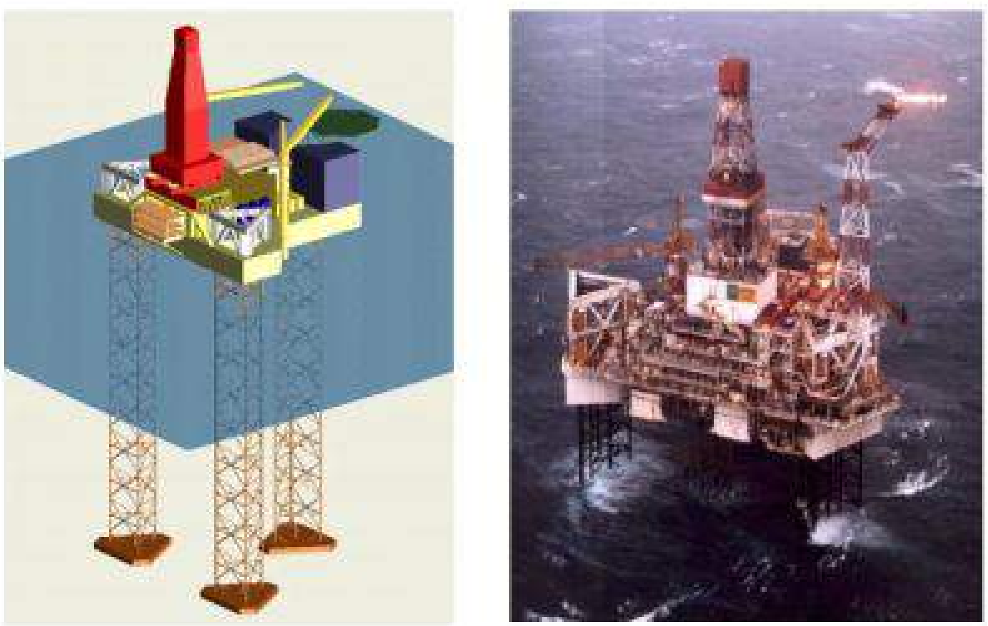
- offshore drilling and production platform;
- three subsea pipelines for the transportation of gas, condensate and monoethylene glycol (MEG), a hydrate inhibitor; and
- an onshore terminal for the reception and processing of gas and condensate.

ES 5.1 Offshore facilities

The offshore drilling and production operations will be carried out from the TPG500 platform (Figure ES.3) to be installed over a pre-installed drilling template. The proposed base-case is to drill nine (9) producing wells at the site. Prior to installation of the TPG500 three wells will be drilled from a semi-submersible drilling rig to enable early production to begin soon after installation of the fixed facility. To maintain gas production in future years, up to five subsea wells will be drilled in the deeper waters to the south for tie-back to the platform facility.

Produced hydrocarbons will be separated into gas and liquids on-board the platform for transfer to shore.

Figure ES.3 TPG500



ES 5.1.1 Pre-platform drilling

The early drilling programme to be carried out prior to the installation of the TPG500 platform will be conducted from the semi-submersible drilling rig, the “Istiglal” that will be towed out and anchored on location.

Three wells will be drilled during this programme and will be drilled in sections with hole diameters of 28”, 22”, 20”, 16”, 12 ¼” and possibly 8 ½” using different drilling fluids. The

28" section will be drilled with a water based mud (WBM) system containing weighting materials and other additives. A synthetic oil based mud (SOBM) system will be used in the lower-hole sections.

Drilled cuttings generated from the 28" section will be deposited directly on the seabed around the well. Cuttings and SOBM from these remaining hole sections will be retained and shipped to shore for treatment and correct disposal. No drilled cuttings generated from the lower-hole sections will be discharged to the sea.

The Istiglal will be supported by a number of conventional utilities including diesel fired (low emission) power generators, sewage treatment systems, a cooling water system, drainage systems, support and supply vessels. Up to 118 people will be accommodated on the rig during the drilling programme.

ES 5.1.2 Platform drilling

Drilling will continue from the TPG500 platform once it is installed on location. It is expected that up to six platform wells will be drilled although provision of up to 15 wells will be provided by a 15-slot drilling template on the platform. The well design will be similar to that for wells drilled from the semi-submersible drilling rig although it is expected that the surface-hole sections of each well will be constructed by installing a 36" conductor pipe into position and, using seawater and/or a WBM system, will be drilled out using a 28" drill bit. As with the drilling from the semi-submersible rig, drilled cuttings from the top-hole sections will be discharged directly to the seabed. All cuttings from the lower-hole sections drilled with SOBM will be returned to the platform, retained and shipped to shore for treatment and correct disposal.

To maintain gas production in future years it is expected that further wells will be drilled in deeper waters to the south of the fixed platform. These wells may be drilled from a mobile drilling rig and completed as subsea wells, or, if technology allows, may be drilled from the platform as "extended reach" wells.

There will be a need to achieve flexibility in adapting plans commensurate with reservoir performance. The future sub-sea development and the number of platform wells may be varied based on field production performance and drilling experience.

Utilities on board the drilling platform are combined for both drilling and production operations and these are discussed below.

ES 5.2 Construction and installation of the offshore facilities

Many of the components for construction of the TPG500 will be pre-fabricated outside of Azerbaijan and transported in modules in to the country for assembly. The hull structure will be manufactured in four strips, fabricated out of country and towed into the Caspian Sea through the canals to the north of the Caspian and onwards to Azerbaijan for assembly. At the time of writing this document, a location for the assembly of the imported components has not been selected but it is expected that an existing fabrication facility will be used. The construction contractors will source the workforce from within Azerbaijan to a significant extent.

ES 5.2.1 Production process

The production process on the TPG500 platform will be a simple process of separation of liquid from gas. The two streams, condensate/water and gas, will be exported by means of two pipelines to the reception and processing terminal at Sangachal. Some gas will be used on the platform as fuel gas.

Power will be supplied by dual-fuel generators that will also include some degree of waste heat recovery. The generators will normally be fuelled by gas but will be able to run on diesel when necessary and during start-up. The TPG500 will be sized to accommodate up to 118 personnel. All sewage generated will be treated in a customised marine sanitation unit after maceration and prior to discharge to the sea via a submerged caisson. Contaminated drainage will also be treated prior to discharge. Seawater will be drawn from the Caspian for use as drilling and production operation cooling and will be discharged below the sea surface via a caisson.

The platform will be supplied by vessel and helicopter, with all operational solid and chemical wastes back-loaded to the support vessels and returned to shore for treatment and disposal.

ES 5.3 Pipelines

The diameter of the subsea gas pipeline will be 26" and the subsea condensate line 12". The pipelines length will be approximately 90 km between the platform and shore. Both pipelines will be coated to provide corrosion protection and will be concrete coated to provide additional weight that will ensure stability of the pipelines on the seabed, as well as providing mechanical protection against impacts. External corrosion protection has been incorporated into the pipeline design through the use of sacrificial anode cathodic protection. A corrosion allowance will also be incorporated into the pipeline design to ensure that the integrity of the pipelines will not be compromised.

Monoethylene glycol (MEG), used to absorb free water from the gas and condensate in the pipelines, will be continually supplied from the onshore terminal to the platform via a 4" diameter pipeline piggybacked onto the 12" condensate pipeline. The MEG line will not be concrete coated as its stability will be ensured by secure attachment to the condensate line.

ES 5.3.1 Installation and commissioning of the pipelines

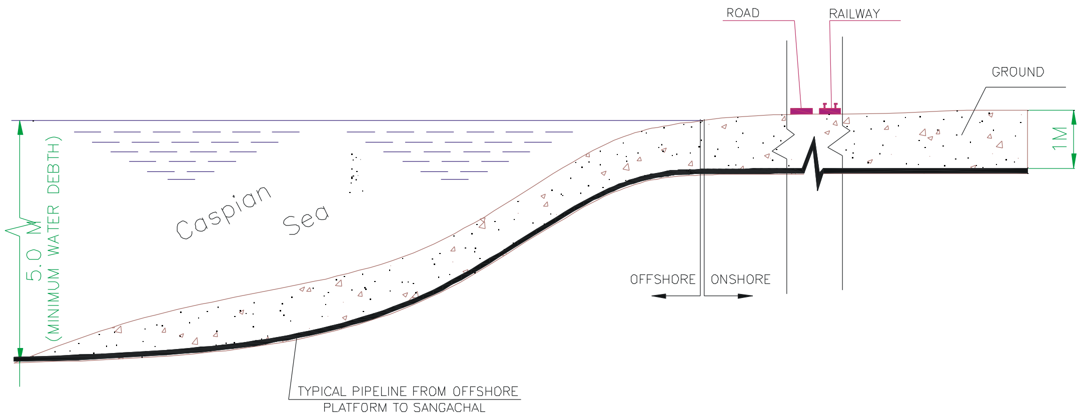
The pipelines will be installed using the pipe-lay vessel "Israfil Guseinov" in water depths of 8 m and greater. The pipe-laying operation is continuous with the barge moving progressively forward as sections of the pipe are welded, inspected, coated and deployed from the stern of the lay-barge. The pipe-laying vessel will be held in position by eight to 10 anchors.

In water depths less than 8 m, the pipeline will be pulled onshore using a shore-based winch. A temporary trench will be dug across the shoreline and this will be allowed to flood so that the pipeline can be pulled through the nearshore zone and into the shoreline.

The base case plan is to bury the pipeline beneath the seabed in water depths of less than 5 m, a total distance of approximately 2 km offshore. A pipeline trench will be excavated for each pipeline in water depths of up to 2 m. Between the shoreline and the 2 m depth contour, the trench may be up to 8 m in width. Beyond the 2 m water depth mark, the pipeline will be buried into the seabed using a mechanical cutter out to water depths of 5 m and the trench will be approximately 3 m in width. A typical pipeline shore approach is shown in Figure ES.4.

A finger pier, approximately 10 m wide at its base and approximately 100 m long, will be built from the shoreline into Sangachal Bay to provide access for an excavator to excavate the pipeline trench from the shoreline out to water depths of approximately 2 m. The pier will be a rock groyne type structure constructed by placing rock aggregate in the shallow inshore zone. A pipeline trench will be constructed on either side of the pier; one each for the gas and condensate subsea pipelines.

Figure ES.4 Typical pipeline shore approach



Marine pipeline installation operations will occur within the existing exclusion zone that extends for 1,000 m across the existing ACG/Early Oil Project pipeline corridor where the Shah Deniz pipeline corridor is common with this. During installation, exclusion buoys will be placed around the installation area to ensure that other vessels do not encroach upon the area of activity. As pipe-laying progresses the exclusion buoys will be moved along the route.

The pipelines will be flooded with filtered seawater following installation and pressure tested to check for any defects or leaks. Following installation of the offshore platforms, the pipelines will be tied-in to the facilities. Carrying out these operations may require the use of a number of vessels. Once connected to the platform facilities the entire system will be pressure tested using treated water left in the pipeline following installation. Following a successful test, the water will be flowed to the terminal for disposal. The project base-case for disposal of hydrotest water is via deep well injection onshore although other options are being assessed. Such options include re-use in a nearby cement manufacturing plant, offshore disposal and re-use as irrigation water.

The onshore segment of the subsea pipelines (i.e. between the shoreline and gas-condensate reception and processing terminal), will be trenched to a depth of 1 m to top-of-pipe. Pipeline installation activities in the onshore environment will occur within a corridor of approximately 30 m width for each pipeline trench. Following installation the corridor will be re-instated and, if shown through longer-term monitoring to be necessary, re-habilitated with direct planting. It will be necessary to cross several existing services (i.e. other pipelines; road; railway line) between the shoreline and the terminal and this will be achieved by directionally drilling underneath the existing services thereby avoiding disturbance to these existing infrastructure.

ES 5.3.2 Pipeline operation

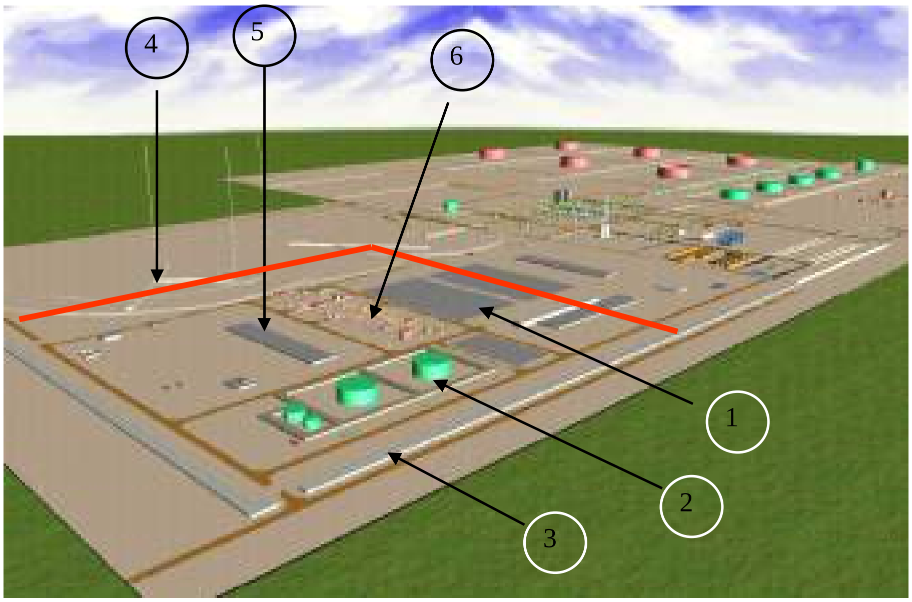
The pipelines are designed to require very little maintenance. A pipeline integrity management system will however, be developed. The strategy will consist of a number of inspection and monitoring activities as well as a programme of regular cleaning of the 12" condensate pipeline using pigs that will push wax to the onshore terminal.

ES 5.4 Onshore facilities

The Shah Deniz gas and condensate processing terminal will be constructed alongside the existing terminal at Sangachal (Figure ES.5) and will comprise of the following principal components:

- Two gas process trains to treat a total of 900 MMscfd. Facilities will include reception, conditioning, recompression, flare, fuel gas system, metering and export facilities.
- Two condensate stabilisation trains each sized to provide a nominal capacity of 31,000 bpd. Facilities will include; reception, stabilisation, tank storage, metering and export by pipeline as a product co-mingled with ACG crude oil export.
- Terminal utilities.

Figure ES.5 Proposed layout of terminal facilities

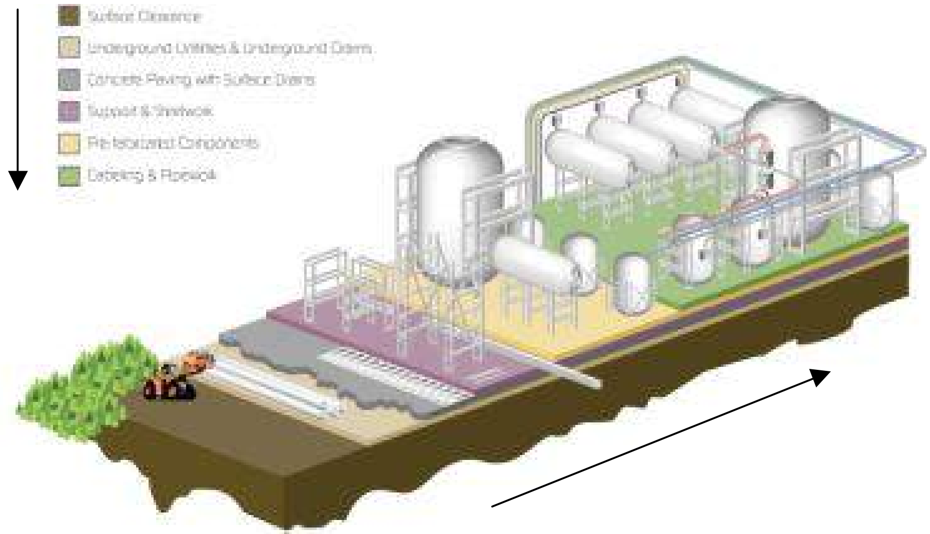


1. Utilities. **3.** Security dyke. **5.** Slug / surge catcher.
2. Condensate storage tank. **4.** Flare system. **6.** Gas processing facilities.

ES 5.4.1 Construction

The sequence of terminal construction activities are illustrated in Figure ES.6

Figure ES.6 Sequence of terminal construction activities



The Shah Deniz Stage 1 terminal and ACG phased terminal expansion requires the use of additional land to that originally acquired for the EOP and ACG facilities. The total land acquisition for all terminal facilities will amount to 730 ha including the 256 ha previously acquired by AIOC of which 40.5 ha is presently occupied by the existing terminal. Within the land acquisition area, a total 428 ha will be required for the new facilities with the remaining 302 ha being designated a "no development zone" around the terminal facilities. The outer limits of the no development zone will be pegged rather than fenced in order to allow access to herders and grazing animals and to maintain a general right of way. Table ES.2 presents the areas that will be occupied by each planned component of the terminal facilities.

Table ES.2 Proposed terminal facilities land-take area breakdown

Terminal Areas	Areas (ha)
Existing EOP	40.5
ACG Phase 1 terminal facilities	41.8
Shah Deniz terminal area	33.3
ACG/Shah Deniz flare area	34.7
BTC pumping station	2.5
Drainage channel	22.5
New access road	2.5
Workers camp area	13.0
ACG Phase 2 facilities	24.1
ACG Phase 3 facilities	24.7

An early civil engineering works programme (which was the subject of a separate ESIA[1]) began in January 2002 and will prepare the terminal area for both the Shah Deniz Stage 1 and ACG Phase 1 terminal facilities and will include:

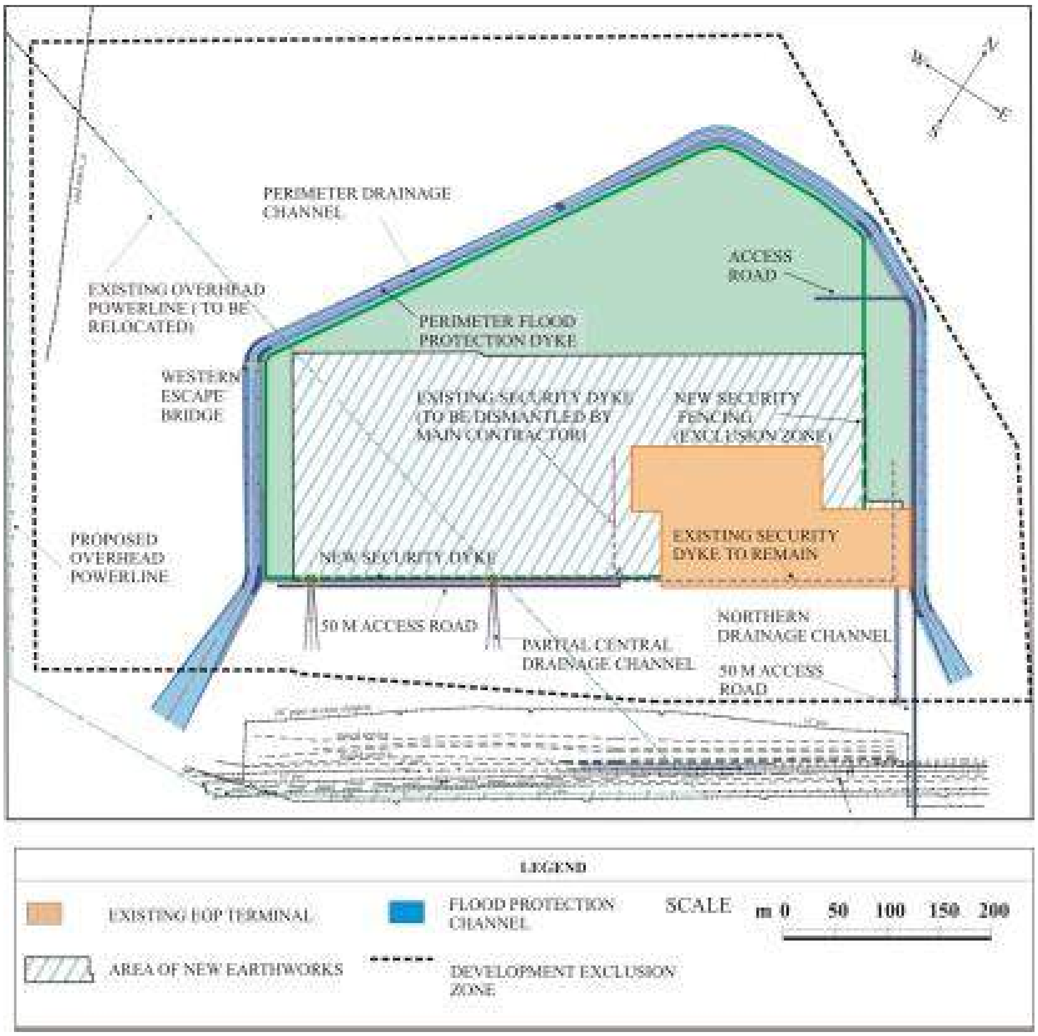
- the clearing, grading and levelling of land in the area on which the terminal facilities will be built;
- the excavation of a flood protection drainage channel and construction of a bund wall on three sides of the proposed terminal site;
- the construction of a security dyke along the south-eastern boundary of the terminal site;

[1] Sangachal Terminal, Early Civil Engineering Work Programme ESIA, BP/AIOC, 2001.

- the construction of a security perimeter fence (inside the bund wall) and lighting;
- the construction of a new access road for the terminal site and railway crossing along with two additional roads within the terminal site; and
- relocation and potential modification of utilities services.

Figure ES.7 illustrates the location and extent of the above features within the terminal land acquisition area.

Figure ES.7 Early civil engineering work programme activities



Following completion of the early civil engineering at the site, construction work on the ACG Phase 1 terminal proper will commence immediately. Shah Deniz terminal facility development is anticipated to commence in early 2003. When construction work commences for Shah Deniz terminal, activities will continue until the completion of commissioning (with gas) in mid 2005.

Terminal foundations and underground services will be constructed prior to pre-fabricated components arriving on site. Once on site, these components will be positioned and secured in their appropriate locations. While process modules will be commissioned prior to transportation to the terminal site, at various stages during the construction programme, non-destructive testing and inspection will be used to confirm the integrity of the equipment.

Pressure vessels, storage tanks and piping runs will be tested with treated water under pressure and the water will be contained for appropriate disposal.

It is anticipated that approximately 1,000 personnel will be needed at the peak of the terminal construction programme when both the ACG Phase 1 and Shah Deniz terminal facilities are being constructed. Construction personnel will include expatriate and local workers. A minimum of 75% of the workforce will be sourced locally from the area around Sangachal or from elsewhere in Azerbaijan during the early stages of construction but may fall to approximately 65% towards the end of the construction programme. The sourcing of the workforce is a reflection of the work being undertaken, the skills required and the available personnel. A large proportion of the workforce, including all expatriate workers, will be accommodated in a construction camp sized for up to 500 workers and located outside the existing security wall of the terminal. Prior to the completion of the camp, the majority of workers will travel to the site from Sangachal, Umid, Sahil and existing camps.

ES 5.4.2 Terminal operations

The gas stream must be dehydrated and conditioned to meet the pipeline export transportation and sales gas specifications. The sales gas hydrocarbon dew point will be achieved by means of gas expansion and recompression. An export compressor will achieve the compression of the gas to the required export pipeline pressure. The export gas will be metered to custody transfer standard before entering the export pipeline. Control of the gas production rate shall be achieved by means of the turbo expander inlet valves. Choke valves on the offshore wells can be adjusted for coarse control of the gas flow to the onshore terminal.

The Shah Deniz condensate has a high wax content and as a result, the condensate pipeline will be pigged frequently to control wax build-up. The pig receiver will be heated so that the wax arriving ahead of the pig will be received in liquid form. The wax components will be processed along with the rest of the condensate stream.

Condensate stabilisation will be achieved in a stabiliser column. All flash gas generated in the stabilisation process will be recovered and compressed using a single compressor. The flash gas shall be routed to the gas processing plant. The condensate should be stored above the wax appearance temperature of 40°C and it may be necessary to heat the tanks to maintain this temperature during periods of low production or during shutdowns.

The main condensate storage tank capacity shall be nominally 165,000 bbls corresponding to three days production. This will ensure that gas production is unaffected by short term outages of the condensate export system. An off-specification condensate storage tank and return pump will be provided for use during start up and shut down of the plant. Any vapour generated in the off-specification tank will be recovered and burnt in the fired heaters.

A flare gas recovery system will be installed to recover the relatively small quantities of gas from depressurisation of equipment, for maintenance, blanket gas, leaking relief and control valves. There will therefore, be no routine flaring of gas at the terminal under normal operating conditions. There will however, be occasions when the flare will have to be used to burn excess gas, for example during a plant shut down. All hydrocarbon vapours generated during plant upsets and emergency blowdown shall be routed to the flare system for safe disposal by combustion. The flare tip will be provided with automatic ignition and will burn any gases in excess of the flare recovery system capacity.

Power generation will be by Rolls Royce RB211 low-NO_X gas turbine. The generators will be gas fuelled.

A temporary wastewater treatment system has been installed at the terminal site for the treatment of sewage waters generated during the terminal Early Civils construction programme. Effluent from this system is transferred by truck to the nearby Sahil Sewerage Treatment Plant for appropriate disposal. A biomass reactor treatment system will be installed for subsequent terminal construction and operation programmes. Effluent from this system will be used for irrigation of ornamental plantings in and possible near to the construction camp and in the terminal office site. The treated water may also be used for dust suppression during the construction programme.

Uncontaminated storm water from internal roads and non-process areas of the site will drain to open ditches located within the terminal bund wall perimeter and on either side of the Shah Deniz terminal site. Water from these drainage lines will be discharged via culverts to outside the terminal bund wall on the southeast side of the facility.

An open drains system will be provided to collect and treat contaminated surface run-off from drip trays and paved areas around equipment containing hydrocarbon liquids. All equipment that contains some inventory of hydrocarbon will be located in kerbed areas that drain to the collection sump.

The open drain system is designed to ensure that there is no planned normal overflow to the Caspian. The system collects the maximum predicted precipitation over a certain time period, plus an allowance for fire monitor/hose reel usage. Any free oil or contaminants present in the drainage water will be removed before the water is pumped to the produced water disposal system.

In the very rare event of a major plant emergency, requiring the usage of very large volumes of firewater, there is the potential for an overflow of water to flow to the Caspian. This however, is an unlikely event and not under normal operating conditions. In such an event, the water overflow is taken from the bottom of the collection sump. As this occurs only after a period of time, the majority of any oil contamination will have floated to the surface where it is collected thereby removing the contamination from the overflow discharge.

A closed drains system, draining to a collection drum will be provided to collect hydrocarbon liquids when draining equipment and piping for maintenance. The drum will be vented to the flare gas recovery system and the collected liquids shall be pumped back to the process for recovery.

ES 6 Existing natural environment

ES 6.1 Overview

The offshore project setting is in the Caspian Sea, an enclosed body of water occupying 386,400 km^2 and with a shoreline of 5,360 km. The Caspian is approximately 1,200 km long and averages about 310 km in width. Caspian sea levels have fluctuated significantly over time and it is currently about 27 to 28 m below the world ocean level. The sea level dropped by 2.9 m in the period between 1929 and 1977 and rose by 2.4 m between 1977 and 1997. The recent sea level rises have resulted in the flooding of coastal land and damage to settlements, industrial enterprises and irrigated land.

The geological history of the Caspian has resulted in a unique assemblage of fauna. About 75% of the species of the Caspian are endemic, 6% are from the Mediterranean and 3% are from the Arctic. The remaining 16% are freshwater immigrants that have adapted themselves to the salinity of the Caspian. These freshwater immigrants tend to inhabit the less saline northern Caspian waters.

The Caspian exhibits a multitude of environmental stresses. Most are the result of the many years of pollution from a vast array of land-based sources that reach the Caspian via the 130 rivers that drain its watershed. The largest of these is the Volga. This river receives domestic waste from over half the population of Russia, along with a significant percentage of the country's heavy industry. It is estimated that the Volga contributes 80% of the pollution load entering the Caspian.

Oil extraction and refining complexes in Baku and Sumgait are also major sources of land-based contamination that impact the Caspian as are many of the older generation offshore oil production facilities. Overall it is estimated that a million cubic meters of untreated industrial wastewater is discharged into the Caspian annually. This discharge, along with variety of chronic sources of industrial pollution, has resulted in almost 30% of the Azerbaijan coast being exposed to some form of land-based contamination.

The combined effect of these and other factors is illustrated by the collapse of the Caspian fishing industry. The effects have been particularly noticeable for the sturgeon fishery, where the Azerbaijan quota has been reduced in recent years.

ES 6.2 Offshore environment

Prominent features of the Shah Deniz Contract Area are the nine mud volcano vents in the centre and an area of slope instability to the east. In general the volcanoes can be considered to lie in a southeastly orientation along the centre of the Contract Area. Accumulations of mud volcano output material at the seabed and also at depth in the sediment sequence, suggest the presence of mud volcano activity at the site over relatively long geological timescales.

There is a strong water depth gradient in the Contract Area range with water depths ranging from less than 40 m in the northeast to over 700 m in the southeast. Water depth at the Stage 1 location is 105 m. The surface waters are highly oxygenated in the winter months, reaching saturation levels in the spring due to increased water mixing during the winter and phytoplankton activity in the spring. During summer months, as the surface water temperature increases, the water column becomes stratified.

The surface sediments in the Shah Deniz Contract Area are predominantly composed of fine clays and silts with occasional deposits of shell debris. In the shallowest waters, the marine biology of the sediments are characterised by low diversity of amphipod and gastropod species coupled with a relatively high abundance of polychaetes and the bivalve Abra. In the vicinity of the Stage 1 offshore location and in deeper waters a much greater diversity of amphipods and gastropods is present.

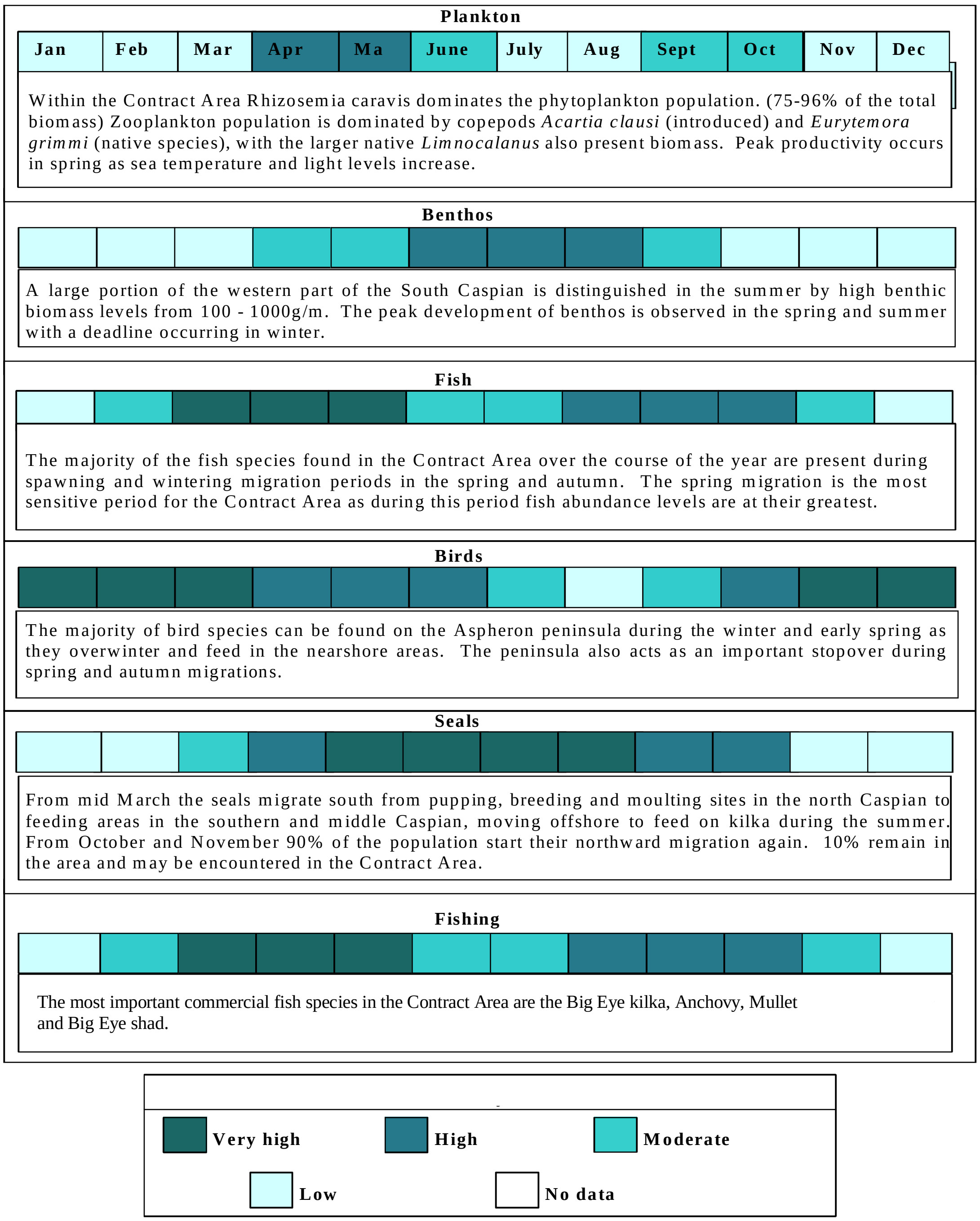
A number of resident and non-resident fish species inhabit the Shah Deniz Contract Area several of which are of commercial importance. The most important commercial species include the big eye kilka (*Clupeonella grimmi*), anchovy kilka (*Clupeonella engrauliformis*), big eye shad (*Alosa saposhnikovi*) mullets (*Liza auratus* and *L. salines*) and sturgeon (*Acipenseridae*). The distribution and abundance of these species varies with depth and season.

A summary of the environmental sensitivities in and adjacent to the Shah Deniz Contract Area is provided in Figure ES.8. The key environmental sensitivities are associated with:

- the presence of numerous fish species including species that pass through the Contract Area during migration periods;
- spawning periods of anchovy and big eyed Kilka;

- migrating birds that use the Apsheron Peninsula as an important stop-over point;
- the presence of seals during the summer and spring and autumn migration periods; and
- spring time benthos and plankton recruitment and increased biological activity and productivity.

Figure ES.8 Summary of offshore environmental sensitivities



ES 6.3 Nearshore and coastal environment

There are several ecological features and seasonal activity within Sangachal Bay. These include:

- seagrass mats and patchy areas of algae;
- fish spawning and nursery grounds for juvenile fish; and
- spring time increases in benthic and plankton productivity and recruitment.

Seasonal fluctuations in the environmental sensitivity occur and are illustrated in Figure ES.9. As water temperatures and light intensity increase fish, plankton, seagrass, algae and benthic communities increase productivity. The majority of the annual recruitment occurs during this period.

Figure ES.9 Seasonal changes in sensitivity

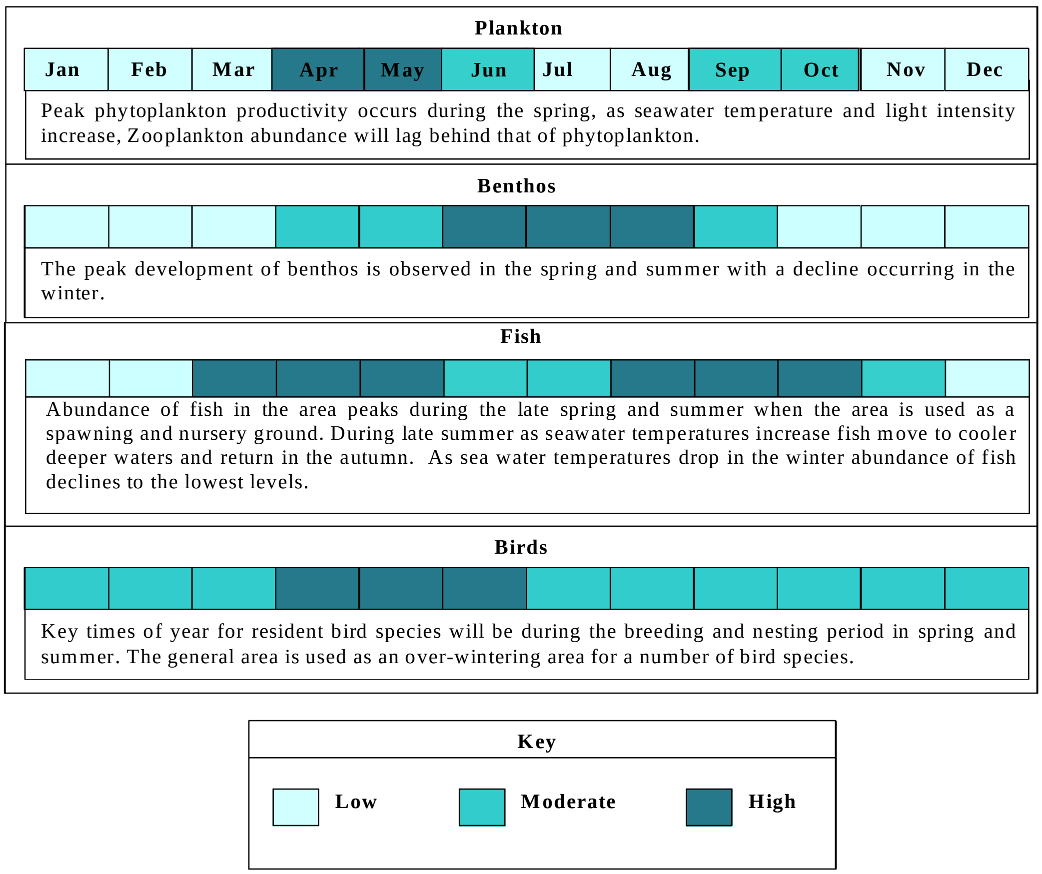
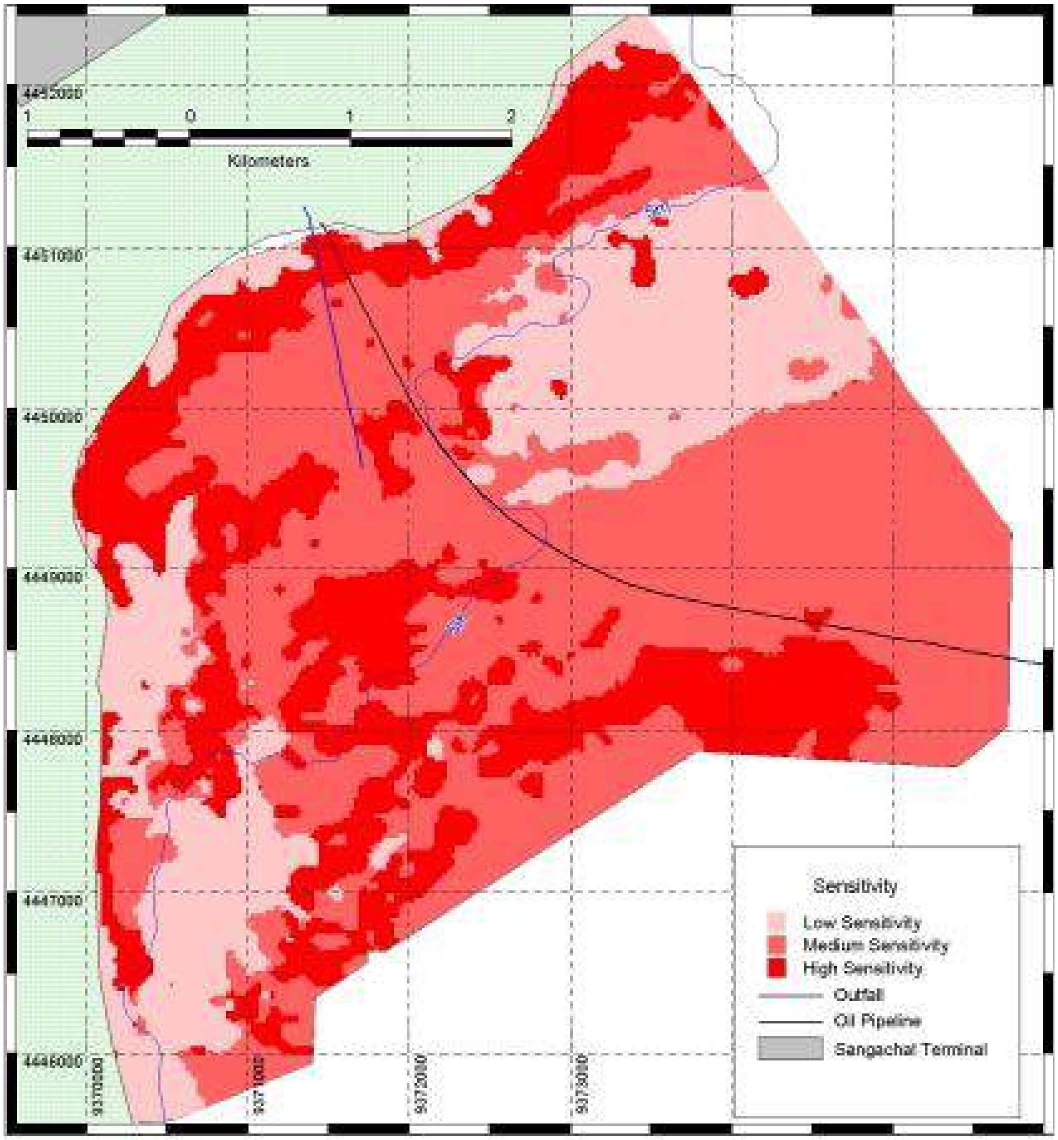


Figure ES.10 illustrates the spatial variation in the seabed sensitivity in Sangachal Bay. This has been developed using information on the distribution of seagrass and algae as well as sediment types and their mobility. Areas that support seagrass and red algae are considered the most sensitive as well as fine-grained sediments that are highly mobile. Disturbance of highly mobile sediments will lead to increased water turbidity.

Areas that supported sparse communities of seagrass and red algae or are sandy sediments that could support seagrass mats were classified as medium. Areas where seagrass or red algae were not observed during the survey and areas composed of silty sand were assigned the lowest sensitivity.

Figure ES.10 Seabed sensitivity in Sangachal Bay



ES 6.4 Onshore environment

ES 6.4.1 Flora (habitat)

The habitats within a 5 km radius of the existing EOP terminal can be divided into two main types as follows:

- semi-desert with desert elements comprising, most of the inland areas, with scattered marshy areas; and
- a coastal community succession of sandy beaches leading to ephemeral, shallow lagoons (usually waterlogged from September/October to March) with a few marshy slacks comprised of riparian vegetation.

The main components of the semi-desert flora are the low perennial bushes wormwood and saltwort species and ephemeral species. The perennial bushes can be observed year-round.

Ephemeral species flower early in spring and within one to two months set seed then wither until the autumn rains stimulate new growth.

Tamarisk thickets are scattered throughout the semi-desert in topographically lower areas, especially alongside and on the banks of the various ephemeral streams, near depressions (often manmade) and where water pipes are leaking.

Seeds of the Sharp-edged Darling Iris (*Iris acutiloba*) listed in the 1989 Red Book of Azerbaijan and in the 1997 International Union for the Conservation of Nature (IUCN) Red List of Threatened Plants were found in the area of proposed terminal development.

The coastal area's sandy beaches are predominated by the pioneer shrub species. The beaches transition to a littoral ecotone. This zone leads to primarily ephemeral reed-beds.

Slightly inland from the coastline is an area with mixed semi-desert and coastal vegetation. In this area two rare and endemic species, Baku Calligonum (*Calligonum bakuense)* and Baku Astragalus (*Astragalus bacuensis)*, were found. These species are listed in the 1989 Red Book of Azerbaijan and in the 1997 International Union for the Conservation of Nature (IUCN) Red List of Threatened Plants.

ES 6.4.2 Fauna

The coastal and semi-desert habitats were found to host a reasonably high level of faunal species diversity. The area southwest of the land acquisition zone showed the greatest concentration of species.

The Spur-thighed tortoise (*Testudo graeca iberia*) a species listed in the 1989 Red Data Book of the Azerbaijan Republic and in 1994 IUCN Red List of Threatened Animals as "vulnerable", has been previously observed throughout the terminal area and it was encountered during surveys for this ESIA carried out in May/June 2001 in the coastal area close to the interface with the inland areas.

Two red-listed bird species were also observed during the 2001 survey namely, the Black-bellied Sandgrouse (*Pterocles orientalis*) (1989 Red Book of Azerbaijan) and the Lesser Kestrel (*Falco naumanni*) (1997 IUCN Red List of Threatened Animals).

The peak sensitive times for fauna species are during mating seasons and while the animals are pregnant. For mammals, these periods vary widely depending upon the species. For amphibians and reptiles, breeding and incubation occurs during April through to August. Birds breed in the region between March to August with the spring and fall migrations occurring March to April, and August to October, respectively. Over-wintering birds inhabit the coastline in great numbers from October to March.

ES 7 Existing Socio-economic environment

ES 7.1 National baseline

The Caspian has traditionally been a region of strategic importance providing a direct link between Europe and Asia and a border between two world religions. Azerbaijan is surrounded by newly independent states and more established countries such as Turkey and Iran. The advent of independence and the economic and social transformation process has been marked by armed conflict, social unrest and ethnic tension.

In 1999 Azerbaijan had a population of 7.9 million people with 52% residing in urban areas and 48% in rural areas. Azerbaijan has a diverse ethnic structure with Russians, Armenians and Lezghins make up approximately 20% of the total population. Over 10% of the Azerbaijani population has become internally displaced as a result of the continuing occupation of part of its territory by Armenia. Islam is the major religion with the majority of the population defined as Muslim. In Azerbaijan women and men possess equal rights and liberties under the constitution although economic and educational gender parity has not been reached.

The income level of most Azerbaijani households remains low. In 2000, the average monthly salary in Azerbaijan was AZM205,112 (US$44). Several indicators suggest however, that real household income has increased in recent years.

The unemployment rate is difficult to track in Azerbaijan. Changes in the public sector profile can however, be tracked and show public sector employment falling steadily in the past decade. This decline has been somewhat offset by increases in the private sector. Unofficial labour markets are also prevalent throughout the country, primarily in the larger settlements.

Until recently the Azerbaijani economy was in the grip of a substantial decline that began in 1989. Whilst GDP has continued to grow since 1996, such growth has been erratic with a recent slowdown. In 2000 however, there was a record increase in growth of 11.3%. Recent monetary and fiscal policies appear to be stabilising the economy and creating a platform for recovery.

Agriculture is the most important sector in terms of employment with around 30% of the workforce directly engaged in agricultural production. Resource based industries have developed a greater importance to the overall economy as compared with manufacturing, due primarily to the development of the oil sector and specifically offshore oil production. The oil and gas sector currently accounts for around 25% of GDP and almost 80% of merchandise exports. As new oil and gas fields and pipeline routes come on stream, export of oil and gas will dwarf the export of other goods and services. Light industry remains underdeveloped due to the former reliance on Soviet markets and a general difficulty in competing with imported goods. The accumulation of foreign assets through the Azerbaijan State Oil Fund and the development of the non-oil economy will however, be vital for providing Azerbaijan with some protection against adverse oil shocks.

Shipping activities in Azerbaijani waters include commercial trade, passenger and vehicular ferry transport, military, scientific and research operations and services and supply operations to the offshore oil and gas industry. Azerbaijan has eight commercial ports centred around the Apsheron Peninsula and the capital, Baku.

Fishing in the Caspian has represented a relatively major contribution to GDP at approximately 1%. The fishing industry employs nearly 4,000 people or 7.3% of the workforce in the food industry. The Caspian is an important fishing area with commercial catches of sturgeon, sprat, carp, darters, gobs, herring, salmon and mullet. Fish stocks have however, fallen substantially since the advent of independence among the littoral states. The industry today is in serious decline not only as a result of falling stocks but also disrupted export routes and markets and inadequate supplies of materials for processing and packaging.

Azerbaijan's access to external markets has continually been disrupted by regional political turmoil. The key route for the transport of goods, including oil and gas, to Western markets is through Georgia to the Black Sea though exports also proceed through Russia and Iran. The geographical location of Azerbaijan creates dependence on its neighbours, especially Russia, for the transport of imports and exports with 90% of road freight and 95% of rail freight passing through Russia. Baku itself is a major transport hub for the entire Caspian region.

In 1999 foreign investment in Azerbaijan decreased by 26%. In aggregate, foreign investment flows have been small (outside the oil sector). Notably, there has been little impact on the entire industry base of Azerbaijan including the agricultural/agri-business that is the heart of the Azerbaijani economy.

The privatisation process and the private sector remain small in relation to state concerns. There is a steady growth of joint venture enterprises involving foreign companies within Azerbaijan. Tax system reforms began in 1995. Taxation remains however, challenging and unpredictable.

Privatisation in the agricultural sector began in 1996 and has progressed rapidly. The privatisation of livestock is nearing completion.

Most of Azerbaijan's infrastructure is in a degraded condition and is in need of upgrade. Clean water is a scarce resource and the problem is compounded by inefficient water use.

Access to effective health services is weak as a result of the deterioration of medical buildings and shortages of up-to-date medical equipment. This has been compounded by the near collapse of emergency services and primary care in most rural areas. Within Baku, a number of modern health facilities have recently become operational however the majority of the population is unable to afford or access these services.

Health indicators for 1997 show male life expectancy as 66.5 years while female life expectancy as 74 years. The birth rate in the same year was 17.4 per thousand and deaths at 6.2 per thousand. The leading causes of mortality in Azerbaijan include cardiovascular disease, cancer, respiratory infections and accidents. The incidence of communicable diseases is on the increase.

Azerbaijan's educational progress is hampered by funding problems and structural weaknesses within the education system. There is also a need for improvement in terms of access to and the quality of, systems and learning.

According to the World Bank, around 20% of families in Azerbaijan can be classified as severely vulnerable. The actual overall income per capita considerably exceeds the official salary level, indicating that unofficial financial turnover has become the main source of income for a large percentage of the population. The major causes of increasing poverty could be perceived as the general economic decline and the fragmentation of the social welfare system. This poverty is intensified by the reduction of access to social services. Social inequality is also a rising problem and is compounded by a tendency towards migration from Azerbaijan, with the consequence that the proportion of young people in the population is decreasing whilst the proportion of elderly citizens is increasing.

This situation is made more complex by the ongoing economic crises, the unresolved conflict with Armenia and the problem of accommodating over half a million people displaced from territories now occupied by Armenia. There are currently about one million Azerbaijani refugees and Internally Displaced People (IDP) within Azerbaijan, accounting for one-seventh of the country's total population.

There are approximately 950 NGOs officially registered in Azerbaijan, although only between 90 and 110 of these are active. The 1995 constitution and 1992 press law ostensibly guarantees free media. The print media in Azerbaijan are however, subject to various restrictions. Recent reports have suggested a lifting of restrictions.[1] The two state-owned television stations dominate the electronic media, although in addition to these there are a number of private and two Russian TV channels. Azerbaijan's telephone system is a combination of old Soviet era technology and modern cellular telephones. Satellite service between Baku and Turkey provides access to 200 countries.

Azerbaijan is a country of ancient history and culture. In ancient times, several states existed on the territory of present day Azerbaijan. In the mountains of Gobustan there is a concentration of rock carvings, settlements and tombstones recording the history of the Azerbaijani people from the Stone Age onwards. The Azerbaijani language is a member of the south Turkic group of languages. Following independence the Government began to phase out the use of Russian, which was widely spoken during Soviet times and is still often spoken in urban areas and understood throughout most of Azerbaijan.

ES 7.2 Regional baseline

The terminal site at Sangachal is located in the Garadag District (Figure ES.11), part of the Baku Administrative Region extending from just south of Baku to Gobustan.

Population figures indicate that almost 94,300 people are resident in the District. The majority of the population in the District is Muslim with only a small minority, (approximately 7.4%) being Christian.

Figure ES.11 Garadag Region

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1 Baku Sun, 2002.

The average monthly income in Garadag District for 2001 is estimated to be US$75. This figure masks the findings of recent survey work in the area local to the Stage 1 and ACG Phase 1 projects, which indicate approximately 35% of those surveyed in Sangachal, Sahil and Umid receive no income at all.

The oil and gas industries support large numbers of workers while activities in the agricultural sector appear to be largely confined to grazing during the winter season. Fishing is limited and is concentrated around Elet, Sangachal and Lokbatan and appears to be undertaken for recreational and subsistence purposes.

The Baku-Alyaty highway routed along the Sangachal Bay coastline passes to the south of the terminal location and is a main highway. A number of utility lines and pipelines are also routed along the coast parallel to the highway and railway line. These utility lines provide electricity, communications, oil, gas and water.

Health services in the area are provided through medical ambulance stations in the main settlements and also two hospitals. Health issues that have arisen include a typhus epidemic in 1989 and respiratory problems.

Figures indicate problems of overcrowding in schools and colleges. A rough estimate is that 5.7% of school age children graduate from secondary school. Of these, 36.5% are continuing their education in colleges and other higher schools.

The Internally Displaced Persons (IDP) and refugees in Garadag District are primarily located in Lokbatan, Sahil, Gizildash and Sangachal settlements. Just over 20% of IDP in the District are from Armenia while the remaining 80% are IDP from occupied territories of Fizuli, Agdam, Zengilan, Gubadli, Kelbejer, Jebrayil, Lachin districts and Shusa, Khojavend, Khojali city and villages of the Nagarno Karabakh region.

ES 7.3 Local baseline

The area local to the project includes Sangachal town, Umid IDP/cement camp, herding settlements, railway barrier operations, a 15th century restaurant, a road-side café/garage, fishing related communities and stone mine operations.

Sangachal town has approximately 4,000 residents, 13% of whom are IDP. The majority of the residents are Muslim. The average monthly income for the Garadag region as a whole in 2001 is US$75 (AZM346,500). Meanwhile a survey of Sangachal residents indicates that 35.6% of respondents have no income at all and of the remaining population some 50% earn between AZM100,000 and AZM500,000. The majority of Sangachal residents view their standard of welfare as poor (51.9% of respondents).[2]

Officially between 250 and 300 people are employed in Sangachal, although this excludes those involved in agriculture, which is thought to comprise a further 5-10%. The majority of people in employment work in a number of State-run enterprises in the town. Unemployment is a key problem in Sangachal with official figures showing between 30-50% of people unemployed.

Sangachal Bay is under the jurisdiction of the Azerbalyk State Fisheries Concern (ASFC). The ASFC allow fishing with rods for subsistence and recreational purposes. The fishing

[2] This information has been drawn from the Azeri Holland Friendship Society survey of Sangachal, Umid and Primorsk. There are methodological difficulties with the interpretation of the survey data and at present these figures are indicative only.

season varies depending on species although it is largely in the spring (February-April) and autumn (August-October).

The majority of the population is housed in state owned apartments with satisfactory supplies of electricity and gas. Cold water is piped into the town. Bottled water is not used for drinking, washing or cooking. The sewage system is basic. There are five garbage disposal sites in the town and they are emptied once or twice a week. There are very few roads in and around Sangachal and most of these are covered in gravel.

It appears there are no major health problems in Sangachal town. A recent survey indicated that over 50% of the Sangachal population assessed their health as poor. An immunisation campaign is being undertaken within the town. There is no hospital or pharmacy in Sangachal however an ambulance station provides basic first aid.

Sangachal has only one school. Last year approximately 10 children went onto university education. Sangachal school faces a number of key problems including necessary and ongoing building maintenance and lack of computer equipment for pupils.

Almost 13% of Sangachal residents are classified as IDP. IDP in Sangachal do not live in permanent accommodation but are housed in either public buildings or abandoned homes. Whilst IDP receive free medical services and also education, they do have to pay for medication. The receipt of foreign aid for IDP at Sangachal and Umid is limited and infrequent and no figures were available on the amounts, frequency or purpose.

Access to telephones is limited to 30% of the households, however the majority of people have access to televisions. There is very limited circulation of newspapers, although radio is accessible to all.

Officials within the government, at the national and regional level, undertake decisions affecting the community, such as those connected with investment and events. In addition to this formal process, Sangachal has a group of elders who bring forward issues and concerns from the residents to the local executive power.

Umid Camp is a settlement with one area housing IDP and another housing workers from the Garadag Cement Plant at Sahil. In total there are more than 1,000 people living in Umid Camp in 130 households. It is estimated that 48.3% of the population is male and 51.7% female. It is estimated that 72% of the households within Umid Camp as a whole are IDP households. The Camp houses a school, medical office, bakery and post office. Households are supplied with gas, electricity and cold running water. The sewage system is a simple open drainage ditch around the camp. The roads in and around the camp are gravel based.

Information indicates that there are low levels of employment, an apparent unreliability of foreign aid, a low level of national aid and injuries to male members of some of the households. All of the employment sources within the camp are state run enterprises. A few residents are involved in fishing, however this is for subsistence purposes to supplement diet. Many of the IDP families have been affected by the war and this specifically affects employment opportunities where the men have been injured. As a result it is often the women within the household who work and not the men, as would normally be the case.

Medical services within the camp are limited and the existing medical facility is a basic first aid post. All the children from the IDP Umid Camp are immunised by doctors from Primorsk hospital. Whilst medical facilities are free, there is a limited supply of medicine. Assistance from international organisations is on a very infrequent and ad hoc basis. Umid camp has one school and is attended by approximately 120 children.

The site in and around the terminal area is winter grazing land for a number of pastoralists their families and their animals. There are two herding settlements within the vicinity of the terminal, one in the Central North area and another situated at the foot of the West Hills.[3]

The West Hills settlement is used by herders during the winter months. There are approximately 31 people living at the West Hills settlement during the winter months. The herders spend around eight months a year at the settlements from approximately mid-August to mid-May each year. The herders are paid a wage for looking after state owned sheep. In addition they earn a living from their own produce such as cheese and wool. The children of the West Hills settlement are not normally vaccinated and usually attend the Sangachal school. The Central North settlement is used by herders during both the winter and summer seasons. Those living in the Central North settlement sustain a living through grazing sheep and cattle. It is understood that they remain in Shamahar during the winter to attend school. There are no water, gas or electricity supplies to these settlements. No accurate health data has been obtained to date. Medical assistance is sought from Sangachal. It is understood that they remain in Shamahar during the winter to attend school.[4] The grazing area around Sangachal, although geographically located within the Garadag Executive Power District, is mainly controlled by the Apsheron Executive Power based in Baku.

Sangachal Bay attracts commercial fish and their fry for spawning and wintering. Azerbalyk State Fisheries Concern has fishing nets and cages positioned in the Bay, which remain there all year round, although fishing is only undertaken during the months of January-May and September-December. There are some 3 or 4 fishermen employed to work these nets and cages.

Fishing is also undertaken some 1-2 km from the coast via nets are thrown into the sea. This fish catch is reported to be low quality and, as a result, is not sold commercially but is used for subsistence purposes. Fishing vessels also catch sprats some 40-60 km further out to sea using a combination of lights and nets.

Other activities and sites within the local area include:

- a **roadside café/garage** beside the main road to Baku near to the entrance of the terminal site. It is owned and run by two Sangachal residents.
- an **open cast stone mine** (Firuza stone mine) operating approximately 10 km from Sangachal town and north of the proposed terminal site. The materials are used for construction in the local area. It is estimated that there is enough stone in the mine to remain in operation for a further 20-30 years. The mine is in operation 24 hours a day with employees working in shifts. There are around 25 people employed at the mine.
- a 15th century **historical restaurant** that was a “caravanserai” and is now a protected state monument approximately 1 km southeast of the terminal site.
- a **railway barrier/crossing** with an associated hut (attended 24 hours per day) situated on the access road into the terminal site. Four people share the job as railway barrier operator, with each working a 24 hour shift and then having three days off. The hut provides shelter with basic facilities.
- **archaeological finds** are scattered around the local area and the proposed terminal site. Survey work undertaken as part of the Shah Deniz Stage 1 ESIA identified some surface finds in the area along with the possibility of sub-surface archaeological features.

[3] Information gathering on the herding settlements is ongoing and the information presented here may change and expand as new data emerges from this process.

[4] This information has been taken from the BP Resettlement Action Plan process for the ACG & Shah Deniz Projects 2001/2.

ES 8 Environmental impact assessment

For the purposes of the environmental impact assessment process, the Shah Deniz Stage 1 project was defined as comprising 85 routine and planned non-routine activities. Each activity was assessed for its potential to interact with 23 identified environmental receptors. Where an interaction was identified, it was denoted as an environmental aspect, each aspect was then in turn assessed for its environmental impact and ranked in terms of its impact significance.

The environmental impact assessment process determined that the majority of environmental aspects identified did not result in significant impacts. This is partly a result of the characteristics of the project and partly the result of project design that has sought to mitigate identified and potentially significant impacts during the early design stages by:

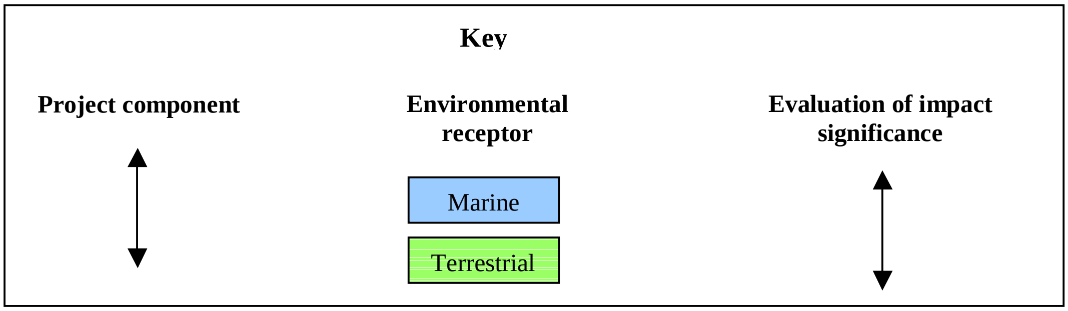
- eliminating the cause of the potential impact through design modifications;
- reducing the negative effects through design and/or operational practices; and
- development of mitigation procedures to minimise the harmful effects of residual impacts.

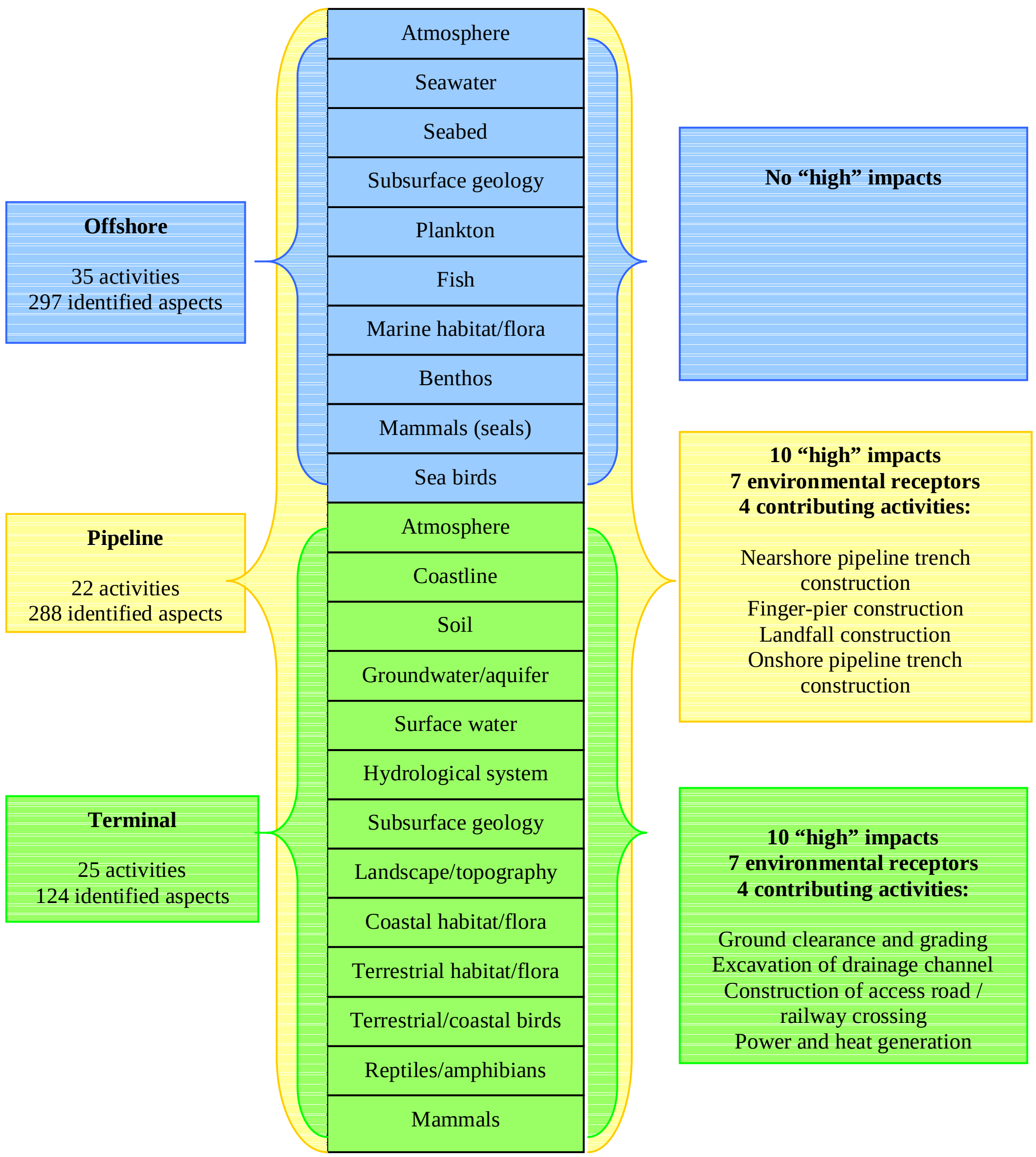
Clear examples of where project design is such that environmental impacts are minimised include:

- the decision to adopt an offshore facility which requires minimum offshore activity in installation and commissioning;
- the decision to contain and ship to shore for disposal all drilled cuttings generated from wells drilled with synthetic oil based mud;
- scheduling pipeline installation activities in the nearshore as far as is practicable to avoid environmentally sensitive times (e.g. marine organisms' breeding seasons);
- the decision for the pipeline to follow, as much as possible, the existing ACG pipeline corridor to the Sangachal terminal, will minimise disturbances to the seabed;
- the decision to locate the Stage 1 terminal alongside the existing ACG terminal and proposed Phase 1 terminals resulting in a reduced land-take requirement;
- the decision to pursue onshore injection of produced water generated at the terminal into dedicated disposal wells;
- use of gas as fuel gas for offshore and onshore facilities;
- the decision to use a turbo-expander for the gas dewpoint process onshore (the largest power consumer at the terminal) as opposed to conventional power generation;
- the decision to install flare gas recovery at the terminal to remove the requirement for routine flaring;
- the decision to fit automatic ignition on the terminal flare therefore removing the need for a pilot-light; and
- the decision to design and install a water treatment plant at the terminal location that will contain and treat sewage waters and eliminate the need to discharge sewage waters to sea.

The impact assessment found no "high" significance environmental impacts associated with the proposed Shah Deniz offshore activities, however four pipeline activities and four onshore activities were assessed to result in impacts of "high" significance. Figure ES.12 illustrates these assessment results in terms of the project's offshore, subsea pipeline and terminal components.

Figure ES.12 Environmental impact assessment results (routine and planned non-routine activities)





Although all potential impacts have been considered during this comprehensive impact assessment only the specific environmental issues and proposed additional mitigation measures associated with the activities identified as having the potential to result in "high" significance environmental impacts are discussed below.

ES 8.1 Installation of 26" and 12" pipelines in Sangachal Bay

Pipeline installation activities in Sangachal Bay, using methods typical of those used worldwide, would result in direct temporary physical disturbance of the seabed, some localised loss of rocky outcrop and the direct loss and indirect disturbance of seagrass habit. The base case pipeline route has been selected to minimise these impacts by considering seagrass and algae habitat distribution in the nearshore and identifying a route with limited impact alongside the existing ACG pipeline and future proposed ACG pipelines. In addition, the seasonal sensitivity of the bay has been considered during the development of the construction schedule with installation activities, wherever possible and practical, avoiding the times of the year with highest biological activity (i.e. spring and late summer).

The nearshore section of the pipelines from offshore will be buried for approximately 2 km from the shoreline. The decision to bury the pipeline has been made for pipeline integrity reasons and will reduce the risk of third party damage. As stated earlier a trench will be mechanically excavated in water depths of up to 2 m. For each pipeline, a trench of up to 8 m in width, approximately 100 m long would result from these excavation activities. Beyond water depths of 2 m, the pipeline will be buried into the seabed using a mechanical cutter and would be approximately 3 m wide and 1,900 m long. Trenching activities for both pipelines will therefore result in the direct loss of seabed habitat over an area of approximately 1.3 ha. Deposition of excavated material adjacent to the trench is estimated to impact an area of at least the same size and possibly up to twice as large. Trench construction activities are therefore, estimated to directly impact 2.6 ha of seabed habitat.

In order to mechanically excavate the trench in the inshore area, it is planned to construct a finger-pier from the shoreline to the 2 m depth contour to support the excavation equipment. The pier will be approximately 10 m at its base and 100 m long. The total area of seabed that will be directly impacted by the structure will therefore, be approximately 0.1 ha.

It is planned to remove the finger pier following installation and to return the area to its original status to minimise the potential to cause a change in coastline configuration in areas removed (i.e. distant) from the pier. Removal of the pier will result in further short-term disturbance and a re-suspension of sediments thereby potentially impacting again on nearby seagrass beds and benthos. The project is therefore considering alternatives to the construction of the finger pier, such as using a flotation pontoon or floating barge, although preliminary indications are that there are potential difficulties associated with the possible alternatives, in particular, the availability of suitable and appropriate equipment in the region.

Apart from the direct impacts on the seabed including rocky outcrops in the pipeline right of way, the most important environmental receptor that will be affected in the Bay would be the seagrass beds. Seagrass habitat is important in terms of the ecological role it plays as a spawning and nursery area for a range of marine organisms including commercially important fish species. The root structure of seagrass beds also plays an important role in the stabilisation of seabed sediments. In total, approximately 450 ha of sensitive seagrass habitat are present in Sangachal Bay and it is estimated that between 20% and 25% of the pipeline corridor in the Bay consists of these seagrass beds. The total area of seagrass habitat that would be directly impacted as a result of pipeline installation activities is, therefore as a percent of total sensitive habitat in the Bay, very small (i.e. <1%).

The excavation activities however, would also result in increased turbidity of the water column from mobilised sediments. Depending on the strength of currents at the time of trench construction, sediments could be mobilised, transported and deposited considerable distances away from the immediate trench construction area and impacting additional benthic habitat and organisms. The dynamic sediment in the Bay suggests the presence of currents strong enough to mobilise the Bay's benthic sediments and as such marine flora and fauna in the Bay are to some degree, accustomed to turbid waters and hence could be expected to be able to sustain short term, low to medium level disturbance. Deposition of significant amounts of sediment over a short timeframe however, may lead to the smothering of marine flora and fauna with potential mortality of the impacted species. Consideration is being given to the use of silt screens around the pipe-lay activities that will trap and limit the lateral movement of mobilised sediments.

Impacts resulting from pipeline installation in the nearshore are considered to be of "high" significance in light of the ecological value of and long restoration times (i.e. years) for seagrass habitat.

The pipeline contractor will develop a management plan prior to any pipeline installation works commencing and will maintain an active monitoring and recording programme during all construction and installation activities. One of the key objectives of the plan will be to restore the impacted habitat as close as possible to its pre-project condition including the removal of the finger-pier. A post-restoration audit will be conducted. The re-instatement will also be followed by monitoring surveys to ascertain how rapidly and effectively the habitat is becoming re-colonised.

Although the nearshore area would be expected to recover over time, recovery of the seabed and associated communities around the pipeline route would be hampered by the subsequent installation of future pipelines required for further developments including later phases of the ACG Full Field Development and potentially, also the future development of the Shah Deniz field. These activities would lead to additional and cumulative impacts on seagrass habitats and benthos within the Bay.

ES 8.2 Terminal and onshore pipeline construction

Construction of the terminal flood protection drainage channel, terminal access road, construction camp, and clearance and levelling of the ground in preparation for the terminal facilities construction will result in the loss of in excess of 170 ha of terrestrial (semi-desert) habitat. As the features will be long term, there is no opportunity for habitat restoration within this footprint. It should be noted however that this area of direct loss also includes the ground clearance and levelling work required for the ACG Phase 1 terminal facilities that is an approved development.

Installation of the three Shah Deniz pipelines in the coastal and onshore environmental would include the excavation of trenches from the shoreline landfall sites to the terminal site and as such would result in the temporary loss of approximately up to 6 ha of habitat.

In addition to impacts on flora as a result of direct habitat loss there is also the potential for these activities to directly impact fauna, resulting in their mortality.

The drainage channel to be constructed, in order to protect the terminal from flood, will result in an alteration to the local hydrological regime with the potential to also impact on wetland habitat (wadis and marshes) in the vicinity of the terminal site. Further investigations will be conducted to establish the potential impacts of the channel, including a watershed analysis, to analyse channel flow and the spatial fate of diverted water. An ecological study to predict the effects a changed hydrological environment has on nearby wetlands is also under consideration although monitoring may be sufficient.

As described earlier, the environment around the terminal site location and the onshore pipeline corridor host a number of nationally and/or internationally red-listed flora and fauna species. Listed flora species are the endemic Baku Calligonum, the Baku Astragalus, and the Sharp-edged Darling Iris. Listed fauna species found in the area include the Spur-thighed tortoise, Black-bellied Sandgrouse and the Lesser Kestrel. Hence, the impacts associated with these installation and construction activities are considered to be significant.

The onshore section for the pipelines will utilise the narrowest possible pipeline corridor in order to minimise the aerial extent of disturbance to habitat. Excavated soils will be collected and stored with the topsoil layer stored separately from the subsoil. These soils (subject to suitability) will be used to backfill the open trench following pipe-lay with the topsoil layer being re-instated to, as close as possible, pre-disturbance conditions. The potential for direct impact resulting in mortality of individual animals will be mitigated through site control and the restriction of vehicle movements in the area.

Monitoring programmes will be conducted following installation and re-instatement to determine the extent to which habitats and specific species have been disturbed and to ensure that the area disturbed is recolonised with natural flora and fauna. In the event that natural recolonisation does not occur at an effective rate, habitat restoration will be conducted including direct planting of relevant flora species.

Impacts resulting from the construction of the terminal and associated facilities are considered to be significant due to the permanent removal of a large area of habitat that hosts the red-listed flora and fauna species in the area.

An environmental management plan to be developed by the construction contractor will include procedures designed to minimise direct impacts to animals in the area during construction. This plan is already in place for early civil engineering programme at the site which began in January 2002 and includes provision for environmental awareness training to ensure that all personnel understand the key sensitivities in the area of work activity and the required vehicle movement controls. In addition, HSE representatives have been on site to monitor construction activities and to identify vulnerable fauna, such as the red-listed Spur-thighed tortoise, for rescue where and when appropriate.

A habitat compensation programme designed to compensate for habitat loss is also under evaluation. This programme would seek to mitigate, through semi-desert habitat rehabilitation/restoration, the habitats lost to the most significantly impacted flora, birds and herpetofauna from terminal construction activities.

In addition to habitat compensation, a Spur-thighed tortoise augmentation programme is under development in order to compensate for impacts associated with construction activities. This programme includes a captive breeding effort with assistance from specialists with previous experience of conducting such programmes with the objective of breeding the animals and subsequently releasing them to the wild thereby adding to currently viable populations in Azerbaijan.

ES 8.3 Greenhouse Gas Emissions

The amount of greenhouse gas (primarily carbon dioxide and methane) that would be released as a result of the Shah Deniz Stage 1 development over the life of the project are comparatively small for a development of its size and nature. Given international concerns regarding the potential for greenhouse gases to contribute to global warming, the fact that emission of such gases has been raised by project stakeholders as an issue of concern and the implications for BP in terms of its Corporate policy to reduce green house gas emissions from its global operations, impacts associated with their release are considered to be of "high" significance. The cumulative emissions of the Shah Deniz and ACG projects are also of concern given the appreciable quantities that will be released as a result of the latter development. BP is committed to monitoring the quantities of all atmospheric releases and to implementing reduction strategies where technically and financially feasible.

ES 9 Socio-economic impact assessment

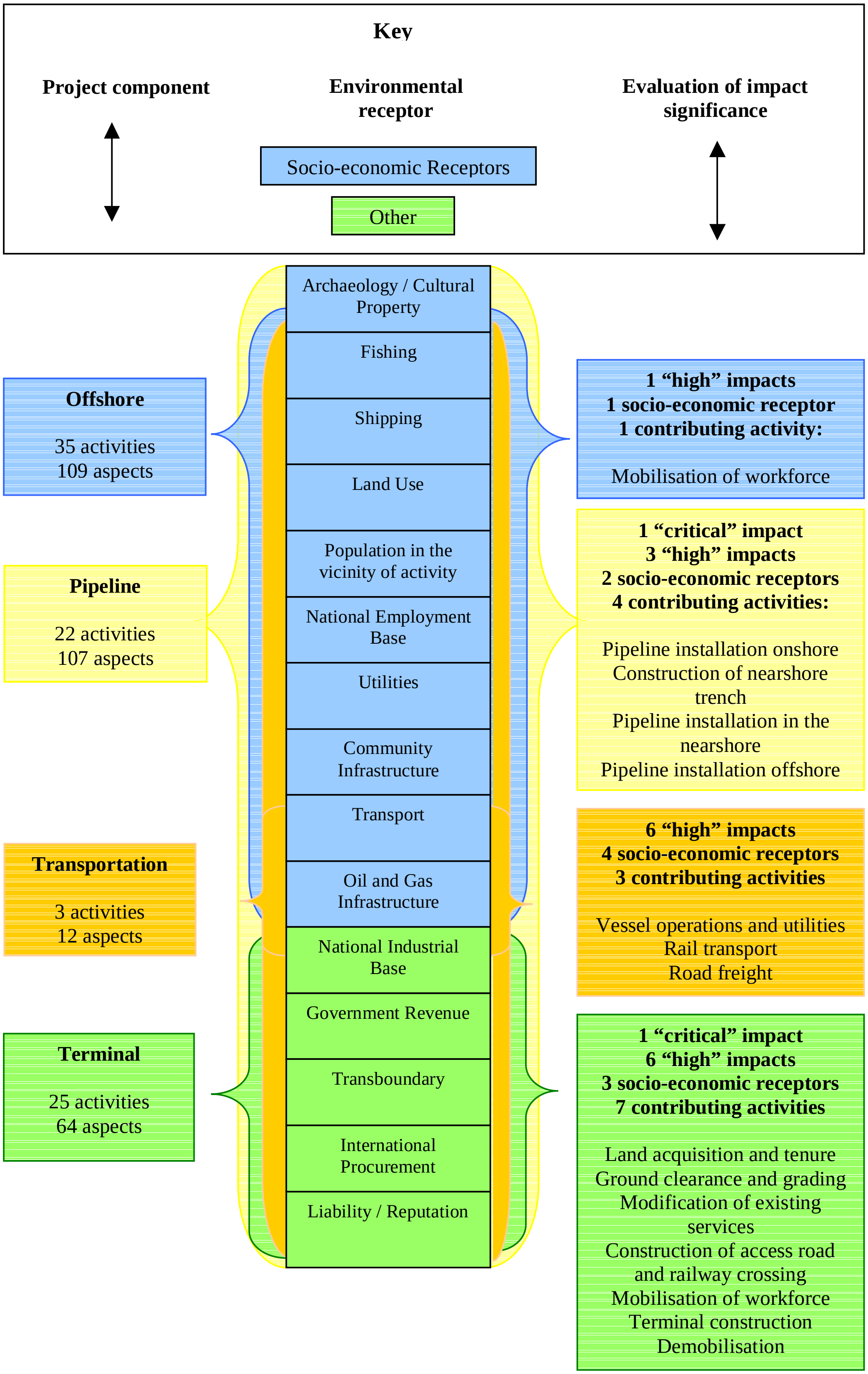
For the purposes of the socio-economic impact assessment process, the Stage 1 project was defined as comprising 82 routine and planned non-routine activities. Each of these activities was assessed for its potential to interact with 11 identified socio-economic receptors. Where an interaction was identified, it was denoted as a socio-economic aspect, each aspect was then in turn assessed for its socio-economic impact and ranked in terms of its impact significance.

The socio-economic impact assessment process determined that the majority of socio-economic aspects identified did not result in significant impacts. This is partly a result of the characteristics of the project and partly the result of project design that has sought to identify all potentially significant impacts during the early design stages by:

- eliminating the cause of the potential impact through design modifications;
- reducing the negative effects through design and/or operational practices; and
- development of mitigation procedures to minimise the harmful effects of residual impacts.

Of the 85 routine and planned non-routine project activities identified, 10 activities were assessed to have the potential to cause 19 "high" impacts. Two activities were assessed as having the potential to result in a socio-economic impact of "critical" significance. These impacts (on the local herding population and the existing café/garage business) are being addressed through a mitigation process seeking an acceptable outcome to all parties. Figure ES.13 illustrates these assessment results in terms of the project's offshore, subsea pipeline and terminal components.

Figure ES.13 Socio-economic impact assessment results (routine and planned non-routine activities)



ES 9.1 Transportation of equipment and materials to Azerbaijan for onshore and TPG500 construction and assembly

The transportation of materials and equipment into Azerbaijan for both onshore terminal construction and TPG500 construction, will have an impact on fishing and shipping activities and the road transport infrastructure.

BP has endeavoured to promote transport synergies with its other concurrent Caspian projects (e.g. ACG Phase 1) wherever schedules allow. This will enable the co-ordinated transportation of similar items to minimise the overall load on the transport routes in Azerbaijan. Some of the project options remain under evaluation and further logistics will be defined as the project develops.[5] Sea transportation routes could include from Europe to the Black Sea and into the Caspian through the Don Volga canal or from Europe to the Baltic Sea and into the Caspian through the Baltic Volga canal.

Although exact figures for current volumes of traffic are not available for all sections of all routes, it is known for instance, that vessel traffic is high in the Turkish Straits generally and especially in the Bosphorus Strait to and from the Black Sea and further shipping will add to the volume. Transportation through the Don Volga canal will require passage through the Bosphorus. At this stage of the development of transportation logistics it is estimated that six barges in total will be used to transport Shah Deniz materials through the Don Volga canal; five in May 2004 and one in June 2004. In addition, 13 riverships will be used for transportation through the Don Volga canal; two ships in each of June, July and August of 2003, five in May 2004 and two in June 2004.[6] Given the low numbers of ships to be used it is unlikely that the Shah Deniz project itself will significantly contribute to river traffic during the construction period.

All vessels will be of international maritime standard and the use of these waterways will be compliant with this transport infrastructure network. Detailed forward planning will be in place for the project and this will include notification of other users of these transport routes of the schedules to minimise any interference caused, thereby reducing any significant impact to shipping that has not been anticipated.

The majority of road and rail vehicle movements for equipment and materials transportation will take place between April 2003 and May 2004.[7] Over this period on average approximately 100 trailers a month will be utilised for road freight transportation with peaks of approximately 200 trailers a month between September and December 2003. Some loads may be considered abnormal and require police escort. For ongoing road and rail transport, contractors will be required to supply detailed transport and traffic management plans including scheduling road traffic activities at times when they will least interfere with other users. As the rail transport network within Azerbaijan is under-utilised, rail transport is not expected to be significantly impacted. The onshore construction contractor will be required to provide affected communities with education on traffic and safety issues.

ES 9.2 Terminal construction and onshore pipeline installation

The terminal construction and onshore pipeline installation activities themselves will impact significantly on the local herder population, the existing café/garage business and on transport facilities in the local area. In addition, the workforce associated with the construction

[5] BP Internal report Total Tonnage ACG-AGT-SD March 2002
[6] Information supplied by BP March 2002 in 'Total Tonnage SD-AGT-ACG'.
[7] Information supplied by BP March 2002 from internal report 'Total Tonnage ACG-AGT-SD'.

activities, and any inwardly migrating population seeking employment, may have a significant impact on the social, cultural and health issues in the local and regional community.

Construction of the terminal flood protection drainage channel, terminal access road, construction camp and clearance and levelling of the ground in preparation for the terminal facilities construction will require a land-take in addition to that already being used for the EOP terminal. The land-take for the Stage 1 and ACG Phase 1 terminal construction (including that portion of the existing AIOC property that is presently undeveloped) will result in the loss of 438.6 ha of existing grazing land used by the local herder population; that is, approximately 30% of their existing grazing land in the area. As the land-take will include both the Shah Deniz gas terminal and ACG Phase 1 terminal facilities, there will be no need for any further land-take for future phases of the developments. The initial land-take however, will result in a permanent reduction in grazing area in the vicinity of the terminal.

The nature and extent of the Qobu State Cattle Breeding Enterprise herders' grazing rights are presently being investigated. In the event that it is found that their grazing rights are adversely impacted by the project, the issue of any applicable compensation will be addressed in the first instance by the local executive authority, the district Department of Lands and the Ministry of Agriculture (which has administrative responsibility for the Qobu State Cattle Breeding Enterprise). So far as feasible, preference will be given to providing the affected herder families with rights to replacement grazing area equivalent to that lost to the project.

Commitments and procedures to be followed for project land acquisition will be documented in a Resettlement Action Plan prepared in accordance with World Bank Operational Directive 4:30 on Involuntary Resettlement.

The route for the onshore pipeline installation has been chosen and will pass under, or close by, the existing café/garage business located near the access road to the Sangachal terminal. This route will entail the removal and relocation of the existing business to an alternative site. It is proposed that the alternative site be within the Sangachal area. Immediate impact mitigation is relatively straightforward. Discussions are currently ongoing with the café/garage owners to ensure that no disruption to livelihood in the short and long term will be caused by the relocation process. Results of the discussions and details on the resettlement actions and agreements will be documented in the publicly available Resettlement Action Plan.

The workforce, and any inward migrating population seeking employment, associated with the terminal and onshore pipeline construction activities (including the Early Civil Engineering Works Programme) may impact on the local and regional community in a number of ways. The main possible significant impacts would be associated with tension created within the local community as a result of labour drawn from outside Azerbaijan, a potential increase in activity in the informal economy in the area, potential market distortion as a result of increased wages and possible associated price inflation and health impacts associated with reproductive health issues and communicable diseases.

Tension may occur within the local community if labour is seen to be unfairly drawn from outside Azerbaijan. Members of the local community may feel that employment opportunities should be for the local and Azerbaijani national population only. Tensions associated with the importation of a labour force from outside of Azerbaijan may become associated with the ethnicity. A number of measures have been included in the operational practices of the project to address this issue including a percentage target of local and Azerbaijan workforce content as a requirement of tender and worker and camp management measures, including regulated hours and on-site entertainment facilities.

An increase in money circulating within the local economy as a result of an increase in waged workers and more (and/or more prosperous) local businesses within the local community may have an impact on both the informal economy and contribute to local market distortion and pricing increases. These issues are recognised as being significant but diffuse and difficult to address properly. Direction will be sought through the BP Social Investment Strategy as to the best way to mitigate such activities, should they occur.

Communicable diseases and reproductive health issues are recognised to be of significance as a result of both the construction workforce and any inward migrating population in search of employment. The worker and camp management measures noted above, along with screening and treatment measures for labour drawn from outside Azerbaijan, will go some way towards addressing these impacts. Contractors will be encouraged to advertise any employment opportunities to help manage expectations but it remains difficult to predict if any significant inward migration will occur as individuals search for employment or to anticipate what measures could be used to control health issues among these people.

Noise levels from the combined operation of the Shah Deniz, ACG and EOP terminals were modelled for the Shah Deniz and ACG ESIA studies. Results indicate that under normal operating conditions, terminal operations will meet the World Bank Guidelines at all nearby sensitive receptors.

Design work in relation to the Shah Deniz terminal flare (which will be used for infrequent emergency shut-down events only) is ongoing. The final flare configuration will comply with the World Bank Guidelines on noise levels at sensitive receptors.

The terminal and onshore pipeline construction activity is likely to lead to an increased road traffic load on the main Baku-Alyat highway and may cause some inconvenience and nuisance to local users and possible deterioration in road infrastructure, although no roads within Sangachal, Umid or Primorsk will be utilised as part of the construction process. Contractors will be required to supply detailed transport and traffic management plans, including scheduling road traffic activities at times when they will least interfere with other users. The onshore construction contractors will also be required to restore any transport access routes, to at least their pre-construction condition, if any deterioration has occurred as a result of construction transportation activities. In addition, the onshore construction contractor will be required to provide affected communities with education on traffic and safety issues.

The public transport system is already overstretched in the local area and an increase in use (arising from project activities) may exacerbate this and impact negatively on the local population. To avoid placing extra pressure on these systems, contractors for onshore construction will use private buses to transport day workers to the site. There may however, still be an increased load placed on the system should camp workers use the system to travel to and from the site for entertainment purposes outside working hours.

ES 9.3 TPG500 construction

At present the location for the TPG500 final construction is yet to be decided. Current plans indicate that an existing fabrication yard within the capital city of Baku will be used for these activities. When a yard near Baku is chosen, it will be necessary to assess the socio-economic impacts associated with the use of the yard on the local community. This will be achieved via the completion of a separate ESIA process that will form an addendum to this ESIA document. The socio-economic impact assessment in presented this Environment Statement report does not address TPG500 construction *per se* but does address the transportation of construction materials and the pre-fabricated hull sections of the TPG500 into Azerbaijan and the impacts on offshore fishing and shipping as a result of transportation activities.

ES 9.4 Nearshore pipeline installation

The fishing currently undertaken within Sangachal Bay will be temporarily directly affected by the proposed Stage 1 developments, as there will be restrictions on access and use of the Bay during pipeline installation. In addition, there will be some disruption to the subsistence and recreational fishing undertaken in the Bay by local residents.

As a result of the restrictions on access and use of the Bay, consultation are ongoing with Azerbalyk, the state fishing concern, over the movement of fishing nets and cages to ensure that their livelihoods are not affected by the removal of the nets and the destruction of the cage. These negotiations will be documented as part of the Resettlement Action Plan that will be publicly available.

Information has been gathered to assess the extent of existing fishing activities and establish the legality of those activities. Significant, disruption to any legal commercial fishing activities will be compensated. Subsistence or recreational fishing activity and any illegal fishing activities will not be compensated. To avoid destroying existing fishing nets, the need for removal of illegal nets will be widely advertised. The significance of the contribution of illegal and subsistence/recreational fishing activities to local livelihoods is unclear and clarification may not be possible (Chapter 7). Current understanding is that subsistence/recreational fishing activity can be undertaken from comparable alternate locations in terms of accessibility and productivity. If not, as noted above, this may adversely affect local socio-economic conditions.

ES 9.5 Offshore installation, hook-up and commissioning and operations

Some 100 fishing boats operate 40-60 km from shore catching sprats and this activity is likely to be negatively impacted by offshore installation of the pipeline although only for a limited duration of time. Baku is also home to one of the key fishing markets in the area and those trying to access it may need to make a small diversion during construction.

ES 9.6 National employment and industrial base

ES 9.6.1 Construction phase

ES9.6.1.1 Direct effects

The onshore and offshore construction contractors will only source labour from the international market where the national labour force cannot supply the skills required for the programme. A target of 75% locally sourced labour for onshore construction programmes has been set for the Shah Deniz and related ACG projects. The contractors are committed to using a maximum of 15% of the man-hours from outside Azerbaijan. It is anticipated that some training of local workers will be required and as such, training and development programmes are to be implemented by Shah Deniz contractors

Approximately 1,000 people will be employed during terminal construction.[8] Employment will gradually build up from January 2002 to September 2002, when it will continue at peak levels until February/March 2004. Terminal construction is envisaged to be complete by the end of 2004/beginning of 2005.

[8] Likely date for choosing the terminal contractor for ACG Phase 1 is estimated to be November 2001. These figures are the estimated maximum number at the peak of construction. Source : BP.

Approximately 300 personnel[9] will be employed for the construction of the pipelines and 75% of these will be Azerbaijani. In addition, the construction of the TPG500 will require (on average) 300-400 personnel over a period of 12 to 15 months, peaking at around 500. A target of between 60-70% Azerbaijani has been set for the TPG500 construction workforce.

Preliminary estimates indicate that total construction costs in relation to Shah Deniz Stage 1 development will be approximately US$2 billion.[10] It has been estimated that approximately 40% of this expenditure will occur within Azerbaijan (i.e. US$0.8 billion).

ES9.6.1.2 Indirect and induced effects

The European Bank for Reconstruction and Development (EBRD) estimates that approximately 70% of expenditure (i.e. procurement and income) will leak from the Azerbaijani economy. On this basis it is considered that a combined indirect and induced multiplier of 1.43 is appropriate for the construction phase on the basis of the size of the area and the limited duration of this particular form of direct employment. For the purpose of estimating the indirect and induced employment effect during the construction phase, the multiplier coefficient applies equally to construction workers recruited locally and those brought in from outside the local area. In both cases, construction jobs represent new employment opportunities for the local economy.

Based on the above, it has been estimated that the impact of Stage 1 is detailed in Table ES.3 below.

Table ES.3 Direct and estimated total (onshore and offshore facilities) impact (US$ million)

	Azerbaijan
Direct:	800
Indirect and Induced:	344
Total:	1.144

Source: Consultants estimates.

ES 9.6.2 Operational phase

ES9.6.2.1 Direct effects

The workforce required for the onshore and offshore operations will be smaller than that required for construction being approximately 65 in total (45 offshore and 20 onshore). It is proposed that after five years, some 70% of the operational jobs would be occupied by Azerbaijani nationals. Within this it is envisaged that approximately 60% of all professional positions will be held by Azerbaijanis.

The key issue during the operational phase will be the role of local people and whether they can benefit from the employment opportunities. BP has a preference for filling the employment places with local people, whilst bearing in mind the necessary skills and experience that will be required. BP has commenced inviting individuals to register at recruitment centres in early 2002 to ensure that any suitable candidates identified can undertake the necessary training in advance of project operational requirements from 2005.

It is estimated that the costs during the operational phase of the project will be approximately US$54 million per annum and in the region of 70% of this expenditure is expected to be

[9] These figures are the estimated maximum number at the peak of construction. Source: BP.
[10] Source: BP.

incurred within Azerbaijan (i.e. US$37.8 million). Based on a 30 year operating period for Stage 1, this equates to an estimated total spend of US$1,620 million, of which approximately US$1,134 million will occur within Azerbaijan.[11]

ES9.6.2.2 Indirect and induced effects

The indirect employment effect arises from secondary business supplying goods and services to on site activities, which in turn, create further economic activity by purchasing additional supplies. The induced employment arises from the creation of additional personal income derived from the first (direct workers), and successive (indirect workers) rounds of spend. The extent of the indirect and induced employment impacts within Azerbaijan will be conditioned by the "leakage" caused by the payment of income (such as the payment of wages and salaries, profits, rents, interest and taxes) rather than the purchase of goods and services to individuals or organisations outside the locality.

Considering the indirect and induced effect for offshore construction activities, it has been estimated that the impact on the Azerbaijani economy resulting from the operation of the Stage 1 development over a 30-year period is as presented in Table ES.4.

Table ES.4 Direct and estimated total impact (US$ million)

	Azerbaijan
Direct	1,134.0
Indirect and Induced	487.6
Total	1,621.6

Source: Consultants estimates.

ES 10 Conclusions

The Shah Deniz Gas Export Project (Stage 1 development), in conjunction with the ACG Full Field Development project and other associated projects (e.g. the AGT pipeline export projects) represents a unique opportunity for Azerbaijan to develop a stable economy, to improve social equity and to reduce poverty. These projects are collectively by far the largest investments ever committed in Azerbaijan.

This Environmental and Socio-Economic Impact assessment describes the extensive engineering design and environmental evaluations conducted over a number of years in preparation for the Shah Deniz Stage 1 development. One of the prime objectives of these past studies was to identify and characterise the potential environmental and socio-economic impacts at each iteration of the conceptual and detailed engineering design process and to either eliminate the cause or contributing factors leading to the impacts through re-design, or reduce the potential effect to an acceptable or manageable level, through mitigation measures and operations management.

Although impacts from the project have been eliminated and/or reduced a result of project design, there remain some residual environmental impacts that have been assessed as being of "high" significance. These are mainly associated with pipeline installation and terminal construction activities and principally pertain to physical impacts to nearshore and onshore habitats and consequent effects on important species of plants and animals. In addition, a number of residual socio-economic impacts have been assessed as being of "high" and "critical" significance. These include potential impacts on fishing and shipping activities, the

[11] Source: BP

transport infrastructure, social and cultural interaction issues, land use and effects on the national employment and procurement base.

There is a range of other important but less significant environmental and socio-economic impacts associated with the project that will require an ongoing management commitment. In this respect, the operator and the project partners are committed to the development of an improved understanding of the socio-economic and environmental issues that characterise the project and to a programme of management and continued improvement in socio-economic and environmental performance.

Notwithstanding the predicted adverse effects, the project, together with the subsequent development proposals, has the potential to make a very significant positive contribution to the development of Azerbaijan over the coming decades. Importantly, the project could indirectly add impetus to energy sector reform within Azerbaijan and could stimulate the creation of new industries that could form the foundation of a more robust Azerbaijani economy. The project should also improve the population's access to energy (gas and electricity) and result in the wider use of cleaner fuels leading to better ambient and indoor air quality and reduced pressure on traditional sources of fuel and hence forest products and therefore, biodiversity. The combined effects of these outcomes would also reduce the country's greenhouse gas emission inventory and partially offset the emissions generated by the project.

SHAH DENIZ GAS EXPORT PROJECT
STAGE 1 DEVELOPMENT

ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACT ASSESSMENT

ENVIRONMENTAL STATEMENT EXECUTIVE SUMMARY

This document summarises the findings of the detailed Environmental and Socio-economic Impact Assessment as completed for the Shah Deniz Gas Export Project Stage 1 Development. The ESIA was completed by URS Corporation on behalf of BP and the Shah Deniz Partners.

Publisher:

BP on behalf of the Shah Deniz Partners.

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GLOSSARY

A

Abandonment
Final plugging of wells and/or permanent dismantling of a production platform or other installation.

Alpine folding
Period of mountain formation that reached its high point during the Late Oligocene and Miocene epochs.

Absorption
The ability of a gas, liquid or solid to attract and retain another substance without chemical combination.

Acute toxicity
The manifestation of a toxic effect over a short period relative to the lifespan of the organism.

Adsorption
The attraction exercised by a solid in drawing a gas or liquid to its surface without absorbing it.

Alien species / introduced species
A species not native to the environment it inhabits.

Alluvial fan
A pattern of sedimentary deposit frequently laid down by streams or rivers where they spread out into plains.

American Petroleum Institute (API)
The world's foremost authority on oil industry standards and practices. API Gravity is a reference system for the density of crude oil and constituent hydrocarbons.

Amphipod
A small crustacean of the order Amphipoda having a laterally compressed body with no carapace.

Anadromous
Migrating up rivers from the sea to breed in fresh water.

Anhydrite
A colourless, white, grey, blue or lilac mineral of anhydrous calcium sulphate occurring as layers in gypsum deposits.

Anodes
A positively charged electrode, as of an electrolytic cell, a storage battery, or an electron tube.

Annelid
Any of various worms or wormlike animals of the phylum Annelida, characterised by an elongated, cylindrical and segmented body.

Annulus
A term loosely used to describe the space between the drill string and the well wall, or casing strings or between casing and the production tubing.

Anti-foulant
Chemicals that are added to fluids, such as cuprous (copper) oxide or tributyl tin (TBT) which inhibit fouling of plant or vessels by organisms.

Anthropogenic
Relating to humans.

Anticline
A geological structure sometimes described as a dome or inverted saucer.

Appraisal well
A well drilled to confirm the size or quality of a hydrocarbon discovery. Before development, a discovery is likely to need at least two or three such wells.

Aquifer
An underground formation of rock saturated with water.

Aromatic hydrocarbons
The group of hydrocarbons which include Benzene, Toluene, Ethylene, Xylene etc.

Artificial drive
Methods of recovering hydrocarbons when natural reservoir pressures are insufficient, such as injection of gas or water into the reservoir structure.

Associated Gas
Natural gas found as part of or in conjunction with other constituents of crude oil as opposed to such gas found on its own.

ASTM
American Society for Testing and Materials publish authoritative standards such as calculation tables etc.

B

Ballast
Water taken aboard a vessel to maintain stability and to distribute load stresses.

Barite
A very heavy substances used as a main component of drilling mud to increase its density (mud weight and counter balance hydrostatic pressures).

Barrels
The traditional unit of measure of oil volume, equivalent to 159 litres (0.159 m^3) or approximately 35 imperial gallons (42 US gallons).

Beaching
The term used when hydrocarbons reach the shore.

Benthos
The collection of organisms attached to or resting on the bottom sediments and those which bore or burrow into the sediments.

Bentonite
A clay mineral.

Best Available Control Technology (BACT)
A 'top-down' approach to the selection and evaluation of technology, starting with the best technology possible for the application, followed by the next best and so on. Each technology is considered on a cost benefit basis, taking into account technical and operational limitations.

Best Practicable Environmental Option (BPEO)
Evaluation of the environmental implications of project options available along with safety and cost considerations.

Biocides
A chemical agent that can be added to fluids for the purpose of prevention or limitation of bacteria growth.

Biodegradable
Susceptible to breakdown into simpler compounds by microorganisms in the soil, water and atmosphere. Biodegradation often converts toxic organic compounds into non- or less toxic substances.

Biodiversity
The diversity of plant and animal life.

Biological Oxygen Demand (BOD)
The amount of oxygen required by aerobic microorganisms to decompose the organic matter in a sample of water, such as that polluted by sewage. It is used as a measure of the degree of water pollution.

Biomass
The total mass of living matter within a given unit of environmental area.

Biota
The plant and animal life of a particular region.

Biotope
An area that is uniform in environmental conditions and in its distribution of animal and plant life.

Bioremediation
The use of biological methods to remediate/restore contaminated land.

Bivalve
A marine or freshwater mollusk having a laterally compressed body and a shell consisting of two hinged valves.

Bitumen
A form of heavy, solid petroleum.

Black Water
Sewage effluent.

Blow-out
Uncontrolled or uncontrollable release of down-hole pressure upward through the wellbore or casing.

Blow-out Preventor (BOP)
Hydraulically operated device used to prevent uncontrolled releases of oil or gas from a well.

Borehole
The hole in the earth made by the drill; the uncased drill hole from the surface to the bottom of the well.

Bund
A wall or dyke around storage tanks to contain the contents in case of rupture or spillage.

C

Caisson
A steel cylindrical chamber extending from the drilling rig or platform that is completely submerged and may be used for the uptake of sea water or the discharge of effluent.

Carcinogenic
A cancer-causing substance or agent.

Casing
The steel pipes with which a well is lined for protection against collapse of the well borehole and unwanted leakage into or from the surrounding formation.

Cathodic protection
A method of neutralising the corrosive static electric charges in a submerged steel structure.

Cement
Used to set casing in the well bore and seal off unproductive formations and apertures. It is also used as a coating to add weight to submarine pipelines.

Chlorophyll
The name given to a series of pigments that produce the green colour of plants. They play a basis role in photosynthesis.

Chronic Toxicity
The manifestation of a toxic effect over a relatively long period of exposure to a substance.

Christmas Tree
The assembly of fittings and valves on the top of the casing that control the production rate of oil.

Chronic
Of long duration.

Circulation
The passage of fluids, primarily drilling mud, down the interior of the drill stem and back to the surface via the annulus.

Coalescer
A device used to change material from a liquid to a thickened curdlike state by chemical reaction.

Coliforms
Of or relating to the bacilli that commonly inhabit the intestines of human beings and other vertebrates, especially the colon bacillus.

Commissioning
Preparatory work, servicing etc. usually on newly installed equipment and all testing prior to full production.

Communities
An ecological unit composed of the various populations of micro-organisms, plants, animals that inhabit a particular area.

Completion
See well completion.

Completion fluid
Chemical mixture present in the well during the placement of production tubing and perforation of the well.

Complexes
Group of inter-related species.

Condensate (Gas condensate)
Light hydrocarbon fractions produced with natural gas which condense into liquid at normal temperatures and pressures associated with surface production equipment.

Conductor Pipe
A relatively short string of large diameter pipe which is set to keep the top of the wellbore open and to provide means of conveying the up-flowing drilling fluid from the wellbore to the surface drilling fluid system until surface casing string is set in the well. Conductor pipe may also be used in well control. Conductor pipe is usually cemented.

Confinement
The process by which injected fluids are kept within specified horizons.

Confinement Zone
The two layers immediately surrounding the containment layers and the geologic strata between them. The confinement zone comprises rock layers into which fracture propagation and migration of injected material is not allowed, the reason being to prevent the migration of fluids or fractures outside the area they confine.

Consequence
The resultant effect (positive or negative) of an activity's interaction with the legal, natural and/or socio-economic environments

Consortium
A joint venture enterprise used by the oil industry as a vehicle for joint operations where a distinct local legal entity and joint staffing are required.

Containment layers
Rock layers just above or below the injection horizon that are not directly accessible from the well bore. The injected water may be allowed to enter the layer, but not escape.

Containment zone
A geological formation, group of formations, or part of a formation that is capable of limiting fluid movement above or below the injection zone. Fluid may enter the zone, but not move outside it.

Contract Area
Area of the sea that has been sub-divided and licensed/leased to a company or group of companies for exploration and production of hydrocarbons.

Copepod
A large family of the phylum Arthropoda, including many crustaceans, living in freshwater and marine water. Some copepods are parasitic and others are free living.

Corrosion
The eating away of metal by chemical action or an electrochemical action. The rusting and pitting of pipelines, steel tanks, and other metal structures is caused by a complex electrochemical action.

Corrosion inhibitors
Chemicals which delay the process of corrosion on metal.

Crude Oil
An unrefined mixture of naturally-occurring hydrocarbons with varying densities and properties.

Ctenophore
Any of various marine animals of the phylum Ctenophora, having transparent, gelatinous bodies bearing eight rows of comb like cilia used for swimming. Also known as comb jelly.

Cuttings
The fragments of rock dislodged by the bit and brought to the surface in the mud.

Cumulative Impact
Environmental and/or socio-economic aspects that may not on their own constitute a significant impact but when combined with impacts from past, present or reasonably foreseeable future activities associated with this and/or other projects, result in a larger and more significance impact(s).

D

Dead oil
Oil containing no natural gas.

Decibel (dB)
A unit used (one tenth of a bel) used in the comparison of two power levels relating to sound intensities.

Decommissioning
Shutdown of the pipeline with system cleaning and dismantling of any facilities.

De-gasser
A separator which removes entrained gas from the returned mud flow. Also any process which removes gases of various kinds from an oil flow.

Dehydration
Removing water from the gas stream.

Demersal
Living at or occurring in deep water at the bottom of a sea or lake.

Denudation
Processes of weathering, transportation and erosion.

Dessicant
A substance, such as calcium oxide or silica gel, that has a high affinity for water and is used as a drying agent.

Demulsifier
A chemical used to break down crude-oil water emulsions. The chemical reduces the surface tension of the film of oil surrounding the droplets of water. The water then settles to the bottom of the tank.

Derrick
A pylon-like steel tower which provides the vertical lifting capacity needed for drilling the well.

Descalers
Substances added to prevent build-up of, and to a lesser extent remove, solids such as calcium carbonates and sulphates deposited on the drill pipe and casing.

Desertification
The transformation of arable or habitable land to desert, as by a change in climate or destructive land use.

Detection limit
The smallest concentration or amount of a substance that can be reported as present with a specified degree of certainty by a definite complete analytical procedure.

Development well
Any well drilled in the course of extraction of reservoir hydrocarbons, whether specifically a production well or injection well.

Diagenesis
The process of chemical and physical change in deposited sediment during its conversion to rock.

Diatom
Any of various microscopic one-celled or colonial algae of the class Bacillariophyceae, having cell walls of silica consisting of two interlocking symmetrical valves.

Diffusion
The transfer of particles by their random motion from one part of the medium to another.

Dispersant
Specially designed oil spill products that are composed of detergent-like surfactants in low toxicity solvents. Dispersants do not actually remove oil from the water but rather break the oil slick into small particles, which then disperse into the water where they are further broken down by natural processes.

Diurnal
Daily.

Diversity
The number and abundance of biological taxa in a specified location.

Down Hole
Down a well.

Downtime
A period when any equipment is unserviceable or out of operation for maintenance.

Drill bit
A drilling tool used to cut through rock.

Drilled cuttings
Chips and small fragments of rock as the result of drilling that are brought to the surface by the flow of the drilling mud as it is circulated.

Drill stem/Drill Stem Test (DST)
The assembled drill pipe in the well which serves to rotate the bit, to convey drilling mud or cement down the well and to flow to the surface the fluids in primary assessment of a discovery.

Drilling mud
A special clay, water and chemical additives, pumped down-hole through the drill pipe (string) and drill bit. The mud cools the rapidly rotating bit, lubricates the drill pipe as it turns in the well bore, carries rock cuttings to the surface and serves as a plaster to prevent the wall of the borehole from collapsing. Also known as drilling fluids.

Drill string
Lengths of steel tubing roughly 10 m long screwed together to form a pipe connecting the drill bit to the drilling rig. It is rotated to drill the hole and delivers the drilling fluids to the cutting edge of the bit.

Dynamic positioning
Use of thrusters instead of anchors to maintain the position of a vessel.

E

Ecosystem
Used to describe the interrelationships between all organisms in a given area, and their relationships to the non-living materials.

Edge/ecotone
Edges or ecotones are areas where two or more habitat types or different aged patches of the same habitat type meet. They occur naturally where there are abrupt changes in soil characteristics and are unique because they combine characteristics of two or more habitats.

Effluent
Waste products emitted by an operation or process.

Electro-chlorination
A process used for the disinfection and control of bacteria and marine growth in water systems. Brine or seawater is passed through a cell where it is subjected to an electrical current causing the dis-association of NaCl (salt) and H2O (water), which then allows for the formation of NaOCl (Sodium Hypochlorite) and Hydrogen gas as a by-product.

Encapsulation
The closure of wastes by a non-permeable substance. Waste constituents are not chemically altered but rather impeded by the encapsulation.

Endemic
Present within a localised area or peculiar to organisms in such an area.

Entrained oil
Small amounts of oil which may form part of a gas stream due to the difficulties of separation at source.

Environmental and Socio-economic Impact Assessment
Systematic review of the environmental or socio-economic effects a proposed project may have on its surrounding environment.

Environmental aspect
An element of an organisation's activities, products or services that can interact with the environment.

Environmental impact
Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.

Environmental Management System (EMS)
System established to manage an organisation's processes and resultant environmental impacts.

Environmental receptors
Any of various organisms that are directly or indirectly affected by environmental impact.

Environmental Statement
Formal document presenting the findings of an ESIA process for a proposed project.

Ephemeral
Living or lasting for a brief time.

Eutrophication
The process of nutrient enrichment that occurs over time in a body of water thereby stimulating the growth of plant life, especially algae. This growth and subsequent decay causes the reduction of the dissolved oxygen in the water.

Exploration well
An exploration well is a well drilled to test a potential but unproven hydrocarbon reservoir.

F

Facies
The composition and characteristics of a rock formation.

Fate
Disposition of a material in various environmental mediums (soil, air etc) as a result of transport, transformation and degradation.

Fault
A discontinuity in a rock formation caused by fracturing of the earth's crust.

Fecundity
Potential level of births over time for a population.

Filter feeder
A variety of animals living mostly on detritus or on plankton, whose feeding mechanism comprises a filter and a means of creating a current carrying particles through the filter.

Finger pier
A jetty at a right-angle to the shoreline.

Firing line
The part of the project where the welding is being done on the pipeline.

Flaring
Controlled disposal of surplus combustible vapours by igniting them in the atmosphere.

Flash
The sudden release of gases and/or vapours from oil as opposed to removal in a number of stages.

Flash point
The lowest temperature at which vapours arising form the oil will ignite momentarily on application of a flame under specified conditions.

Folding
Bend in stratified rocks that resulted from movements within the earth's crust.

Float-out/Float-over
The launch or loading out of jackets or other structures for installation offshore on a flotation barge or other vessel.

Floating-Roof Tank
A storage tank for crude oil which has roofs floating on, and in contact with, the oil so as to prevent the build up of volatile gases.

Flowline
The pipe through which oil travels from the well to the processing equipment or to storage.

Fluvial
Of or relating to rivers or streams or produced by the action of a river or stream.

Footprint
The impact/impression on the seabed or land from a facility.

Formation
A rock deposit or structure of homogenous origin and appearance.

Formation damage
Damage to the reservoir rock around a well due to e.g. plugging with mud, infiltration by water from the well or high flow rate.

Fracture azimuth
The main direction of any hydraulically induced fracture. This direction is generally perpendicular to the direction of the minimum horizontal stress acting at the fracture depth.

Fracture closure pressure
The fluid pressure at which an existing fracture is no longer deemed open mechanically (at which the fracture surfaces touch).

Fracture propagation pressure
The fluid pressure which will cause an existing fracture to start extending in any direction.

Fracturing
The process of cracking open by applying hydraulic pressure, the rock formation around a well bore to increase productivity or injectivity.

Fracturing fluid
Heavy, viscous fluid pumped down a well under high pressure to fracture the target formation in order to enhance fluid flow.

Fugitive emissions
Very small chronic escape of gas and liquids from equipment and pipework.

G

Gas cap
The natural accumulation of associated gas in the top of an oil reservoir.

Gas chromatography
A very accurate laboratory method of separating and analysing the components of a volatile hydrocarbon mixture.

Gas condensate
Light hydrocarbon fractions entrained in gas production which condense into liquid when brought to the surfaces.

Gas injection
Natural gas injected under high pressure into a production reservoir through an input of injection well as part of a pressure maintenance, secondary recovery, or recycling operation.

Gas lift
Increasing the production flow of oil by injecting gas down a well to mingle with the oil, thus increasing pressure and flow rate.

Gas-oil ratio
The proportional amount of gas to oil liquid occurring in production from a reservoir, usually expressed as cubic feet per barrel.

Gastropod
Any of the various mollusks of the class Gastropoda such as the snail, characteristically having a single, usually coiled shell or no shell at all, a ventral muscular foot for locomotion, and eyes and feelers located on a distinct head.

Gravel pack
A fill of fine gravel used to support the formation and keep the interior of the well clean when the producing formation of a well is crumbling or caving into the well bore and is plugging the perforations.

Greenhouse effect
Rise in the earth's temperature due to infra-red radiation being trapped in the atmosphere by water vapour, carbon dioxide, methane and other gases.

Greenhouse gases
Gases believed to contribute to the greenhouse effect, including carbon dioxide, water vapour and methane.

Grey Water
Waste water (from wash basins, showers etc) that does not contain sewage or oil.

H

Habitat
An area where particular animal or plant species and assemblages are found, defined by environmental parameters.

Halophyte
An organism which prefers highly saline environments for growth.

Hazard
The potential to cause harm, including ill health or injury; damage to property, plant, products or the environment; production losses or increased liabilities.

Health, Safety and Environmental Management Plan
A description of the means of achieving health, safety and environmental objectives.

Health Safety and Environmental Management System
The company structure, responsibilities, practices, procedures, processes and resources for implementing health, safety and environmental management.

Hook-up
The activity following offshore development installation during which all connections and services are made operable for commissioning and 'start-up'.

Horizon
Layers within the soil or subsoil in a vertical cross section of land.

Horizontal stress
The stress representing the horizontal forces within the porous saturated rock.

Horst
Elongated crustal block between faults on both sides that is pushed up or elevated relative to the surrounding countryside; reverse of a graben.

Hundred Year Storm
For construction design purposes, the worst weather conditions that can be statistically predicted within a hundred-year period.

Hydrocarbon
Organic chemical compounds of hydrogen and carbon atoms. There are a vast number of these compounds and they form the basis of all petroleum products. They may exist as gases, liquids or solids, examples being methane, hexane and asphalt.

Hydrogen Sulfide
A pungent corrosive toxic gas occurring naturally in some oil and gas reservoirs (and elsewhere) generated by the metabolism of certain types of bacteria.

Hydrographic
The description of surveying water ways, including seas, lakes, rivers, especially as navigation purposes.

Hydrostatic pressure
The pressure exerted by a column of liquid at a given depth such as that exerted by drilling fluid in a well.

Hydrostatic Testing/Hydrotest
The checking of the integrity of a container (e.g. tank or pipe) by filling it with water under pressure and testing for any loss of pressure.

I

Ichtiyofauna
Fish

Incident
An event or chain of events which has caused or could have caused injury, illness and/or damage (loss) to assets, the environment or third parties.

Incineration
The use of combustion to convert waste into less bulky materials

Inert Gas
Chemically unreactive gases used to flood comparments when there is fire or imminent danger of fire.

Injection well
A well used to introduce fluids into a reservoir, usually for enhanced recovery

Injectivity
The injection rate divided by the difference between the injection pressure and the reservoir pressure. A measure of the ability of the well and injection interval to take up injected fluids.

Invertebrates
Any animal lacking a backbone, including all species not classified as vertebrates.

ISO 14001
An evolving series of generic standards developed by the International Standards Organisation that provides business management with the structure for managing environmental impacts. The standards include a broad range of environmental disciplines including the basic management system.

Isobath
A seabed contour line.

J

Juvenile fish
Immature fish.

K

Knock-out drum
A drum or other process vessel used for rapid separation of water etc from a stream of hydrocarbons.

L

Lacustrine
Of or relating to lakes.

Lagomorph
Any of various plant-eating mammals having fully furred feet and two pairs of upper incisors and belonging to the order Lagomorpha, which includes the rabbits and hares.

Larvae
An immature free-living form of animal that develops into a different form by metamorphosis.

Lay barge / Pipe-lay barge
A vessel designed for welding together pipelines and laying them on the seabed.

LC_{50}
Standard test used to measure the toxicity of chemicals based on time required to kill 50% of the test organisms over a specified time.

Likelihood
The likelihood that an activity will occur.

Lithology
The study of rocks and hence the description of different formations encountered by a well.

Littoral
The part of the shore that is under water at high tide and exposed when the tide is low. Also known as the intertidal zone.

Log/Logging
Various devices for taking measurements of formations, physical conditions and fluids encountered by a well, together with the records produced by them.

Long-line fishing
The basic method involves setting out a length of line, often several kilometres long to which short lengths of line carrying baited hooks are attached every one to three metres. The long-line with its baited hooks lies on or near the seabed and is maintained in position by anchors at each end.

Lost circulation
Failure to recover to the surface all the drilling fluids at the same rate as they are pumped down a well, usually because of escapes into the surrounding formations.

M

Macroeconomic
The national economy.

Macrofauna
Those animals of the benthos, which are found within or upon the sediment and are of a size range of approximately 20 cm to 0.5 mm.

Manifold
Assembly of pipes, valves and fittings which allows fluids from more than one source to be directed to various alternative routes.

Microeconomic
Local economies or individual industries.

Mammal
A large class of warm-blooded vertebrates having mammary glands in the female.

Marine transgression
An advance of the sea to cover new land areas due to a rise in the sea level relative to the land.

Material Safety Data Sheet (MSDS)
An information sheet used by chemical suppliers to summarise properties of products, including health, safety and environmental aspects.

Mat/Mattress
A structure to support and protect the lay down head and pig launcher/receiver during installation and pre-commissioning activities and also to provide any additional dropped object protection to the pipeline and tie-in spool arrangement.

Meiofauna
Benthic animals of approximately <0.5 mm in size, abundantly found within the interstices of sand and mud.

Migration
Any regular animal journeys along well-defined routes, particularly those involving a return to breeding grounds.

Mitigation
Process that would make a consequence less severe.

Module
A separate section or box-like compartment of the top side of an offshore construction, as far as possible self-contained, designed to be lifted into place and connected to other modules offshore.

Monitoring activities
All inspection, test and monitoring work related to health, safety and environmental management.

Monoethylene Glycol (MEG)
A chemical that is injected into pipelines for the purpose of preventing hydrate formation by means of absorbing any free water in the system.

Mussel
Marine bivalve.

N

Natural Gas conditioning
Process of removing impurities from the gas stream to a high enough quality to pass through a transportation system.

Naturally Occurring Radioactive Material (NORM)
Low Specific Activity scale is an example of NORM.

Non-destructive testing (NDT)
Methods of inspecting and testing the quality or integrity of vessels or equipment that do not involve the removal or testing to destruction of representative sections.

Non-Water Based Muds
Drilling fluids such as Oil Based Muds and Synthetic Based Muds, which are not based on suspension of solids using water.

O

Oligochaete
Any of various annelid worms of the class Oligochaeta, including the earthworms and a few small freshwater forms.

Orogenic
Produced during the folding or faulting of the earth’s crust.

Operator
The company responsible for conducting operations on a concession on behalf of itself and any other concession-holders.

Outcrop
The appearance of occurrence of a rock formation at the surface.

Overburden stress
The stress that reflects the total weight of the overlying rock and fluid, if present, from the surface of the sea or land down to the depth at which the stress is defined.

P

Performance goals
Criteria that describes the measurable standards set by company management to which an activity or system element is to perform.

pH
A scale of alkalinity or acidity, running from 0 to 14 with 7 representing neutrality, 0 maximum acidity and 1 maximum alkalinity.

Photic zone
Surface layer at depths of up to 100 m of the sea where photosynthesis takes place.

Photosynthesis
The process by which plants and some single-celled flagellate organisms convert inorganic carbon dioxide, water nitrite ion (NO 3-) and phosphate ion (PO 4 3-) into sugars and amino acids using the energy in sunlight.

Phytoplankton
Microscopic planktonic plants, e.g. diatoms,
dinoflagellates.

Pig
A bullet shaped, cylindrical or spherical capsule which is inserted into a pipeline flow and travels along with the fluid in the pipeline. Its primary purpose is to scrape the pipeline clean from rust, wax or other deposits. More sophisticated pigs, called intelligent pigs, carry instrumentation used in pipeline inspection.

Pig receiving station
A valve opens on the bypass line, permitting the pig to be pushed into the receiving cylinder or trap, along with the sludge ahead of it. The valve closes and isolates the pig, at which time the end cap of the receiver is unlatched. The sludge drains into a sump and the pig is removed for cleaning and reconditioning.

Piling
Tubular steel shafts driven into the seabed to secure a structure to the seabed. Piles are usually driven through external sleeves or skirts attached to legs.

Pioneer species
The first to reside in an area.

Pipe Rack
Where stands of drill pipe are stacked verticaly in a derrick ready for use.

Plankton
Tiny plants and animals that drift in the surface waters of seas and lakes. Of great economic and ecological importance as they are a major component of marine food chains.

Platform
One of the various types of offshore structures.

Pleistocene
Formed in the first epoch of the Quarternary Period.

Pliocene
Of, belonging to, or designating the geologic time, rock series, and sedimentary deposits of the last of the five epochs of the Tertiary Period, characterized by the appearance of distinctly modern animals.

Plug/Plug and Abandon
To seal a well or part of a well with cement.

Pollution
The introduction by man, directly or indirectly, of substances or energy to the marine environment resulting in deleterious effects such as harm to living resources; hazards to human health; hindrance of marine activities including fishing; and impairment of the quality for use of seawater and reduction of amenities.

Polychaete
Any of various annelid worms of the class Polychaeta, including mostly marine worms such as the lugworm, and characterized by fleshy paired appendages tipped with bristles on each body segment.

Polycyclic Aromatic Hydrocarbon (PAH)
Hydrocarbons whose carbon atoms form a ring or rings.

Polymer
Two or more molecules of the same kind, combined to form a compound with different physical properties.

Porosity
The volume of free space between the grains of a rock capable of holding fluid.

Practice
Accepted methods or means of accomplishing stated tasks.

Precautionary principle
When there is little scientific information on an effect of a process on the marine environment then it should be treated that it would harm the environment. A precautionary approach should be in place.

Pressure maintenance
The process of keeping reservoir pressure at the optimum level during production, usually by water or gas injection to replace the extracted fluids.

Produced Water
Water that naturally accompanies produced oil. Also known as produced formation water.

Production
The full-scale extraction of hydrocarbon reserves.

Q

Quaternary period
A division of geologic time in the Cenozoic era following the Tertiary period. It began about 1.6 million years ago and continues to the present. The period is divided into the Pleistocene epoch, also known as the Ice Age; and the Recent, or Postglacial, epoch, also known as the Holocene.

R

Reclamation
The activities undertaken to restore a site to a predetermined land-use.

Recoverable reserves
The proportion of the oil/gas in a reservoir that can be removed using currently available techniques.

Reduction
The generation of less waste through more efficient practices.

Recycling/Recovery
The conversion of wastes into usable materials and/or extraction of energy or materials from wastes.

Red List / Red Book
A list comprised of rare or threatened species of plants and animals. The book containing Red List species.

Reservoir
A porous, fractured or cavitied rock formation with a geological seal forming a trap for producible hydrocarbons.

Reservoir pressure
The pressure at reservoir depth in a shut-in well.

Residual Impacts
Residual impacts are impacts that remain after mitigation measures, including those incorporated into the project's base case design and those developed in addition to the base design, have been applied.

Residual Oil
The dense, viscous "Heavy Ends" of the barrel, remaining after extraction of higher-value fractions.

Reuse
The use of materials or products that are reusable in their original form.

Reverse Osmosis
A process in which pressure forces water through a permeable membrane to remove salt and other impurities.

Richter Scale
The scale for expressing the magnitude of an earthquake, ranging from 0 to 8.

Rig
A collective term to describe the permanent equipment needed for drilling a well.

Riparian
Of, on, or relating to the banks of a natural course of water.

Riser
A pipe through which fluids flow upwards.

Risk
The product of the chance that a specified undesired event will occur and the severity of the consequences of the event.

S

Salinity
Total amount of solid material dissolved in aqueous solution. Salinity is measured in parts per thousand.

Scrubbing
Purifying gas by treatment with a water or chemical wash.

Screen
A tubular "sieve" inserted in a well bore to hold back loose sand and rock while letting oil and gas enter the well.

Screening criteria
The values or standards against which the significance of the identified hazard or effect can be judged.

Screen out
A term used to describe when a fluid that is loaded with solids has insufficient energy to carry its solids and as a consequence the fluid very quickly loses or deposits its solids in an uncontrolled way.

Seismic survey
A survey conducted to map the depths and contours of various prospective rock strata by timing the reflections from strata-tops of sound waves released on the surface or down a borehole.

Semi-submersible drilling rig
A type of floating offshore drilling rig which has pontoons or buoyancy chambers located on short legs below the drilling platform.

Separator
A process vessel used to separate gases and liquids in a hydrocarbon stream.

Shale shaker
Screen for extracting rock cuttings from circulating drilling mud.

Significance
The significance of the impact is expressed as the product of the consequence and likelihood of occurrence of the activity.

Slurry
A mix of cement and water used in drilling/cementing.

Solidification
The addition of materials (sawdust, adsorbent polymers etc) to a waste to change its physical state and improve handling and weight-bearing characteristics.

Sour oil/gas
Oil or gas with a relatively high content of odorous, poisonous or corrosive sulfur compounds such as Hydrogen Sulfide.

Stochastic oil spill modelling
A simulation of the distance and speed with which oil travels following a spill, based on range of possible input conditions, the product of which is an array of probable results.

Strata
Distinct and usually parallel beds of rock.

Stratosphere
A layer of the atmosphere beginning approximately 7 miles (11 km) above the surface of the earth.

Stimulation fluids
Chemical mixture pumped down a well to stimulate or enhance the production of hydrocarbons from that well.

Sublittoral
The sublittoral or infralittoral zone extends from the intertidal zone into deeper waters.

Surfactant
A detergent or emulsifier.

Syncline
A basin or trough-shaped fold whose upper component strata are younger than those below.

T

Taxon
Plural-Taxa. Any taxonomic group or rank.

Template
The structural framework within which subsea wellheads are grouped. Also, the prepared foundation or "mattress" for soft or shifting seabeds on which a jackup rig can be stably installed.

Teratogenic
Malformation occurring of an embryo.

Thermal desorption
A non-oxidising process using heat to desorp oil from oily wastes.

Thermocline
Temperature differential in the water.

Total Depth
The target depth for a well or the achieved (drilled) depth in a well at any one time.

Toxicity
Inherent potential or capacity of a test substance to cause adverse effects on living organisms.

Toxicity test
Procedure that measures the toxicity produced by exposure to a series of concentrations of a test substance. In an aquatic toxicity test, the effect is usually measured as either the proportion of organisms affected or the degree of effect shown by the organism.

Trajectory oil spill modelling
Estimated distance and speed with which oil travels following a spill, based on a single release scenario.

Trawling
Method of fishing in which a large bag shaped net is dragged or trawled. Mouth of the bag is kept open by a variety of methods including wooden beam (beam trawl) or a large flat board (otter trawl).

Trophic level
Any of a series of distinct feeding levels in a food chain. Most food chains comprise three separate levels: primary producers (plants), primary consumers (herbivores) and secondary consumers (carnivores).

Tubing
Tubing installed within the casing through which wells are normally produced.

U

Unresolved Complex Mixture (UCM)
A mixture of hydrocarbons which produce a baseline rise in gas chromatograms of petroleum-derived hydrocarbons.

V

Venting
The release of gases to the atmosphere without burning.

Vertical conformance
The characteristic of the flow into the vertical cross section of the rock column in which injection is taking place and the extent to which such characteristic is consistent with the desired outcome of the injection process. Good conformance implies fluid flow rates into various layers are in agreement with injection plans.

Viscosity
The resistance of a fluid to flow due to the mutual adherence to its molecules.

W

Water Based Muds (WBM)
Drilling fluid based on suspension of solids in water.

Water injection
The injection of water into a reservoir.

Water washing
A process where water removes light hydrocarbons, aromatics and other soluble compounds from petroleum.

Water separation
The removal of water from the production flow of oil or gas.

Wax
Paraffin wax is a constituent of crude oil which often requires special treatment to allow the oil to flow freely at surface conditions.

Weathering
Processes related to the chemical action of air, water and organisms. Weathering results in evaporative loss of light hydrocarbons and it is commonly accompanied by biodegradation and water washing.

Well clean-up
Ridding the borehole of spent fluid. This returns the well to an original state and drains back into the borehole where it is pumped or circulated out, leaving the hole clean.

Well completion
The work of preparing a newly drilled well for production, including Christmas tree deployment and erecting flow tanks.

Wellhead
A top of casing and the attached control and flow valves. The well head is where the control valves, testing equipment and take-off piping are located.

Well testing
Testing in an exploration or appraisal well is directed at estimating of reserves in communication with that well, in addition to well productivity. Testing in a production well also monitors the effects of cumulative production on the formation.

Wet Gas
Natural hydrocarbon gas containing significant amounts of naturally liquid hydrocarbons.

Whole effluent toxicity
The total toxic effect of an effluent measured directly with a toxicity test.

Wind Rose
A diagram with radiating lines showing the frequency and strength of winds from each direction affecting a specific place.

Z

Zooplankton
Free floating microscopic animals.

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Units and Abbreviations

Units

Barg	1 bar (guage) = 14.5 psi
bbl	Barrel (6.2898 barrels = 1 m^3)
bcm	Billion cubic meters
bopd	Barrels of oil per day
Bpd	Barrels per day
Bwpd	Barrels of water per day
Bscm	Billion standard cubic meters
cms^{-1}	Centimeter per second
cm	Centimetre
dB	Decibel
^0C	Degrees centigrade
DWT	Dead weight tonne
gm^{-1}	grams per meter
gm^{-2}	grams per square meter
ha	Hectare
in	inches
km	Kilometre
lb/MMscf	Pounds per million standard cubic feet per day
m	meter
m^2	square meters
m^3	cubic meters
m^2/dy	Meters squared per day
m^3/hr	cubic meters per hour
mbgl	meters below ground level
ms^{-1}	meters per second
mt	Metric tonnes
µm	micgrograms
μgg^{-1}	micrograms per gram
μgm^{-3}	Micrograms per cubic meter
$mgkg^{-1}$	Milligram per kilogram
mm	Millimeters
Mmscfd	Million standard cubic feet per day
MW	Megawatt
ppb	parts per billion
ppm	Parts per million
ppmv	Parts per million by volume
psi	Pounds per square inch
%	Percent
‰	Parts per thousand
km^2	Square kilometre
t	tonnes
Tcf	Trillion cubic feet
US$M	US Dollars (Millions)

Abbreviations

4WD	4-wheel drive
ACCMP	Archaeological/Cultural Construction Monitoring Programme
ACG	Azeri Chirag Gunashli
ADMS3	Atmospheric Dispersion Modelling System Version 3

AET	Azerbaijan Economic Trends
AGT	Azerbaijan Georgia Turkey
AIDS	Acquired Immune Deficiency Syndrome
AIOC	Azerbaijan International Operating Company
AHFS	Azerbaijan Holland Friendship Society
AMP	Archaeological Management Plan
API	American Petroleum Institute
AQS	Air Quality Standards
ASCE	Azerbaijan State Committee for Ecology
ASFC	Azerbaijan State Fisheries Concern
ASSC	Azerbaijan State Statistical Committee
ASY	Azerbaijan Statistical Yearbook
Avg	Average
AZM	Azerbaijan Manat
BACT	Best Available Control Technology
BAD	Biodiversity Action Plan
BAP	Biodiversity Action Plan
BAT	Best Available Technology
BCES	Baku City Electrical Services
BIC	Business Information Center
BOD	Biological Oxygen Demand
BOP	Blow Out Preventer
BPCS	BP Caspian Sea
BPEO	Best Practicable Environmental Option
BS	British Standard
BTC	Baku-Tbilisi-Ceyhan
BU	Business Unit
C&WP	Compression and Water injection platform
c.	Approximately
CAPEX	Capital expenditure
CCCR	Common central control room
CDV	Canine Distemper Virus
CEP	Caspian Environmental Program
CERC	Cambridge Environmental Research Consultants
CERL	Complex Environmental Research Laboratory
CFC	Chlorofluorocarbon
CH_4	Methane
CIS	Commonwealth of Independent States
CITES	Convention on the International Trade of Endangered Species
CLO	Community Liaison Officer
CMC	Contracts Management Committee
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CRI	Cuttings Re-injection
CRM	Community Relations Manager
CRP	Community Relations Programme
CRRP	Coastal Rehabilitation and Reinstatement Programme
CSC	Caspian Shipping Company
CVP	Capital Value Process
DBA	Derrick Barge Azerbaijan
DDT / DDE	Dichlorodiphenyltrichloroethane
DLE	Ductility Level Earthquake
DLE	Dry Low Emission
DPS	Diverse Path Shutdown System

DST	Drill Stem Test
DSV	Dive Support Vessel
DTM	Digital Terrain Model
EA	Environmental Assessment
EAP	Environmental Action Plan
EBRD	European Bank for Reconstruction and Development
ECA	Export Credit Agency
ECEWP	Early Civil Engineering Work Programme
EDC	Enterprise Development Committee
EEC	European Economic Community
EHRA	Environmental Hazard and Risk Assessment
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
EOP	Early Oil Project
EPS	Environmental Protection Standards
ERT	Environment & Resource Technology Ltd
ES	Environmental Statement
ESMMP	Environmental & Social Mitigation and Monitoring Plan
ESIA	Environmental and Socio-Economic Impact Assessment
ESS	Emergency Shutdown System
EU	European Union
F&G	Fire and Gas System
FEED	Front end engineering design
FFD	Full Field Development
FOC	Foreign Oil Companies
FSU	Former Soviet Union
GCA	Gunashli, Chirag, Azeri
GCP	Garadag Cement Plant
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GHSER	Getting HSE Right
GIS	Geographic Information System
GLP	Good Laboratory Practice
GT	Gas turbine
GWP	Global Warming Potential
HADT	Hazardous Area Drainage Tank
HFCs	Hydrofluorocarbons
HIPPS	High Integrity Process Protection System
HIV	Human Immunodeficiency Virus
HNO_3	Nitric Acid
HOCNS	Harmonised Offshore Chemical Notification Scheme
HOVHL	High Voltage Overhead Line
HP	High Pressure
HSE	Health, Safety & Environment
H_2S	Hydrogen Sulphide
H_2SO_4	Sulphuric Acid
HSO_3	Sulphurus Acid
ICES	International Council for the Exploration of the Seas
ICSS	Integrated Control and Safety System
IDP	Internally Displaced Persons
IEA	National Institute of Ethnography and Archaeology
IFC	International Finance Corporation
IFI	International Finance Institutions
ILO	International Labour Organisation

IMDG	International Maritime Dangerous Goods
IMF	International Monetary Fund
IMO	International Maritime Organisation
INTERPOL	International Police Organisation
ISAR	Initiative for Social Action and Renewal in Eurasia
ISO	International Organisation for Standardisation
ITT	Invitation to Tender
IUCN	International Union for the Conservation of Nature
IWMP	Integrated Waste Management Plan
JAOC	Japan Azerbaijan Operating Company
KAP	Knowledge, attitudes, practices
KP	Kilometre Point
L_{10}	noise level exceeded for 10% of measurement time
L_{50}	noise level exceeded for 50% of measurement time
L_{90}	noise level exceeded for 90% of measurement time
Leq (L_{Aeq})	equivalent continuous noise level
L_P	Pressure Level
LAO	Linear alpha olefin
LP	Low Pressure
LLP	Low Low Pressure
LSA	Low specific activity
LRTAP	Convention on Long-Range Transboundary Air Pollution 1991
LTU	Large Taxpayers Unit
L_W	Power Level
MARPOL	International Convention for the Pollution of Prevention by Ships, 1973, as modified by the Protocol of 1978
Max	Maximum
MCR	Maximum Capacity Rating
MDCQ	Maximum Daily Contract Quantity
MDHS	Method for Determining Hazardous Substances
MEG	Monoethylene Glycol
MEL	Maximum Exposure Level
MENR	Ministry of Ecology and Natural Resources
MEP	Main Export Pipeline
MEPC	Marine Environmental Protection Committee
MIGA	Multilateral Investment Guarantee Agency
Min	Minimum
MLA	Multilateral Lending Agency
MOD	Ministry of Defence
MODU	Mobile Offshore Drilling Unit
MOL	Main Oil Line
MOU	Memorandum of Understanding
MOWP	Minimum Obligatory Work Programme
MP	Medium Pressure
MPN	Most Probable Number
MSD	Marine Sanitation Device
MSDS	Material Safety Data Sheet
MW	Megawatt
NO	Nitric Oxide
NO_2	Nitrogen dioxide
NDT	Non Destructive Testing
NE	Northeast
NEBA	Net Environmental Benefits Analysis
NER	Northern Export Route
NETCEN	National Environmental Technology Centre

NGO	Non-governmental Organisation
NMVOC	Non-methane Volatile Organic Compounds
NO_X	Nitrogen Oxides
NORM	Naturally Occurring Radioactive Material
NWBM	Non Water Based Mud
OBM	Oil Based Mud
OCNS	Offshore Chemical Notification Scheme
OGP	International Offshore Association of Oil & Gas Producers
OECD	Organisation for Economic Cooperation and Development
OH	Hydroxyl
OHGP	Open-hole gravel packs
OPEX	Operating expenditure
OPIC	Overseas Private Investment Corporation
OSCP	Oil Spill Contigency Plan
OSIS	Oil Spill Information System
OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment of the North East Atlantic, 1992
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PCDP	Public Consultation and Disclosure Plan
PCS	Process Control System
PDQ	Production, drilling and quarters platform
PFCs	perfluorocarbons
ph	Power of (the concentration of) Hydrogen ion
PM	Particulate matter
POB	Persons on Board
PPAH	Pollution Prevention and Abatement Handbook
PQ	Production and living quarters
PSA	Production Sharing Agreement
PSA	Particle Size Analysis
PSD	Project Summary Document
PSI	Pounds per square inch
PSS	Process Shutdown System
QA	Quality assurance
RAP	Resettlement Action Plan
RKB	Rotary Kelly Bushing
RO	Reverse Osmosis
Ro/Ro	Roll-on / Roll-off
ROP	Rate of penetration
ROV	Remotely operated vehicle
ROW	Right of Way
SBM	Synthetic Based Mud
SCE	State Committee for Ecology
SCI	State Caspian Inspectorate
SCP	Semi-desert Compensation Plan
SCP	South Caucusus Pipeline
SCR	Selective Catalytic Reduction
SD	Shah Deniz
SDGP	Shah Deniz Gas Pipeline
SE	Southeast
SF_6	Sulphur hexafluoride
SIC	Sound Immission Contours
SLE	Strength Level Earthquake
SME	Small Medium Enterprise
SO_2	Sulfur dioxide

SOBM	Synthetic oil based mud
SOCAR	State Oil Company of the Azerbaijan Republic
SOLAS	Safety of Life at Sea
SOW	Statement of Work
SPS	Shelprojecstroy
SPT	Standard Penetration Test
SRP	Semi-desert Restoration Program
SCSSV	Surface Controlled Subsurface Safety Valves
stbd	Standard barrels per day
STD	Sexually Transmitted Disease
STRAI	Spur-thighed Tortoise Rescue and Awareness Initiative
SWOT	Strengths, Weaknesses, Opportunities and Threats
TACIS	Technical Assistance for the Commonwealth of Independent States
TAD	Tender Assist Drilling
TAE	Trans-Asia-Europe Fibre-Optic Line
TB	Tuberculosis
TCN	Third Country Nationals
THA	Total Hydrocarbon Analysis
THC	Total Hydrocarbon Content
TOP	Top of Pipe
TPG500	Technip-GeoProduction 500
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
TVD	Total Vertical Depth
TVP	True Vapour Pressure
TWA	Time Weighted Average
TWMI	Total Waste Management International
UAE	United Arab Emirates
UCM	Unresolved complex mixture
UCP	Unit control panel
UK	United Kingdom
UN	United Nations
UNAIDS	Joint United Nations Programme on AIDS
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Food Programme
UNHDR	United Nations Human Development Report, 2001
UNICEF	United Nations Children's Fund
USA	United States of America
USCG	United States Coast Guard
USExIm	United States Export-Import Bank
USSR	Union of Soviet Socicialist Republics
UTM	Universe Transverse Mercator
UV	Ultra Violet
VOCs	Volatile Organic Compounds
WBG	World Bank Group
WBM	Water Based Mud
WER	Western Export Route
WHO	World Health Organisation
WHT	Well Head Tower
WTO	World Trade Organisation
WTP	Wastewater Treatment Plant
ZDBC	Zero Damage Base Case

1 Introduction

This Environmental Statement (ES) has been prepared following a detailed Environmental and Socio-economic Impact Assessment (ESIA) of the proposed Stage 1 development of the Shah Deniz Gas Export Project in the Caspian Sea, Republic of Azerbaijan. The ES has been prepared for submission to the Azerbaijan Ministry of Ecology and Natural Resources (MENR) to gain approval for the project and, as such, has been conducted in accordance with the legal requirements and policies of Azerbaijan. In addition, the assessment has been carried out in a manner that ensures it satisfies international environmental and social guidelines as recommended by International Finance Institutions (IFI), described in greater detail in Section 2 below. Furthermore, the ESIA process has been undertaken in the context of BP's Health, Safety and Environment (HSE) Policy as described in Section 1.5.

Considerable environmental and socio-economic study has been carried out for the Shah Deniz field and for the Azeri, Chirag & Gunashli (ACG) fields, which lie approximately 55 km to the east of the Shah Deniz field. BP is operator of both areas as outlined below.

The Shah Deniz Stage 1 ESIA programme of work has built on these earlier studies where appropriate and has conducted additional studies to augment this knowledge base. This has enabled the assessment process to benefit from a comprehensive understanding of the environments in which the development is proposed.

1.1 Geographic location

The independent Republic of Azerbaijan covers a total area of 86,600 km^2 and is located in southern portion of the Greater Caucasus mountain range. It is bordered to the north by the Russian Federation and the Republic of Georgia, to the west by Armenia and Turkey, to the south by Iran and to the east by the Caspian Sea as illustrated in Figure 1.1.

Figure 1.1 Location of Azerbaijan

Throughout history, Azerbaijan has played an important role in the region, bridging the border between Europe and Asia and serving as an import trade route and economic region. Azerbaijan was incorporated into the Soviet Union, following invasion by the Soviet Red Army in 1920. After independence was achieved in 1991 and the collapse of the Soviet economy, it was revealed that many of the country's enterprises were loss making and uncompetitive, Azerbaijan was left struggling to regain the relative prosperity it had once enjoyed prior to Soviet influence. In more recent years and with the increase in foreign investment in the country, Azerbaijan is once more increasing its prosperity and position in the global market.

1.2 History of oil and gas development in Azerbaijan

From the turn of the 19th century Azerbaijan has been known to be one of the world's premier sources of oil. Whilst oil production did occur during the period of Soviet rule in Azerbaijan, the hydrocarbon reserves in the country were generally not fully exploited by the ruling administration. Following the dissolution of the Soviet Union, Azerbaijan has again sought to become a leader in oil and gas production in an effort to bolster and redevelop its economy.

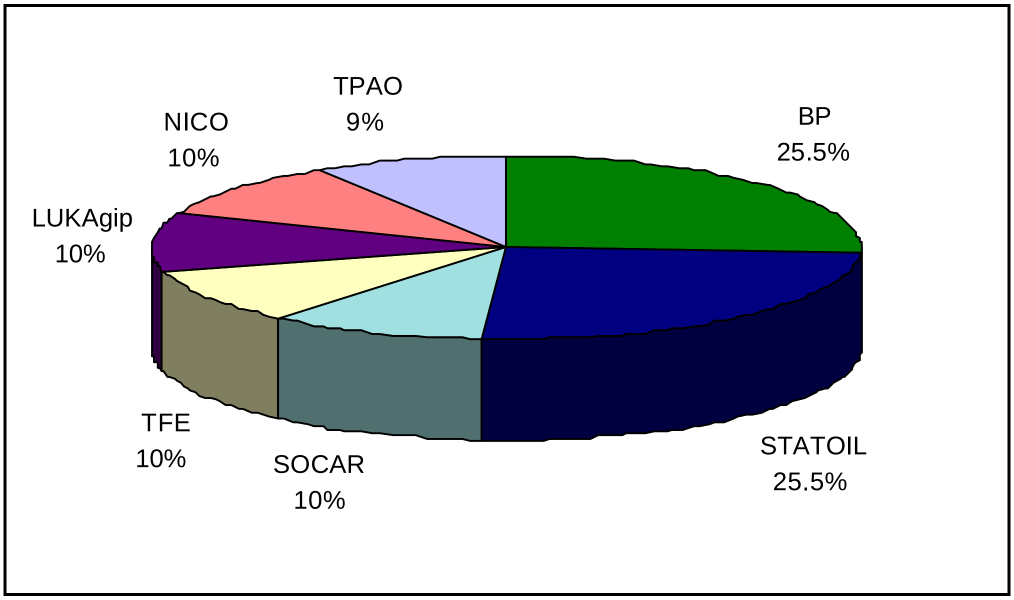
Although a significant amount of national oil development has been undertaken in offshore Azerbaijan over the last decade or so, limited infrastructure, technology and services, combined with a struggling economy, have significantly limited the country from developing its reserves to their full potential.

In seeking to stimulate the development of its significant reserves, Azerbaijan has invited Foreign Oil Companies (FOC) to invest in the development of its hydrocarbon wealth. By inviting FOC to jointly develop existing and potential reserves it is intended that sufficient investment, including international technology, will be introduced to the country thus enabling Azerbaijan to become a leader in the export of oil and gas. Production Sharing Agreements (PSAs) are the legal arrangements under which FOC operate in Azerbaijan.

1.3 Shah Deniz Production Sharing Agreement

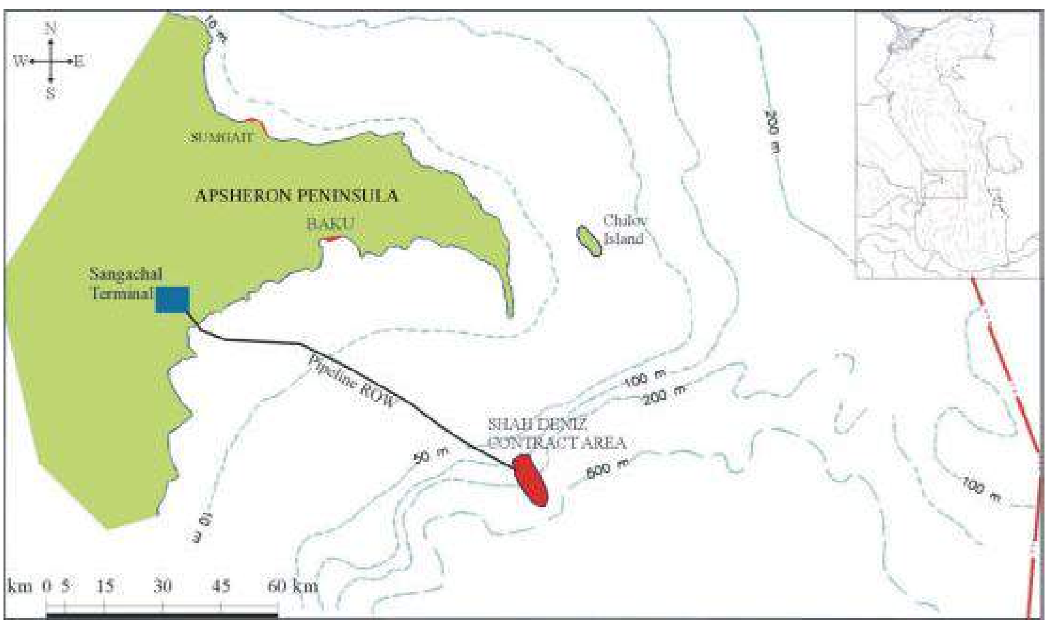
A Production Sharing Agreement (PSA) to develop and manage the reserves of the Shah Deniz gas-condensate field, herein after termed "Contract Area", was signed between the State Oil Company of the Azerbaijan Republic (SOCAR) and a consortium of seven FOC. BP is operator of the proposed development. The member companies of Shah Deniz are shown in Figure 1.2.

Figure 1.2 Members of Shah Deniz PSA



Early appraisal well drilling has indicated that the Shah Deniz field (Figure 1.3) is a world-class gas-condensate discovery, the full potential of which requires further appraisal. It lies in the Azerbaijan sector of the Caspian Sea, approximately 100 km southeast of Baku and covers an area of 858 km^2 in water depths ranging from 50 m to 500 m.

Figure 1.3 Shah Deniz Gas Export Stage 1 Development



1.3.1 Shah Deniz Full Field Development

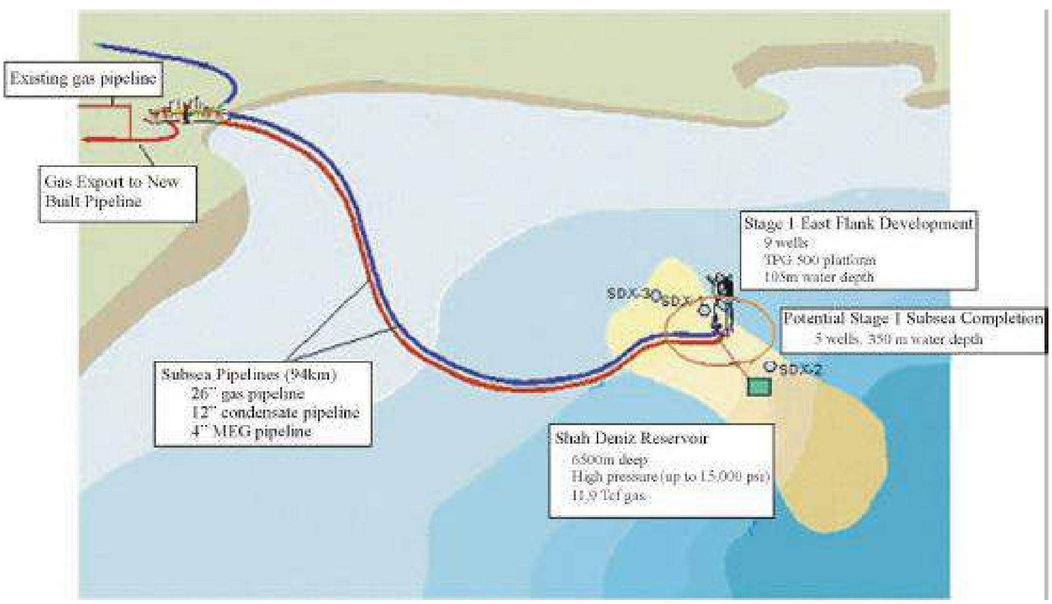
Full development of the Shah Deniz gas-condensate field will be undertaken in a number of consecutive stages. The approach is, at present conceptual, especially in respect to future development stages. It is also very likely that the approach, once initially defined, will change as the reservoir itself becomes better defined. The Shah Deniz Stage 1 development represents the first stage of the Shah Deniz field development.

Stage 1 development will be located on the Eastern Flank of the field in approximately 100 m of water and will include the installation of a fixed platform consisting of drilling and processing facilities limited to primary separation of gas and liquids. Gas and condensate will be delivered via two subsea marine pipelines to an onshore reception and gas-processing terminal to be constructed adjacent to the AIOC terminal at Sangachal and located some 38 km to the south of Baku (Figure 1.3).

To maintain gas production rates from the field in the future, a subsea completion is proposed some 4 km to the south of the fixed platform, five to 10 years after the first gas delivery. The subsea development will be installed in 350 m of water and produced fluids tied back to the Stage 1 platform via a marine pipeline for primary separation and onward transport to the onshore terminal (Figure 1.4).

Gas, conditioned for transportation and sale, will be transferred from the terminal to an export pipeline system, ultimately delivering the product to the Turkish market. First gas delivery from the Shah Deniz Stage 1 project is planned for 2005.

Figure 1.4 Shah Deniz Stage 1 Development



The environmental and socio-economic programmes of work carried out by BP and AIOC, operated by BP, to develop a knowledge and understanding of the environments in which their project developments will occur, are outlined in Table 1.1. These studies have assisted BP in identifying and understanding the potential effects that their proposed activities may have on these environments enabling the proposed programmes to be designed and planned in a manner that would minimise any effects.

Table 1.1 BP environmental and social programmes undertaken to date (including AIOC programmes)

Environmental / Social Programmes undertaken	Date
Shah Deniz Stage 1 Platform and Pipeline Survey	2001
Post well survey of the SDX1 and SDX3 well locations and repeat survey of the baseline stations	1998 / 2000
Shah Deniz Environmental Impact Assessment for Exploration Drilling	1998
Shah Deniz Environmental Impact Assessment - Seismic Operations	1997
Shah Deniz Baseline Assessment	1997, 2001
ACG Baseline Assessment	1995
Seismic Survey EIAs	1995
Appraisal Drilling EIAs for GCA Wells 5, 6	1996
Northern Route Export Pipeline EIA	1996
Western Route Export Pipeline EIA	1997
Supsa Terminal EIA	1997
EOP Environmental Impact Assessment	1997
Ongoing monitoring for EOP	1997 - present
ACG Phase 1 Baseline Assessments	1998, 2000 & 2001
FFD consultation with regulators and NGOs	2000 - ongoing
Early Template Well EIA for ACG Phase 1	2001
Sangachal Terminal, Early Civil Engineering Work Programme ESIA (ACG FFD Phase 1 and Shah Deniz Gas Export Stage 1)	2001
ACG FFD Phase 1 development ESIA	2002

In addition, during 1997, AIOC developed the concept and scope of services for the creation of an environmental laboratory in Baku, capable of working to established international standards.

This resulted in the Caspian Environmental Laboratory (originally designed and operated by ERT Ltd; now owned and operated by Akvamiljø Caspian) that has been providing environmental services to the oil and gas industry since the commencement of its operations in March 1998. Services include marine environmental survey, chemical analysis, biological and ecological assessment and ecotoxicology. Ecotoxicology was a key component of the services required. To meet this need, ERT Ltd undertook the development and implementation of methods for testing the aquatic toxicity of drilling fluids and oil industry chemicals using Caspian organisms. This was achieved with the support of a team of leading Azerbaijani scientists. The methods are comparable in design, scope and technical performance to those specified by OSPAR (*Oslo and Paris Convention for the Protection of the Marine Environment of the North East Atlantic, 1992*) for use by North Sea states and have been used successfully for almost three years.

1.4 Other offshore oil and gas projects in Azerbaijan

1.4.1 Overview of activity in the Caspian Region

Oil and gas exploration, development and production operations have been underway in the Azerbaijan sector of the Caspian Sea for many years. In addition, other FOC have been invited to sign PSAs to further develop reserves.

Offshore development commenced under Soviet rule in 1949 with the discovery of the Oil Rocks field. This, followed by the discovery of other offshore fields, began the production of large volumes of oil to complement extensive and existing onshore production. As Soviet technology was limited to shallow water most development took place in waters less than 125 m. By 1996, the number of offshore wells had reached 1,400.

SOCAR operated fields in the vicinity of the Shah Deniz area include:

?? Oil Rocks to the north east, which comprises a number of fields and produces approximately 15,770 bpd;
?? shallow-water Gunashli, adjacent to BP's Deep-Water Gunashli tract in the ACG contract area is one of Azerbaijan's largest oil producing fields;
?? the Bahar field, the northern portion of which has been operational since the 1970s, provides gas to Azerbaijan; and
?? the 28 May Field which was established in 1994.

To date, offshore exploration and development PSAs have been signed as follows:

?? **Apsheron, 1997:**
Operated by Chevron, the Apsheron prospect, a deep-water geologic structure approximately 60 km southeast off the coast of Azerbaijan, is thought to be one of the largest gas reserves in the Caspian basin. At the time of writing this report, drilling has been delayed reportedly due to lack of commercially recoverable reserves.
?? **Oguz, 1997:**
Operated by Exxon-Mobil, the Oguz block is located 90 km east of Baku adjacent to Oil rocks and the Gunashli fields. Presently, exploration drilling in this contract area has been abandoned and there are no plans for drilling in the future.
?? **Nakchivan D-3, 1997:**
Operated by Exxon-Mobil, the Nakchivan area is approximately 280 km^2 and is located about 100 km south of Baku in water depths of 100-700 m. Exploration drilling in the Nakchivan block began in 2001.
?? **Lenkoran-Talysh, 1997:**
Operated by TotalElfFina, the Lenkoran Talysh fields are located offshore from the southern town of Lenkoran. Seismic operations on the 420 km^2 contract area were undertaken in 1997. Negative results were returned for the first exploration well drilled in the Talysh field. It is not known whether future drilling is planned.
?? **Yalama D222, 1997:**
Operated by LukArco, the Yalama field is located in the northwestern section of Azeri waters. Seismic operations have been undertaken to date on the Yalama field. It is not known when the first exploratory well will be drilled.
?? **Kurdashi, Araz Shirvan, 1998:**
Operated by Agip, the Kurdashi field is located approximately 45 km east of Lenkoran and south of the Kura river delta. The contract area covers an area of approximately 550 km2 with water depths from 10 m to more than 700 m. Seismic operations were undertaken between 1998 and April 1999. The first two exploration wells drilled this year have both returned negative results; therefore drilling in the Kurdashi field has been suspended.
?? **Yanan Tava, Atashgah, Mugan, 1998:**
Operated by JAOC, the Atashgah field lies to the north of BP's Inam field. Geophysical surveys were completed for the Yanan Tava, Atashgah and Mugan fields in December 2000. It is anticipated that drilling will be undertaken in the first three quarters of 2002.
?? **Savalan, Dalaga, Lerik, 1999:**
Operated by Exxon-Mobil, the contract area covers an area approximately 850 km^2. It is anticipated that seismic operations will be undertaken followed by the drilling of two exploration wells by the end of 2002.
?? **Zafar-Mashal, 1999:**
Operated by Exxon-Mobil, the Zafar Mashal contract area is located about 110 km southeast of Baku in water depths ranging from 550 m to 900 m. It covers approximately 640 km^2.

In addition to the above there are a further three BP operated PSAs namely; ACG (1995), Inam (1998) and Alov (1998). These are described in Sections 1.4.2.2 and 1.4.2.4 below.

An overview of these PSA areas can be seen in Figure 1.5.

Figure 1.5 Azerbaijan Offshore PSAs

1.4.2 BP-operated projects in the Caspian Region

In addition to the Shah Deniz Gas Export Project Stage 1 development, BP is undertaking a number of other projects in the Caspian Region. These projects are briefly outlined below.

1.4.2.1 Shah Deniz Gas Pipeline Project

Shah Deniz gas, conditioned for transportation and sale, will be transferred from the planned gas condensate-processing terminal at Sangachal, to an export pipeline system, ultimately delivering the gas to the Turkish market. The proposed pipeline route would run from the terminal, through Azerbaijan and Georgia and into Turkey. Markets in Turkey will be supplied from the town of Erzurum. Plans to run South Caucasus Pipeline (SCP) in parallel with the proposed Baku-Tbilisi-Ceyhan Pipeline (BTC) oil pipeline for most of the route are being considered.

1.4.2.2 Azeri Chirag Gunashli Full Field Development

The ACG Contract Area has estimated oil reserves in excess of 4.6 billion barrels of oil and 3.5 trillion cubic feet of associated natural gas. It lies in Azerbaijan sector of the Caspian Sea, approximately 120 km south east of Baku. The Contract Area covers an area of 432 km^2 in water depths ranging from 100 m to 400 m. Primary oil bearing zones occur at depths of between 2,500 m and 3,000 m below the surface.

Full Field Development (FFD) of ACG will be achieved through the implementation of three Phases of development. The Phase 1 development follows the Early Oil Project (EOP) that started production in 1997 from the Chirag-1 platform and will develop the central part of the Azeri reservoir, to the south east of Chirag-1. The development will consist of a production, drilling and quarters platform (PDQ) bridge-linked to a compression and water injection platform (C&WP) for gas and water injection to the reservoir, a new 30" sub-sea oil pipeline from the PDQ to shore, plus a potential new 30" gas line to shore or the conversion of the existing 24" sub-sea oil pipeline from Chirag-1 to gas service. The Sangachal terminal will be expanded to receive the increased production and export requirements. In addition, the Chirag-1 platform will be integrated with the Phase 1 project by means of interfield oil and gas sub-sea pipelines. First oil production from Phase 1 is scheduled for early 2005. An ESIA was carried out for the Phase 1 Development and the final document was submitted to the MENR in February 2002 for approval. Approval for the Phase 1 development was granted in April 2002.

Phase 2 has commenced detailed engineering whereas Phase 3 development designs are conceptual at present and a number of options are under consideration.

Phase 2 will be designed to develop the remaining part of the Azeri reservoir to the west and east of the Phase 1 development and will probably include two fixed production and drilling facilities, a new 30" sub-sea oil pipeline, in-field sub-sea pipelines and further expansion at the Sangachal terminal. First oil production from Phase 2 is anticipated in 2006.

Phase 3 will develop the Deep Water Gunashli reservoir and facility concepts under consideration also include fixed offshore facilities, in field subsea lines and a new 30" sub-sea gas pipeline to shore if not installed during Phase 1. It is anticipated that the 24" EOP pipeline will be reconverted from gas service back to oil service (if converted during Phase 1). Phase 3 development is planning for first oil production in 2008.

ESIAs for both the Phase 2 and Phase 3 developments will be carried out in the future before work on these developments begins.

1.4.2.3 Baku-Tblisi-Ceyhan Main Export Pipeline

The proposed Baku-Tblisi-Ceyhan (BTC) pipeline will transport oil from the Sangachal terminal through Azerbaijan, Georgia and Turkey to the Mediterranean Sea port at Ceyhan. The length of the pipeline totals around 1,750 km and, with a proposed diameter of 42", will have a peak capacity of one million barrels of oil per day. At present the pipeline is in the Detailed Engineering Stage. The construction phase will take up to 32 months. Construction is planned in order for the pipeline to be in place in time to deliver the first oil from the ACG Phase 1 development; that is, by early 2005.

1.4.2.4 Inam and Alov Projects

Inam is located in the South Caspian basin at a distance of only 40 km from the shore and in shallow water depths (Figure 1.5). To date one exploration well has been drilled in the field. Drilling has been suspended due to high pressure in the field.

The Alov field, further offshore to the south west of Baku, is located in water depths of between 450 m and 1,000 m and is still in the exploration phase. Operated by BP, exploration of the field was suspended due to a confrontation with Iranian gunboat in July 2001. Resumption of survey activities is dependent on a resolution of Caspian Sea borders between Azerbaijan and Iran. The field is estimated to have 4 billion barrels of oil.

1.5 BP HSE Policy and Upstream Environmental Expectations

BP is committed to ensuring that the principles and expectations contained within the BP Amoco document "What We Stand For" are applied to all aspects and phases of all business operations. The principles focus on five key areas:

?? Ethical conduct;
?? Employees;
?? Relationships;
?? HSE performance; and
?? Control and finance.

These principles seek to encourage safer and more secure employment, increase efficiency, improve job satisfaction and provide a better-trained workforce within all business operations. The HSE principle reflects BP's commitment to health, safety and environmental performance *"no accidents, no harm to people and no damage to the environment"* as endorsed by the Chief Executive Officer.

HSE expectations to be adopted by all BP managers and the boundaries within which all BP managers must operate are further described in the document "Getting HSE Right", which provides a broad-based set of expectations collated into a series of thirteen elements of accountability, and which forms the central part of the BP HSE Management System Framework. The document covers:

?? HSE risk management including personal security;
?? Technical/operational integrity of facilities and equipment; and
?? Product stewardship.

"Getting HSE Right" will be adhered to during the Stage 1 project.

The HSE Management System Framework is designed to assist managers in the delivery of continually improving HSE performance by focusing managers on critical HSE requirements, through the application of the thirteen elements of accountability as follows:

?? Leadership and Accountability;
?? Risk Assessment and Management;
?? People, Training and Behaviours;
?? Working with Contractors and Others;
?? Facilities Design and Construction;
?? Operations and Maintenance;
?? Management of Change;
?? Information and Documentation;

?? Customers and Products;
?? Community and Stakeholder Awareness;
?? Crisis and Emergency Management;
?? Incident Analysis and Prevention; and
?? Assessment, Assurance and Improvement.

This Framework links into BP's commitment to HSE whilst at the same time driving the processes, procedures and management systems implemented by individual Business Units. Staff at all levels of the organisation are responsible for health, safety, technical integrity and environmental goals and objectives. Best demonstrated practice, good operating procedures and information on new technology are shared between Business Units and through discussions to ensure that lessons learned are shared and adopted. Auditing and monitoring programmes are used to confirm that systems and processes are in place and working effectively.

BP has also set global Upstream Environmental Expectations with the aim of continued improvement towards the stated goal of *"no damage to the environment"*. The expectations cover long-term focus on the following issues:

?? halocarbons;
?? well testing;
?? greenhouse gas emissions;
?? air emissions;
?? discharges to water;
?? disposal to land, and
?? local environmental protection.

Continued improvement is achieved by setting performance targets within each Business Unit. Targets depend on site-specific circumstances. Performance against the set targets is audited and monitored.

The general environmental requirements laid down in the Shah Deniz PSA will be applied to Shah Deniz Stage 1. In addition, environmental standards will be developed in conjunction with SOCAR and the MENR taking into account Caspian characteristics, international petroleum industry standards and Azerbaijan environmental legislation as stipulated by the PSA.

The environmental and socio-economic assessment process findings are presented in this ES. Details of the environmental and social mitigation and management measures that will be instigated for Stage 1 to ensure that the goals, objectives and requirements of the Shah Deniz PSA are met are included in this document (Chapters 14 and 15).

1.6 Environment and socio-economic impact assessment

1.6.1 Objectives

The overall objective of the Environment and Socio-Economic Impact Assessment (ESIA) process for the Shah Deniz Stage 1 development is to ensure that any adverse environmental or socio-economic impacts arising from Stage 1 project activities are identified and where possible, eliminated or minimised through early recognition of and response to the issues. The purpose of the ESIA is to:

?? ensure that environmental considerations are integrated into the project planning and design activities;

?? ensure that a high standard of environmental performance is planned and achieved for the project;
?? ensure that environmental and social aspects and impacts are identified, quantified where appropriate, and assessed and mitigation measures proposed;
?? ensure that legal and company policy requirements and expectations are addressed;
?? consult with all of the project stakeholders and address their concerns; and
?? demonstrate that the project will be implemented with due regard to environmental and social considerations in mind.

Potential impacts of all stages of the project are evaluated against applicable environmental standards, regulations and guidelines, the existing environmental conditions, and issues and concerns raised by all project stakeholders. Evaluation of the implementation, quality and effectiveness, of existing and planned environmental controls and monitoring and mitigation measures are also considered.

The Stage 1 development planning is currently underway, which allows for the ESIA team to feedback to the design engineers any environmental and socio-economic issues identified during the process. Consideration of these issues can then be incorporated into the design and planning of the final development.

1.6.2 Structure of the Environmental Statement

This Environmental Statement has been compiled to report the findings of the detailed ESIA process. It is presented in the following Sections:

Executive Summary	A summary of the Environment Statement report.
Units and Abbreviations	A list of the units and abbreviations used in the ES
Glossary	A glossary of terms.
Introduction	A general introduction to the Stage 1 project in the context of other projects underway or proposed for the region, the composition and HSE policies of the project proponent, the objectives of the assessment, and the report structure of the ES.
Policy Legal and Administrative Framework	A summary of relevant national and international environmental standards and guidelines, BP project environmental standards and expectations and the HSE requirements set out in the Shah Deniz PSA.
ESIA Methodology	A description of the methods used to conduct the ESIA.
Options Assessed	A description of the alternative concept options assessed for the Stage 1 Project.
Project Description	A detailed description of the Stage 1 Project.
Environmental Baseline	A description of the environmental baseline conditions in the vicinity of the Stage 1 Project activities.

Socio-Economic Baseline	A description of the socio-economic baseline conditions in the vicinity of the Stage 1 Project activities.
Consultation	An overview of the consultation undertaken during the ESIA programme and the issues and concerns raised.
Environmental and Socio-Economic Aspects	Determination of all environmental and socio-economic aspects associated with the Stage 1 Project.
Potential Environmental Impacts	An assessment of the potential environmental impacts associated with the Stage 1 development.
Potential Socio-Economic Impacts	An assessment of the potential socio-economic impacts associated with the Stage 1 development.
Cumulative Impacts	An assessment of the potential cumulative impacts arising from the interaction between the Shah Deniz Stage 1 Project and other projects.
Transboundary Impacts	An assessment of the potential transboundary impacts arising from the Shah Deniz Stage 1 Project.
Environmental Mitigation and Monitoring	A description of environmental management systems and plans in place, further mitigation measures proposed, and monitoring measures.
Socio-Economic Mitigation and Monitoring	A description of socio-economic management systems and plans in place, further mitigation measures proposed, and monitoring measures.
Conclusions	Conclusions arising from the ESIA process.
References	A list of all of the literature sources referred to in the ES.
Appendices	Supporting technical information.

1.6.3 Additional Studies

As part of the ESIA process, a number of studies have been conducted to provide additional information to augment the existing knowledge base so that an informed impact assessment study may be carried out. The findings from these studies have been integrated into this ES and have provided the base for impact assessment and the development of the mitigation and monitoring plan.

The additional studies conducted were:

Atmospheric Emissions Dispersion Modelling Study	Air dispersion modelling of estimated air emissions from the terminal and offshore facilities was conducted in 2001 and studies are ongoing in 2002.

Marine Dispersion Modelling	Modelling of cooling water discharges offshore including temperature plume dispersion. Chemical plume dispersion modelling is ongoing in 2002. Modelling of drilled cuttings discharge dispersion characteristics. Modelling of sewerage discharge dispersion. Modelling of cement discharge dispersion.
Condensate Spill Risk Assessment	Identification of potential spill risks and spill scenarios from offshore facilities and sub-sea pipelines. This risk assessment was conducted in June/July 2001.
Condensate Weathering Study	A study was undertaken in June/July 2001 for the determination of condensate weathering characteristics and OSIS constants. The results were also used to complete a preliminary assessment of the effectiveness of a standard dispersant.
Condensate Spill Dispersion Modelling	The spill trajectory and fate of condensate and diesel fuel spill scenarios was determined in June/July 2001 using the OSIS model (Oil Spill Information System). Spill scenarios were developed from the condensate spill risk assessment carried out.
Sea Grass and Red Algae Study in Sangachal Bay	Characterisation of the distribution and type of marine flora in Sangachal Bay. This study was undertaken in July 2001.
Sediment Transport and Nearshore Hydrodynamic Study in Sangachal Bay	This study was conducted in June 2001 to provide a characterisation of nearshore of sediment dynamic, sediment transport and hydrodynamic regime in Sangachal Bay.
Soil and Groundwater Investigation at Sangachal Terminal	A survey was undertaken in May 2001 to provide a characterisation of soil type, contaminant status of surface and subsurface soils and determination of groundwater depth and conditions in the vicinity of the Sangachal Terminal.
Terrestrial Flora and Fauna Study at Sangachal Terminal	A baseline survey of terrestrial flora and fauna at and in the vicinity of the Sangachal Terminal was undertaken in May/June 2001.
Archaeology and Cultural Heritage Study at Sangachal	The baseline survey of archaeological property sites and features at and in the vicinity of the Sangachal Terminal was undertaken in May/June 2001.
Socio-Economic Baseline Data Gathering at Sangachal District.	A Baseline survey to characterise socio-economic environment at the local and regional level within areas of the proposed development was undertaken from April – August 2001.

Technical reports have been prepared for each specific study and these are included in the Technical Appendix to this ES. Additional reports will be prepared as addendums to this ES for those studies that are ongoing in 2002.

The scope and focus of the studies was defined so as to address concerns raised during the early scoping work undertaken as part of the ESIA process. In many of the studies, local Azerbaijani experts were involved thereby ensuring the best opportunity for the project to benefit from local knowledge of the natural and socio-economic environment in which project activities are proposed.

2. Policy, Regulatory and Administrative Framework

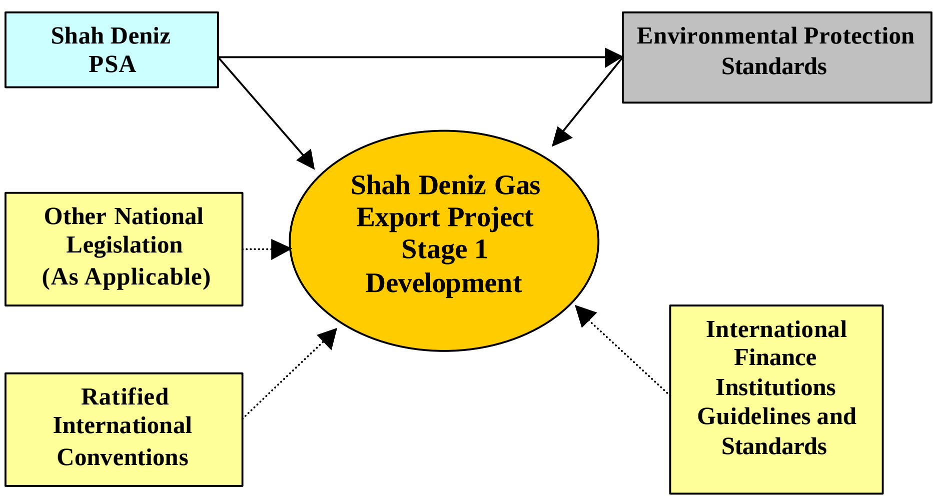
2.1 Introduction

The Shah Deniz Gas Export Project Stage 1 Development is subject to the terms and conditions of the Shah Deniz Production Sharing Agreement (PSA). Article 26.1 of the PSA requires BP and its Shah Deniz Partners to develop and implement specific Environmental Protection Standards (EPS) appropriate to petroleum operations, taking into account the specific nature of the Caspian, international oil and gas industry experience, technical feasibility and economic and commercial viability.

Beyond the framework of the PSA, the project will also be undertaken with due regard to international conventions as ratified by the Azerbaijan government. In addition, as some member companies of Shah Deniz may seek funding from International Finance Institutions (IFI), BP has consulted with the major lending institutions in regards to their requirements. Applicable national and international guidelines and standards have also been reviewed as part of this ESIA in order to ensure that the development is undertaken in a manner that is compliant with these guidelines and standards.

Figure 2.1 provides a visual summary of legislative framework relevant to the Shah Deniz Gas Export Project.

Figure 2.1 Legislative Framework of the Shah Deniz Stage 1 Project



Statutory Requirements.

Environmental Protection Standards (currently being developed).

Other legislation, guidelines and standards.

The following sections present an overview of each of these key elements of the legal and policy framework for the Shah Deniz Gas Export Project.

2.2 The Shah Deniz Production Sharing Agreement

The Shah Deniz PSA is the legally binding agreement for the joint development and production sharing for the Shah Deniz field. This contract, signed by BP, its international partner companies and the State Oil Company of the Azerbaijan Republic (SOCAR), was entered into in Baku in June 1996. It was subsequently enacted into Azerbaijani law on 17th of October 1996.

Article 26.1 of the PSA requires that the partners jointly develop Environmental Protection Standards (EPS) with SOCAR and the Ministry of Ecology and Natural Resources (MENR) taking into account Caspian characteristics, international petroleum industry standards and Azerbaijan environmental legislation. Article 26.1 also requires that in compiling such standards and practices, environmental quality objectives, technical feasibility and economic and commercial viability must also be taken into account. Article 26.4 stipulates that the partners comply with both present and future Azerbaijan laws and regulations to the extent that they are no more stringent than the standards set forth in the PSA.

Relevant sections of the Shah Deniz PSA are presented in the Technical Appendix 1 to this ES.

2.3 Project Health, Safety & Environment Design Standards

EPS for Shah Deniz exploration were prepared and agreed, in 1998, with the former Azerbaijani State Committee for Ecology and all Shah Deniz stakeholders. These incorporate a number of standards covering the following items:

?? deepwater seismic surveys;
?? drilling, completion and cementing fluids management and cuttings disposal;
?? well testing;
?? well plugging and wellhead removal;
?? materials handling and storage;
?? atmospheric emissions and energy efficiency;
?? domestic and accommodation effluents;
?? rig drainage;
?? waste management; and
?? oil spill risk and oil spill response management.

To supplement the existing exploration EPS, a framework is being prepared for developing the specific standards that are currently being developed to cover the production and development phases of the Shah Deniz project. The key principles on which these standards will be developed include:

?? Sustainable Development Processes;
?? Best Available Technology;
?? Best Practicable Environmental Option;
?? Environmental Quality Standards; and
?? Self-Regulation based on Performance Measurement.

A key environmental premise applied in the design of the Shah Deniz project is "Zero Environmental Damage" (from *BP's Upstream Environmental Performance Guidelines for New Projects and Developments)* that establishes a conceptual Zero Damage Base Case

(ZDBC) and provides the optimum outcome for the environment. Importantly, "Zero Environmental Damage" is the start point for the decision-making process, which leads to the development of project specific Environmental Goals. These goals provide the environmental parameters within which the project's design evolves and develops. By keeping the project design within these parameters, the project will cause zero if not negligible damage to the environment. Conversely, should the project design develop outside these parameters, the project may have an impact on the environment, necessitating justification of the projects' particular requirement and subsequent development of mitigation measures.

The zero damage approach together with proposed production and development EPS shall therefore, broadly align to provide guidance for high-level environmental performance.

The production and development EPS being developed for the Shah Deniz Stage 1 project include:

?? Approval and Permitting Process for Major, Minor Projects and Variations to Previously Issued Permits;
?? Environmental Quality Standards;
?? Environmental Management and Planning;
?? Environmental risk evaluation and management;
?? Assessing Best Available Technology (BAT);
?? Production Operations and Maintenance;
?? New Developments and Modifications;
?? Facility and Infrastructure and Decommissioning;
?? Chemical Selection and Management;
?? Oil/Chemical Spill Contingency Planning; and
?? Waste Management.

Under the PSA, the responsibility for the development of the Shah Deniz EPS lies with the BP and the PSA Partners. The standards will however, be developed in close cooperation with the MENR, SOCAR and other interested parties. The process described in the Technical Appendix 1 shall be used to set, vary or delete an EPS.

2.4 International conventions

The Azerbaijan Republic has entered into and ratified a number of international conventions and many within the last year. Although not required by the Shah Deniz PSA, BP will endeavour to assist the government in meeting their obligations with respect to these conventions. The conventions relevant to the Shah Deniz Gas Export Project include:

?? 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes;
?? 1985 Vienna Convention for the Protection of the Ozone Layer and Montreal Protocol (1990) and Copenhagen amendments (1992);
?? 1979 Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention);
?? 1972 Convention for the Protection of the World Cultural and National Heritage;
?? 1992 Convention on Biological Diversity;
?? 1994 Convention to Combat Desertification;
?? 1971 Convention on Wetlands (Ramsar Convention);
?? Applicable International Labour Organisation conventions;
?? 1973 Convention on the Prevention of Pollution from Ships and Protocol 1978 (MARPOL 73/78 Annexes I and II);

?? 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (The London Dumping Convention);
?? 1992 United Nations Framework Convention on Climate Change (Climate Change Convention);
?? 1991 Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention); and
?? 1998 Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention).

The following conventions are particularly relevant to the ESIA process for the Stage 1 development:

1998 Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention)

The objective of the Convention is to ensure the right of access to information, public participation in decision-making, and access to justice in environmental matters, in order to protect people's rights to a healthy environment. The convention sets out the following:

?? Obliges public authorities to make sure that environmental information is available to the public upon request without discrimination and without having to state an interest. Although provisions are made for limitation of access to certain types of environmental information, this limitation is not strict and should take into account the public interest served by the disclosure. The Convention encourages public authorities to collect environmental information regularly and disseminate it in the form of computerised and publicly accessible database.
?? Entitles the public to participate in the environmental decision-making concerning a wide range of economic activities, not only those covered by environmental impact assessment procedures. Government authorities should ensure that the public is involved at as early stage of the project planning as possible when various project options are open for discussion. Public participation should also take place in the preparation of environmental plans and programmes, and to a lesser degree, in the preparation of policies.
?? Ensures that anyone who considers that his or her request for information has been inadequately dealt with has access to court for a review procedure.

1991 Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention)

This Convention was signed in Espoo, Finland by governments of European Countries, the United States and the European Community in 1991. Azerbaijan later ratified the Convention in 1999. The main objective of the Convention is to promote environmentally sound and sustainable economic development, through the application of ESIA, especially as a preventive measure against transboundary environmental degradation.

Although the Convention does not specifically deal with public participation in environmental decision-making, it sets forth the requirement for a country in which a proposed activity is to be undertaken to provide an opportunity for involvement in the ESIA process to the public of those countries likely to be affected. Comments on the project are then fed back to the project country's relevant authorities for consideration. Under the terms of this Convention therefore, Azerbaijan is required to notify other contracting states if there is a potential impact upon their environment, resulting from a development on the territory of Azerbaijan including its waters. This notification can be done directly or through a third party coordinator.

In the strictest sense however, the Espoo Convention is only applicable if both the party conducting a proposed project and the affected party have ratified the Convention. The only other Espoo signatory parties bordering Azerbaijan or the Caspian include Armenia and Kazakhstan. Should potential transboundary impacts to these countries be identified, these countries should be notified of the project by the relevant Azerbaijan authorities. Notified countries are required to respond as to whether they wish to participate in the ESIA process. Should these countries wish to participate, Azerbaijan should ensure that the public of these countries be provided with the opportunity to participate in the ESIA process equivalent to that provided to the public of Azerbaijan.

1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes

The main objective of this Convention is to prevent, control or reduce any transboundary impact resulting from the pollution of transboundary waters caused by human activity. Transboundary waters are defined as those surface or ground waters that are located on or pass into the boundaries of another convention state. As the Caspian is bordered by four other states, two of which are Parties to the convention, it is considered a transboundary watercourse. Article 16 of the Convention contains requirements for public information. Under these requirements, Azerbaijan should ensure that information on the conditions of transboundary waters, measures taken to control, reduce and mitigate transboundary water pollution and effectiveness of these measures are made available to the public. The information that should be made available to the public includes:

?? water quality objectives;
?? permits issued and the conditions required to be met; and
?? results of analysis of water sampling carried out for monitoring and assessment and results of checking compliance with water quality objectives.

The Parties have to ensure that the information is made immediately available to the public of their states, and is free of charge. Azerbaijan authorities should provide the information to littoral Parties of the convention, which include the Russian Federation and Kazakhstan, upon reasonable payment.

1973 Convention on the Prevention of Pollution from Ships and Protocol 1978 (MARPOL 73/78 Annexes I - II)

As a signing member to the International Maritime Organisation (IMO) MARPOL 73/78 Convention (Annex I and II to date), Azerbaijan may also seek to adhere to the standards regulating certain discharges from ships. The MARPOL definition of a ship includes fixed or floating platforms, therefore the Azerbaijan government may view the Stage 1 development in this category. At the outset however, it is important to point out that in the international arena the application of MARPOL 73/78 to platforms is not settled and has not been interpreted uniformly by all states.

Annex I of this convention is primarily aimed at oil tankers and sets standards for ships including retaining oily wastes on board, oil/water separation, discharge monitoring systems, segregated ballasts, crude oil washing and double hulls. All ships including platforms are however, to be regulated in terms of machinery space discharges; in effect, machinery space discharges are only allowed under the following conditions:

?? the ship is not in a "special area" (the Caspian is not designated a special area under this convention);
?? the oil content is <15 ppm oil-in-water;

?? the ship is proceeding en route; and
?? the ship has oil discharge monitoring and control system and oil filtration equipment.

In addition, an emergency plan for oil pollution response is also required under a 1991 amendment.

Annex II of this convention sets mandatory discharge criteria for noxious substances (or mixtures containing noxious substances) carried in bulk. As it is likely that substances will be transported in bulk for Stage 1 (e.g. diesel for re-fueling), the Azerbaijan government may seek to apply this Annex. The substances are categorised into four categories, with Category A being the most hazardous. The Annex prohibits release of these substances according to the following parameters:

?? maximum quantity of substance that may be discharged;
?? speed of ship;
?? distance from nearest land;
?? depth of water;
?? maximum concentration in the ship's wake; and
?? dilution of substance prior to discharge.

Discharge of any noxious substance is prohibited within 12 miles of the nearest land and more stringent requirements are in force for special areas (the Caspian is not considered a special area). Category A discharge to a reception facility is mandatory unless the discharge occurs from a completely emptied, washed tank to which clean water has been added.

2.5 International Finance Institution Environmental and Social Guidelines

As external project finance may be sought on behalf of some shareholders of Shah Deniz, environmental and social standards, practices and guidelines set forth by IFI have been reviewed in the preparation of this ESIA. Potential IFI include:

?? World Bank Group (WBG) including potentially the International Finance Corporation (IFC) and Multilateral Investment Guarantee Agency (MIGA);
?? European Bank for Reconstruction and Development (EBRD);
?? United States Export-Import Bank (US ExIm);
?? Overseas Private Investment Corporation (OPIC);
?? Other Multilateral Lending Agencies (MLAs); and
?? Other Export Credit Agencies (ECAs).

2.5.1 World Bank Group

The WBG comprises a number of organisations for private investment projects including the International Finance Corporation (IFC) and Multilateral Investment Guarantee Agency (MIGA). WBG members apply industry-specific guidelines set out in the World Bank's Pollution Prevention and Abatement Handbook (PPAH). For the most part, where a guideline is not covered in the PPAH, the IFC has developed a guideline. Used in conjunction with each other, these guidelines cover the major industries including both onshore and offshore oil and gas development projects. In particular, the following policies and guidelines from the WBG have been reviewed as part of Shah Deniz Stage 1 ESIA process:

?? IFC Environmental, Health and Safety Guidelines, Oil & Gas Development (Offshore), 2000;

?? IFC Environmental, Health and Safety Guidelines, Gas Terminal Systems, 1998;
?? World Bank Standards, Oil & Gas Development (Onshore), 1998; and
?? World Bank Operational Policy 4.01, Environmental Assessment.

In addition, EBRD policies and guidelines were also reviewed as part of Stage 1 ESIA process including:

?? EBRD Public Information Policy, 2000; and
?? EBRD Environmental Procedures.

2.6 National legislation

As indicated in Section 2.1, the Shah Deniz PSA sets out the national Azerbaijan environmental legislation specific to the exploration and development of the contract area. As part of the ESIA process, other relevant national environmental legislation was also reviewed for the Stage 1 project and particularly where such was more stringent than or in conflict with international legislation. Particular regard was given to the environmental impact assessment process.

2.6.1 Environmental and Social Impact Assessment

In Azerbaijan, major private and public developments require the preparation of an impact assessment report. The objective of the impact assessment process is to provide a means whereby adverse effects can be identified and either avoided or minimised to acceptable levels. Although the Shah Deniz PSA does not specifically require an impact assessment report to be prepared, BP is undertaking an ESIA process in the interests of it and Shah Deniz Partners' policies, IFI requirements and best practice.

The fundamental principle of the ESIA is applied by the MENR (Section 2.6.2) using the *Law of the Azerbaijan Republic on Environmental Protection, 1999* and the *Handbook for the Environmental Impact Assessment Process, 1996* (with the assistance of the United Nations Development Programme). The handbook includes requirements for scientific expertise and public consultation. Following its submission to the Ministry, the document is reviewed for up to three months by an expert panel.

BP has incorporated the elements of this handbook in the Stage 1 ESIA process.

2.6.2 Azerbaijan regulatory agencies

The main environmental regulatory body is the MENR, recently formed from the merger of four state organisations including the State Committee for Ecology, State Committee for Hydrometeorology, State Forestry Committee, and the State Committee for Geology. This body is responsible for the following:

?? development of draft environmental legislation for submission to the Parliament (Milli Mejlis);
?? implementation of environmental policy;
?? enforcement of standards and requirements for environmental protection;
?? suspension or termination of activities not meeting set standards;
?? advising on environmental issues; and
?? expert review and approval of environmental documentation including Environmental Impact Assessment.

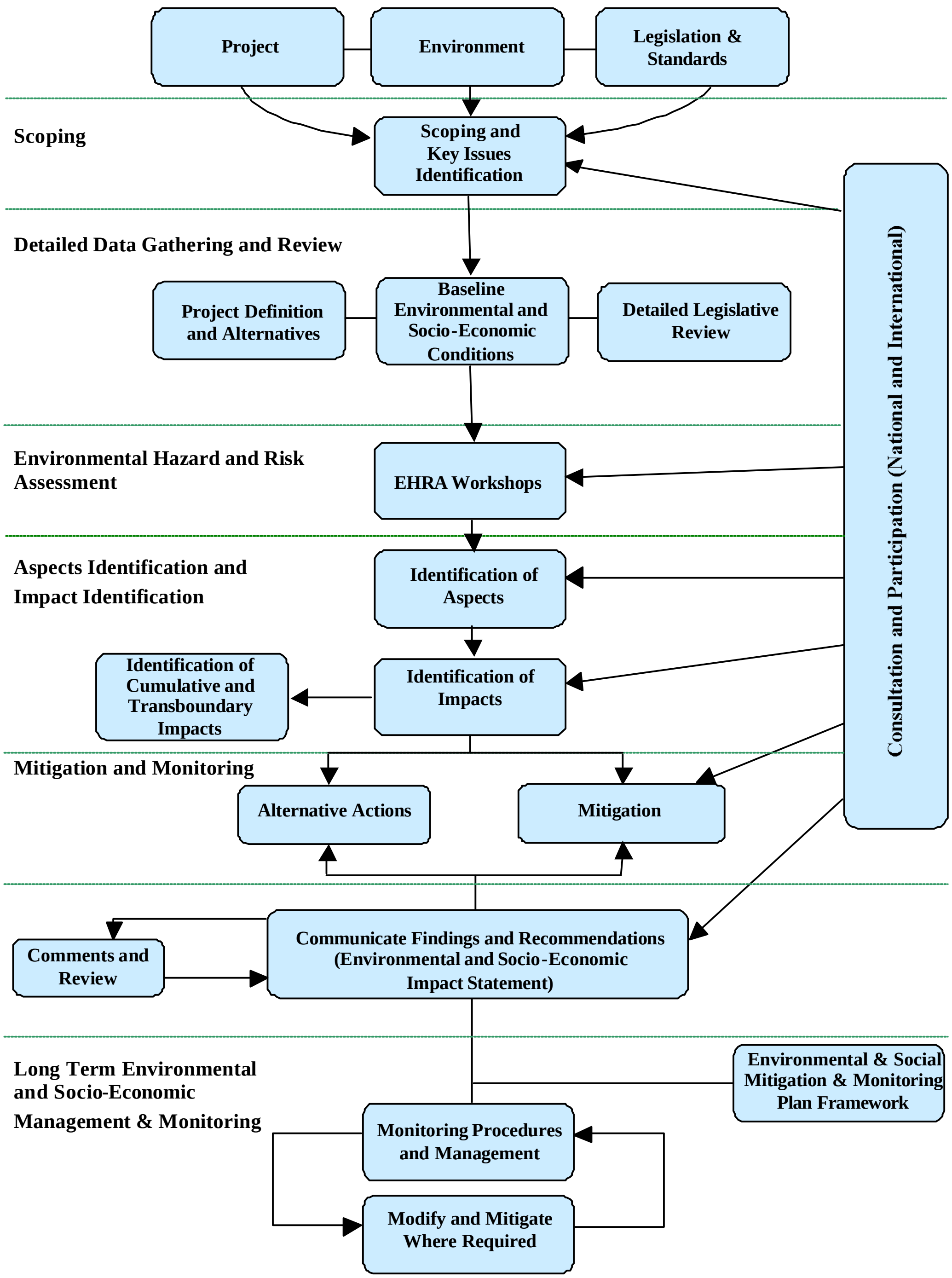
In addition, the responsibility for implementation of the requirements set out in international environmental conventions ratified by the Azerbaijan Republic lies with the Ministry. Further definition of the roles and responsibilities of this new organisation are anticipated within the future as the reorganisation proceeds.

3 Environmental and Socio-economic Impact Assessment Methodology

3.1 Introduction

The Environmental and Social Impact Assessment (ESIA) process incorporates a number of key steps as illustrated in Figure 3.1. The assessment process constitutes a systematic approach to the evaluation of a project in the context of the natural, regulatory and socio-economic environments of the area in which development is proposed.

Figure 3.1 The ESIA process



The following Sections describe each of the assessment process steps illustrated in Figure 3.1.

3.2 Scoping

The first step in the ESIA is to define the proposed project activities and the natural, regulatory (i.e. legal) and socio-economic environments in which these activities will occur. This is achieved through scoping. Scoping identifies which of the activities has a potential to interact with the environment. Scoping is conducted early in the ESIA process so that a focus on the priority issues (i.e. those that have the greatest potential to affect the natural and/or socio-economic environment) can be established for the rest of the ESIA process.

There are a number of key elements to the scoping exercise as follows:

?? Gather and review existing environmental and socio-economic data relevant to the proposed development area; that is, the area in the vicinity of the existing Sangachal terminal and in the offshore and nearshore environments in which developments are proposed.
?? Gather and review existing engineering design definition with respect to the proposed development. All project elements have been considered including fabrication, transportation, construction and installation, commissioning, operations, maintenance and decommissioning. Routine, planned but non-routine and unplanned (i.e. accidental) events are considered.
?? Assemble and review relevant legislative requirements, environmental standards and guidelines (national and international) associated with the proposed development as well as BP (operator) and Shah Deniz partner policy.
?? Consult with project stakeholders and other potentially interested and affected parties.

Scoping also helps identify gaps in the environmental, socio-economic and engineering information that need to be addressed so that an informed impact assessment can be completed. The results of the scoping exercise have been presented in a Scoping Report.

3.3 Detailed data gathering and review

Following scoping, assembled legislative requirements, engineering, environmental and socio-economic data were assessed in greater detail to ensure that all of the proposed activities and their consequences were considered in full.

3.3.1 Existing environmental conditions

In order to identify any potential impact on and potential change to the natural and socio-economic environments, it is essential to have a thorough understanding of the nature of those existing environments prior to commencement of the proposed activities. This translates as a need to characterise the existing baseline environmental and socio-economic conditions including establishing the prevailing conditions for a range of media as follows:

?? natural environment media such as air, water, soil and groundwater, flora and fauna; and
?? socio-economic media such as demographics, economic activity and service provision.

Definition of the existing environmental conditions was achieved by completing two main tasks as follows:

?? Conducting a detailed review of all secondary data sources (i.e. existing documentation and literature). Significant environmental data acquisition surveys and studies have been carried out in the Sangachal area and in the vicinity of the Shah Deniz PSA Contract Area offshore. Such studies include the 1998 Shah Deniz Baseline Survey and Environmental Impact Assessment as well as studies undertaken for the BP-operated Azerbaijan International Operating Company (AIOC). Data from these studies and other relevant historical studies has been used in the ESIA process.

?? Undertaking primary (baseline) studies to collect data required to supplement and build upon the existing information base. Additional field surveys and data acquisition programmes were implemented as part of the ESIA process to supplement the existing information base especially where existing data was found during the project scoping exercise to be sparse and/or less reliable than desired. These included surveys of flora and fauna (in both onshore and offshore environments), soil and groundwater sampling and a survey of the cultural heritage in the vicinity of the existing Sangachal Terminal. In addition, a socio-economic baseline survey was completed for local (Sangachal) and regional (Garadag District) environments. This survey also assessed marine-based industries such as fishing.

The existing secondary sources and results of the primary studies have been analysed and integrated into coherent descriptions of baseline characteristics. These are presented in Environmental Description (Chapters 6) and Socio-economic Baseline (Chapter 7) of this ES. Technical reports detailing the full results of the primary studies are included in Technical Appendices 8 to 13.

3.3.2 Project alternatives and definition

3.3.2.1 Alternatives

A number of engineering design concepts were studied before arriving at the current project concept. The process applied to engineering alternatives attempted to highlight the key advantages and disadvantages of each concept, together with a view on the level of confidence in each concept against agreed themes.

The themes used to consider the relative differences in the selection of the offshore facilities concepts included:

?? Health, Safety and Environment;
?? Design & Technical Issues;
?? Project Execution;
?? Drilling Issues; and
?? Operational Aspects.

The key issues within each category are identified and the overall view of the relative merits of each of the concepts documented in Decision Support Packages (DSPs). Engineering design is developed in five distinct stages culminating in Detailed Design and Execution of the project. The above themes are used in an iterative manner to assess and select increasingly more specific aspects of the project design.

For all aspects of the project design that have a significant potential to interact with the environment, BP Upstream Environmental Expectations require that a more detailed environmental assessment of the options be undertaken. The Expectations state that, “All new Projects will demonstrate World Class Performance" and the associated Environmental Performance Guidelines for New Projects are designed to help deliver this aim in the most cost effective manner. The Guidelines require projects to consider Zero Environmental Damage as the starting point and to develop a series of engineering options to achieve the zero base case. Variations away from this base case must be evaluated and justified using the following evaluation criteria:

?? technical feasibility;
?? safety;
?? legislation/legal compliance;
?? good engineering practice;
?? environmental damage cost factors;
?? reputation;
?? expert judgement; and
?? optimum environmental alternative.

Chapter 4 presents a summary of how the preferred base case project design was established and, where appropriate, the environmental and socio-economic implications that were considered. Where alternatives within the base case design existed, the opportunity to provide feedback on environmental and socio-economic factors was achieved as discussed below.

3.3.2.2 Definition

Project and ESIA environmental engineers have worked alongside design engineers to gather and interpret relevant environmental and engineering design information. Information gathered for the proposed Shah Deniz Stage 1 project was reviewed, assessed and delivered to the assessment team.

Continuous interaction between the environmental and engineering teams has allowed the ESIA process to influence the project design when there was a requirement for further development of the programme or the mitigation measures being proposed as an integral part of the base case design. The base case design has, for the purposes of this ESIA, been condensed into a Project Description as presented in Chapter 5.

3.3.3 Detailed legislative review

The legislative context of the Shah Deniz Stage 1 project is described in Chapter 2. The BP Upstream Environmental Performance Guidelines for New Projects played a significant role in helping to ensure that the project will meet or exceed relevant environmental regulations and guidelines as well as BP environmental policy. For environmental aspects of the project that cannot be engineered out, environmental mitigation and management proposals will be developed to deliver compliance with or exceedance of relevant national and international standards.

3.4 Environmental hazard and risk assessment

Environmental Hazard and Risk Assessment (EHRA) is a process whereby the impact assessment team can:

?? confirm its understanding of the project with the design engineers;
?? identify to the design engineers areas of potential environmental concern, and
?? jointly develop alternatives so that potential impacts can be proactively mitigated.

Following description of the proposed project development and environmental and socio-economic conditions, a series of EHRA workshops were conducted. These workshops were held to identify the potential environmental hazards associated with each proposed activity. Participants included key project engineers and Health, Safety and Environment (HSE) advisors. Members of the environmental and socio-economic impact assessment team facilitated the sessions.

The workshops focussed on specific areas as follows:

- offshore facility fabrication, transport, construction, commissioning and installation;
- drilling;
- offshore production operations and processes;
- subsea pipeline fabrication, transport, construction, installation, commissioning and operation;
- terminal construction, installation and commissioning, and
- terminal operation and processes.

Each workshop allowed input from all workshop participants in the identification of potential environmental hazards associated with the subject project activities and the evaluation of possible alternatives and options. Each workshop was also used to confirm the impact assessment team's understanding of the project design and as an opportunity to gather additional information on the project where necessary.

The workshop process considered each activity that will, or may, occur during the project including:

- planned routine activities;
- planned but non-routine activities, and
- unplanned or accidental activities.

This process culminated in the development of a list of activities and the identification of potential corresponding environmental hazards. It is important to note that existing mitigation measures designed into the project were considered during the workshops.

3.5 Consultations

Project stakeholder consultation is a vital component of the ESIA process. The consultation process focuses on providing information on the proposed project in a manner that can be understood and interpreted by the audience, seeking comment on key issues and concerns, sourcing accurate information, identifying potential impacts and offering the opportunity for alternatives or objections to be raised by the potentially affected parties; non-governmental organisations, members of the public and other stakeholders. Consultation has also been found to develop a sense of stakeholder ownership of the project and the realisation that their concerns are taken seriously, that the issues they raise, if relevant, will be addressed in the ESIA process and will be considered during project design refinement.

Consultation with all project stakeholders for Shah Deniz Stage 1 began in November 2000 during workshops held to disseminate information about Shah Deniz Full Field Development and to receive feedback from key stakeholders. More detailed consultation commenced in March 2001 during the scoping phase of the Shah Deniz Stage 1 ESIA and will continue throughout the entire ESIA process and into execution of the project. All relevant stakeholders were identified using the most recent and accurate information available. This has ensured that people who may be affected by or have an interest in the proposed project have had an opportunity to express their opinions and concerns. Views have been sought at a local, regional and national level. An ESIA Public Consultation and Disclosure Plan (PCDP) was developed and includes:

?? the consultation methods employed for the ESIA;
?? a list of stakeholders consulted, and
?? a summary of the issues and concerned raised.

3.6 Environmental and socio-economic aspects and impacts identification

3.6.1 Definition of environmental aspects

The International Standard Organisation's standard for Environmental Management Systems (EMS), ISO 14001 defines an environmental aspect as:

> "A*n element of an organisation's activities, products or services that can interact with the environment*."

This definition has been used in the identification of the proposed project's environmental, legal and socio-economic aspects.

3.6.2 Identification of environmental and socio-economic aspects

To identify project environmental and socio-economic aspects all proposed activities, as initially established during the EHRA workshop process, have been considered in terms of their potential to:

?? interact with the natural environment including its physical and biological elements;
?? breach the Production Sharing Agreement, relevant international, national, industry and BP policy; and
?? interact with the existing socio-economic environment.

In addition to the above, all concerns and issues raised by members of the community and/or project stakeholders have been included as environmental / socio-economic aspects.

Assessed activities include:

?? planned routine activities;
?? planned but non-routine activities; and
?? unplanned (accidental) events.

Identified environmental aspects are presented in Chapter 9.

3.6.3 Definition of impacts

ISO 14001 defines an environmental impact as:

> *"Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services."*

An environmental or socio-economic impact may result from any of the identified project aspects; that is, activity-receptor interaction.

3.6.4 Determining impact significance

Once all project environmental and socio-economic aspects were identified, the level of impact that may result from each of the activity-receptor interactions is assessed. In assessing the level of impact that an activity may cause, two key elements are considered namely:

?? **consequence:** the resultant effect (positive or negative) of an activity's interaction with the legal, natural and/or socio-economic environments; and
?? **likelihood:** the likelihood that an activity will occur.

3.6.4.1 Consequence

To assign a level of consequence to each impact, criteria were defined for environmental and socio-economic consequence. Legal issues are embedded in both criteria sets. The environmental and socio-economic consequence criteria are presented in Tables 10.1 and 11.1, respectively. The consequence categories and their ranking are presented in Table 3.1 below. "Catastrophic" represents the most severe consequence.

Table 3.1 Consequence categories and rankings

Consequence Category	Ranking
Catastrophic	5
Major	4
Moderate	3
Minor	2
Negligible	1
None	0
Positive	+

It should be noted that it is often difficult to compare environmental impacts consistently across different natural and socio-economic environments. In evaluating the environmental and socio-economic aspects, emphasis is placed on specific cause and effect relationships.

Scientific evidence as well as predictions based on observation of previous similar activities can and have been used in the impact assessment process. Where it has not been possible to fully quantify the effect that an activity may have on the environment or a component of the environment, or where there is a lack of scientific knowledge, qualitative judgment can and has been used. Such judgments have been based on a full understanding of the proposed development, the impact assessment team's extensive experience in assessing oil and gas production activities and its knowledge of the environment of the region in which project activities will occur. In addition, the inter-connectedness of various environmental or socio-economic receptors has also been considered in the assessment of impacts. In this way, it has been assured that systemic nature of both natural and socio-economic environments has been considered.

3.6.4.2 Likelihood

To assign likelihood to each activity, five criteria were defined and ranked. The criteria for likelihood are shown in Table 3.2. Level five, "certain", represents the highest likelihood that the activity will occur.

Table 3.2 Likelihood categories and rankings natural and socio-economic impacts

Category	Ranking	Definition
Certain	5	The activity will occur under normal operating conditions.
Very Likely	4	The activity is very likely to occur under normal operational conditions.
Likely	3	The activity is likely to occur at some time under normal operating conditions.
Unlikely	2	The activity is unlikely to but may occur at some time under normal operating conditions.
Very Unlikely	1	The activity is very unlikely to occur under normal operating conditions but may occur in exceptional circumstances.

3.6.4.3 Significance

The significance of the impact is expressed as the product of the consequence and likelihood of occurrence of the activity, expressed as follows:

Significance = Consequence x Likelihood

Figure 3.2 below illustrates all possible product results for the five consequence and likelihood categories.

Figure 3.2 Consequence-likelihood product results

LIKELIHOOD \ CONSEQUENCE	1	2	3	4	5
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

Based on its consequence-likelihood score, each environmental aspect was again ranked into five categories or orders of significance as illustrated in Table 3.4.

Table 3.4 Environmental aspect significance rankings

Ranking (Consequence x Likelihood)	Significance
>16	Critical
9-16	High
6-8	Medium
2-5	Low
<2	Negligible

To assist in determining and calculating the significance of an impact, impact assessment matrices have been developed based on those developed for the aspect identification exercise (Tables 9.2 through 9.5; Chapter 9). Activities are listed on the y-axis and receptors on the x-axis. Two columns were created for each receptor; one for consequence and one for likelihood. Drop-down menus containing the criteria levels, were entered into the cells in these columns.

A second matrix was compiled to calculate the overall significance of each of the identified potential impacts. In this significant impact matrix, each receptor has only one column in which the significance of the impact (i.e. consequence x likelihood) is calculated. From this matrix, those impacts that fall into the "critical" (i.e. >16) and "high" (i.e. 9-16) can be identified. These impacts require further examination and analysis in terms of identifying activities for which additional mitigation measures may be required (Chapters 14 and 15).

The results of the environmental and socio-economic impact assessment processes are presented in Chapters 10 and 11, respectively.

3.6.5 Residual impacts

Residual impacts are impacts that remain after mitigation measures, including those incorporated into the project's base case design and those developed in addition to the base design, have been applied.

The impact assessment process described above has identified where residual impacts are likely to occur. The mitigation and management assessment (Chapter 14 and 15) identifies where environmental management effort additional to that in the base design, is required.

The residual impacts assessment identifies which project activities are likely to result in a semi-permanent to permanent change in the natural (i.e. physical, chemical, biological) and/or socio-economic environments. The significance of this change is also assessed.

3.6.6 Cumulative impacts

The December 1998 IFC "Procedure for Environmental and Social Review of Projects" states that that an environmental assessment should also address cumulative impacts (draft Guidance Note # [G]; OP 4.01). The objective of the cumulative impact assessment is to identify those environmental and/or socio-economic aspects that may not on their own constitute a significant impact but when combined with impacts from past, present or reasonably foreseeable future activities associated with this and/or other projects, result in a larger and more significance impact(s). Examples of cumulative impacts include:

?? the recurring loss of habitat in areas that are disturbed and re-disturbed over an extended period;
?? additional emissions as a processing plant is extended and expanded over a period of time, and
?? the ongoing development of employment opportunities and enhancement of local labour skills base as successive projects (related or unrelated) come on stream.

Activities proposed under the Shah Deniz Stage 1 project have been assessed in terms of their potential to:

?? cause impacts, including transboundary impacts;
?? contribute to existing environmental stresses and impacts, and

?? contribute to cumulative impacts in their own right due to the fact that the project may be immediately followed by further phases of development.

The methodology described above has also been generally applied to assess the significance of identified potential project cumulative impacts.

3.6.7 Transboundary impacts

The World Bank OP 4.01 stipulates that transboundary impacts, (i.e. impacts that cross the border of Azerbaijan into neighbouring countries) should be considered during the ESIA process. The assessment of transboundary impacts for the Shah Deniz Stage 1 ESIA examines:

?? social and economic issues relating to the sourcing of labour, goods and services from the international market;
?? air emissions;
?? discharges to the marine environment; and
?? hydrocarbon spill trajectories.

The significance of identified transboundary impacts has been assessed broadly using the methodology described above.

3.7 Mitigation and monitoring

3.7.1 Mitigation

A considerable number of mitigation measures are already included in the base project design and these have been taken into consideration during the impact assessment process. Impacts that are identified as having a significance ranking of "high" or "critical" have been further analysed to identify additional mitigation measures that are potentially available to eliminate or reduce the predicted level of impact to acceptable levels. Potential mitigation measures considered included:

?? habitat compensation programmes;
?? species specific management programmes;
?? social and economic investment programmes;
?? engineering design solutions;
?? alternative approaches and methods to achieving an activity's objective;
?? operational control procedures, and
?? management systems.

The results of the mitigation analysis are presented in Chapter 14 and 15 for the natural and socio-economic environments respectively.

3.7.2 Monitoring

It will be necessary to monitor and audit project development and operation. Monitoring will provide the information necessary for feedback into the environmental management process and will assist in identifying where additional mitigation effort or where alteration to the adopted management approach may be required.

To assist in the implementation of identified mitigation and monitoring strategies, an Environmental and Social Mitigation and Monitoring Plan (ESMMP) will be developed for the Shah Deniz Stage 1 project and will be further developed as the project progresses. It describes the various environmental management strategies and presents generic procedures for their implementation. Further, it identifies the management roles and responsibilities for ensuring that monitoring is undertaken and that the results are analysed and any necessary amendments to practices are identified and implemented in a timely manner.

It will be important for the Shah Deniz Stage 1 contractors to consider the provisions and requirements of the Plan when developing their own environmental management arrangements for the work programmes. Bridging documents linking contractor Environmental Plans to those detailed in this ESIA will be developed.

4 Options Assessed

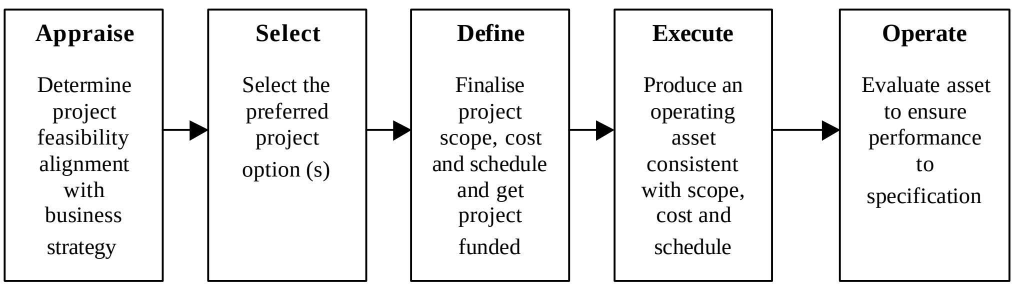
4.1 Introduction

The primary objective of the Shah Deniz Gas Export Project Stage 1 development is to produce, condition and transport to market the recoverable gas and condensate reserves in the eastern sector of the Shah Deniz field.

The project will require offshore drilling and production facilities, a means of transferring the produced hydrocarbons to shore and a gas/condensate reception/conditioning facility onshore that will process the hydrocarbons for onward delivery to market.

To achieve the primary project objective, a number of decisions have to be made as to which of the concept engineering options available best meet the specific requirements for the development. BP's Capital Value Process (CVP) provides the mechanism to sanction projects, as they pass through a number of stages, in such a way that consistency in approach across all projects is assured and which importantly, is synergistic with the standard engineering design phases. Stages of the CVP are as illustrated in Figure 4.1 below.

Figure 4.1 BP's Capital Value Process



At the time of writing this document, the Shah Deniz Stage 1 development was in the Define stage of the CVP. As part of the Appraise and Select stages, a number of alternative engineering design options, starting at a conceptual level, were considered including the "no development option". Subsequently, additional detail for each conceptual option under consideration was added through the design and planning process with each option evaluated using a number of screening criteria. Non-viable options were rejected at an early stage in the process and potentially viable options were taken forward for further consideration. This process will continue up until Execute.

This Chapter reviews the main decisions regarding the engineering and design options that have been made to date for the project components. The Project Description (Chapter 5) describes the project's base case design.

4.2 No development option

The Shah Deniz Gas Export Project has the potential to provide a number of benefits to Azerbaijan and the Caspian region as a whole. Were the project not to proceed, many of these benefits would not be realised. In particular, Azerbaijan would not benefit from the revenue generated from the export of gas and condensate from the Shah Deniz field. As most of the national share of this revenue would go to the government, a "no development option" would mean that the Azerbaijan government would not be in a position to deliver the broader benefits from gas/condensate export earnings which could (with prudent management) assist with the removal of Government budget deficits and consequently assist with positive social and environmental change in the country including government expenditure on public reform, administration programs and infrastructure modernisation and development.

Shah Deniz gas will also be sold in the Azerbaijan market that is currently unable to meet domestic requirements during periods of peak demand. By enhancing domestic supply, the Shah Deniz project would therefore help to improve living conditions for many people in the country.

Development of the Shah Deniz field will provide a range of employment and training opportunities for Azeri citizens through the project's upstream (offshore facilities and processing terminal) and midstream (proposed export pipeline through Azerbaijan and Georgia and into Turkey) development, construction and operation phases. The construction phase of the project will create many opportunities for employment of Azeri citizens and at the same time will provide experience of working to international standards in construction and operation of oil and gas projects. The nature of the project will broadly require the same level of institutional strengthening and training irrespective of the final design option selected including a substantial requirement for the training of a new workforce and re-training of the local work force that has previously been involved in oil and gas projects in Azerbaijan. The availability of internationally recognised facilities and infrastructure along with a skilled workforce would, in the future, make the region more attractive to potential investors. Institutional issues will include strengthening of the network of local suppliers, possibly through the establishment of joint ventures with international companies, in order to ensure locally manufactured equipment meets the international standards required by the oil and gas industry. A "no development option" would deny these technology transfer opportunities, through employment and training and associated capacity building for the Caspian region as a whole.

In addition, the Stage 1 development along with the development of the ACG oil field by AIOC are integral to the wider development of the Region and it is possible that without them, many other large-scale oil and gas development projects and associated non-oil projects in Azerbaijan and the wider Caspian region may not be realised.

No development would also mean that specific environmental benefits accruing from the project such as the opportunity to provide 'cleaner' gas fuels (i.e. replacing 'dirtier' fuels such as wood) to the market. Additionally social investment programmes and biodiversity investment would not be as forthcoming.

4.3 The Project

A number of concepts were considered for the project and environmental criteria were included in the project concept evaluation process where appropriate. This section outlines the main options considered for the major components of the development and, where appropriate, highlights the environmental benefits of the selected options.

4.3.1 Offshore facilities

Hydrocarbon deposits are at significant depth in the Shah Deniz field (i.e. between 5,000 m and 7,000 m) and offshore drilling facilities will be required to support drilling into these deep gas reservoirs. To support transfer of the produced hydrocarbons to shore it was decided at an early stage that offshore separation of gas from condensate and produced water at the offshore facility would be necessary. Not providing separation facilities offshore would require a multi-phase pipeline to shore (see below), additional processing facilities onshore and no gas for power generation would be available at the offshore facility. The optimum offshore facilities selected would therefore, be designed to provide a long-term centre for the drilling of development wells, the separation of gas and liquids, accommodation for personnel and the onward transportation of the produced hydrocarbons to an onshore terminal.

A number of concepts were considered for the offshore facilities during the Appraise stage of CVP and seven main options were taken forward to the Select stage. The seven options included:

1. **Modular Production, Drilling and Living Quarters platform (PDQ):** a 'traditional' fixed jacket structure with topside processing and drilling facilities, living quarters, power generation package and other utilities with each module installed onto a main support frame by a series of heavy lifts offshore.
2. **Integrated Deck Float Over Platform:** all processing and drilling facilities, living quarters and utilities packages built onto a main support frame onshore then floated by barge to the offshore location where it is installed onto a pre-installed jacket using a "float over" method.
3. **Integrated Deck Float Through Platform:** all processing and drilling facilities, living quarters and utilities packages built onto a main support frame onshore then floated by barge to the offshore location where it is installed onto a pre-installed jacket using a "float through" method. This is the concept selected by ACG for the Phase 1 development.
4. **Tender Assist Drilling (TAD):** consisting of a light weight processing and drilling platform with all living quarters and utilities packages onboard a tender support vessel alongside the platform.
5. **Production and Living Quarters platform (PQ) with Jack Up Skid Off:** consisting of a lightweight production and living quarters and utilities platform with drilling conducted by a jack-up drilling rig located alongside the PQ with the drilling equipment being 'skidded off' onto the PQ during drilling operations.
6. **Subsea System and Well Head Tower (WHT):** consisting of a subsea well development tied back to a lightweight WHT. Fluids are collected at the WHT and tied into the pipeline systems.
7. **Technip-GeoProduction 500 (TPG500):** a proprietary purpose designed self-installing jack-up drilling and production platform consisting of all processing and drilling facilities, living quarters and utilities packages. This would have the same equipment as the modular and float-over/through platforms but differs in the choice of substructure.

A technical ranking exercise was undertaken to identify which of these seven offshore facility concepts should be taken forward to the Define stage of the Project. The process used highlighted the key advantages and disadvantages of each concept, together with a view on the level of confidence in each concept against six key themes as follows:

?? Health, Safety and Environment (HSE);
?? design and technical issues;
?? project execution;
?? drilling issues;
?? operational aspects; and
?? political issues.

An additional key driver in the decision-making process included consideration of the availability of infrastructure and resources in Azerbaijan as well as the wider Caspian region and, in this respect, the possibility of schedule conflict between the requirements of the Shah Deniz offshore facility concept with that of the infrastructure and resource requirements for ACG Phases 1 and 2.

A simple relative scoring mechanism was used to compare each concept against all of the other six concepts under consideration for each of the six key themes. The results of the technical ranking are discussed below.

4.3.1.1 Modular PDQ

The Modular PDQ is a well-defined and proven concept. Issues of concern were however, associated with project Execution due to the significant infrastructure upgrades that may be required for fabrication of the facility and the potential for competition with ACG for resources and infrastructure for the onshore construction programme. A relatively high level of marine activity would also be necessary for the installation phase for this facility. A large number of heavy lifts offshore for the topsides modules were also considered problematic as there only limited heavy lift vessel capacity available in the Caspian.

4.3.1.2 Integrated deck float over platform

The topside deck design concept for this option as a facility for the Shah Deniz Project was considered feasible, although the design was at an immature stage of development. As with the Modular PDQ concept, the potential for competition with ACG for resources and infrastructure for onshore construction with associated schedule risks was also a concern.

4.3.1.3 Integrated deck float through

The topside deck design for this concept would have greater flexibility in design and for the future in comparison with the integrated deck float over platform option. Again there may be a potential for resource and infrastructure competition with ACG for the onshore construction of this platform option.

4.3.1.4 PQ-TAD

There was less confidence in delivery of the project objectives from the TAD concept over deck concepts. The main concern was associated with the ability to convert to TAD following the proposed early well drilling programme (see below) from the Mobile Offshore Drilling Unit (MODU) within the schedule required to begin drilling of the wells for the project. More complex manual handling with a greater number of hazardous operations would also result if this concept were to be selected. The design is also untested.

4.3.1.5 PQ jack-up skid-off

As with the PQ-TAD concept, there was less confidence of project delivery from the PQ Jack-up Skid-off option compared with traditional deck concepts. Again the main concern was with the potential for this concept to deliver the drilling required as well as the potential for poor drilling efficiency from the skidded drilling package. Long-term access to a jack up rig was considered a problem at the time of the review.

4.3.1.6 Subsea system and WHT

The subsea system and WHT option has the least definition and it was considered not to be a concept that could be delivered with a high degree of confidence for the project at this stage. The main concerns with the concept were that it was not believed that a robust subsea system design could be prepared within the schedule available, there would be undue reliance on a MODU for long term well intervention requirements in the field. There is no infrastructure to support subsea operations in the Caspian and support vessel availability is limited. The Shah Deniz fluids are difficult to produce and thus embarking on a subsea scheme for the first stage of such a large development was viewed as a considerable risk.

4.3.1.7 TPG500

The main components for the TPG500 can be fabricated out of country and transported into Azerbaijan in modules for assembly, thus avoiding any potential competition with ACG for in country construction infrastructure and resources and associated risks to the schedule. This type of self-installation has a proven record of success in the North Sea and it was believed that this concept had a number of advantages for the project objectives.

From a technical viewpoint, three of the concepts were considered to offer the most acceptable solutions for the offshore facility, with very little difference between the three:

?? the Modular PDQ;
?? the Integrated Deck Float Through; and
?? the TPG500.

The above three solutions all offered a technically robust solution, enabled a high integrity and safe design and permitted adherence to BP HSE goals.

Taking into account the potential risks in schedule that may result from construction of both the Modular PDQ or the Integrated Deck Float Through facilities at the same time as the ACG facilities, it was decided to adopt the TPG500 facility as the base-case option for the Stage 1 development of the Shah Deniz field.

A parallel investigation of the costs of the various options also concluded that the TPG500 option was the most attractive.

The TPG500 has some additional environmental benefits over the other options considered. It allows the minimisation of offshore activity in both installation and commissioning phases. The assembled facility can be mainly commissioned at the assembly yard and is designed for tow out to the offshore location. The jack-up design is self-installing, thereby reducing the scale and duration of offshore marine activities that would be required in comparison to the installation requirements typically associated with the other offshore facility concepts considered. Decommissioning of the TPG500 would also be simpler in that removal of the installation at the end of the field life would essentially be a reversal of the installation process, resulting in a reduction of the potential environmental impacts associated with decommissioning activities.

The option to drill a number of wells from a MODU, prior to installation of the TPG500 as opposed to waiting for the TPG500 to be installed before starting the drilling programme was considered. Early drilling will enable hydrocarbons to be brought on-stream more rapidly following installation of the TPG500 and as first gas is scheduled for 2005, it was decided that early drilling would be necessary to achieve the project schedule and to comply with international sales agreements between the governments of Azerbaijan and Turkey.

4.3.2 Transfer of hydrocarbons to shore

Transfer of the produced liquid hydrocarbons to shore using shuttle tanker was discounted early in the option evaluation process. This option would require the installation of a very large offshore processing facility to process condensate to export quality. Condensate tankers were initially contemplated during the option selection, but as existing vessels are not available within the Caspian Sea, a purpose-built vessel would need to be constructed in the region. In addition, it is considered that a marine pipeline presents lower spill risks than offshore loading and shuttle tanker transportation as tanker transportation results in increased vessel movements between the offshore facility and the terminal and a consequent increased collision risk. Offshore storage of condensate, tanker loading and off-loading operations would also result in increased emissions of volatile organic compounds (VOC) to the atmosphere.

Marine pipeline transportation of the production fluids was adopted and two principal options were considered as follows:

- a single 26” multi-phase pipeline; and
- dual single-phase pipelines (one 26” gas and one 12” condensate).

Option assessment included a detailed consideration of a number of factors including fluid properties, wax deposition characteristics and the pigging requirements of the pipelines for wax control.

The Shah Deniz condensate is relatively waxy with wax formation temperatures well above the seabed ambient temperature; hence significant wax build up on the pipeline internal walls would be expected. The wax will be removed though the implementation of a regular pigging regime. Predicted wax deposition rates indicate that pigging frequency would be in the order of every two to three days for both multi-phase and single-phase condensate lines. Pigging of a single-phase gas line would only be infrequently required.

There has been little experience of pigging of gas dominated multi-phase lines as wax deposition has been rarely encountered in this type of environment. In contrast, there is a significant track record of wax removal from single-phase lines with a number of simple pig configurations available for the operation. In addition, the velocity of the pig moving through a multiphase pipeline would be too high at maximum production flow-rate to safely perform the pigging operation. The flow-rate through a multiphase pipeline would therefore, have to be turned down during pigging operations, with an increase in flow-rate necessary for the time that the line was not being pigged in order to achieve the required export rate. These regular variations in flow would introduce operational difficulties at the onshore terminal and would require additional gas processing equipment at the terminal, including a very large slug-catcher to handle the fluctuations in fluids arriving.

Overall, the uncertainties associated with the wax deposition, pigging operations and turndown requirements for the multi-phase line, led to the decision to select the dual single-phase pipelines as the preferred option for the development. The selected option offers a higher degree of confidence with respect to operability as the underlying principals of the single-phase lines are better understood for such a gas dominated gas/liquid stream.

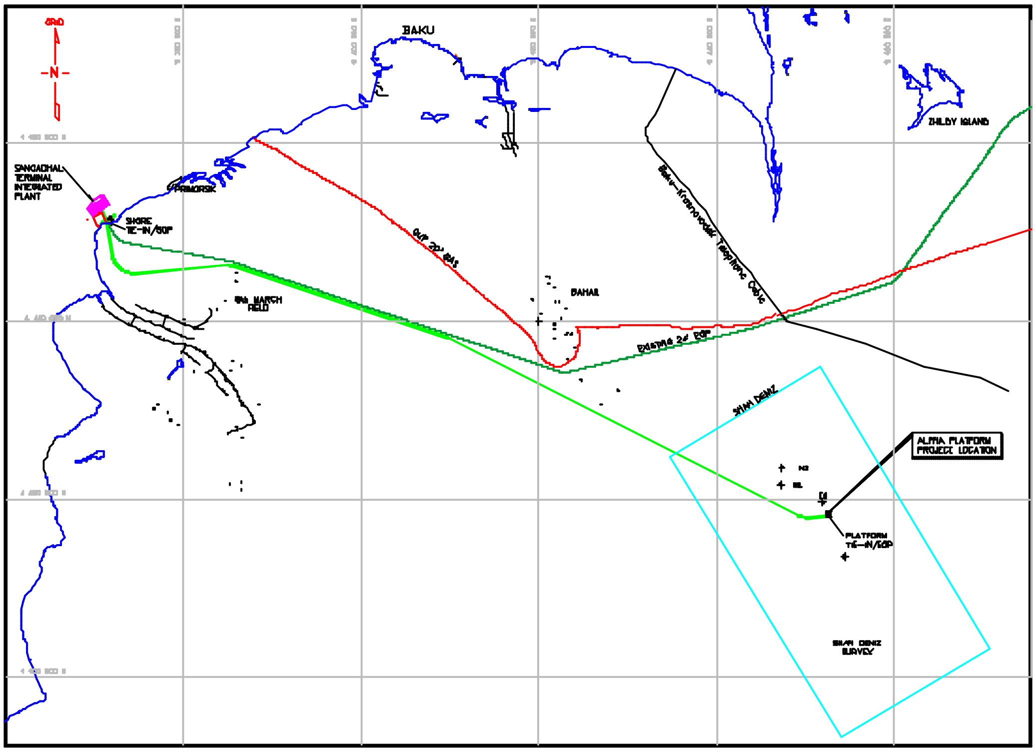
4.3.3 Pipeline routes

The routes that the pipelines will follow from the offshore production location to the onshore terminal have been considered in three sections as follows:

- nearshore/onshore;
- EOP common corridor; and
- the route section that deviates from the existing EOP route offshore towards the Shah Deniz field.

It was decided early in the options evaluation process to follow as much as is possible the existing Early Oil Project (EOP) oil pipeline corridor (the common corridor) that runs from the Chirag-1 platform in the ACG field to the chosen location for the gas/condensate processing terminal at Sangachal (see below). The existing EOP pipeline corridor was considered to be the preferred route as this is a proven route with both physical benefits in that it follows a known geotechnically sound route and environmental benefits in that it would not give rise to impacts on a separate and distinct area of seabed. As such this section of the route will follow the existing route from Sangachal to the Bahar field and then will deviate towards the Shah Deniz field (Figure 4.2).

Figure 4.2 Shah Deniz Gas Export Project Stage 1 offshore pipeline corridor route

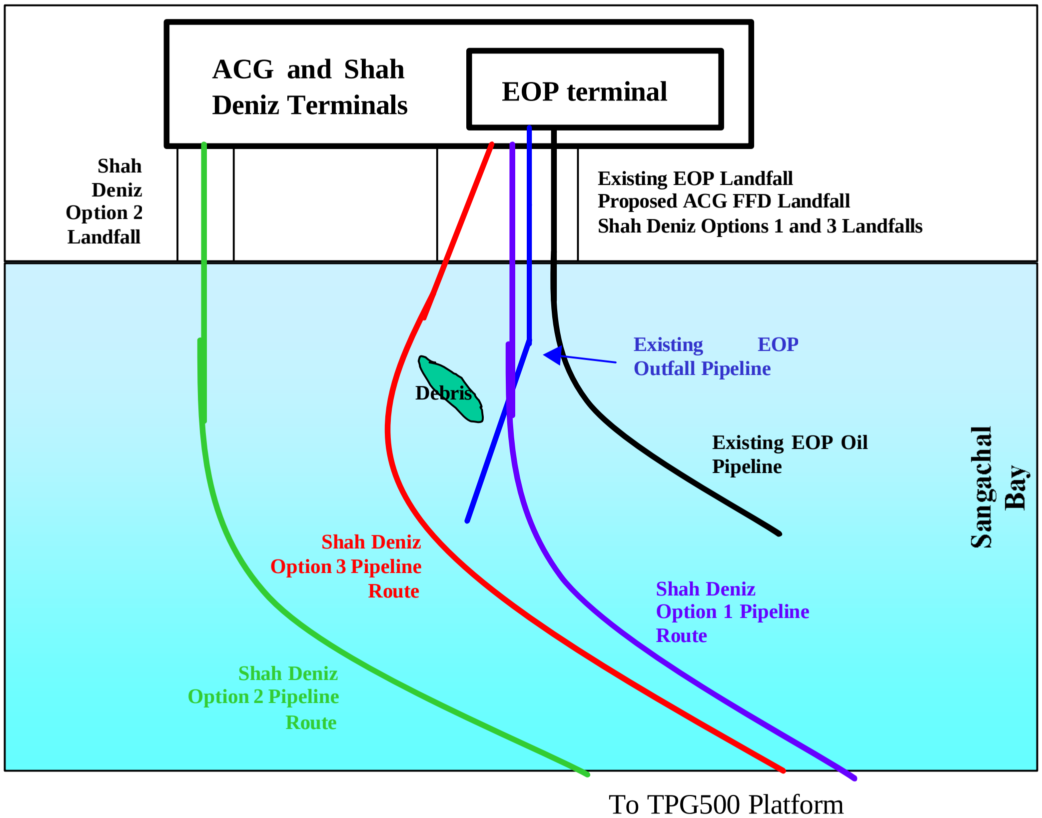


4.3.3.1 Nearshore/onshore section

Three landfall options were assessed for the Shah Deniz pipelines at Sangachal (Figure 4.3) as follows:

- ?? **Option 1:** alongside the existing EOP pipeline nearshore approach corridor and using the same landfall, requiring the removal of a section of the existing water outfall pipeline used for the EOP terminal;
- ?? **Option 2:** a direct approach corridor by passing the existing EOP outfall pipeline to a new landfall area; and
- ?? **Option 3:** extended pipe lay around the existing outfall pipeline without interference to the outfall and on to the common landfall.

Figure 4.3 Shah Deniz Gas Export Stage 1 nearshore/onshore pipeline route options



Each of these options was evaluated on the basis of environmental impact, risks to schedule, existing operations and additional modification costs.

The landfall for Option 1 would be located on the beach to the west of the existing EOP landfall. In order to use this corridor it would be necessary to remove the existing water outfall pipe used for the EOP terminal.

Option 2 would route the pipelines away from the EOP water outfall pipeline and would landfall further to the west. This would be a more direct approach from shore and would allow some flexibility for changes to future expansion plans for both the Shah Deniz and ACG fields. The phased expansion of the ACG field will result in the need for additional pipelines from offshore facilities to shore and each additional line will follow the existing shore approach corridor.

Option 2 would however result in additional environmental impacts to the seabed and marine flora due to the requirement for a separate shore approach corridor in the bay. The landfall for Option 2 would be located to the west of a natural wadi that carries water from the surrounding hills behind the terminal site. Routing of the pipelines to the terminal once onshore would require a crossing of the wadi feature and, although the natural drainage patterns through the wadi are not fully understood, the landfall and crossing may have a potential to interfere with the natural drainage of the area.

Option 3 would landfall in a similar location as Option 1, the route arcs southwards to avoid the existing EOP water outfall pipeline. This route is 1.1 km longer than the Option 1 route.

The pipeline corridor route onshore for landfall Options 1 and 3 and will essentially follow the direct approach taken by the existing EOP pipeline between the landfall and the terminal. The pipelines will pass under the main Baku to Astara highway, many existing underground service lines (oil, gas, water, electricity) and a railway line on route to the terminal. The onshore section route of the pipelines on Option 2 will also be fairly direct to the terminal beyond the railway line the route would pass between a caravanserai restaurant and a water pumping station with electricity sub station.

Route Option 3 has been selected as it resulted in the lowest risks to ongoing operations and followed the most preferable route in terms of environmental impact. It also provides a solution that allows the landfall and onshore pipeline corridor to remain common across the Shah Deniz and ACG projects.

4.3.3.2 Offshore route

As stated above the pipelines will follow the existing EOP pipeline route as far as possible offshore. This is a proven pipeline corridor where the seabed is generally flat. Approximately 20 km from the shore, the route passes by the "8th of May field" where there are a number of offshore platforms and jetties outside of the existing corridor. At a distance of approximately 50 km the pipeline route passes the "Bahar field" where the Bahar mud volcano is situated. At this point, the route is diverted to a distance of 4 km from the centre of the Bahar volcano and it is close to this point that the EOP pipeline heads northeast and that the Shah Deniz pipelines would deviate from the common corridor and onwards to the Shah Deniz field. Optional routes for this section of the Shah Deniz pipelines considered amongst other aspects:

?? water depth;
?? seabed profiles;
?? seabed debris (wrecks etc);
?? available geotechnical information; and
?? geo-hazards and seismic risks.

There are a number of unusual geological features in the Shah Deniz field and the pipeline routes will cross some geohazard features such as mud volcanoes, seabed subsidence and fault lines.

At the time of writing, the route is expected to continue from the common corridor almost directly to the mud volcano present in the Shah Deniz field. The seabed along this route is believed to be similar to that along the common corridor and survey data has shown that the route is at a safe distance from seabed slump features.

An option to avoid the mud volcano was originally considered which involved routing the pipeline down a sloping cliff before routing back up the cliff on the other side of the volcano. The mud volcano is heavily faulted, however survey data has confirmed that the pipeline can be trenched across the mud volcano, with a single spool installed to prevent lateral buckling problems. Predicted fault movements have been safely accounted for within the pipeline design.

4.3.4 Terminal

The existing EOP oil reception and storage terminal is located south of Baku near Sangachal. The EOP terminal site was considered the best location in terms of its proximity to transportation routes and associated infrastructure in the region. Initial land acquisition undertaken for this development also considered the requirements for future terminal expansion for each Phase of the ACG Full Field Development (FFD) and preferred export pipeline routes. The existing EOP terminal at present receives oil from the Chirag-1 platform. Once the ACG Phase 1 development becomes operational, hydrocarbons from Chirag-1 will be co-mingled with Phase 1 hydrocarbons for onward transfer to the expanded terminal. As a result, the Phase 1 terminal will comprise an expansion of the EOP existing terminal facilities located near Sangachal. Benefits of using the same location include the use of existing access and infrastructure and ease of building on existing services at the location as well as significant cost savings associated with these benefits.

As the Shah Deniz development included the need for a gas/condensate processing terminal to be sited onshore it was considered that similar benefits would result from siting the terminal alongside the ACG facilities at the Sangachal location as opposed to developing a new site at a different location. In addition to the benefits gained from the use of existing access and infrastructure, benefits would also include the potential for integrated operational control as well as combined maintenance and support services. Potential cost savings would be possible from combined engineering construction works as well as the advantage of developing a skilled workforce at one location.

Environmental benefits would also be gained through the elimination of the requirement for additional land-take at a separate and new location whilst planning for a relatively constant environmental footprint (with some enhancement) for both the Shah Deniz and ACG FFD onshore terminal facilities at one location.

Planning for the terminal development has included terminal layout options with a view to realising the potential synergies between Shah Deniz and ACG.

Two options have been considered during the terminal facility design:

?? independent (stand alone) terminal facilities for Shah Deniz and ACG; and
?? an integrated layout for both terminals.

Independent standalone terminal development included the Phase 1 expansion alongside the existing EOP terminal with the Shah Deniz terminal separated from ACG by a distance of approximately 50 m to 100 m to the west. It was considered however, that the standalone option would not capture potential operational synergies that would be realised if a more integrated approach to both facilities were to be adopted.

The potential benefits that could be achieved from an integrated layout for both terminals include:

?? common control room and safety systems to maximise site coordination and operating efficiency, and emergency response;
?? shared administration, warehousing and other service buildings (for example fire service, accommodation and mess facilities);
?? shared site security;
?? single flare area, with separate Shah Deniz and ACG flare stacks co-located; and
?? reduced land-take requirement.

The reduced land-take requirement would also result in an increased distance between the terminal and the location of the local communities, potentially reducing noise, odour and visual impact to the residents.

The integrated approach to the terminal facilities was considered in greater detail in a number of areas and it was decided that as the benefits of integration outweighed a standalone option, maximising the potential for integration of the facilities wherever possible was the approach to be adopted.

The presence of existing facilities and infrastructure at the terminal site also directly affected the choice of options available for the terminal layout. This included the location of administration, warehousing and fire brigade station within the existing EOP administration and warehousing facilities at the eastern end of the EOP site ensuring that the majority of personnel are kept as far away as possible from the process areas. It is proposed that terminal utilities will be located together to reduce costs and allow for better utilisation of energy and a common control room will also reduce cost while at the same time enable operators and technicians to be trained to operate and maintain common control systems and equipment.

4.3.5 New access road

A new access road for the terminal site is required to enable the movement of construction plant and equipment into the site whilst simultaneously continuing with operations at the existing terminal. Once in place the existing road will be decommissioned but will remain accessible in the event of an emergency.

A number of potential routes were considered for the new access roads:

?? a 5 km road running from the south side of the terminal with a connection to a secondary road;
?? a 7 km road running from the north side of the terminal and connecting to the road close to the Garadag Cement Plant;
?? a 2.5 km road running from the south east of the terminal and connecting to the main Baku to Astara highway, and
?? a 2 km road running from the north east side of the terminal and connecting to the main Baku to Astara highway (preferred option).

The final option is preferred for a number of reasons. The location means that this road would result in minimum land-take. The route is also closest to the SPS fabrication yard where it is planned that the majority of the heavy equipment required for the terminal will be laid down prior to transfer to the construction site. The location is also furthest away from Sangachal village and like some of the other options, is located in position where the predominant prevailing wind direction is away from the Umid Internally Displaced Persons (IDP) camp hence reducing the potential impacts from noise and dust on the local communities. The preferred route may however, require some modification to balance railway crossing safety requirements and land-take considerations whilst retaining the benefits.

The route selection for new access road is expected to necessitate the incorporation of a new level crossing for the railway to ensure the safe passage of the workers and suppliers to the construction site. The proposed new level crossing will be semi-automatic and will be permanently manned to ensure safe operation. A small security building will also be provided next to the railway crossing. The new access road will mean the overall benefits of greater safety at crossings and an upgrade in the capacity and quality of the access road.

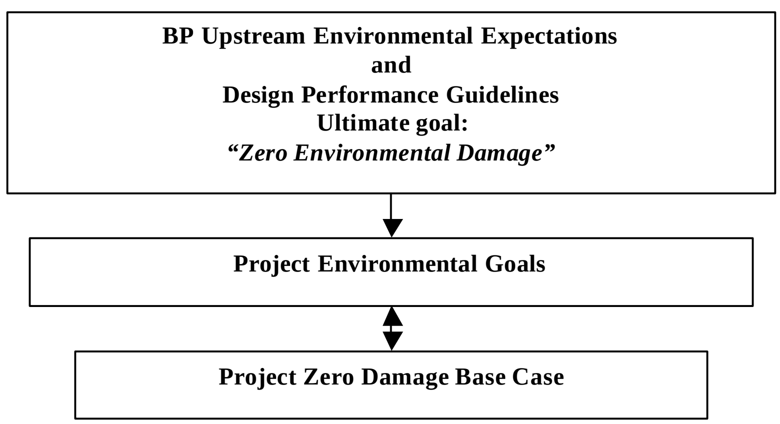
4.4 Zero Environmental Damage options assessed

In its assessment of the options available for the final design of project components and utilities required for the offshore and onshore facilities selected, the Shah Deniz project has implemented BP's Upstream Environmental Goals and Design Performance Guidelines for new projects. "Zero Environmental Damage" has been used as a starting point for the decision-making process and this, in turn, led to the development of project Environmental Goals which represent the environmental principles for Shah Deniz. Subsequent to defining project Environmental Goals, project Zero Damage Base Cases (ZDBC) for both offshore and onshore facilities were established. The ZDBC included the following steps:

?? confirmation of environmental goals for the project;
?? identification of options to attain the goals;
?? emissions identification and quantification;
?? assessment of options against standard criteria including:
    ?? technical feasibility;
    ?? safety screening;
    ?? environmental cost benefit analysis; and
?? development of solutions and mitigation proposals.

Figure 4.4 illustrates the hierarchy of these drivers to the options selection process. The top priority for the project is safety. A key principle of the process is to confirm that any selected mitigation options do not compromise the safe design of the facilities.

Figure 4.4 Hierarchy of drivers to options selection process



The ZDBC was established early in the Select stage of the project design process with the initial objective of identifying potential zero damage base case solutions that meet the intent of each of the environmental goals established for the project and carry these forward into the project design. In cases where the environmental goals cannot be attained alternatives to the ZDBC were considered using some or all of the tools described above to justify the variance from the goal.

The process focussed on the identification of sources and the potential for environmental damage of all emissions from the facilities and the identification of options available to eliminate or minimise each of the emissions identified. As such the areas mainly considered included:

?? hydrocarbon emissions;
?? combustion emissions;
?? liquid discharges to sea; and
?? energy efficiency.

4.4.1 Hydrocarbon emissions

Shah Deniz offshore and onshore facilities have been designed so as to minimise the emission of hydrocarbons. Contaminated drainage will be contained for disposal and any hydrocarbon leaks at the facilities will be contained in kerbed areas. It is expected that only limited amounts of produced water will be generated from the Stage 1 development. It will be transferred to shore with the condensate and following separation at the terminal will be transferred to a suitable dedicated onshore disposal well and injected down hole or alternatively, potentially transferred to a nearby cement plant for use in the cement manufacturing process. Deep well injection is the project base-case and further evaluation of the injected produced water migration routes and attendant risks including the potential of polluting potable aquifers and leakage to other areas is ongoing. It should be noted that produced water would not be generated until later in the field development programme and therefore, it will be several years before onshore injection facilities are required thus allowing adequate time to prove the viability of the preferred onshore injection site (i.e. Lokbatan).

Drill cuttings from well sections drilled with non-water based mud (NWBM) systems will be contained and sent to shore for disposal (see below, Section 4.4.3).

Sources of atmospheric hydrocarbons emissions from both on and offshore sources include:

?? combustion emissions from power generators;
?? the fired heater at the terminal;
?? leaking gas from control, relief and blow-down valves;
?? drain vessel vapours;
?? offshore flaring during well clean-ups and drill stem tests (DSTs);
?? flaring (onshore) and venting (offshore) during maintenance, emergency and shut-down conditions (facility blow-down); and
?? fugitive emissions from condensate storage tanks onshore.

Combustion emissions from power generation sources are discussed below (Section 4.4.2).

To reduce the source of leakage, high integrity valves will be selected for the project. These valves will result in gas being less likely to pass through seats and seals and efforts will be directed at minimising the use of valves and flanges in the facility design through the use of welded joints where possible.

4.4.1.1 Offshore

The following options were considered by the project for the control of atmospheric hydrocarbon emissions offshore:

?? **Zero flaring/venting (selected as ZDBC):** consisting of flare/vent gas recovery, a high integrity pressure protection system (HIPPS), blow-down compressors and a subsea storage vessel to store gas from blow-down.
?? **No routine flaring – unlit flare:** consisting of a flare tip and tower boom, flare gas recovery, an inert gas purge and automatic ignition instead of pilot lights. In this case, routine emissions (e.g. gas from the drains and leaking valves) would be recovered and the flare system would be used only for disposing of blow-down gas.
?? **No routine flaring (lit flare):** consisting of a flare tip and tower/boom, flare gas recovery, an inert gas purge and conservation pilots. Similar to the no routine flaring option except that the conservation pilots are continuously lit.

?? **Routine Flaring (lit flare):** consisting of flare tip and tower, but no flare gas recovery system. Conventional and conservation pilots were considered. This system would dispose of all of the sources of gas.

?? **Cold Vent only:** consisting of a vent tip and tower. This option includes provisions to reduce the sources of venting so that only very small quantities of gas are continually vented. Maintenance and emergency venting would take place infrequently.

In all of the above cases, the use of a High Integrity Protection System (HIPPS) was included to minimise emissions to flare/vent from pressure relief systems.

The ZDBC was eliminated early in the assessment process as depressurisation of hydrocarbons (blow-down) for maintenance or under emergency conditions by injection of the gas into a sub-sea storage vessel would mean a departure from known safe industry practices. The other options are all feasible from a technical and safety consideration and were subject to an environmental cost benefit analysis using BP criteria.

As the offshore Shah Deniz facility will have minimal sources of excess gas it was found that the cold venting option demonstrated the least cost of damage to the environment when compared to the other options considered, which either involved large capital expenditure for little environmental benefit (e.g. recovery compressors), or produced high volumes of continuously flared gas (e.g. for pilots) and therefore a relatively high environmental cost. Therefore the cold venting option has been adopted as the best environmental option for the facility.

4.4.1.2 Onshore

As with the offshore facilities, the ZDBC for the Shah Deniz onshore facilities was for no flaring/venting at the terminal. Again this would involve the adoption of flare/vent gas recovery to eliminate the routine flaring of gas emissions, blow-down compressors for depressurisation events and HIPPS.

It was again decided to reject the option of handling the gas inventory onshore without venting/flaring during blow-down as this is not considered to be a safe option. Gas during blow-down events will thus be flared representing a departure from the onshore ZDBC.

A number of alternative options were considered for the disposal of other gas sources at the terminal. It was decided to reject the option of a conventional lit flare with no gas recovery in favour of a system of no routine flaring with flare gas recovery for all gas passed by leaking valves and vapours from drains vessels in order to reduce atmospheric emissions. Additional options adopted in order to minimise emissions include the use of an inert nitrogen purge for the flare and an automatic ignition system. As with the offshore facilities, HIPPS has also been adopted in order to eliminate relief emissions from process upsets.

Fugitive emissions will be reduced by adopting the option of gas detectors for early identification of leaks at the site and emissions from the pipeline pig receiver when it is opened will be minimised by reducing the receiver opening frequency by designing the pig receiver to accommodate two pigs.

It is intended to directly export condensate through the ACG terminal export facilities, however a condensate storage tank will be required in case of any unavailability or loss of the export route. An additional off-specification “off-spec” condensate storage tank will also be required at the terminal. The options considered to minimise fugitive emissions from the condensate storage tank include:

?? external floating roof tank with basic fittings;
?? external floating roof tank with low loss fittings;
?? internal floating roof tank with primary seals;
?? internal floating roof tank with primary and secondary seals; and
?? internal floating roof tank with vapour recovery on the primary seals.

On assessment of the estimated emissions from each option, it was decided that a vapour recovery system was necessary for the off-spec storage tank as off-specification condensate requires a vapour space to stabilise and this can only be achieved with a fixed roof tank Vapours removed from this tank will be recovered and sent to the terminal fuel gas system.

Vapour recovery was not justifiable for the condensate storage tank given that such a facility will not, under normal operations, be used. The proposed option for the storage tank is an external floating roof tank design with low loss (double seal) fittings.

4.4.2 Combustion emissions

The options considered for the reduction of emissions from the onshore facility flare system are described above (Section 4.4.1.2). A number of options have been considered to eliminate or reduce the remaining combustion emissions that will be generated from the burning of fuel to generate power and heat at both the offshore and onshore facilities.

4.4.2.1 Offshore

Power generation is required offshore for essential platform utilities and all drilling system and topside processing requirements. During the drilling programme, the total offshore power requirement fluctuates between three and nine megawatt depending on the drilling operations taking place. Selection of the offshore power generation system must therefore, meet the changing demands.

Renewable energy sources including solar energy, wind power, combined wind and wave power and fuel cells were considered during the Select stage of the project. These energy sources were found to be impractical for various reasons, including the large solar panel area that would be required for solar energy, safety concerns from wind turbine blades, unproven technology and fuel cell size required for offshore applications.

The option of power generation from a single source at the onshore facilities and transmitting the electricity through a subsea cable to the offshore location, eliminating the need for offshore power generation facilities, was assessed. The assessment found that all of the emissions from this option were concentrated at one (onshore) point resulting in higher emissions onshore with an associated potential for local air quality issues to arise. In addition, efficiency losses are anticipated with the transmission technology available with this length of cable.

The above options represent the ZDBC options for offshore power generation for Shah Deniz and once rejected, a number of alternative power generation layouts were considered in a high-level options assessment as follows:

?? turbo expander;
?? micro turbines; and
?? reciprocating engines (diesel, gas or dual-fuel).

Conventional diesel, gas or dual-fuel power generation was selected with the other options being rejected on practicality, technical or safety grounds.

The remaining options, which included where possible the use of Dry Low Emission (DLE) technology, were broken into several configurations were examined in more detail, assessing factors such as capital and operating costs, weight and space requirements, power profile adaptability, operability and maintenance and environmental impact including atmospheric emissions and platform noise and vibration.

From this assessment, the use of centralised dual fuel reciprocating engine driven generators were recommended due to their simple and robust design, their dual fuel capability (fuel gas and diesel), their load variation adaptability, reduced technical risk and lower environmental emissions when operating on fuel gas which will be for the majority of the time.

4.4.2.2 Onshore

Renewable energy sources were again considered for power supply to the terminal but as with the offshore facility were discounted due to their current impracticality. Solar power could only be used for low-level applications such as lighting but any environmental benefit gained would be marginal. Early work on wind power generation indicated that five wind turbines could meet only 30% of the terminal power demand and would only be viable if supplemented by a reliable grid network or full set of conventional power equipment at the terminal.

Importing power from a local power station is considered to be the ZDBC. No suitable facility exists in the region however, for this purpose. Power import from a power station would necessitate the construction of a purpose built 100 MW power station that may be viable in the future as regional power requirements increase This option would be possible for all AIOC/BP projects but the phasing of the projects over many years precludes its selection due to economic reasons.

As with the offshore facilities the alternative options available for power generation onshore included a turbo expander and various diesel and gas turbine generators. The turbo expander uses expanding gas to drive gas recompression equipment, as opposed to using a separate electrically driven compressor. There is not sufficient pressure available at the terminal to generate the full power demand using turbo expanders but sufficient pressure is available to utilise turbo-expanders for the gas Dew Point process.

The gas Dew Point process will be the largest power consumer at the Shah Deniz terminal and emissions from turbo expander instead of conventional power generation are zero. As such the turbo expander option has been adopted for the terminal. The shortfall in terminal power requirements will be met by using turbine generation and dry low emission (DLE) gas turbines have been selected from the alternatives available. DLE technology is sensitive to fuel composition and high quality gas will be available as a fuel from the terminal process.

4.4.3 Discharges to sea

4.4.3.1 Onshore

The onshore facilities have been designed so that there will be no direct discharges to the sea. As described previously all contaminated drainage and any leaks or spill will be contained for disposal. Produced water will be injected into a dedicated onshore disposal well or transferred to a nearby cement plant for use in their process.

Options for sewage treatment disposal have also been assessed, with the selected treatment system consisting of a wastewater treatment plant (biomass reactor) with final effluent being of irrigation water quality standard.

4.4.3.2 Offshore

Treated drainage, treated sewage waters, cooling waters and top-hole section drilled cuttings will be discharged to sea from the offshore facilities. The drainage and sewage treatment systems and the cooling water composition and flow-rate are discussed in Chapter 5. The discharge of drilled cuttings will depend on the type of drilling mud systems used in the drilling programme. There will be two types of drilling mud systems used in the Shah Deniz Stage 1 drilling programme as follows:

?? water based mud (WBM); and
?? synthetic oil based mud (SOBM).

Drilled cuttings generated during drilling operations carried out with SOBM systems will not be discharged to the sea. The options considered for the handling and disposal of these cuttings included:

?? collection on the platform and shipment to shore for processing and disposal; and
?? re-injection offshore.

Cuttings re-injection was initially adopted as the base case disposal option for the SOBM drilled cuttings. Implementation of a drill cuttings re-injection operation involves the collection and transportation of drilled cuttings to a slurrification unit for milling with seawater. The resultant slurry can then be injected under high pressure into a disposal formation.

Suitable formations were identified offshore for disposal and a dedicated offshore cuttings re-injection well was to be constructed for this purpose. Shipment of cuttings to shore was to be used as a contingency disposal route if the cuttings re-injection equipment or disposal well became unavailable.

The seabed in the vicinity of the offshore facilities in the Shah Deniz field has suffered significant slope failure with a dense fault distribution around the facility location. Stability of the offshore location has been extensively analysed and risk analysis results suggest that the proposed re-injection location met the required risk level. The analysis did not however, include the impact of cuttings re-injection on subsurface stability. As such, a number of potential cuttings re-injection zones and injection well scenarios were subsequently evaluated to determine the viability of cuttings re-injection at the location.

Injection wells located at a 1.5 km step-out were considered unacceptable due to their proximity to the shallow faults that control slope stability in the area and due to the associated unacceptable risks to offshore platform stability. Risk analysis carried out on re-injection wells with a 4.5 km step-out were determined to provide a reduced risk associated with shallow faulting in the area as the re-injection zone is sufficiently removed from the fault zone. Drilling difficulties to achieve such a step-out would however, present a risk to well bore stability and disposal well management. Cuttings re-injection at the offshore location was therefore, rejected.

Rejection of the re-injection option left ship-to-shore of the NWBM drilled cuttings for storage and disposal as the remaining viable option and as such this has been selected as the optimum disposal route for these wastes.

A number of processing and remediation trials for the cuttings transferred to shore have been implemented and trials are ongoing. It should be noted that onshore cuttings treatment and disposal issues are subject to a separate environmental approval process.

A Best Practicable Environmental Option (BPEO) study was carried out to assess the options for the disposal of drilled cuttings generated from well sections drilled with WBM. The following cuttings handling and disposal options were considered:

- ?? discharge to sea;
- ?? collection on the platform and shipment to shore for processing and disposal; and
- ?? re-injection offshore.

The results of the study recommended discharge to sea as the mud systems are carefully formulated to be non-toxic to the marine environment and the extent of impact of the solids deposition would be in the local vicinity of the discharge point. The rate of cuttings generation during drilling with WBM is high and may require a dedicated vessel on a permanent mooring alongside the platform during drilling operations for the ship-to-shore option. Bulk handling such volumes of cuttings at the planned drilling rate of penetration (ROP) is also not proven technology and re-injection of cuttings at the Shah Deniz field has been precluded due to the risks described above.

The option to dispose of pipeline hydrotest waters containing some chemical additives to the offshore environment remains under consideration. Hydrotest water disposal options will be compared during a BPEO study that will establish the proposed base case disposal option.

4.4.4 Energy efficiency

4.4.4.1 Onshore

Energy efficiency through waste heat recovery from power generation gas turbine exhausts were considered and selected for the onshore terminal. Recovered heat will be delivered to other parts of the process via a closed loop hot oil system. The objective of a waste heat recovery system is to reduce the amount of fuel gas consumed in the process and minimise combustion emissions.

Energy efficiency at the terminal will also be achieved via use of a turbo expander to power the dew pointing process and the use of a DLE gas turbine generator for other terminal power requirements.

4.4.4.2 Offshore

The option to install small waste heat recovery units on the dual fuel engines used for offshore power generation has been selected.

The base case design for the Shah Deniz Gas Export Project Stage 1 development project is described in detail in the Chapter 5. Detailed discussions of the impacts arising from the base case design are included in Chapters 9 to 13.

4.4.5 Greenhouse gas emissions

The Shah Deniz Stage 1 project has been assessed against other BP projects around the world in terms of its relative performance in regards to the generation of greenhouse gases. This “benchmarking” exercise has determined that the Stage 1 development is a world leader and is among the “best in class” in terms of the predicted small amounts of greenhouse emissions that will be generated over the life of the project.

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Institute of Geography
Garadagh District Executive Power

Stakeholder and Socio-Economic Survey participants within the Umid, Sangachal, Masiv 3 and Azim Kend communities.

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Executive Summary

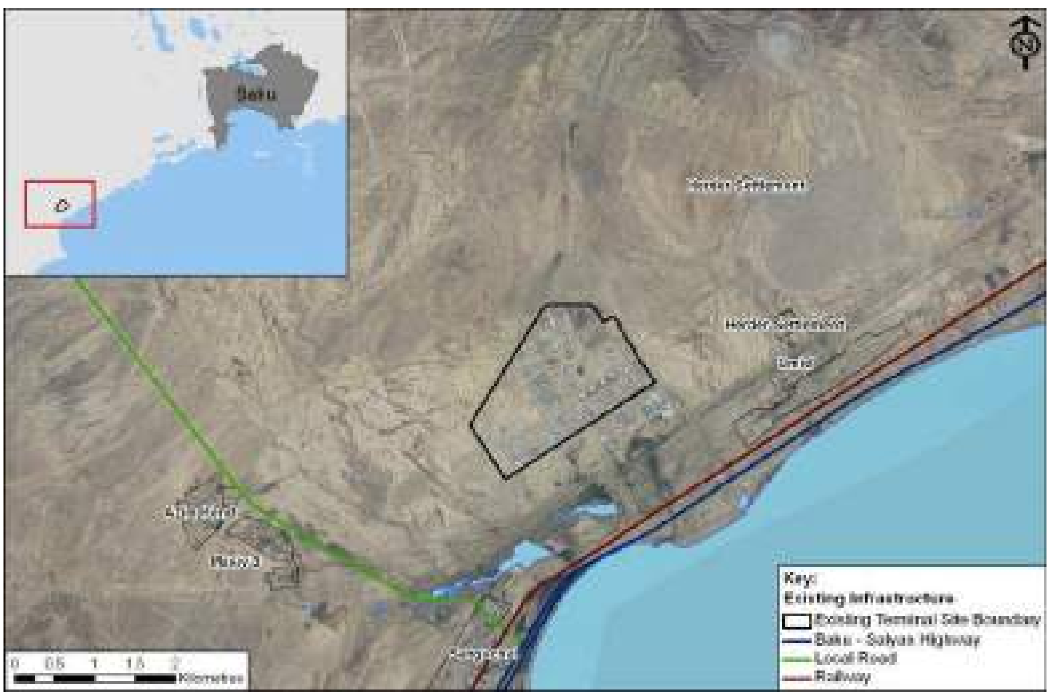
This Executive Summary presents a concise non-technical overview of the Shah Deniz 2 (SD2) Infrastructure Project Environmental and Socio-Economic Impact Assessment (ESIA). It is intended to provide a summary of the project design and activities, of the issues considered in the ESIA and of the main conclusions with respect to environmental and socio-economic impacts.

E.1 Introduction

The Shah Deniz (SD) Contract Area is a high pressure gas-condensate field located in the Azerbaijan sector of the Caspian Sea. Development of the SD Contract Area, which is operated by BP Exploration (Azerbaijan) Limited on behalf of the other Production Sharing Agreement (PSA) consortium members, is being pursued in phases and to date has included the SD Stage 1 Project (SD1).

The SD 1 Project was approved in 2003 and production began in late 2006. SD1, via the SD Alpha (SDA) Platform, provides production from the SD reservoir. Onshore SD1 processing facilities are provided at the Sangachal Terminal located approximately 60km south of Baku (refer to Figure E.1). The SD2 Project represents the second development stage of the SD Contract Area of which the SD2 Infrastructure Project represents the first major work onshore.

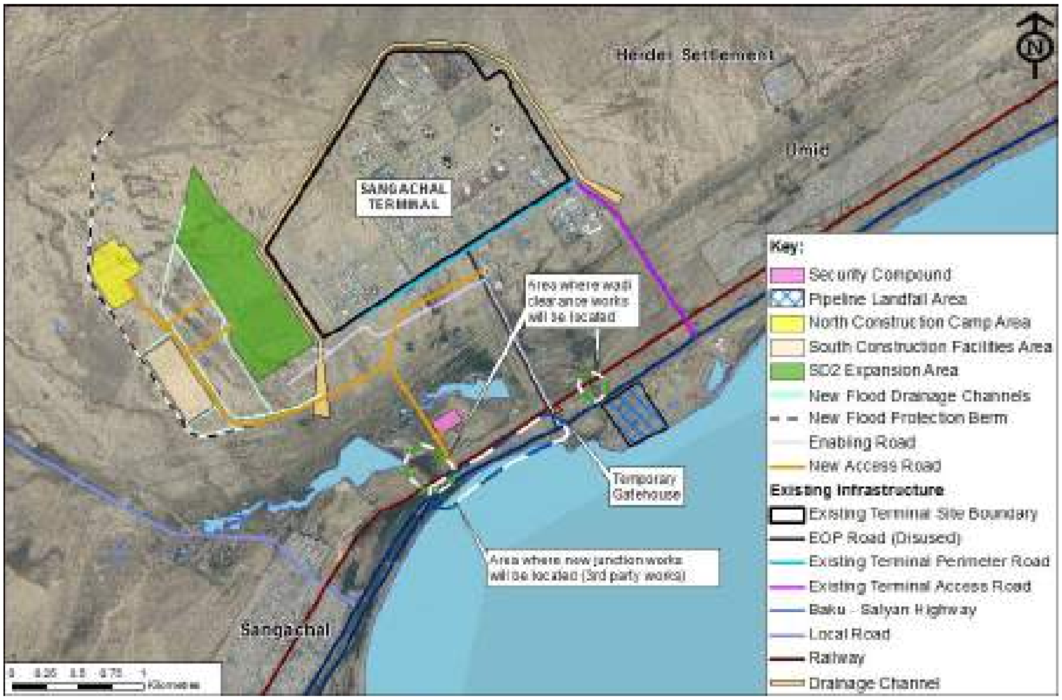
Figure E.1 Sangachal Terminal Location



E.2 Project Overview and Need for an ESIA

The purpose of the SD2 Project is to further exploit the gas and condensate reserves within the offshore Shah Deniz Contract Area. The SD2 Infrastructure Project comprises the works needed prior to the construction of the new SD2 Project onshore facilities. The SD2 Expansion Area will provide processing facilities for the SD2 Project and will increase production beyond the SD1 planned 900 million standard cubic feet per day (mmscfd). Figure E.2 shows the location of the proposed SD2 Expansion Area adjacent to the existing Sangachal Terminal facilities.

Figure E.2 SD2 Infrastructure Scope of Work



Given the location, scale and planned activities associated with the SD2 Infrastructure Project, it was agreed with the Ministry of Ecology and Natural Resources (MENR) that the project should be subject to an ESIA. Another ESIA will be prepared and submitted in 2012/2013 for the main SD2 Project works that will cover the construction and operation of the onshore and offshore gas and condensate production facilities.

E.3 Options Assessed and Terminal Expansion Planning

It was determined that the SD2 facilities should be located adjacent to the existing Sangachal Terminal. The areas considered included areas to the east, north and west of the existing Terminal boundary. A suitable location was identified to the west of the Terminal.

Options assessed as part of the SD2 Infrastructure Project cover the following key aspects:

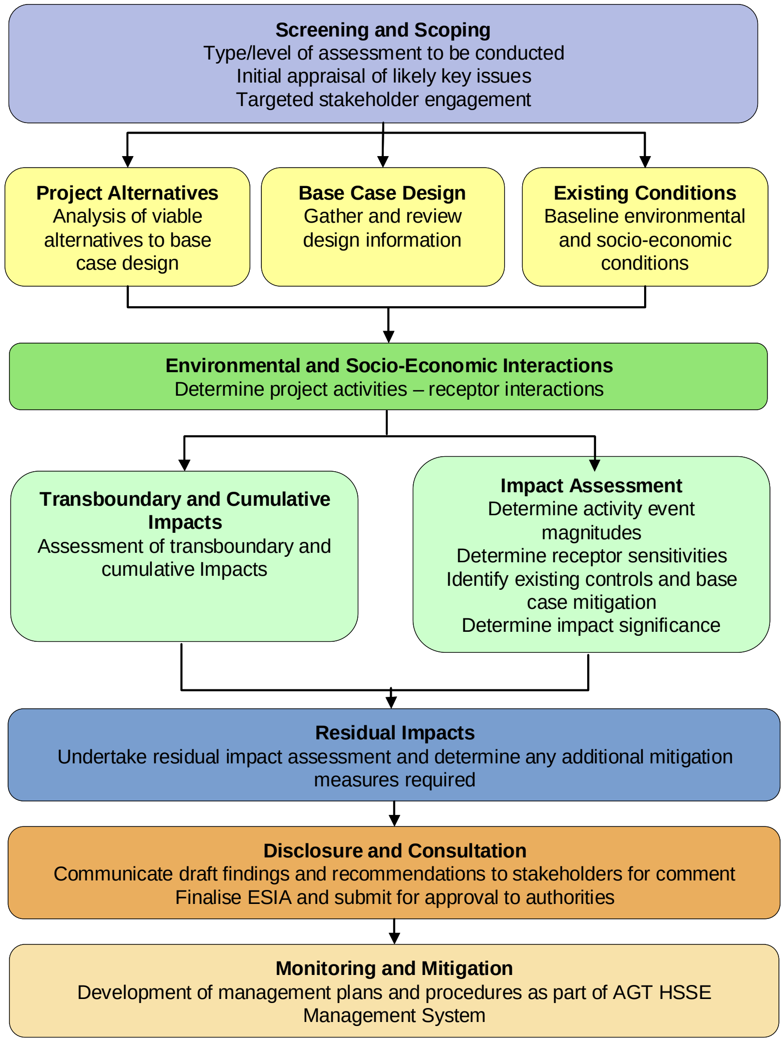
- New Terminal access road;
- Construction camp and construction facilities; and
- Drainage and flood protection design measures.

The potential locations of the project elements were informed by physical, environmental and safety constraints. On the basis of technical feasibility and as a result of consultations with stakeholders, an access road route was identified. Following the selection of the access route, it was determined that the construction camp and construction facilities should be located adjacent to the SD2 Expansion Area. Hydrological modelling and flood risk assessment work was also undertaken and has informed the access road location and design.

E.4 Assessment Methodology

The ESIA assessment process adopted for the SD2 Infrastructure Project, as illustrated in Figure E.3, constitutes a systematic approach to the evaluation of the project and its associated activities throughout the project lifecycle from pre-construction to construction.

Figure E.3 The ESIA Assessment Process



Assessment of SD2 Infrastructure Project environmental and socio-economic impacts has been undertaken based on the identification of SD2 Infrastructure Project activities and events for each project phase that have the potential to interact with the environment and socio-economic receptors.

The expected significance of environmental impacts has been assessed taking into account:

- **Event Magnitude:** Determined based on the following parameters:
  - ***Extent –*** *the size of the area that is affected by the activity being undertaken;*
  - ***Duration*** *– the length of time that the activity occurs;*
  - ***Frequency*** *– how often the activity occurs; and*
  - ***Intensity of the impact*** *- concentration of an emission or discharge with respect to standards of acceptability that include applicable legislation and international guidance, its toxicity or potential for bioaccumulation, and its likely persistence in the environment.*

- **Receptor Sensitivity:** Determined based on:
  - ***Presence*** *– whether species/people are regularly present/transient, and whether species present are unique, threatened or protected; and*

– ***Resilience –** how vulnerable people/species are to the change or disturbance associated with the environmental interaction with reference to existing baseline conditions and trends (e.g. trends in ecological abundance/diversity/status, ambient air quality etc).*

Socio-economic impacts have been assessed taking into account event magnitude, likelihood, and receptor sensitivity.

In order to identify the potential impact to receptors, an understanding of the existing conditions has been established. The SD2 Infrastructure ESIA Scoping exercise determined that the project will likely result in impacts on the following receptor groups:

- Biological/Ecological Receptors;
- Physical Receptor/Features;
- Soil, Ground Water and Surface Water Quality; and
- Socio-Economic/Human Receptors.

The evaluation of impacts has been based on the following principal sources of information:

- Meteorological data from the Baku State University National Hydrometeorological Department;
- Hydrology information from the Institute of Geography of the National Academy of Sciences of the Azerbaijan Republic;
- A number of specific surveys, including results of noise, odour, visual context and lighting surveys were undertaken to gather additional environmental data;
- A review of existing baseline conditions from 1996 to 2011, including results of the on-going Integrated Environmental Monitoring Programme (IEMP), which has regularly carried out 'regional' monitoring to identify and quantify natural environmental trends. Onshore surveys undertaken include ecological and air quality monitoring in and around the Terminal; and
- Data associated with existing socio economic conditions was obtained from secondary data sources including State Statistical data and data provided by the Garadagh Executive Committee. A Stakeholder and Socio Economic Survey (SSES) was also commissioned to obtain relevant up to date information to characterise socio-economic conditions within four local communities surrounding the Terminal.

E.5 Consultation and Disclosure

The first stages of the Public Consultation and Disclosure process were initiated before drafting of the main ESIA document began. Scoping meetings were held in March and May 2011 to inform and receive comment from representatives from the key regulatory authorities and the Government to allow key issues to be incorporated into the ESIA scope. Scoping meetings were held with the MENR as well as meeting with the Garadagh Executive Committee, Ministry of Culture and Tourism (MoCT) and Institute of Archaeology and Ethnography (IoAE). The four local communities have been engaged through the SSES. Consultation with the SD2 Infrastructure Project Design Team has also been completed during the preparation of the SD2 Infrastructure Project ESIA.

The Draft ESIA report was submitted to the MENR and simultaneously released to public and stakeholder groups for comment. As part of the Draft ESIA consultation process, public meetings were held in Azim Kend ,Sangachal Town and Umid during October 2011. Comments received on the Draft ESIA report were collated, analysed and responses issued where relevant. The ESIA was subsequently revised and finalised for MENR approval.

E.6 Environmental Impact Assessment

Environmental impacts have been assessed for the SD2 Infrastructure Project and Table E.1 provides a summary of the residual impacts.

Table E.1 Summary of Residual Environmental Impacts

	Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from onsite and offsite construction plant and vehicles.	Medium	(Humans) Medium	**Moderate Negative**
	Emissions from surface soil layer removal and spoil movement.			
Noise	Noise emissions associated with construction activities.	Medium	(Humans) Medium	**Moderate Negative**
			(Biological/ Ecological) Medium	
Impact to the Terrestrial and Coastal Environment (Ecology)	Surface soil layer removal and spoil movement, drainage management works and Pipeline Landfall Area preparation.	Medium	(Biological/ Ecological) Medium	**Moderate Negative**
Impact to the Terrestrial Environment (Soil, Groundwater and Surface Water)	Excavation works and ground disturbance	Medium	(Soil) Medium	**Moderate Negative**
			(Surface Water) Medium	**Moderate Negative**
Impact to the Terrestrial and Coastal Environment (Cultural Heritage)	Impacts to cultural heritage due to earthworks and piling.	Medium	(Physical Receptors) Medium	**Moderate Negative**

E.7 Socio-Economic Impacts

Socio-economic impacts have been assessed for SD2 Infrastructure Project and Table E.2 provides a summary of the residual impacts.

Table E.2 Summary of Residual Socio-Economic Impacts

Event	Magnitude: Spatial Scope	Magnitude: Timing and Duration	Probability	Receptor Sensitivity	Significance
Direct Impacts					
Disruption and access restrictions (SD2 Infrastructure Area)	Local	All SD2 Infrastructure area will be temporarily fenced during works to prevent unauthorised access. Temporary impact	Highly likely	Local herders – High	**Moderate – major negative**
		Up to approximately 115 hectares will be permanently removed from use for herders. Permanent impact			
Disruption and access restrictions (Pipeline Landfall Area)	Local	The majority of the SD2 Infrastructure Area will be temporarily fenced during works (between March 2012 and June 2013). Temporary impact	Highly likely	Recreational fishermen - Low	**Negligible**
			Highly likely	Commercial fishermen - Medium	**Negative**
			Highly likely	Recreational users - Low	**Negligible**
			Unlikely	Shoreline property values - Low	**Negligible**
Employment creation	Local	Employment will occur throughout the project, and is expected to peak between April 2012 and November 2012. Temporary impact	Highly likely	Local community - High	**Moderate-Major Positive**
	Regional		Likely	Regional community – Medium	**Positive**
Training and skills development	Local	Training will commence prior to the project activities and continue throughout the project. Permanent	Highly likely	Local community – High	**Moderate-Major positive**
	Regional		Highly likely	Local community – Medium	**Positive**
Procurement of goods and services	Local, and Regional	Procurement will take place throughout the project and benefits will cease shortly after the project finishes. Temporary	Highly likely	Local and regional businesses - High	**Moderate-Major positive**
	National			National businesses - High	**Positive**
Disruption and impact to community safety associated with construction vehicle movements (offsite)	Local	Off site traffic movements will take place throughout the project. Temporary	Unlikely	Road users and local community – High	**Negative**
Deterioration in Road Conditions	Local	Changes to road condition from the transportation of construction materials will take place throughout the project and will cease after the project finishes. Temporary	Highly unlikely	Local Roads – High Main highway - Low	**Negligible**
Road and rail works	Local, and regional	Road and rail works are expected throughout the project but disruption is expected to be of short duration. Temporary	Highly likely	Local, regional and national businesses – High	**Negative**
De-manning	Local	De-manning will likely commence prior to end of the project as manning levels decrease however it is expected that the main SD2 Project will provide relevant employment opportunities for workers. Permanent	Unlikely	Local community – High	**Negligible**

E.8 Cumulative, Transboundary and Accidental Events

Cumulative impacts, potential transboundary impacts and the impacts of accidental events associated with the SD2 Infrastructure Project have been assessed.

The potential for interaction between the different SD2 Infrastructure Project related residual impacts, resulting in a cumulative impact has been considered. The cumulative effect of all expected project activities will be managed through the implementation of a Nuisance Management Plan. The Plan will detail the processes used to prevent nuisance associated with construction noise, light from construction work areas, odours, pests and vermin. In addition a Community Interaction and Social Impact Management Plan will be implemented and maintained as a mechanism of communicating with the community and responding to community grievances.

Given the existing control measures in place, it is considered that the appropriate measures are in place to mitigate and manage potential cumulative effects between project related residual impacts.

Based on a review of available information, it is understood that the following projects (which have the potential to interact with the impacts of the SD2 Infrastructure Project based on their location and scale) are planned or under construction in the vicinity of the Terminal:

- **Qizildas Cement Plant** – To be located approximately 4km north of the Terminal;
- **Garadagh Dry Kiln Upgrade Project** – Upgrade to the existing Garadagh cement works (approximately 6km to the east) to install dry kiln technology and increase production; and
- **New Highway Junction** – Planned immediately to the south of the Terminal and planned to connect to the new Terminal access road, which forms part of the SD2 Infrastructure works.

The assessment of cumulative impacts demonstrated that negative cumulative impacts associated with the SD2 Infrastructure Project and other projects in the Terminal vicinity planned or under construction are expected to be limited.

The aspect with the greatest potential for negative impact is traffic disruption, assuming that the SD2 Infrastructure Project and the Qizildas Cement Plant construction schedules overlap. There is also potential for cumulative noise impacts at sensitive receptors associated with the SD2 Infrastructure Project and the Highway Junction. It will therefore, be necessary for the construction contractors and the Highways Authority to liaise to ensure these impacts are minimised through scheduling of works and use of appropriate mitigation measures.

There are also a number of significant positive cumulative impacts, primarily associated with employment and economic flows.

Accidental events are considered separately from routine and non-routine activities as they only arise as a result of a technical failure, human error or as a result of natural phenomena such as a seismic event.

Potential accidental events associated with the SD2 Infrastructure Project works include:

- Impact to a pipeline(s) within the existing pipeline corridor during construction activities;
- Loss of containment from fuel tanks within the construction camp/facilities area;
- Loss of containment from a fuel bowser, drum, Intermediate Bulk Container or fuel transfer container;
- Minor spills associated with leaks/small spills;
- Failure of the sewage treatment plant;
- Overflow of underground oil separators or septic tanks;
- Release of concrete into watercourses or the Caspian Sea; and
- Flood events causing silty water runoff from stockpiles and exposed ground.

Measures to mitigate accidental events have been incorporated at the project design stage and include:

- Pipeline mapping and condition assessment of existing pipelines;
- Construction of culverts/crossings over existing pipelines;
- Use of concrete barriers and buried pipeline protection on the EOP road;
- Bunding and containment; and
- Design of underground and septic tanks.

In addition, procedures and controls will be implemented during the construction to ensure that there is a minimum risk of spills. Key controls include:

- Production of site drainage and pollution hazard maps, showing the sources of potential pollution pathways and key receptors;
- Provision of adequate training in spill response for all personnel; and
- Maintenance of a spills register documenting key details of all spills including remediation works, if required.

Furthermore, a Spill Response Plan will be prepared prior to commencing work on the SD2 Infrastructure Project. This document will be aligned with BP's Oil Spill Response Plans (OSRP) and integrate with those plans maintained by the 3rd party pipeline owners that operate those pipelines over which crossings will be installed.

E.9 Environmental and Social Management

The SD2 Infrastructure works will be performed by key contractors, appointed by BP. A rigorous contractor selection process will be in place to ensure that key contractors used during the SD2 Infrastructure Project have effective HSSE Management Systems that align with BP expectations.

The appointed contractor(s) will be required to develop, implement and monitor environment and social requirements through the HSSE Management System (aligned with ISO 14001 and OHSAS 18001 Standard).

The environmental and social management process will benefit from accumulated experience and 'lessons learned' from executing previous projects and a well-established environmental monitoring programme. Other benefits of previous project experience include the development of:

- Effective and reliable procedures for onsite segregation and management of waste;
- A non-hazardous landfill site designed and constructed to EU standards; and
- An effective process for identifying and utilising opportunities for waste recovery and recycling.

E.10 Conclusions

Planning for the SD2 Infrastructure Project has benefited, to a considerable extent, from the experience gained from previous construction projects at the Terminal. Lessons learnt from previous projects have informed the SD2 Infrastructure Project.

In conclusion, the SD2 Infrastructure Project has considered all aspects of its impact on the environmental and socio-economic receptors and incorporated additional mitigation to existing controls to ensure any negative impacts are minimised as far as practicable.

Units and Abbreviations

Units

dB	Decibel
dB (A)	A weighted unit of sound intensity weighted in favour of frequencies audible to the human ear
dB L_{AEQ}	Sound pressure level
ha	Hectare
HP	Horsepower
hr	Hour
kg	Kilograms
km	Kilometre
km^2	Square kilometre
Ktonnes	Kilo tonnes
kVA	Kilovolt- ampere
kW	Kilowatts
l	Litres
m	Metre
m/s	Metres per second
m^2	Square metre
m^3	Cubic metre
m^3/day	Cubic metres per day
m^3/hour	Cubic metres per hour
μ	Microns
μm	Micrometres
μg	Micrograms
μg/g	Micrograms per gram
μg/m^3	Micrograms per cubic metre
μg/l	Micrograms per litre
mg	Milligrams
mg/l	Milligrams per litre
mg/m^2/s	Milligrams per square metre per second
ml	Millilitres
mm	Millimetre
Mm^3	Million cubic metres
mm/month	Millimetres per month
mmscf	Million standard cubic feet
mmscfd	Million standard cubic feet per day
mph	Miles per hour
m/s	Metres per second
pH	$-\log_{10} [H^+]$ (measure of acidity or alkalinity)
PM_{10}	Particulate matter measuring less than 10μm in diameter
ppm	Parts per million
1Q	A quarter of one year
s	Second
US$	US dollars
US$M	US dollars (Millions)
%	Percent
˚C	Degrees Celsius
>	Greater than
<	Less than

Chemicals, Elements and Compounds

As	Arsenic
Ba	Barium
BTEX	Benzene, toluene, ethylbenzene, xylene
Cd	Cadmium
CH_4	Methane
CO_2	Carbon Dioxide
Cr	Chromium
Cu	Copper
Fe	Iron
Hg	Mercury
MEG	Mono Ethylene Glycol
NO	Nitrous Oxide
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
PAH	Poly aromatic hydrocarbons
Pb	Lead
SOx	Sulphur Oxides
SO_2	Sulphur Dioxide
Zn	Zinc

Abbreviations

ACG	Azeri-Chirag-Gunashli
ACG1	Azeri-Chirag-Gunashli Phase 1
AGT	Azerbaijan Georgia Turkey
ANAS	Azerbaijan National Academy of Sciences
AZN	Azerbaijan Manat
AzRDB	Azerbaijan Red Data Book
BC	Before Christ
BOD	Biological Oxygen Demand
BPEO	Best Practicable Environmental Option
BS	British Standard
BST	Business Support Team
BTC	Baku-Tbilisi-Ceyhan
C&EA	Communications and External Affairs
CCSCP	Condensate and Chemical Spill Contingency Plan
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COD	Chemical Oxygen Demand
COP	Chirag Oil Project
CWAA	Central Waste Accumulation Area
CSR	Corporate Social Responsibility
E&P Forum	Exploration and Production Forum
EIA	Environmental Impact Assessment
EMTAG	Environmental Monitoring Technical Advisory Group
ENP	European Neighbourhood Policy
ENVIID	Environmental Issues Identification
EOP	Early Oil Project
EPS	Environmental Protection Standards
ERA	Environmental Risk Assessment
ESC	Environmental Sub-Committee
ESIA	Environmental and Socio-Economic Impact Assessment
EU	European Union
FAO	Food and Agricultural Organisation
FOC	Foreign Oil Companies
GDP	Group Defined Practice
GHG	Greenhouse Gases
GOST	*Gosudarstvennye Standarty* State Standard (Russian standard)

GP	General Practitioner
GRP	Group Recommended Practice
HSE	Health, Safety & Environment
HSSE	Health, Safety, Security and Environment
IADC	International Association of Drilling Contractors
IAGC	International Association of Geophysical Contractors
IDP	Internally Displaced Person
IEMP	Integrated Environmental Monitoring Programme
IFC	International Finance Corporation
ILE	Institute of Lighting Engineers
IMP	Impact Management Process
IMS	Incident Management System
IMT	Incident Management Team
IoAE	Institute of Archaeology and Ethnography
ISO	International Organisation for Standardisation
IUCN	International Union for the Conservation of Nature
JV	Joint Venture
Laeq	Equivalent average sound level
MEG	Mono ethylene glycol
MENR	Ministry of Ecology and Natural Resources
MES	Ministry of Emergency Situations
MoCT	Ministry of Culture and Tourism
MPC	Maximum Permissible Concentration
MPE	Maximum Permissible Emissions
MPN	Most Probable Number
MSDS	Material Safety Data Sheet
MSL	Mean Sea Level
Mt	Mount
NGO	Non Governmental Organisation
NMVOC	Non-methane Volatile Organic Compounds
OHSAS	Occupational Health and Safety and Advisory Service
OSRP	Oil Spill Response Plan
PAH	Poly Aromatic Hydrocarbons
PCA	Partnership and Cooperation Agreement
PCDP	Public Consultation and Disclosure Plan
PR	Production and Risers
PR	Performance Recommendations
PSA	Production Sharing Agreement
QU	Quarters and Utilities
RSL	Regional Screening Level
SCP	South Caucasus Pipeline
SD	Shah Deniz
SD1	Shah Deniz Stage 1
SD2	Shah Deniz 2
SDA	SD Alpha
SDB	SD Bravo
SEE	State Ecological Expertise
SME	Small and Medium Enterprises
SOCAR	State Oil Company of the Azerbaijan Republic
SOCIID	Social Impacts and Identification
SPU	Strategic Performance Unit
SRT	Site Response Team
SSES	Stakeholder and Socio-Economic Survey
STP	Sewage Treatment Plant
THC	Total Hydrocarbon Content
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
UK	United Kingdom
UN	United Nations

UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
URS	URS Corporation Ltd
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
WHO	World Health Organisation
WRA	Water Resource Associates
WTN	Waste Transfer Note

Glossary

Aarhus Convention
An international legal agreement which promotes access to information, public participation in decision making and access to justice in environmental matters.

Accidental Events
Incidents or non-routine events that have the potential to trigger impacts that would otherwise not be anticipated.

Ambient Levels
Sharing the same physical and/or chemical properties as the immediate surroundings.

Anthropogenic
Relating to humans.

Aromatic Hydrocarbons
Hydrocarbons which include cyclic conjugated carbon atoms such as benzene, toluene, xylene etc.

Azerbaijan Manat (AZN)
Currency of Azerbaijan.

Azeris or Azerbaijanis
People of the Republic of Azerbaijan.

Background Level
The concentration of a substance or energy intensity level (such as noise or light) that is characteristic of the surrounding environment.

Ballast
Course gravel or crushed rock laid to form a bed for road or railway lines.

Base Case Design
Project design as described and assessed within the ESIA.

Birth Rate
Childbirth per 1,000 people per year.

Black Water
Human generated wastewater containing faecal matter and urine.

Borehole
A hole in the ground made by drilling.

Bored Piles
Concrete pile which is screwed into the ground to support a structure which has a heavy vertical load.

Bowsers
A vehicle tanker containing fuel or water.

Bund
Containment around a storage area to contain the contents in case of rupture or spillage.

Caravanserai
An inn built around a large court for accommodating caravans along trade routes in central and western Asia.

Cement
A powdery substance that acts as a binder that hardens (sets) after mixing with water. Cement is often used to bind aggregate materials (such as sand and gravel) together, to form concrete.

Chal Meadow
Vegetation community that is linked to the temporary retention of surface water following rainfall, this community is dominated by *Tamarix meyeri* scrub and usually occurs in depressions and along drainage lines.

Coliform
Of or relating to the bacteria that commonly inhabit the intestines/colons of humans and other vertebrates.

Communities
A social group whose members reside in a specific locality, share government and often have a common cultural and historical heritage / an ecological unit composed of the various populations of micro-organisms, plants, animals that inhabit a particular area.

Condensate (Gas Condensate)
Light hydrocarbon fractions produced with natural gas which condense into liquid at normal temperatures and pressures associated with surface production equipment.

Consequence
The resultant effect (positive or negative) of an activity's interaction with the legal, natural and/or socio-economic environments.

Consultation
A formal process which aims to obtain the views and opinions from stakeholders about a project.

Continental Plate
A tectonic plate that forms part of one of the Earth's continents.

Contract Area
Area of the sea that has been sub-divided and licensed/leased to a company or group of companies for exploration and production of hydrocarbons.

Convergent plate boundary
Where two continental plates converge.

Crude Oil
An unrefined mixture of naturally-occurring hydrocarbons with varying densities and properties.

Culvert
A man made structure used to channel water.

Cumulative Impact
Environmental and/or socio-economic aspects that may not on their own constitute a significant impact but when combined with impacts from reasonably foreseeable future activities, result in a larger /more significant impact(s).

Decibel (dB)
A unit used (one tenth of a bel) in the comparison of two power levels relating to sound intensities.

Decommissioning
Shutdown and dismantling of any facilities.

Disclosure
Release of ESIA information into the public domain.

Domestic waste
Waste, composed of garbage and rubbish, which normally originates from a residence/living quarters.

Drainage Catchment
The shape of the land which naturally forms different areas such that water falling as rain on the ground will drain into the lowest parts of the area.

Dry Tree
Device which controls the production from the surface/platform.

Early Oil Project
The first large-scale oil project in the Caspian Sea. It commenced in 1994 and involved a consortium of companies who invested to extract oil from the Azeri, Chirag and Guneshli wells.

Ecosystem
The interrelationships between all living organisms in a given area, and their relationships to non-living materials.

Effluent
Waste products emitted as a liquid by an operation or process.

Emergency / Abnormal Activity
An unplanned activity e.g. due to equipment failure, loss of containment, operator error or design error.

Embankment
A raised mass of earth or stone built to hold back water or to support a roadway.

Endemic
Present within a localised area or characteristic to organisms in such an area.

Environment for Europe
A partnership of member states, including Azerbaijan, and other organisations within the UNECE region.

Environmental and Socio-economic Impact Assessment (ESIA)
The systematic identification and evaluation of environmental and socio-economic impacts linked to a project and its associated activities.

Environmental Aspect
An element of an organisation's activities, products or services that can interact with the environment and therefore requires a form of management.

Environmental Impact
Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.

Environmental Management System
A system established to plan, manage and document an organisation's activities and processes and resultant environmental impacts.

Environmental Receptors
Any of various organisms that are directly or indirectly affected by environmental impact.

Ephemeral
Something living or lasting for a brief time, such as the flow of a river during certain months of the year.

Espoo Convention
A regional legal agreement to promote environmentally sound and sustainable economic development through the application of ESIA.

Ethnography
The study of customs and the cultural heritage of separate ethnic and human groups and tribes.

Eurasian
The extended landmass of Europe and Asia and specifically the large indeterminate region where the two continents join.

Fertility Rate
The average number of children that would be born to a woman in a certain area over her lifetime.

Flood Plain
A flood plain is a near flat land adjacent to a stream or a river which experiences flooding during periods of high discharge.

Flora/fauna
Plants/wildlife that occur within a defined geographical area.

Footprint
The spatial impact/impression on the land from a facility, building or disturbed area.

Geocell structures
A layer of interconnecting strips of geogrids/geofabrics filled with granular material to create a stiffened basal layer which can be used to control differential settlement under embankments constructed on compressible ground.

Geotextile
A strong synthetic fabric used in civil engineering to retain an embankment.

Greenhouse Gases (GHG)
Atmospheric gases considered to contribute to the Earth's greenhouse effect by absorbing and emitting radiation within the thermal infrared range. GHG include carbon dioxide and methane.

Habitat
An area where a particular animal or plant species and assemblages are found, defined by environmental parameters.

Harmful Substances
Those substances that are identified as marine pollutants in the IMDG Code.

Hazard
The potential to cause harm, including ill health or injury; damage to property, plant, products or the environment; production losses or increased liabilities.

Heavy Metals
Metallic elements with high atomic weights including mercury, chromium, cadmium, arsenic and lead.

Heritage
Valued objects and qualities such as cultural traditions, unspoiled countryside, and historic building that have been passed down previous generations.

Hydrocarbon
Organic chemical compounds of hydrogen and carbon atoms. There are a vast number of these compounds and they form the basis of all petroleum products. They may exist as gases, liquids or solids, examples being methane, hexane and paraffin.

Hydrology
The science dealing with the occurrence, circulation, distribution, and properties of water of the earth and its atmosphere.

Impermeable
Not allowing the passage of a fluid.

International Finance Corporation
Organisation that is a member of the World Bank, and promotes sustainable private sector investment in developing countries.

Invertebrates
Any animal lacking a backbone, including all species not classified as vertebrates.

Infiltration
The flow of water from the land surface into the subsurface.

ISO 14001
An evolving series of generic environmental management system standards developed by the International Standards Organisation that provides business management with a structure for managing environmental impacts.

Landfill
Disposal of waste materials by burial.

Law on Normative-Legal Acts
Azerbaijani legislation that stipulates that acts in force prior to independence, not subsequently cancelled or contradictory to the Constitution, remain in force.

Law on the Protection of the Environment
Azerbaijani legislation that addresses use of natural resources, the rights and responsibilities of the State and its citizens, ecological requirements for economic activities, ecological emergencies and disaster zones, etc.

Lay down area
Temporary storage area for supplies and materials.

Flood Levee
An embankment designed to prevent the flooding of a river.

Likelihood
The possibility that an activity or effect will occur.

Mammal
A class of air-breathing, warm-blooded vertebrates.

Meteorological dynamics
The study of those motions of the atmosphere that is associated with weather and climate.

Migration
Movement of people to a new area or country in order to find work or better living conditions / any regular animal journeys along well-defined routes, particularly those involving a return to breeding grounds.

Milli Mejlis
Azerbaijan Parliament.

Mitigation
The measures put forward to prevent, reduce and where possible, offset any adverse environmental or socio-economic effects.

Non Routine Activity
An activity that occurs when plant / vessels or equipment is operated not as specified within the Base Case but in a previously planned manner.

Operator
The company responsible for conducting operations on a concession on behalf of itself and any other concession-holders.

Overtopping
The flow of water over a dam wall or embankment.

Particulates
Particles of solid or liquid suspended in a gas or liquid.

pH
A scale of alkalinity or acidity, running from 0 to 14 with 7 representing neutrality, 0 maximum acidity and 14 maximum alkalinity.

Precipitation
The product of atmospheric water vapour condensation that falls to the Earth's surface under gravity. The main types of precipitation are: drizzle, rain, sleet, snow and hail.

Producer Well
A drilled hole through which oil and gas is extracted.

Piling
A heavy beam of timber, concrete, or steel, driven into the earth as a foundation or support for a structure.

Pipeline Landfall
Location where an offshore pipeline reaches the coast.

Platform
A large structure offshore which has facilities to drill, extract, process and temporarily store hydrocarbons.

Pollution
The introduction by man, directly or indirectly, of substances or energy to the environment resulting in deleterious effects such as harm to living resources; hazards to human health; hindrance of marine activities including fishing and impairment of the quality for use of seawater and reduction of amenities.

Production
The full-scale extraction of hydrocarbon reserves.

Production Sharing Agreement (PSA)
Type of contract signed between a government and a resource extraction company (or group of companies).

Public Participation
Process where the public are informed about the planned activities.

RAMSAR Convention
The intergovernmental treaty that provides designations to sites that are considered internationally important wetlands.

Receptor
The aspect of the environment (air, water, ecosystem, human, fauna, etc.) that is affected by/interacts with an environmental or socio-economic impact.

Recycling/Recovery
The conversion of wastes into usable materials and/or extraction of energy or materials from wastes.

Red List / Red Book
A list comprised of rare or endangered species of plants and animals.

Reedbed
Tall plants that grow in large groups in shallow water or on ground that is always wet and soft.

Reservoir
A porous, fractured or cavitied rock formation with a geological seal forming a trap for producible hydrocarbons.

Residual Impacts
Residual impacts are impacts that remain after mitigation measures, including those incorporated into the project's Base Case design and those developed in addition to the base design, have been applied.

Resilience
A measure of how a biological, ecological or human receptor is affected by an identified stressor.

Reuse
The use of materials or products that is reusable in their original form.

Richter Scale
The scale for expressing the magnitude of an earthquake, ranging from 0 to 10.

Riser
A pipe through which fluids flow upwards.

Routine Activity
An activity that occurs during routine operations when plant / vessels or equipment is operating as specified within the design base case e.g. operation of the sewage treatment plant as designed.

Runoff Coefficient
The ratio of the amount of water that is not absorbed by the surface to the total amount of water that falls during a rainstorm.

Scoping
Early stage in the ESIA process which appraises the likely key issues requiring detailed assessment.

Scouring
A form of erosion; removal by hydrodynamic forces of granular bed material in the vicinity of structures, such as roads and railway lines.

Screening
The process by which it is decided if an ESIA is required to be carried out for a project.

Seismic
The characteristics (e.g. frequency and intensity) of earthquake activity in a given region.

Sediment
Any particular matter that is transported by fluid flow and subsequently deposited.

Sensitivity
The recovery rate of flora or fauna from significant disturbance or degradation.

Shrub
A woody plant of relatively low height, having several stems from the base.

Spoil
Material generated during clearance /excavation works.

Stakeholder
A person, group and/or organisation with an interest in a project.

Stockholm Convention
An international legal agreement requiring Governments to reduce the release of persistent organic pollutants.

Strata
Distinct, usually parallel beds of rock.

Transboundary impact
An impact which crosses any boundaries between two geopolitical boundaries (i.e. a border).

Unit hydrograph
Graphical representation of stage, flow, velocity or other characteristics of water over a period of time.

Vienna Convention
An international legal agreement regarding the protection of the Ozone Layer.

Wadi
A river valley which may be ephemeral and flow only after heavy rain, or during certain periods of the year.

Wastewater
Water contaminated with domestic and production wastes.

Wetland
An area of land whose soil is saturated with moisture either permanently or seasonally.

Well Completion
The work of preparing a newly drilled well for production.

World Heritage Site
A site (such as a forest, mountain, lake, desert, monument, building, complex, or city) that is on the list that is maintained by the international World Heritage Programme administered by the UNESCO World Heritage Committee.

1. Introduction

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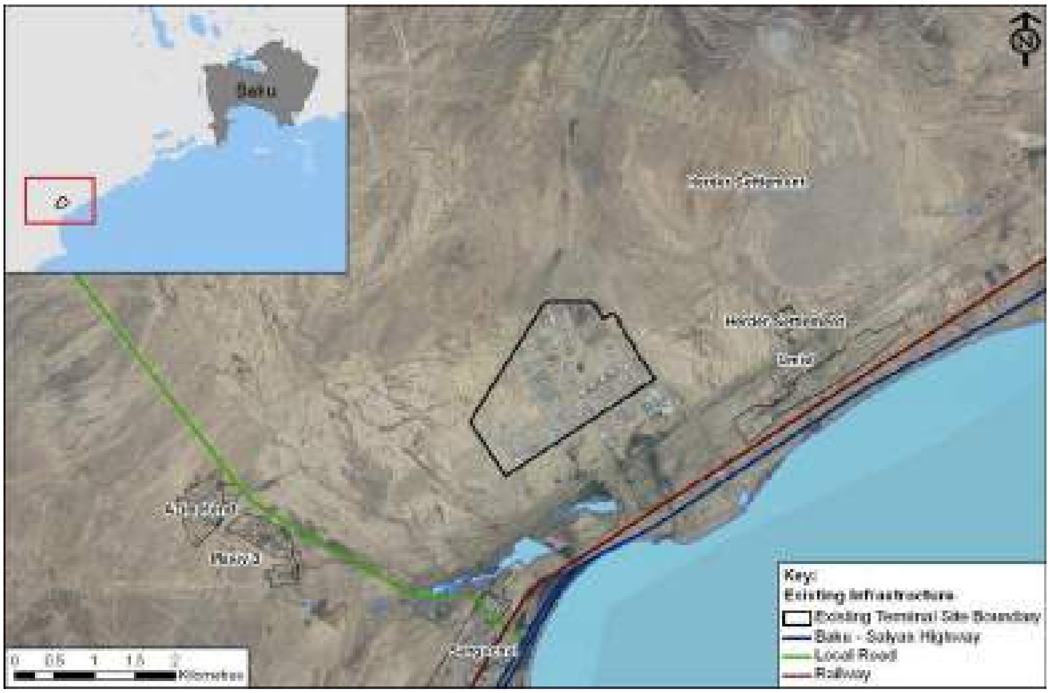
1.1 Introduction

The Shah Deniz (SD) Contract Area is a high pressure gas-condensate field located in the Azerbaijan sector of the Caspian Sea.

Shah Deniz Stage 1 (SD1) entered the Operate phase with first gas achieved during the fourth quarter of 2006. SD1, via the SD Alpha (SDA) platform, provides production from the SD reservoir. Onshore SD1 processing facilities are provided at the Sangachal Terminal, located approximately 60km south west of Baku (refer to Figure 1.1).

Figure 1.1 Sangachal Terminal Location



SD1 is a 'localised, stand alone' development with little opportunity, beyond limited debottlenecking opportunities, to increase production beyond the originally planned 900 million standard cubic feet per day (mmscfd).

The Shah Deniz 2 (SD2) Project, the second stage of SD field development, is planned to comprise:

- A fixed SD Bravo (SDB) platform complex including Production and Risers platform (SDB-PR) and a Quarters and Utilities (SDB-QU) platform, bridge linked to the SDB-PR;
- Subsea manifolds and associated well clusters, tied back to the fixed SD Bravo (SDB) platform complex by flowlines; and
- Subsea export pipelines from the SDB-PR platform to the Terminal and a dedicated monoethylene glycol (MEG) import pipeline from the Terminal to the SDB-PR platform.

The Terminal will be expanded to provide processing facilities for the SD2 Project.

The purpose of this Environmental & Socio-Economic Impact Assessment (ESIA) is to assess the environmental and socio-economic impacts associated with the works required prior to the construction, installation, commissioning and operation of the onshore SD2 facilities within the SD2 Expansion Area at the Sangachal Terminal.

The environmental and socio-economic impacts associated with the following SD2 Project activities will be assessed and reported separately:

- Construction, installation, hook up and commissioning of the onshore, offshore and subsea facilities (including the SD2 export and MEG pipelines to the Terminal);
- Drilling and well completion; and
- Operation of the offshore and onshore SD2 Project facilities.

The SD2 Infrastructure Project will be carried out taking into account applicable national and international legal requirements, and in accordance with the requirements of BP's Azerbaijan Georgia Turkey (AGT) Region Local Operating Management System.

1.1.1 Shah Deniz Production Sharing Agreement

The SD Production Sharing Agreement (PSA) was signed on 4th June 1996 between the State Oil Company of the Azerbaijan Republic (SOCAR) and a consortium of Foreign Oil Companies (FOC) to develop and manage the reserves of the SD gas-condensate field, herein after termed "Contract Area". BP Exploration (Azerbaijan) Limited have been appointed Operator of the PSA on behalf of the consortium partners. The consortium partners of SD are as follows:

- BP 25.5%
- Statoil 25.5%
- TOTAL 10.0%
- Lukoil 10.0%
- NICO 10.0%
- TPAO 9.0%
- SOCAR 10.0%

1.1.2 Previous Terminal Development

Phased expansion of the Sangachal Terminal has been undertaken over the past 10 years to accommodate the additional processing and ancillary facilities required to support the phased development of the Azeri-Chirag-Guneshli (ACG)[1] and SD Contract Areas. ESIAs have been completed for each development phase as detailed within Table 1.1.

Table 1.1 Onshore Scope of Works Assessed Within Previous ACG and SD ESIAs

ESIA	Project Scope

Early Civils (2001)	• Clearing and grading of:
	  ◦ ACG1 and SD1 Terminal facility areas located directly to the west of the Early Oil Project (EOP) facilities and;
	  ◦ BTC pumping and metering station location, adjacent to the EOP facilities to the north.
	• Excavation of a drainage channel around the Terminal boundary.
	• Construction of perimeter fencing, lighting and a bund wall.
	• Construction of a new access road to the Terminal and railway crossing.
	• Relocation and modification of utilities services.

ACG Phase 1 (2002)	• Construction, installation and operation of additional oil receiving and stabilisation facilities at Sangachal Terminal (within the Terminal boundary located directly to the west of the EOP facilities). • Construction of construction camp (including waste water treatment plant) directly to the south of the Terminal boundary.
SD Stage 1 (2002)	• Construction, installation and operation of onshore reception, gas-processing and condensate facilities located adjacent to and integrated with the ACG facilities at Sangachal Terminal.
ACG Phase 2 (2003)	• Construction, installation and operation of additional oil receiving and stabilisation facilities at Sangachal Terminal (within the Terminal boundary located directly north of the ACG Phase 1 facilities).
ACG Phase 3 (2004)	• Construction, installation and operation of additional oil receiving and stabilisation facilities at Sangachal Terminal (within the Terminal boundary located directly north of the ACG Phase 2 facilities)
ACG FFD PWD (2007)	• Construction, installation and operation of produced water treatment facilities (within the Terminal boundary located directly north of the BTC pumping and metering station)

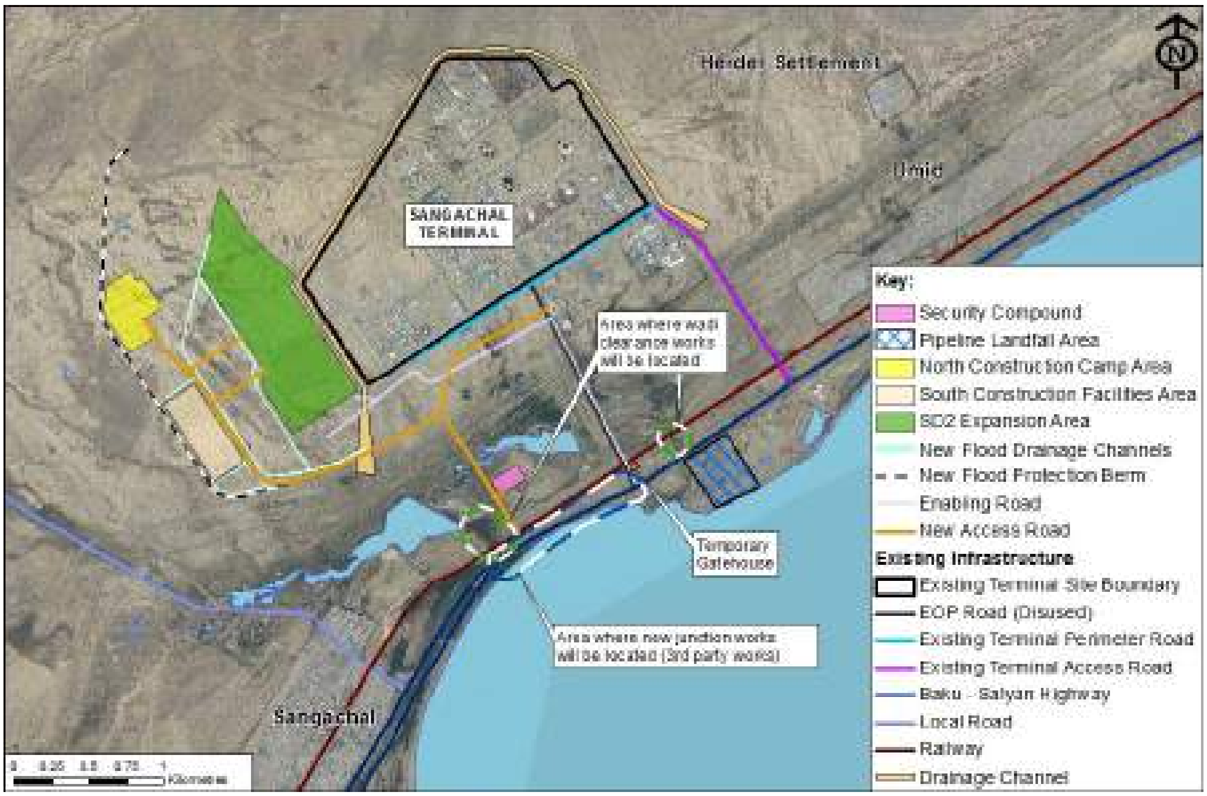
[1] The SD and ACG Contract Areas lie approximately 66km east and 135km north east from the Sangachal Terminal respectively.

1.2 SD2 Infrastructure Project Overview

The main components of the SD2 Infrastructure Project comprise (refer to Figure 1.2):

- Temporary reinstatement of the Early Oil Project Terminal access road;
- New access road from the Baku-Salyan highway to the Sangachal Terminal (and associated facilities);
- Clearance and terracing of the SD2 Expansion Area, located immediately to the west of the existing Terminal;
- Construction and fit out of the construction camp and construction facilities;
- Installation and operation of a sewage treatment plant;
- Installation of storm water drainage and surface water/flood protection berms; and
- Levelling of the SD2 Pipeline Landfall Area.

Figure 1.2 SD2 Infrastructure Project Scope of Work



1.3 SD2 Infrastructure Environmental and Socio-Economic Impact Assessment

1.3.1 Objectives

The overall objective of the SD2 Infrastructure Project ESIA process is to ensure that adverse environmental or socio-economic impacts arising from proposed works are identified and, where possible, eliminated or minimised.

The purpose of the ESIA is to:

- Ensure that environmental and socio-economic considerations are integrated into project design and operation;
- Ensure that previous experience is acknowledged and where appropriate, integrated into the project design;

- Ensure that environmental and socio-economic impacts are identified, quantified and assessed and appropriate mitigation measures proposed;
- Ensure that a high standard of environmental and socio-economic performance is planned and achieved for the project;
- Ensure that applicable legal, operator and PSA requirements and expectations are addressed;
- Consult with relevant stakeholders throughout the project and address their concerns; and
- Demonstrate that the project will be implemented with due regard to environmental and socio-economic considerations.

Within the impact assessment, activities and potential receptor interactions are evaluated against existing environmental and socio-economic conditions and sensitivities, and the potential impacts are ranked. The assessment of potential impacts takes account of existing and planned controls and monitoring and mitigation measures developed as part of earlier ACG and SD Projects.

1.3.2 ESIA Team and Structure

The details of the SD2 Infrastructure Project ESIA Team are provided in Table 1.2.

Table 1.2 SD2 Infrastructure Project ESIA Team

Team Member	Role
URS	ESIA Project Manager and Lead Authors
The Social Consultancy	Socio-Economic Specialist
WRA	Hydrology Specialist
Synergetics	Local Socio-Economic Specialists
KBR	Project Engineers
BP	SD Contract Area PSA Operator on behalf of SD PSA Partners

Table 1.3 provides a summary of the SD2 Infrastructure Project ESIA structure and content.

Table 1.3 Structure and Content of the ESIA

Section/Chapter	Content
Executive Summary	A summary of the ESIA
Units and Abbreviations	A list of the units and abbreviations used in the ESIA.
Glossary	A glossary of terms.
1 Introduction	A general introduction to the SD2 Infrastructure Project, the objectives of the assessment, and the report structure of the ESIA.
2 Policy, Regulatory and Administrative Framework	A summary of the composition and HSE policies of the project proponent, the HSE requirements set out in the Shah Deniz PSA, relevant international and national environmental standards and guidelines.
3 Impact Assessment Methodology	A description of the methods used to conduct the ESIA.
4 Options Assessed	A description of the alternative concept options assessed for the SD2 Infrastructure Project.
5 Project Description	A detailed description of the SD2 Infrastructure Project.
6 Environmental Description	A description of the environmental baseline conditions in the vicinity of the SD2 Infrastructure area.
7 Socio-Economic Description	A description of the socio-economic baseline conditions in the vicinity of the SD2 Infrastructure area.
8 Consultation and Disclosure	An overview of the consultation undertaken during the ESIA and key issues raised.
9 Environmental Impact Assessment, Mitigation and Monitoring	An assessment of the potential environmental impacts associated with the SD2 Infrastructure Project activities.
10 Socio-Economic Impact Assessment, Mitigation and Monitoring	An assessment of the potential socio-economic impacts associated with the SD2 Infrastructure Project activities.
11 Cumulative and Transboundary Impacts and Accidental Events	An assessment of the potential cumulative and transboundary impacts and accidental events associated with the SD2 Infrastructure Project.
12 Environmental and Social Management	A summary of the environmental and social management system associated with the SD2 Infrastructure Project activities.
13 Residual Impacts and Conclusions	A summary of the residual impacts and conclusions arising from the ESIA process.
Appendices	Supporting technical information.

2 Policy, Regulatory and Administrative Framework

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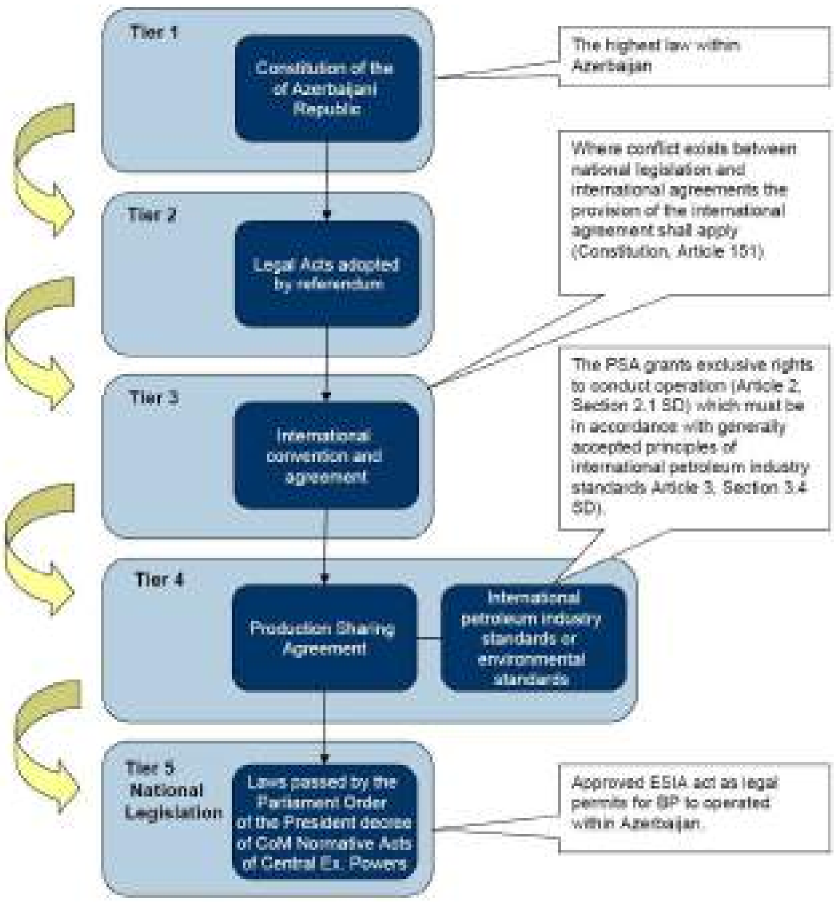
2.1 Introduction

The Shah Deniz 2 (SD2) Infrastructure Project will be undertaken in accordance with the Agreement on the Exploration, Development and Production Sharing for Shah Deniz Prospective Area in the Azerbaijan Sector of the Caspian Sea (referred to herein as the "PSA"), applicable requirements of international conventions ratified by the Azerbaijan government, international petroleum industry standards and practices, applicable national legislation and BP's Health Safety Security and Environment (HSSE) Policy. The legal hierarchy applicable to the SD2 Infrastructure Project is illustrated in Figure 2.1.

Figure 2.1 Azerbaijan Legal Hierarchy



2.2 The Constitution

The Constitution is the highest law in the Azerbaijan Republic and prevails over national legislation and international agreements. It stipulates the basic rights of people to live in a healthy environment, to have access to information on the state of the environment and to obtain compensation for damage suffered as the result of a violation of environmental legislation.

2.3 Production Sharing Agreement

The PSA establishes the legal regime for the joint development and production sharing of the Shah Deniz field. This agreement, signed by BP and its co-venturers as Contractor Parties and the State Oil Company of the Republic of Azerbaijan (SOCAR) was entered into in Baku in June 1996. It was subsequently enacted into the law of the Republic of Azerbaijan after ratification by the Parliament on 17th October 1996. BP Exploration (Shah Deniz) Limited is acting as the Technical Operator for and on behalf of SD PSA participants in accordance with a Joint Operating Agreement and the Operator Services Agreement.

The PSA states that the conduct of operations should be undertaken with respect to the general environment, other natural resources and property, with the order of priority being the protection of life, environment and property.

Article 26.1 of the PSA states:

"Contractor shall develop jointly with SOCAR and the State Committee of the Azerbaijan Republic on Ecology and Control over the Use of Natural Resources ("SCE") safety and environmental protection standards and practices appropriate for the relations of Petroleum Operations[1]"

Article 26.1 also requires that in developing relevant standards and practices, environmental quality objectives, technical feasibility and economic and commercial viability must also be taken into account (refer to Appendix 2A for SD PSA extract) and further states:

"*Subject to the first sentence of Article 26.4 the standards, which shall apply to Petroleum Operations from Effective Date shall be the standards and practices set out in part II of Appendix IX until substituted by new safety and environmental protection standards devised and agreed between Contractor, SOCAR and SCE on a date between the Parties and SCE and from such date such agreed standards and practices shall have the force of law as if set out in full in the Agreement."*

In response to the requirement under Article 26.1 of the PSA, SD specific Environmental Protection Standards (EPS) have been developed and have been formally approved via signed letters from SOCAR and the MENR in 1998. Technical work on development of the Environmental Production Standards began in 2001. Production Standards have been approved by Shah Deniz Co-venturers. The protocol for their entrance into legal force has been signed by BP on behalf of the SD partners and SOCAR, but has yet to be signed by the MENR. The following SD EPS documents have been developed:

- **SD EPS: Approval and Permitting** – details the permitting and approval process for SD projects and activities resulting in potential environmental impacts.
- **SD EPS: Environmental Planning and Environment** – provides an overview of environmental management requirements for SD projects.
- **SD EPS: Environmental Risk Assessment and Management** – details the EPS to be complied with by the Operator for the purposes of conducting Environmental Risk Assessments (ERA) associated with the execution of SD projects.
- **SD EPS: Standards for Environmental Quality** – details the preliminary Maximum Permissible Concentration (MPC) of pollutants which will be used as the basis for deriving EPS which will be applied to discharges and emissions to the environment.
- **SD EPS: Discharges and Emissions** – describes the EPS to be complied with by the Operator and all contractors involved in the execution of SD projects for the purpose of controlling emissions and discharges to the environment.
- **SD EPS: Chemical Selection and Management** – details the EPS to be complied with for the purposes of chemical selection and management by the Operator and all contractors involved in the execution of SD projects.
- **SD EPS: Condensate and Chemical Spill Contingency Planning** – details the EPS to be complied with by the Contractor and all Subcontractors involved in the execution of SD projects for the purposes of condensate and chemical spill contingency planning (CCSCP).
- **SD EPS: Waste Management** – details the EPS to be complied with by the Operator and all contractors involved in the execution of SD projects for the purposes of waste

[1] The PSA defines petroleum operations as: "*all operations relating to the exploration, appraisal, development, extraction, production, stabilisation, treatment (including processing of natural gas), stimulation, injection, gathering, storage, handling, lifting, transporting petroleum to the delivery point and marketing of petroleum from, and abandonment operations with respect to the Contract Area*".

management to ensure waste will be managed in an environmentally safe manner from the site of waste generation to the point of final disposal.

Accordingly, until the protocol on entrance into legal force of the Production Standards has been signed by all of the parties, the standards and practices set out in part II of Appendix IX to the PSA shall continue to apply to production activities.

Article 26.4 of the PSA requires BP Exploration (Azerbaijan) Limited to: *" …comply with present and future Azerbaijani laws or regulations of general applicability with respect to public heath, safety and the protection and restoration of the environment, to the extent that such laws and regulations are no more stringent than the Environmental Standards."*

Appendix 9 of the PSA describes the standards and practices common for international petroleum industry that were in existence at the time when the PSA was signed. Tables 2.1 and 2.2 provide a summary of international and regional conventions, which form part of the current international petroleum industry framework.

Table 2.1 Summary of International Conventions

Convention	Purpose	Status
UN Framework Convention on Climate Change.	To collate information on greenhouse gas emissions and cooperate in planning.	Azerbaijan not formally required to meet specific reduction targets.
Bern Convention.	Conservation of wild flora and fauna and their natural habitats.	In force in Azerbaijan since 2002.
UNESCO Convention on Wetlands of International Importance especially as Waterfowl Habitat / RAMSAR Convention.	Promote conservation of wetlands and waterfowl. In addition, certain wetlands are designated as Wetlands of International Importance and receive additional protection.	Azerbaijan signed the Ramsar Convention in 2001.
Stockholm Convention on Persistent Organic Pollutants.	Reduction in releases of dioxins, furans, hexachlorobenzene and PCBs with the aim of minimisation or elimination.	Azerbaijan acceded in 2004.
UN Convention on the Protection of the Ozone Layer (Vienna Convention).	Framework for directing international effort to protect the ozone layer, including legally binding requirements limiting the production and use of ozone depleting substances as defined in the Montreal Protocol to the Convention.	Azerbaijan acceded in 1996.
UN Convention on Biological Diversity.	Conservation of biological diversity including the sustainable use of its components and the fair and equitable sharing of benefits.	Azerbaijan became party to the Convention in 2000.
FAO Plant Protection Convention.	A treaty to prevent the spread and introduction of pests of plants and plant products and to promote measures for their control.	Entered into force in Azerbaijan in 2000.
Convention to Combat Desertification.	To combat desertification and mitigate the effects of drought.	Entered force in Azerbaijan in 1998.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).	Controls trade in selected species of plant and animals.	Entered into force in Azerbaijan in 1999.
Convention for the Protection of the Archaeological Heritage of Europe.	Requires each state party to support archaeological research financially and promote archaeology, using public or private funding as the case may be.	Azerbaijan ratified in 2000.
UNESCO Convention on the Protection and Promotion of the Diversity of Cultural Expressions.	Promotes participants' right to formulate and implement their cultural policies and to adopt measures to protect and promote the diversity of cultural expressions and to strengthen international cooperation.	Azerbaijan acceded in 2010.

Table 2.2 Summary of Regional Conventions

Convention	Purpose	Status
Aarhus Convention*.	To guarantee the rights of access to information, public participation in decision-making and access to justice in environmental matters.	Azerbaijan acceded in 2000.
Espoo Convention*.	To promote environmentally sound and sustainable development through the application of ESIA, especially as a preventive measure against transboundary environmental degradation.	Azerbaijan acceded in 1999. At the time of writing, Azerbaijan had not signed a related protocol on Strategic Environmental Assessment.
Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki Convention)*.	To prevent, control or reduce and transboundary impact resulting from the pollution of transboundary waters by human activity.	Azerbaijan acceded in 2002.
UN Convention on Control of Transboundary Movements of Hazardous Wastes and their Disposals.	Regulates the transboundary movements of hazardous wastes and provides obligations to its Parties to ensure that such wastes are managed and disposed of in an environmentally sound manner.	Azerbaijan ratified in 2001.
Protocol on Water and Health*.	To protect human health and well-being by better water management and by preventing, controlling and reducing water-related diseases.	Azerbaijan acceded in 2003.
UNECE Geneva Convention on Long-range Transboundary Air Pollution*.	Provides a framework for controlling and reducing transboundary air pollution.	Entered into force in Azerbaijan in 2002. Has been extended by 8 protocols, none of which at the time of writing have been ratified by Azerbaijan.
Convention on the Transboundary Effects of Industrial Accidents*.	To prevent industrial accidents that may have transboundary effects and to prepare for and respond to such events.	Azerbaijan acceded in 2004.
International Carriage of Dangerous Goods by Road*.	Provides requirements for the packaging and labelling of dangerous goods and the construction, equipment and operations of transportation vehicles. Annexes provide detailed technical requirements.	Entered into force in Azerbaijan in 2000.
Tehran- Caspian Framework Convention.	Ratified by all five littoral states and entered into force in 2006. Requires member states to take a number of generic measures to control pollution of the Caspian Sea. Four protocols have been drafted which will, when adopted, form the basis for national legislation and regulations.	Convention is ratified, but protocols are at the time of writing still in draft form and do not therefore at present provide a binding basis for the development of legislation.

* A UNECE agreement; Azerbaijan became a member of the UNECE in 1993. The major aim of the UNECE is to promote pan-European integration through the establishment of norms, standards and conventions.

2.4 National Environmental Legislation

The Government has committed to a process to align national environmental legislation with the principles of internationally recognised legislation, based on EU environmental legislation. As this process is on-going, the SD2 Infrastructure Project will comply with the intent of current national legal requirements where those requirements are consistent with the provisions of the PSA, and do not contradict, or are otherwise incompatible with, international petroleum industry standards and practice.

The framework for national environmental legislation in Azerbaijan is provided by the Law on the Protection of the Environment (1999), which addresses the following issues:

- The rights and responsibilities of the State, the citizens, public associations and local authorities;
- The use of natural resources;
- Monitoring, standardisation and certification;
- Economic regulation of environmental protection;
- State Ecological Expertise (SEE);
- Ecological requirements for economic activities;
- Education, scientific research, statistics and information;
- Ecological emergencies and ecological disaster zones;
- Control of environmental protection;
- Ecological auditing;
- Responsibility for the violation of environmental legislation; and
- International cooperation.

According to Article 54.2 of the Law on Protection of the Environment, EIAs are subject to SEE, which means that the environmental authority (MENR) is responsible for the review and approval of EIA reports submitted by developers. The Law establishes the basis for the SEE procedure, which can be seen as a “stand-alone” check of compliance of the proposed Project with the relevant environmental standards (e.g. for pollution levels, discharges and noise). In addition the law determines that projects cannot be implemented without a positive SEE resolution.

The SEE approach requires state authorities to formally verify all submitted developments for their potential environmental impacts. Current internationally recognised practice emphasises a proportionate, consultative and publicly accountable approach to assessing impacts.

Table 2.3 provides a summary of the key national environmental and social laws.

Table 2.3 Key National Environmental and Social Laws[2]

Subject	Title	Date	Description / Relevance to SD2 Infrastructure ESIA
General	Law of Azerbaijan Republic on the Protection of the Environment No. 678-IQ.	08/06/1999 (last amendment 30/03/2001)	Establishes the main environmental protection principles and the rights and obligations of the State, public associations and citizens regarding environmental protection (described above).
	Law on Automobile Roads, Section 39: Protection of the Environment.	10/03/2000	Requires that any construction or reconstruction of roads receives official approval from SEE where the project must demonstrate that best practicable techniques are used and all chemicals used during a project must be environmentally sound.
	SNIP 2.05.02-85 Building Code & Regulations for Automobile Roads Ch. 3: Environmental Protection.	1987 revised 2000	Promotes minimising adverse environmental impacts through effective road design, as well as: • Providing instructions on the removal and reuse of top soil (no. 3.4); • Establishing the need to provide a buffer between the road and populated areas; • Requiring noise reduction measures such that compliance with relevant noise norms are met (no. 3.9.); and • Setting out the process of dumping excess materials (no. 3.12).
	Guidelines for Road Construction, Management and Design: Part I: Planning of Automobile Roads. Part II: Construction of Automobile Roads.	07/02/2000	Addresses environmental issues in road design, construction and maintenance. Provides comprehensive provisions on environmental protection measures in road construction such as use of soils; protection of surface and groundwater resources; protection of flora and fauna; use, preparation and storage of road construction machinery and materials; servicing of construction machinery; provisional structures; provisional roads; fire protection; borrow pits and material transport; avoidance of dust; protection of soils from pollution, prevention of soil erosion etc. The appendices to this document also state standards for, maximum permitted concentrations of toxic substances; noise control measures; soil pollution through losses of oil and fuel from construction equipment; and the quality of surface water.
	Law of Azerbaijan Republic on Ecological Safety No. 677-IQ.	08/06/1999	One of two keystone laws of the country's environmental legislation (along with the *Law on the Protection of the Environment*). Its purpose is to establish a legal basis for the protection of life and health, society, the environment, including atmospheric air, space, water bodies, mineral resources, natural landscapes, plants and animals from natural and anthropogenic dangers. The Law assigns the rights and responsibilities of the State, citizens and public associations in ecological safety, including information and liability. The Law also deals with the regulation of economic activity, territorial zoning and the alleviation of the consequences of environmental disasters.
Ecosystems	Law of the Azerbaijan Republic on Specially Protected Natural Territories and Objects No. 840-IQ.	24/03/2000	Determines the legal basis for protected natural areas and objects in Azerbaijan.
	Law of Azerbaijan Republic on Fauna No. 675-IQ.	04/06/1999	Defines the animal world, property rights over fauna and legal relationships between parties. It also describes issues of State inventory and monitoring, and economic and punitive regulations.

[2] This table is compiled from a variety of sources including: United Nations 2004, Environmental Performance Reviews Series No. 19 – Azerbaijan; Currie & Brown, 2008, Integrated Solid Waste Management System for the Absheron Peninsula Project, and Popov 2005, Azerbaijan Urban Environmental Profile (an ADB Publication).

Subject	Title	Date	Description / Relevance to SD2 Infrastructure ESIA
Water	Water Code of Azerbaijan Republic (approved by Law No. 418-IQ).	26/12/1997	Regulates the use of water bodies, sets property rights and covers issues of inventory and monitoring. The Code regulates the use of water bodies for drinking and service water and for medical treatment, spas, recreation and sports, agricultural needs, industrial needs and hydro energy, transport, fishing and hunting, discharge of waste water, fire protection and specially protected water bodies. It provides for zoning, maximum allowable concentrations of harmful substances and basic rules of industry conduct.
	Law of the Azerbaijan Republic on Water Supply and Wastewater No. 723-1Q.	28/10/1999	Applicability limited to onshore operations. Restricts industrial waste releases into the sewage system; requires segregation of stormwater and industrial wastes from sewage, and requires legal entities to acquire permissions to operate sewage treatment plant.
	Rules of Referral of Specially Protected Water Objects to Individual Categories, Cabinet of Ministers Decree No. 77.	01/05/2000	The Caspian Sea is a specially protected water body. This resolution requires special permits for disposal if there are no other options for wastewater discharge. The resolution allows for restrictions to be placed on the use of specially protected water bodies, and for further development of regulations related to these water bodies. It requires consent from MENR for activities that modify the natural conditions of specially protected water bodies, and includes provisions for permitting of any discharges to water that cannot be avoided. There are also special requirements for the protection of water bodies designated for recreational or sports use (which includes the Caspian).
	Rules for Protection of Surface Waters from Waste Water Pollution, State Committee of Ecology Decree No. 1.	04/01/1994	Under this legislation the *Permitted Norms of Harmful Impact Upon Water Bodies of Importance to Fisheries* require discharges to meet several specified standards for designated water bodies in terms of suspended solids; floating matter; colour, smell and taste; temperature; dissolved oxygen; pH; Biological Oxygen Demand (BOD) and poisonous substances. Limits are based on Soviet era standards and are to be achieved at the boundary of the facility (specific “sanitary protection zone limits”) rather than “end-of-pipe” limits. End of pipe limits are defined in facility-specific “eco-passports” and are established with the intent to ensure compliance with applicable ambient standards.
Air	Law of Azerbaijan Republic on Air Protection No. 109-IIQ.	27/03/2001	Establishes the legal basis for the protection of air, thus implementing the constitutional right of the population to live in a healthy environment. It stipulates the rights and obligations of the authorities, legal and physical persons and NGOs in this respect, sets general requirements for air protection during economic activities, establishes norms for mitigating physical and chemical impacts to the atmosphere, establishes rules for the State inventory of harmful emissions and their sources and introduces general categories of breaches of the Law that will trigger punitive measures.
	Methodology to Define Facilities’ Hazards Categories Subject to Hazardous Substance Emissions Levels and Need to Develop Projects’ Maximum Permissible Emissions (MPEs).	04/09/1990	Under this methodology the maximum permissible concentrations of harmful substances and their hazard classes are provided. Limits are based on Soviet era standards.
Waste	Law of Azerbaijan Republic on Industrial and Domestic Waste No. 514-IQ.	30/06/1998	Describes State policy in environmental protection from industrial and household waste including harmful gases, waste water and radioactive waste. It defines the rights and responsibilities of the State and other entities, sets requirements for the design and construction of waste-treatment installations, licensing of waste generating activities, and for the storage and transport of waste (including transboundary transportation). The Law also encourages the introduction of technologies for the minimisation of waste generation by industrial enterprises. There is a general description of responses to infringements. This law is specified by Resolutions of the Cabinet of Ministers on the rules of certification of hazardous wastes, state strategy on management of hazardous wastes in Azerbaijan and by Instructions on the Inventorisation Rules and Classification System of the Wastes generated by Industrial Processes and In the Field of Services approved by the MENR.

Subject	Title	Date	Description / Relevance to SD2 Infrastructure ESIA
Information	Law of the Azerbaijan Republic on Access to Environmental Information No. 270-IIQ.	12/03/2002	Establishes the classification of environmental information. If information is not explicitly classified "for restricted use" then it is available to the public. Procedures for the application of restrictions are described. Law aims to incorporate the provisions of the Aarhus Convention (ratified by Azerbaijan in 1999) into Azeri Law.
Community heath & safety	Law on Sanitary-Epidemiological Services (authorised by Presidential Decree No. 371).	10/11/1992	Establishes sanitary and epidemiological requirements for industrial entities to be met at design, construction and operational stages, and for other economic activities. Aims to protect the health of the population. It addresses the rights of citizens to live in a safe environment and to receive full and free information on sanitary-epidemic conditions, the environment and public health.
	Law of the Azerbaijan Republic on Protection of Public Health No. 360-IQ.	26/06/1997	Sets out the basic principles of public health protection and the health care system. The Law assigns liability for harmful impact on public health, stipulating that damage to health that results from a polluted environment shall be compensated by the entity or person that caused the damage.
	Law of the Azerbaijan Republic on Public Radiation Safety No. 423-IQ.	30/12/1997	Includes requirements for ensuring radiation safety in industrial entities. The Law establishes the main principles of government policy on radiation safety, as well as environmental norms protecting the safety of employees and populations in areas potentially affected by the use of radioactive sources. The Law provides for compensation for damage to health, property and life during accidents.
	Rules of Filing and Consideration of Applications for Withdrawal of Plots of Land, Allocation of Plots of Land for State and Public Purposes, Resolution No. 42 on Certain Normative-Legal Acts related to the Land Code of the Azerbaijan Republic.	15/03/2000	Identifies process of applying for withdrawal and allocation of plots of land for state and public purposes, including construction of industrial facilities and pipelines.
	State Standard for Stationary Equipment State Committee of Metrology and Standardisation of USSR as GOST 27409-87- from 1987-07-01.	01/07/1987	Includes noise level limitations for the operation of stationary equipment.
Liability	Law on Azerbaijan Republic on Mandatory Environmental Insurance No. 271.	12/03/2002	Identifies requirements for the mandatory insurance of civil liability for damage caused to life, health, property and the environment resulting from accidental environmental pollution.
Permitting	A System of Standards for the Environment Protection and Improvement of Natural Resources Utilisation. Industrial Enterprise Ecological Certificate Fundamental Regulations, GOST 17.0.0.04-90.	01/07/1990	The MENR issues ecological documents on the impact on the environment of potentially polluting enterprises. The documents include maximum allowable emissions, maximum allowable discharges, and an "ecological passport." The last item is specific to countries of the Former Soviet Union and contains a broad profile of an enterprise's environmental impacts, including resource consumption, waste management, recycling, and the effectiveness of pollution treatment. Enterprises develop the draft passport themselves and send it to MENR for approval.
Cultural heritage	Law on the Protection of Historical and Cultural Monuments.	1998	Specifies the responsibilities of state and local authorities, and lays down principles for the use, study, conservation, restoration, reconstruction, renovation and safety of monuments. The Law declares that cultural objects with national status: historical and cultural monuments, cultural goods stored in state museums, archives, libraries, as well as the territories where they are situated, are not subject to privatisation. Requires archaeological studies prior to construction works in areas with archaeological significance.

2.4.1 National EIA Guidance

Guidance on the EIA process in Azerbaijan is provided in the Handbook for the Environmental Impact Assessment Process in Azerbaijan. The handbook introduces the main principles of the 'western'-type EIA process and details:

- The EIA process, i.e. the sequence of events and the roles and responsibilities of applicants and Government institutions;
- The purpose and scope of the EIA document;
- Public participation in the process;
- Environmental review decision (following its submission to the MENR, the ESIA document is reviewed for up to three months by an expert panel); and
- The appeal process.

A summary of the guidance provided in the handbook is given in Table 2.4 below.

The approval of an EIA by the MENR establishes the compliance framework, including the environmental and social standards that an organisation should adhere to.

Table 2.4 Summary of Guidance on the EIA Process in Azerbaijan[3]

Screening	The developer is required to submit an Application (containing basic information on the proposal) to MENR to determine whether an EIA is required.
Scoping	Requirement for a Scoping Meeting to be attended by the developer, experts and concerned members of the public, and aimed at reaching a consensus on the scope of the EIA.
Project Description	Full description of technological process and analysis of what is being proposed in terms of planning, pre-feasibility, construction and operation.
Environmental Studies	Requirement to describe fully the baseline environment at the site and elsewhere, if likely to be affected by the proposal. The environment must be described in terms of its various components – physical, ecological and social.
Consideration of Alternatives	No requirement to discuss Project alternatives and their potential impacts (including the so-called "do-nothing" alternative), except for the description of alternative technologies.
Impact Assessment and Mitigation	Requirement to identify all impacts (direct and indirect, onsite and offsite, acute and chronic, one-off and cumulative, transient and irreversible). Each impact must be evaluated according to its significance and severity and mitigation measures provided to avoid, reduce, or compensate for these impacts.
Public Participation	Requirement to inform the affected public about the planned activities twice: when the application is submitted to the MENR for the preliminary assessment and during the EIA process. The developer is expected to involve the affected public in discussions on the proposal.
Monitoring	The developer is responsible for continuous compliance with the conditions of the EIA approval through a monitoring programme. The MENR undertakes inspections of the implementation of activities in order to verify the accuracy and reliability of the developer's monitoring data. The developer is responsible for notifying the MENR and taking necessary measures in case the monitoring reveals inconsistencies with the conditions of the EIA approval.

[3] Source: based on a review of the EIA Handbook and "EIA in the New Oil and Gas Projects in Azerbaijan", Parviz, 2005.

2.5 Regional Processes

2.5.1 European Union

EU relations with Azerbaijan are governed primarily by the EU-Azerbaijan Partnership and Cooperation Agreement (PCA) and the European Neighbourhood Policy (ENP).

The PCA entered into force in 1999, under Article 43:

"The Republic of Azerbaijan should endeavour to ensure that its legislation will be gradually made compatible with that of the Community".

As part of the PCA an EU assessment of Azerbaijan's environmental legislation against EU Directives identified a number of recommendations for the approximation of national legislation with EU Directives[4]. Based on this, a draft national programme was developed that emphasises a flexible approach to amending national legislation to take account of institutional capacity and cost[5].

Following the enlargement of the European Union, the EU launched the ENP and Azerbaijan became part of this policy in 2004. The current National Indicative Programme for implementing the ENP[6] includes a commitment to support legislative reform in the environmental sector, including:

- Approximation of Azerbaijan's environmental legislation and standards with the EU's;
- Strengthening of management capacity through integrated environmental authorisation;
- Improved procedures and structures for environmental impact assessment; and
- Development of sectoral environmental plans (waste and water management, air pollution, etc.).

2.5.2 Environment for Europe

Environment for Europe[7] is a partnership of member states, including Azerbaijan, and other organisations within the UNECE region. Under the auspices of the Environment for Europe a series of ministerial conferences on the environment have been held that have resulted in the establishment of the UNECE conventions described in Section 2.4.

2.6 International Petroleum Industry Standards and Practices

SD related activities are required to comply with national legislation with respect to public health, safety and protection and restoration of the environment where it is no more stringent than the Environmental Standards (SD PSA Article 26.4). Consideration of relevant international industry standards is therefore an important element in determining the applicability or otherwise of national legislation. Industry standards including those of the Oil Industry International Exploration and Production Forum (E&P Forum), the International Association of Geophysical Contractors (IAGC) and the International Association of Drilling Contractors (IADC) were specifically mentioned in the SD PSA. There are no specific international standards with regard to construction activities within the PSA.

[4] Mammadov, A. & Apruzzi, F. (2004) Support for the Implementation of the Partnership Cooperation Agreement between EU-Azerbaijan. Scoreboard Report on Environment and Utilisation of Natural Resources. Report prepared for TACIS.
[5] SOFRECO (undated) Support for the Implementation of the PCA between EU-Azerbaijan, Draft Programme of legal Approximation.
[6] NIP (2007) European Neighbourhood and Partnership Instrument, Azerbaijan National Indicative Programme.
[7] UNECE (2008) Environment for Europe (http://www.unece.org/env/efe/welcome.html).

2.7 BP Requirements

The BP Group Defined Practice (GDP) 'Environmental and Social Requirements for New Access Projects, Major Projects, International Protected Area Projects and Acquisition Negotiations' sets out a rigorous, consistent methodology for early identification of potential environmental and social impacts, known as screening. This practice is supported by the BP Group Recommended Practice (GRP) 'Environmental and Social Recommendations for Projects' which provides recommendations that support the management of potential environmental and social impacts from Projects. The GRP contains seven Impact Management Processes (IMPs) and sixteen Performance Recommendations (PRs) which are relevant to the SD2 Infrastructure Project's activities.

3 Impact Assessment Methodology

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3.1 Introduction

This Chapter presents a description of the Environmental and Socio-Economic Impact Assessment (ESIA) process adopted for the Shah Deniz 2 (SD2) Infrastructure Project and the methodology used to assess impact significance.

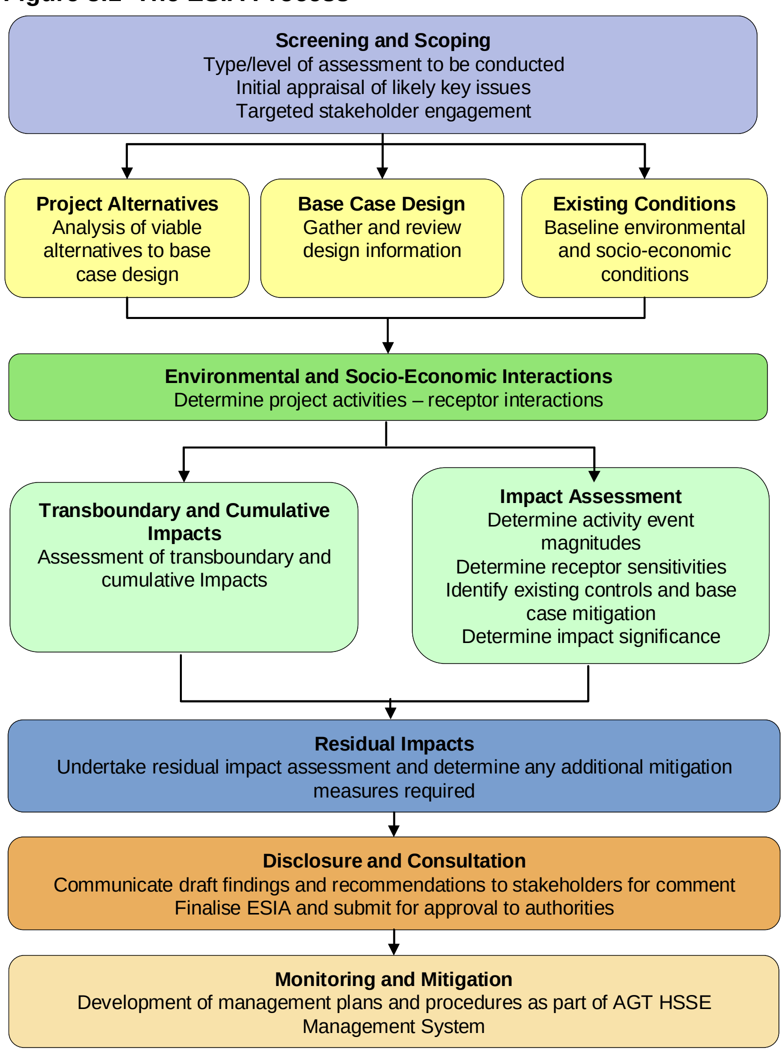
3.2 ESIA Process

The ESIA process constitutes a systematic approach to the evaluation of a project and its associated activities throughout the project lifecycle. The process (refer to Figure 3.1) includes:

- Screening and Scoping;
- Project Alternatives and Base Case Design;
- Existing Environmental and Socio-Economic Conditions;
- Impact Significance Assessment;
- Mitigation and Monitoring;
- Residual Impacts; and
- Disclosure and Stakeholder Consultation.

The ESIA also includes stakeholder consultation that identifies the views and opinions of potentially affected people and other interested parties. Stakeholder feedback is used to focus the impact assessment and, where appropriate, influence project design and execution.

Figure 3.1 The ESIA Process



3.2.1 Screening and Scoping

Screening is the first step in the assessment process. It confirms the need (or otherwise) for an ESIA by appraising the type of project and its associated activities throughout its lifecycle in the context of its biophysical, socio-economic, policy and regulatory environments.

Given the location, scale and planned activities associated with the SD2 Infrastructure Project, it was agreed with the Ministry of Ecology and Natural Resources (MENR) that the project should be subject to an ESIA, and the ESIA should take account of applicable national and international legislation, SD PSA and BP standards as detailed in Chapter 2: Policy, Regulatory and Administrative Framework.

Scoping is a high level assessment of anticipated "interactions" between project activities and environmental "receptors". Its purpose is to focus the assessment on key issues and eliminate certain activities from the full impact assessment process based on their limited potential to result in discernable impacts. To arrive at a conclusion to 'scope out' an activity/event, a mixture of expert scientific judgement based on prior experience of similar activities and events and, in some instances, scoping level quantification/numerical analysis (e.g. emission and discharge modelling) is used.

The SD2 Infrastructure Project Scoping process has included:

- Review of existing environmental and socio-economic data and reports relevant to the project activities; and
- Liaison with the SD Infrastructure Design Team to gather data and to formulate an understanding of project activities.

Based on the findings and results of these reviews, investigations and consultations, the SD2 Infrastructure Project Team identified:

- Potential project related environmental and socio-economic impacts based on likely interactions between SD2 Infrastructure Project activities and environmental/socio-economic receptors; and
- Gaps where the extent, depth and/or quality of environmental, socio-economic and/or technical data is insufficient for the SD2 Infrastructure ESIA process, thus identifying the additional work required to complete the ESIA.

3.2.2 Project Alternatives and Base Case Design

3.2.3.1 Project Alternatives

The initial step in defining a project is to identify, at a conceptual level, viable alternatives to the project so that a Base Case Design may be realised. Consideration of project alternatives occurs at two levels:

- To the development as a whole, including the "no development" option, and
- Engineering alternatives within the selected project's concept design definition.

Project alternatives were defined during the early conceptual design of the SD2 Infrastructure Project and were compared on financial, technical design, safety, environmental and socio-economic criteria. The alternative that represented the best balance in regards all criteria was taken forward to the subsequent detailed design stage.

Chapter 4: Options Assessed presents a summary of the alternative designs considered and options evaluated for the SD2 Infrastructure Project.

3.2.3.2 Project Design

The SD2 Infrastructure ESIA Team worked with the SD2 Infrastructure Design Team to gather and interpret relevant information for the ESIA. This dialogue between the teams identified where additional project design definition, in terms of existing controls and additional mitigation measures, was required in the SD2 Infrastructure Base Case Design to minimise impacts. Opportunities identified for environmental and socio-economic enhancements were considered by the teams and incorporated into the Base Case Design where appropriate and practicable.

The SD2 Infrastructure Base Case Design, on which the SD2 Infrastructure impact assessment is based, is presented in Chapter 5: Project Description.

3.2.3 Existing Conditions

In order to identify potential impacts to receptors, an understanding of the existing conditions was established prior to execution of project activities. The SD2 Infrastructure ESIA Scoping exercise determined that the project will likely result in impacts on the following receptor groups:

- Biological/Ecological Receptor;
- Physical Receptor/Feature;
- Soil, Ground Water and Surface Water Quality; and
- Socio-Economic/Human.

A review of existing baseline data, covering a period from 1996 to 2011, and including results of the ongoing Integrated Environmental Monitoring Programme (IEMP), was undertaken to identify the existing conditions within the Terminal vicinity. A number of specific surveys were also undertaken to gather additional environmental data. These included noise, odour, visual context and light surveys. Meteorological and hydrological data was provided by the Baku State University National Hydrometeorological Department and the Institute of Geography at the National Academy of Sciences of the Azerbaijan Republic respectively.

Data associated with existing socio-economic conditions was obtained from secondary data sources including State Statistical data and directly from the Garadagh District Executive Power. A Stakeholder and Socio-Economic Survey (SSES) was commissioned to obtain relevant up to date information to characterise socio economic conditions within the local communities surrounding the Terminal. More details regarding this survey are provided in Chapter 8: Consultation and Disclosure.

Chapter 6: Environmental Description and Chapter 7: Socio-Economic Description describe the existing environments based on a review of existing data, specific environmental surveys undertaken to inform this ESIA and the findings of the SSES.

3.2.4 Impact Significance Assessment

An impact, as defined by ISO14001:2004 is: *"Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's environmental aspects (activities, products or services)".*

Where project activity – receptor interactions occur, an impact is defined. The ESIA process ranks impacts according to their "significance" determined by considering project activity "event magnitude" and "receptor sensitivity". Determining event magnitude requires the identification and quantification (as far as practical) of the sources of potential environmental and social effects from routine and non-routine project activities. Determining receptor environmental sensitivity requires an understanding of the biophysical environment.

The sections below set out the methodology for both environmental and socio-economic impact assessment.

3.2.5 Environmental Impacts

Method for Determining Event Magnitude

Event magnitude is determined based on the following parameters, which are equally weighted and are each assigned a rating of ”1”, ”2”, or ”3”:

- **Extent / Scale**: Events range from those affecting an area:

  1 – Up to 500m from the source or an area less than 50 hectares; to
  2 – Greater than 500m and up to 1km from the source or an area between 50-100 hectares; to
  3 – Greater than 1km from the source or an area greater than 100 hectares.

- **Frequency**: Events range from those occurring:

  1 - Once; to
  2 - Up to 50 times; to
  3 - More than 50 times or continuously.

- **Duration**: Events range from those occurring for:

  1 – Up to one week; to
  2 - More than one week and up to one month; to
  3 - Periods longer than one month to permanent.

- **Intensity**: Concentration of an emission or discharge or noise level with respect to standards of acceptability that include applicable legislation and international guidance. Degree/permanence of disturbance or physical impact (e.g. disturbance to species, loss of habitat or damage to cultural heritage). Ranges from:

  1 - A low intensity event; to
  2 - A moderate intensity event; to
  3 - A high intensity event.

Overall event magnitude is then scored on a spectrum from low (1) to high (12) by adding the individual parameter scores:

Resulting individual ratings are summed to give the overall event magnitude ranking. Table 3.1 presents the score ranges for magnitude rankings of ”Low”, ”Medium” and ”High”.

Table 3.1 Event Magnitude Rankings

Event Magnitude	Score (Summed Parameter Rankings)
Low	4
Medium	5-8
High	9-12

Method for Determining Receptor Sensitivity

Receptor sensitivity is determined based on the following parameters, which are equally weighted and are each assigned a rating of ”1”, ”2”, or ”3”:

- **Biological/Ecological Receptors:**

  – ***Presence***: Ranges from:

    3 - Routine, regular or reliably predictable presence of any species which is, in reverse order, a unique, threatened or protected species; to
    2 - Regionally rare or largely confined to the SD2 Infrastructure area or sensitive to industry emissions /disturbances; to
    1 - A species which is none of the above and is therefore assessed at the community level only.

  – ***Resilience (to the identified stressor)***: Ranges from:

    1 - Species or community unaffected or marginally affected; to
    2 - Species undergoing moderate but sustainable change which stabilises under constant presence of impact source, with ecological functionality maintained; to
    3 - Substantial loss of ecological functionality (e.g. loss of species in key groups, substantially lower abundance and diversity).

- **Human Receptor:**

  – ***Presence:*** Ranges from:

    3 - People being permanently present (e.g. residential property) in the geographical area of anticipated impact; to
    2 - People being present some of the time (e.g. commercial property); to
    1 - People being uncommon in the geographical area of anticipated impact.

  – ***Resilience (to the identified stressor):*** Ranges from:

    1 -People being least vulnerable to change or disturbance (i.e. ambient conditions (air quality, noise) are well below applicable legislation and international guidance); to
    2 - People being vulnerable to change or disturbance (i.e. ambient conditions (air quality, noise) are below adopted standards); to
    3 - Most vulnerable groups (i.e. ambient conditions (air quality, noise) are at or above adopted standards).

- **Physical Receptor/Feature:**

  – ***Presence (to the identified stressor):*** Ranges from:

    3 - Presence of feature any species which has, in reverse order, national or international value (e.g. state protected monument); to
    2 – Feature with local or regional value and is sensitive to disturbance; to
    1 - Feature which is none of the above.

  – ***Resilience (to the identified stressor):*** Ranges from:

    1 – Feature/receptor is unaffected or marginally affected i.e. resilient to change;
    2 – Undergoes moderate but sustainable change which stabilises under constant presence of impact source, with physical integrity maintained; and
    3 – Highly vulnerable i.e. potential for substantial damage or loss of physical integrity.

- **Soil, Ground Water and Surface Water**

  – ***Presence:*** Ranges from:

    3 – Receptor is highly valued e.g. used extensively for agriculture, used as a public water supply; to
    2 – Receptor has moderate value e.g. moderate/occasional use for agriculture purposes; to
    1 – Receptor has limited or no value.

  – ***Resilience (to the identified stressor):*** Ranges from:

    1 – No or low levels of existing contamination (well below accepted standards) and receptor is unaffected or marginally affected i.e. resilient to change; to
    2 – Moderate levels of mobile contamination present which are vulnerable to physical disturbance; to
    3 – High levels of mobile contamination present which are highly sensitive to physical disturbance.

Overall receptor sensitivity is then scored on a spectrum from low (1) to high (6) by adding the individual parameter scores:

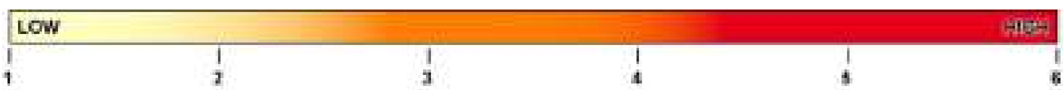


Table 3.2 presents the score ranges for sensitivity rankings of ”Low”, ”Medium” and ”High”’.

Table 3.2 Receptor Sensitivity Rankings

Receptor Sensitivity	Score (Summed Parameter Rankings)
Low	2
Medium	3-4
High	5-6

Method for Determining Environmental Impact Significance

Impact significance, as a function of event magnitude and receptor sensitivity is subsequently ranked as “Negligible”, “Minor”, “Moderate” or “Major” as presented in Table 3.3 below. Impacts can be “positive” or “negative”.

Table 3.3 Impact Significance

		Receptor Sensitivity		
		Low	Medium	High
Event Magnitude	Low	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Major

Any impact classified as “Major” is considered to be significant and where the impact is negative, requires additional mitigation. Impacts of negligible, minor or moderate significance are considered as being mitigated as far as practicable and necessary, and therefore, do not require further mitigation.

3.2.6 Socio-Economic Impacts

The socio-economic impact assessment identifies and evaluates the significance of impacts associated with the SD2 Infrastructure Project, including:

- The identification of all socio-economic impacts (direct and indirect, positive and negative) that are linked to the SD2 Infrastructure Project.
- The measurement (and where possible, monetisation) of socio-economic impacts, including the following:
  - The numbers and characteristics of people affected (number of property owners, affected people and/or those subjected directly to changes in their socio-economic conditions and living environment);
  - Changes in people's access to, or changes in the status of: employment, commercial, recreational, cultural and social services and facilities;
  - Direct loss of land, or change in people's access to land;
  - Social patterns and linkages: changes in how areas function as a community with respect to levels of social interaction; personal relationships; feeling of belonging to the area or aspects relating to self-identification; and
  - General amenity (perceived and actual) and change in the physical conditions that affect the quality of the environment and residential amenity; change in aesthetic values; change in recreation development and opportunities.

The socio-economic impact assessment assesses the significance of potential direct impacts based on probability, magnitude and receptor sensitivity.

- **Probability:** The likelihood that the impact will occur, and degrees of uncertainty, based on the following criteria:
  - ***Highly likely*** - almost certain to occur or may have already occurred.
  - ***Likely*** - some substantiated evidence that the impact is likely to occur, or has previously occurred in a similar context.
  - ***Possible*** - could occur without intervention.
  - ***Unlikely*** - some evidence that impact could occur, no such incident in the region but may have occurred elsewhere.
  - ***Highly unlikely***- no evidence to suggest impact will occur.
- **Magnitude:** Determined based on:
  - **Spatial Scope:** The geographical scope of the impact relative to local community receptors:
    - ***Local –*** effects extending to the communities in the immediate Terminal vicinity (i.e. Sangachal town, Umid, Azim Kend and Masiv 3);
    - ***Regional –*** effects extending to the Garadagh District; and
    - ***National -*** effects extending to Azerbaijan.
  - **Timing and Duration:** The likely timing and duration of the impact (including whether the impact would be temporary or permanent in nature) and how this links to activities undertaken by the SD2 Infrastructure Project;
- **Receptor Sensitivity:** The groups of people or populations most likely to be affected and, in particular, whether impacts are likely to be disproportionately experienced by **vulnerable groups.**

Significance of impacts will be assessed as presented in Table 3.4.

Table 3.4 Socio-economic Impact Significance

Event	Magnitude		Probability	Receptor Sensitivity	Significance
	Spatial Scope	Timing and Duration			

Significance is based on judgement taking into account the likelihood and magnitude of the impact and the sensitivity of the population or group of people that may be affected. The significance of impact (taking into account existing controls) is categorised as follows:

- **Major Positive** – a substantial positive change.
- **Positive** - some positive change.
- **Negligible** - very little change or no change.
- **Negative** - measurable negative change.
- **Major Negative** - considerable negative change.

Any impact classified as “Major Negative” is considered to be significant and requires additional mitigation. Impacts of “Negligible”, “Major Positive” or “Positive” significance are not considered to require mitigation.

Indirect impacts i.e. induced effects, cannot be readily assessed using the same approach. A qualitative assessment is therefore made based on judgement and taking into account existing controls.

3.3 Transboundary and Cumulative Impacts

Transboundary impacts are impacts that occur outside the jurisdictional borders of a project’s host country. Potential SD2 Infrastructure Project transboundary impacts are considered to include:

- Social and economic issues surrounding the sourcing of labour, goods and services from the international market; and
- GHG emissions to air.

Cumulative impacts arise from:

- Interactions between separate project-related residual impacts; and
- Interactions between project-related residual impacts in combination with impacts from other projects and their associated activities.

These can be either additive or synergistic effects, which result in a larger (in terms of extent or duration) or different (dependent on impact interaction) impacts when compared to project-related residual impacts alone.

The cumulative assessment presented in Chapter 11: Cumulative and Transboundary Impacts and Accidental Events, initially considers the potential for impact interaction and accumulation in terms of the following:

- **Temporal Overlap** – the impacts are so close in time that the effect of one is not dissipated before the next one occurs;
- **Spatial Overlap** – the impacts are so close in space that their effects overlap.

At the time of writing the following new projects are proposed or are under construction in the vicinity of the Sangachal Terminal:

- Qizildas Cement Plant – new 5,000 tonne capacity cement plant (approximately 4km to the north);
- Garadagh Dry Kiln Project – works to upgrade at the existing Garadagh cement works to install dry kiln technology (approximately 6km to the east); and
- New Highway Junction – immediately to the south of the Terminal and planned to connect to the new Terminal access road, which forms part of the SD2 Infrastructure works.

In addition it is understood that, a result of an expected significant increase in traffic flows due to industrial development to the north (towards Sahil) and to the south (at Alyat), it is planned to expand the Baku-Salyan Highway along its length to 4 lanes in each direction.

Where there is potential for impact interaction, the project is sufficiently defined and sufficient data is available, a quantitative assessment is undertaken. Where insufficient data is available a qualitative assessment is presented (refer to Chapter 11).

3.4 Mitigation and Monitoring

The iterative and integrated nature of the ESIA and project planning processes means that the majority of proposed additional mitigation measures and strategies have been incorporated into the project Base Case (as provided within Chapter 5: Project Description). These measures / strategies have included mitigation measures and ongoing commitments as previously adopted by other ACG & SD projects and which are of relevance to SD2 Infrastructure Project. These include monitoring and reporting commitments, for, for example, emissions and discharges, as well as policies and procedures that form part of the AGT Environmental Management System.

4 Options Assessed

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4.1 Introduction

The purpose of the Shah Deniz 2 (SD2) Project is to further exploit the gas and condensate reserves within the offshore SD Contract Area. The existing Shah Deniz Stage 1 (SD1) processing facilities at the Sangachal Terminal do not have the capacity to accommodate the additional production from the SD2 Project. Therefore, new onshore facilities for the SD2 Project are required.

It was decided to locate the new onshore SD2 facilities next to the existing Terminal. A review of the adjacent areas indicated that a location to the west of the Terminal was the most suitable.

The SD2 Infrastructure Project comprises the works needed prior to the construction of the new SD2 Project onshore facilities. This Chapter discusses the decision making process regarding the location and design of the following key aspects:

- New Terminal access road;
- Construction camp and construction facilities; and
- Drainage and flood protection design measures.

The Chapter presents a summary of the key decisions made during the SD2 Infrastructure Project design stages and the options assessed specifically taking into account environmental and socio-economic issues.

4.1.1 Determination of Project Scope

The works required prior to the construction of the SD2 onshore facilities within the SD2 Expansion Area form the scope of the SD2 Infrastructure Project. The project elements were determined based on the following key requirements:

- Establish an access route from the Baku-Salyan Highway for SD2 Project construction traffic and future operations traffic. The route should allow:
  - Separation between existing Terminal operations and construction traffic as far as practical; and
  - Construction traffic to have direct access to/from the highway.
- Establish construction camp (to accommodate up to 600 people), construction facilities (e.g. workshops, laydown areas etc.) and associated utilities for the main SD2 Project works;
- Complete works to prepare the SD2 Expansion Area including clearance and terracing;
- Establish the drainage/flood protection measures to be incorporated into the design; and
- Complete works to prepare the pipeline landfall area for the new SD2 subsea export pipelines from the offshore SD2 facilities.

The potential locations of the project elements were informed by physical, environmental and safety constraints (refer to Table 4.1). Figure 4.1 shows the location of the key physical, environmental and safety constraints taken into account.

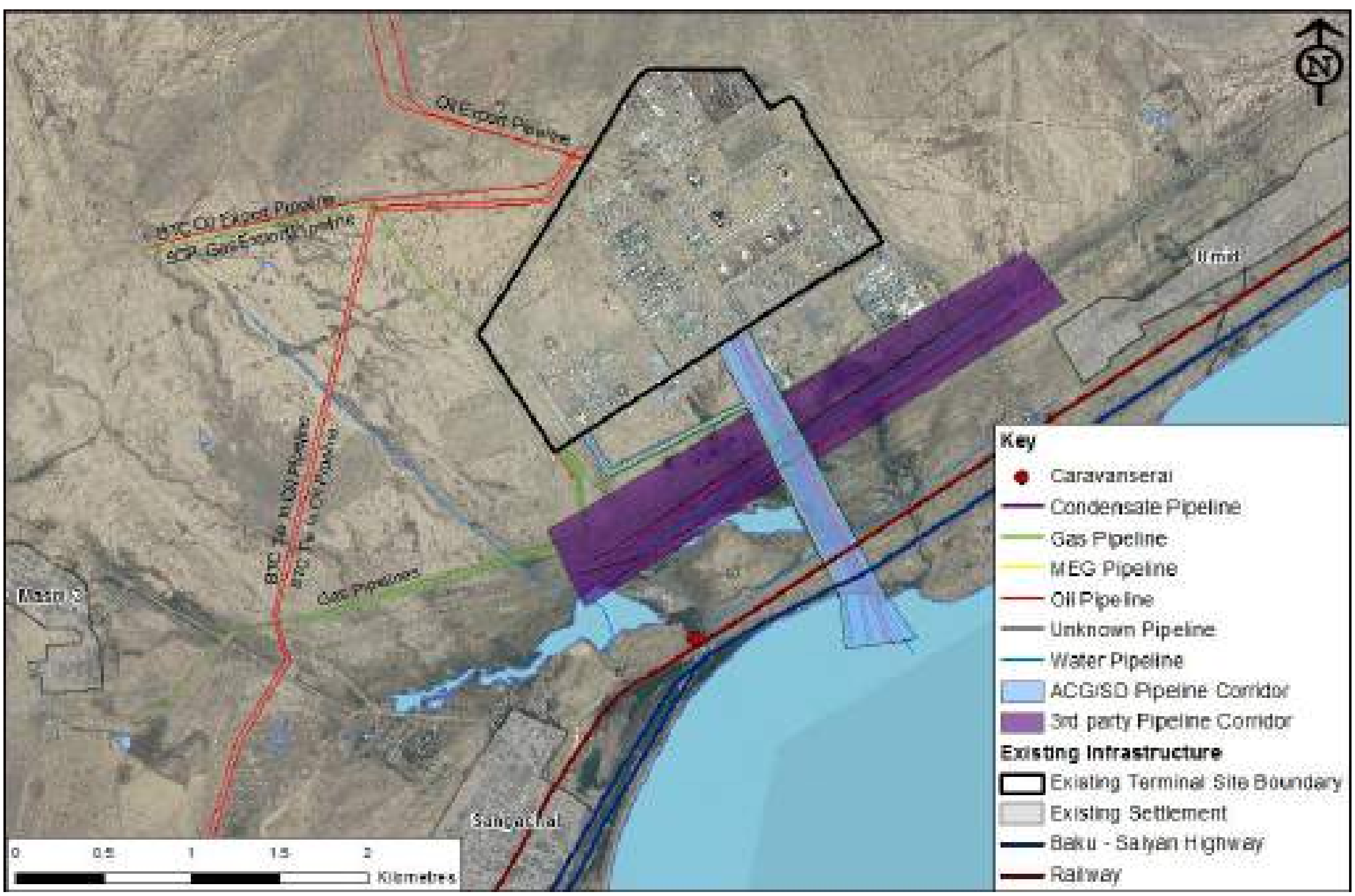
Table 4.1 Existing Physical, Environmental and Safety Constraints

Aspect	Constraint/Requirement
Existing settlements including: • Sangachal; • Umid; and • Azim Kend/ Masiv 3.	• Minimise adverse environmental and socio-economic impacts to the local community e.g. noise, air quality, disruption to local community routes and land use. • Maximise potential community benefits.
Baku-Salyan Highway.	• Minimise disruption to existing road users. • Minimise potential for community safety issues associated with traffic.
Railway.	• Minimise disruption to railway operations. • No permanent at-grade rail crossings.
Caravanserai[1].	• Minimise potential impacts to structure which is listed as a State protected monument. • Observe no work zone of 50m around structure.
Pipelines (including ACG and SD Pipeline Corridor, 3rd party Pipeline Corridor and Export Pipelines).	• Ensure potential for physical impact to pipelines is minimised during construction works.
Existing utilities including power lines.	• Minimise potential diversions and associated disruption to users. • Comply with safety zoning requirements associated with structures and roads adjacent to power lines.
Existing Terminal.	• Minimise any disruption to existing operations at the Terminal.

Safety Zoning.	• Comply with all relevant safety zoning requirements associated with permitted distances for development (buildings and roads) near to:
	  o Existing gas and oil pipelines;
	  o Existing export pipelines (including BTC and SCP); and
	  o Future SCP expansion pipeline route.

Flare Zones.	• No facilities to be located within existing ACG/SD or future SD2 flare zones.
Notes: 1. 15th Century monument – refer to Chapter 6 Section 6.6 for further detail.	

Figure 4.1 Key Constraints



4.1.2 Route Options Assessment

The first stage of the options assessment was to consider potential access road routes and then, based on these routes, the location of the construction camp and facilities.

Access Road

The access road options assessment has been undertaken over two phases between 2008 and 2010:

- **Early Review –** During 2008 and 2009 BP Engineers completed an initial review which focused on eight early road options; and
- **Route Option Assessment** – Following the appointment of the infrastructure design contractor, an initial assessment was undertaken which looked at 26 route options, categorised into 6 coloured groups. Further assessments were then undertaken to refine the shortlisted route options.

Baku-Salyan Highway Junction

It had not been confirmed at the time of the assessments that the Baku Salyan Highway Junction would be designed and constructed by the Azerbaijan Highways Authority. A conceptual junction design was incorporated within the consideration of each of the route options to ensure that the selected access road route design remained technically feasible.

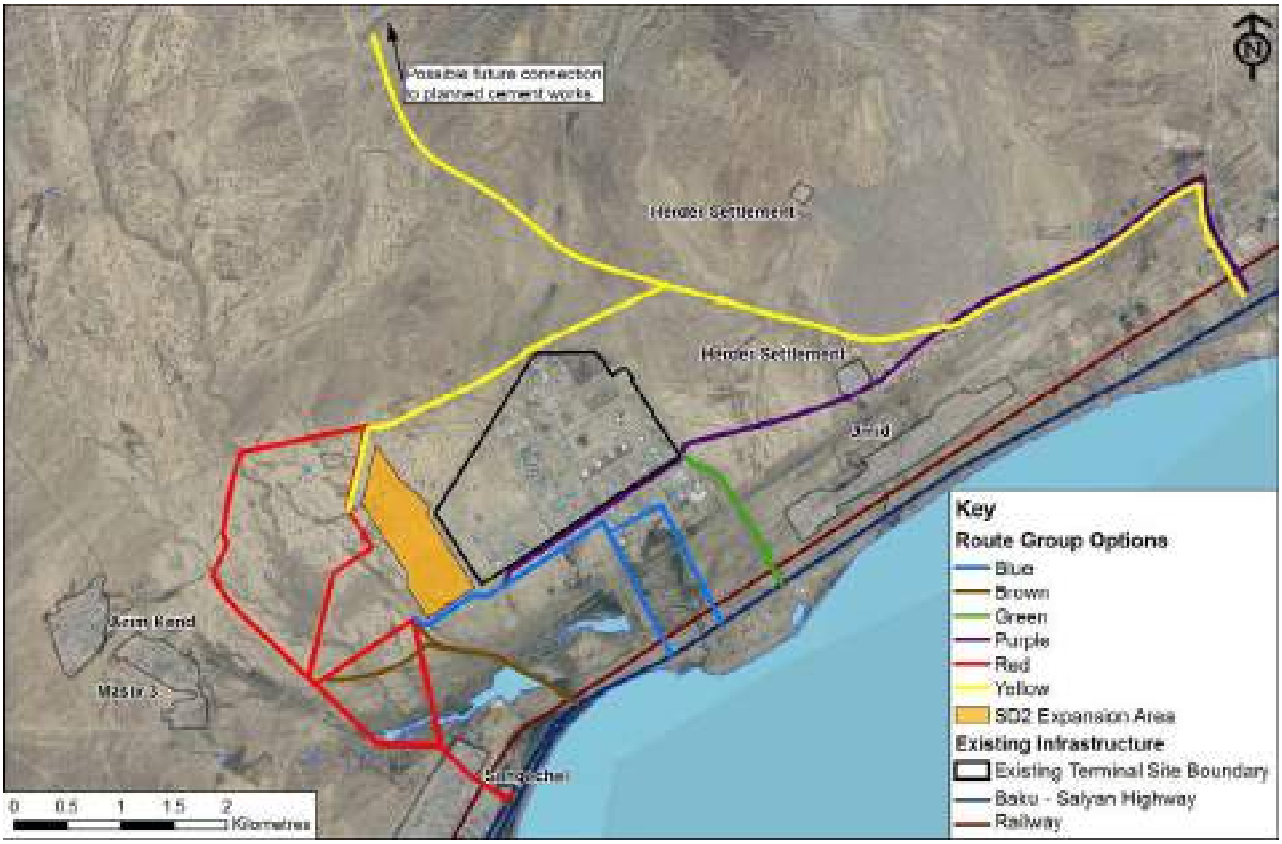
Route Option Assessment

A description of the general characteristics of each colour group assessed is provided in Table 4.2 and illustrated in Figure 4.2.

Table 4.2 Description of the Route Groups

Route Group	Description of Route Characteristics
Red	From the Baku-Salyan Highway, routes pass through Sangachal Town, crossing the Shachkaiya Wadi before passing to the west of the Terminal.
Brown	From the Baku-Salyan Highway, routes pass between the Sangachal Power Station and the existing ACG/SD pipeline corridor.
Blue	Routes pass from the Baku-Salyan Highway directly to the south of the Terminal, perpendicular to the existing ACG/SD pipeline corridor.
Green	Routes utilising the existing Terminal access road and junction facilities.
Purple	Routes via the Garadagh Road to the east of the Terminal, which pass adjacent and parallel to the railway line before reaching the SD2 Expansion Area.
Yellow	Routes via the Garadagh Road, which follow the same routing as the purple routes but pass north of the Terminal to reach the SD2 Expansion Area from the north.

Figure 4.2 Access Road Route Options



The key criteria used to assess the routes included:

- Environmental and socio-economic impacts on local communities and 3rd parties;
- Access to and from the Baku-Salyan Highway (including the requirement for new permanent access to the Terminal);
- Elimination of an at-grade rail crossing;
- Separation of construction and operational traffic;
- Health and safety;
- Security;
- Constructability; and
- Technical Feasibility.

A summary of the assessments undertaken is presented in Table 4.3. In each case the route group was either:

- Eliminated after Early Review & Route Option Screening; or
- Selected for masterplanning i.e. a process of further development and consideration, including additional consultation with the operational stakeholders at the Terminal.

Table 4.3 Route Option Assessment

Route Group	Advantages	Disadvantages	Overall Assessment	Eliminated after Early Review & Route Option Screening	Selected for Masterplanning
Red	• Shorter than other options and no complicated design features. • Avoids ACG/SD and 3rd party pipeline corridors. • Makes use of the existing highways junction and road through Sangachal Town.	• Environmental and socio-economic impacts. • Does not eliminate an at-grade rail crossing.	• Technically feasible. • Meets requirement to minimise number of railway crossings but does not eliminate crossing. • Meets safety requirements. • Potential significant adverse environmental and socio economic impacts associated with: - Land acquisition to widen road through Sangachal Town. - Potential resettlement of residents/businesses. - Short to medium duration impacts to residents associated with construction phase traffic (e.g. noise, dust, nuisance).	✓	
Brown	• Most direct access from main highway to SD2 construction area. • Ability to incorporate improved flood management. • Acceptable to State Security. • Avoids ACG/SD pipeline corridor. • Complete segregation from Operations traffic.	• Not centrally located to the Terminal. • More complex bridge and access road configuration than other routes. • Junction potentially encroaches on edge of Caspian Sea. • Route close to Caravanserai (but outside 50m exclusion zone).	• Technically feasible. • Meets railway regulation requirements. • Meets safety requirements. • Meets requirement for dedicated access road for SD2 construction vehicles. • Minimal adverse socio economic and environmental impacts.		✓
Blue	• Centrally located access to the Terminal. • Acceptable for State Security. • Footprint of route is within land currently owned / used by the Terminal. • Eliminates the need for a rail crossing.	• Conflict with routes of existing and future pipelines. • Located within wetland in front of the Terminal, making construction technically difficult.	• Meets railway regulation requirements. • Meets safety requirements. • Some options meet requirement for dedicated access road for SD2 construction vehicles. • Minimal adverse socio economic and environmental impacts. • Deemed not technically feasible after masterplanning phase because of land required for incoming SD2 and future pipeline corridors.		✓

Route Group	Advantages	Disadvantages	Overall Assessment	Eliminated after Early Review & Route Option Screening	Selected for Masterplanning
Green	• Utilises existing access road. • Limited requirement for land acquisition. • Most cost effective route. • Shortest construction period. • Allows use of existing construction camp/facilities at the Terminal.	• Does not provide new future Terminal entrance. • Increased congestion at existing security post expected. • Increased traffic hold up at rail crossing due to increased construction traffic. • Potential high congestion between existing work camp and operations offices resulting from Traffic Segregation and Security Monitoring. • Disruption to road users on highway likely. • Existing project offices and construction facilities will require upgrade – uncertainty on condition of existing facilities.	• Technically feasible. • Meets railway regulation requirements. • Meets safety requirements. • Does not meet requirement for dedicated access road for SD2 construction vehicles. • Does not meet requirement to minimise traffic disruption.		✓
Purple	• Makes use of existing highway junction. • No pipeline crossing required.	• Does not provide future permanent entrance for the Terminal. • Traffic approach from west has extended journey. • Community/settlement impacts. • Existing State Highway Bridges will require repair / upgrade. • Strong reservations from State Security	• Technically feasible. • Meets safety requirements. • Potential significant adverse environmental and socio economic impacts associated with: - land acquisition to widen road near Umid settlement. - potential resettlement of residents/businesses. - short-medium duration impacts to settlement associated with construction phase traffic (e.g. noise, dust, nuisance).	✓	

Route Group	Advantages	Disadvantages	Overall Assessment	Eliminated after Early Review & Route Option Screening	Selected for Masterplanning
Yellow	• Makes use of existing highway junction. • No pipeline crossing required.	• Does not provide future permanent entrance for the Terminal. • Requires upgrade to four lanes to accommodate safe transit of Sangachal Terminal traffic. • Significant land acquisition requirement. • Traffic approach from west has potential 12km additional journey. • Community / settlement impacts. • Existing State Highway Bridges will require repair / upgrade. • Strong reservations from State Security.	• Technically feasible. • Meets safety requirements. • Potential significant adverse environmental and socio economic impacts associated with: - land acquisition to widen road near Umid settlement. - potential resettlement of residents/businesses. - short-medium duration impacts to settlement associated with construction phase traffic (e.g. noise, dust, nuisance).	✓	

As a result of the assessment summarised in Table 4.3 above, three of the access route groups (Brown, Blue and Green) were taken forward to masterplanning. On the basis of technical feasibility and as a result of the consultation with the relevant stakeholders, it was determined that the brown route group was the most suitable road access option.

The brown route was subsequently developed further as the layout of the elements discussed in the sections below became more defined and as additional information became available with regard to location of pipelines and power lines. The measures incorporated into the road design to mitigate for potential accidental events associated with pipelines are discussed in Chapter 11 Section 11.4. The work undertaken to incorporate drainage management and flood protection measures into the road design are discussed in Section 4.1.5 below.

4.1.3 Construction Camp and Facilities Locations

Construction camp and construction facilities locations were assessed in parallel with the access road routes. Seven potential construction camp and construction facilities locations were considered by the SD2 Infrastructure Design Team in areas to the east, west and north of the Terminal and offsite. The initial stage of the assessment was to consider the advantages and disadvantages of each location against pre-determined aspects e.g. environmental impacts (noise, dust and light emissions), technical feasibility, accessibility and security.

Based on the initial assessment it was determined that the following options associated with the construction camp and construction facilities should be rejected:

- **Off-site locations –** Due to security requirements of an off-site location and need for daily transportation of workers to site;
- **Locations east of the Terminal** – Infeasible following the rejection of the Yellow and Purple route groups;
- **Locations north of the Terminal** – Due to existing restrictions in the area (e.g. topography and security) and a preference to avoid adopting an access road route which passes over the BTC, SCP and other oil export pipelines to a location to the north; and
- **Locations west of the Shachkaiya Wadi** – Infeasible as the area lies within a flood plain and the site would be at risk from flooding.

Following the selection of the Brown route group, it was determined that the construction camp and construction facilities should be located adjacent to the SD2 Expansion Area, with the layout of the area informed by the relevant safety zone requirement (refer to Table 4.1).

To provide a degree of separation between the accommodation and workshops, with workers welfare in consideration, it was decided to segregate the construction camp (including accommodation, recreational, canteen and other support facilities) and the construction facilities (including offices, workforce and materials areas). Within the final design the construction camp and construction facilities are located to the north and south of the SD2 Infrastructure area respectively (see Chapter 5 Figure 5.10 for conceptual layouts).

4.1.4 Pipeline Landfall Area

The location of the Pipeline Landfall Area has been determined as part of a separate study considering the routing of the SD2 Export Pipelines both offshore and onshore. The routing options considered will be discussed within the SD2 Project ESIA.

4.1.5 Hydrological Modelling During Design Development

Extensive hydrological modelling and assessment, by Water Resources Associates (WRA), has been undertaken to inform the SD2 Infrastructure Project design. The work was supported with:

- Meteorological data from the Baku State University National Hydrometeorological Department; and
- Hydrology information from the Institute of Geography of the National Academy of Sciences of the Azerbaijan Republic.

An initial study completed in 2008 comprised:

- An assessment of the flood run-off from hills and slopes to the west and northwest of the new facilities;
- Validation of the capacity of existing southern flood protection channel and consideration of whether this channel could be narrowed;
- Assessment of the internal drainage issues within the SD2 Infrastructure Area;
- Assessment of how outflows from the existing northern, southern and new western flood protection channels plus internal Terminal drainage outflows can be effectively routed across the 3rd party pipeline corridor;
- Understanding of current flood problems posed by the 3rd party pipeline corridor; and
- Identification of further hydrological modelling studies to assist in determining potential routes for new access roads, height of new roads and the design of any culverts or bridges.

Using the results of the initial modelling, further hydrological modelling was undertaken in 2010 and 2011 to inform the design. The results (described in full within Appendix 9E) were used to:

- Determine the requirement, location and dimensions for a flood protection berm (to be located to the west of the SD2 Infrastructure Area between the Shachkaiya Wadi and the existing Terminal);
- Determine the channel and associated culvert dimensions (including locations) associated with the new drainage channels within the SD2 Infrastructure area; and
- Inform the design of the new access road including the:
  - Embankment height;
  - Culvert positions and dimensions; and
  - Role of the access road embankment in redirecting flood flows.

The modelling undertaken to determine the existing flow conditions and flood risk is discussed in Chapter 6 Section 6.4.2. The results of the assessment showed that current flood waters flow through the Western and Central drainage channels via storage areas, under the highway and into the Caspian Sea. Hydrological modelling indicated that a major flood event may result in:

- Flooding of the railway in the vicinity of the railway bridge under which the Central drainage channel passes; and
- Flooding of the highway in the vicinity of the highway bridge under which the Western drainage channel passes.

To minimise the impact of flood risk to the railway, it was decided that the embankment associated with the access road should act as a barrier, preventing the majority of flow from the Shachkaiya Wadi to the low lying Central flood storage area. To ensure that during a major flood event the Western flood storage area does not over fill, it was decided that some flow would be permitted to the Central flood storage area, through the culverts under the access road, which are included in the design to enable the access road to cross the 3rd party pipelines. The dimensions of the culverts and the associated small levee, designed to regulate flow under the access road, were informed by hydrological modelling. The location of the culverts and levee are shown in Chapter 5 Figure 5.8.

Design measures to minimise flood risk to the highway where the Western drainage channel passes under the highway were not incorporated into the design as a new highway junction (to be designed and constructed by the State Highways Authority) is proposed in this location. The junction is planned to be elevated and will provide an alternative route should infrequent major flooding of the highway occur in this location.

5 Project Description

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5.1 Introduction

This Chapter of the Environmental and Socio-Economic Impact Assessment (ESIA) describes the activities associated with the SD2 Infrastructure Project. The Project includes the works required prior to the construction, installation, commissioning and operation of the onshore Shah Deniz 2 (SD2) facilities within the SD2 Expansion Area at the Sangachal Terminal.

The main components of the SD2 Infrastructure Project comprise (refer to Figure 5.1):

- Construction of access roads (temporary and permanent) to the SD2 Expansion Area and the associated construction areas;
- Construction of a flood protection berm, drainage channel and improvement works to the existing drainage in the Terminal vicinity;
- Utility works including connections to the mains water supply, sewerage pipework (connecting to a new sewage treatment plant (STP)) and power connections and diversions;
- Preparation of the onshore SD2 Pipeline Landfall Area;
- Profiling of the ground levels across the SD2 Expansion Area; and
- Construction and fit out of the north construction camp and south construction facilities.

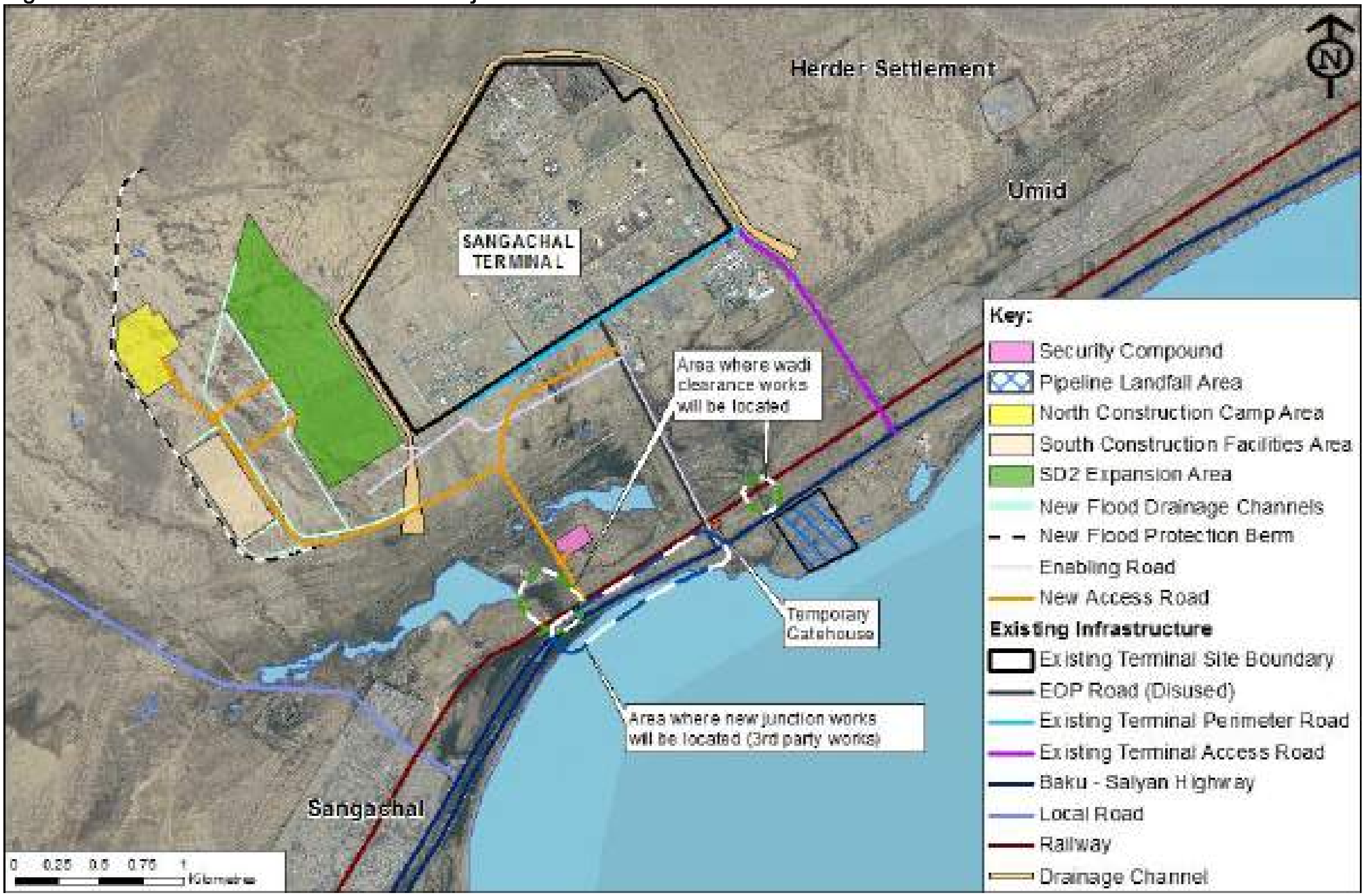
In addition, a new road junction will be constructed between the new permanent access road and the Baku-Salyan Highway. BP will be responsible for appointing contractors for all elements of the project scope with the exception of the Baku-Salyan Highway Junction, which will be the responsibility of the Azerbaijan Highways Authority.

It is intended that temporary fencing is erected around all construction works prior to commencement to demarcate the works area and prevent unauthorised access.

This Chapter describes the Base Case Design which has been developed using a masterplan approach. The project has now entered the detailed design phase. It may be necessary as the design progresses to change an element(s) of the project. The Management of Change process that will be followed should this be necessary is presented in Section 5.11 of this Chapter.

Estimated emissions, discharges and waste from the project are presented within Section 5.8 below; emissions estimate assumptions are provided within Appendix 5A.

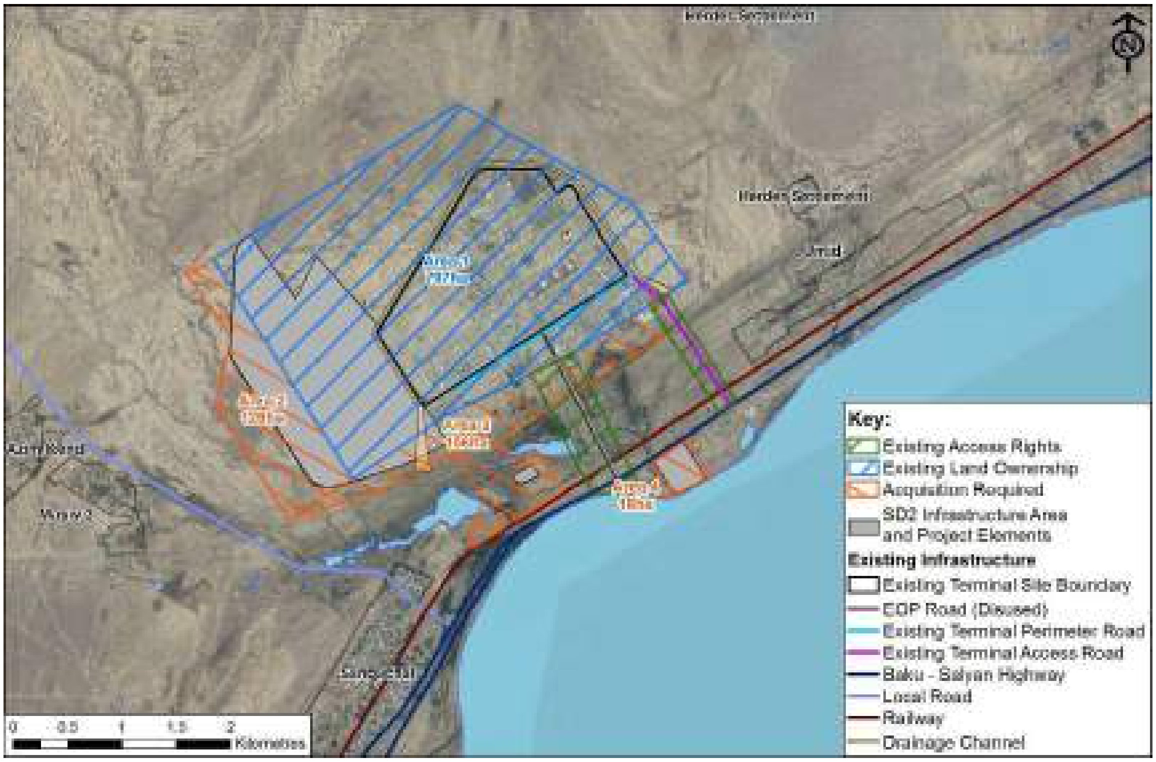
Figure 5.1 Overview of SD2 Infrastructure Project



5.2 Development Areas and Land Acquisition

A number of the project elements as detailed within Figure 5.1 are planned to be located in areas outside the current Terminal ownership boundary. The maximum extent of land acquisition required is presented within Figure 5.2.

Figure 5.2 Maximum Extent of Acquisition and Current Terminal Property Boundary



It is planned to acquire up to 302 hectares (ha) to the immediate west and south of the existing Terminal ownership boundary and at the shoreline, where the pipeline landfall is proposed. The area to the west extends beyond the physical boundary of the SD2 Infrastructure facilities to provide space should future development be required.

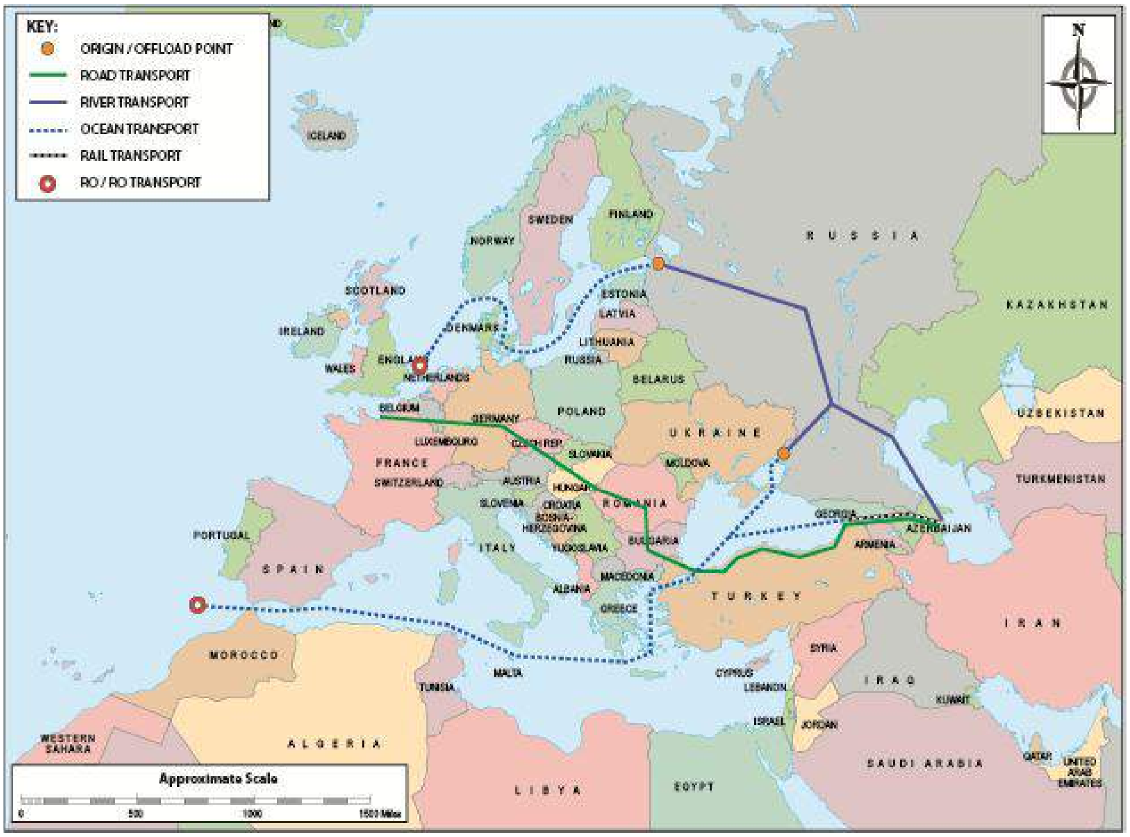
5.3 Logistics and Material Supply

Preference will be given to source equipment (such as plant and construction vehicles) and materials (such as gravel) which meet the required project specifications from within Azerbaijan wherever possible. It is planned to transport this material and equipment to site by road and rail. Where international procurement is required, materials and equipment will arrive by road, rail, sea and air using the transportation routes established for the previous ACG and SD Terminal expansion construction programmes.

Goods arriving via sea can travel by two main routes. From the Mediterranean and Black Sea, vessels must pass through the Don-Volga canal system. Cargoes following the Baltic Sea route, would be transhipped at St. Petersburg and travel along the Baltic-Volga system. These routes are not available during the ice season (November - April).

Rail links are available from Poti in Georgia and Riga in Latvia. Deliveries by road from Europe would be through Turkey and Georgia and via Iran. Figure 5.3 illustrates potential transport routes.

Figure 5.3 Import Routes to Azerbaijan

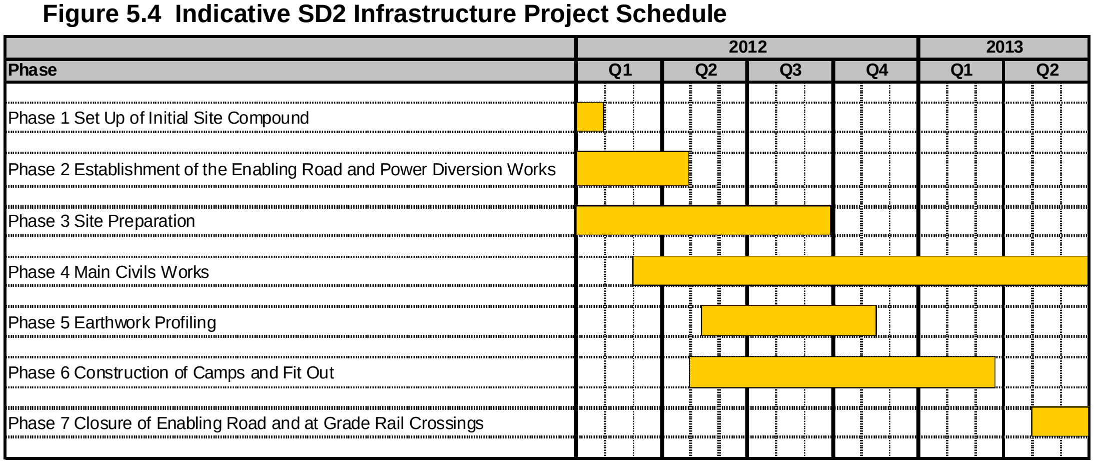


While available transport routes can be identified, the likely use of each and what will be transported cannot be determined with any certainty until the procurement strategy and award of construction contracts has been made. Anticipated construction materials and estimated vehicle movements onsite and offsite are presented in Sections 5.6 and 5.7 below.

5.4 Project Schedule

The indicative project schedule is provided within Figure 5.4. Works are expected to last for approximately 18 months, commencing first quarter of 2012.

Figure 5.4 Indicative SD2 Infrastructure Project Schedule



As Figure 5.4 shows the SD2 Infrastructure works comprise a series of phases, each of which include key project activities. These phases will not occur in strict sequential order and there will be overlap between phases, with some activities being undertaken in parallel. The precise sequence of activities will be determined by the contractors appointed to undertake the works. The contractors will be required to sequence activities in accordance with technical and safety requirements and also with reference to principles intended to minimise environmental impacts, e.g. minimise double handling of excavated materials, optimise scheduling of surface soil layer removal to minimise dust impacts etc (refer to Section 5.5.3 below).

The project activities associated with each phase are described below.

5.5 Project Phases

5.5.1 Phase 1 – Set Up of Initial Site Compound

Phase 1 will involve establishing an initial site compound (of approximately 2 ha) to comprise:

- Temporary site offices;
- Fitters' workshops;
- Welfare facilities of portable, modular construction (to include changing, toilet and catering facilities and first aid station);
- Space for the storage of construction materials and construction equipment/plant/vehicles; and
- Designated areas for fuel, oil and chemicals storage/handling.

Prior to establishing the compound, it is planned to use existing temporary site offices. The compound (approximate area of 7,500m^2) is planned to be located within the SD2 Infrastructure area (refer to Figure 5.1). It is anticipated that some ground works and levelling will be necessary to prepare the compound area. It is intended that construction traffic will first use the current Terminal site access road and the perimeter road, which will be extended to reach the compound. Minor modifications to the existing Terminal road network, such as the provision of vehicle waiting/passing areas and traffic management measures (refer to Chapter 12) may be necessary to avoid construction traffic causing congestion to existing vehicle movements into and out of the Terminal site.

Compound Utilities

Utilities will include:

- **Power** - diesel generators will be used to supply power to the compound offices, workshops and welfare facilities;
- **Water** – water for general use e.g. cleaning, wheel washing will be supplied by tankers and stored in a day tank. Bottled drinking water will be provided;
- **Sewage** – a septic tank will be located at the compound. The contents will be tankered off site for appropriate treatment either to the existing Terminal sewage treatment plant or to a municipal sewage treatment plant; and
- **Drainage** – the compound will be designed to:
  - Route rainwater run-off to the wadi system via the existing Terminal drainage system.
  - Route drainage from parking areas and bunding around hazardous areas (e.g. areas for chemical/fuel storage) to dedicated oil water separator systems, designed such that discharges meet applicable oil in water standards[1].
  - Route initial site compound canteen waste to a dedicated separation system to remove fats, oil and grease, prior to collection of effluent and solid waste which will be transported offsite for disposal.

[1] Less than 10 mg/l as a monthly average and less than 19 mg/l on a daily basis

Waste

It is planned to appropriately store all wastes at the initial site compound prior to transfer to appropriate disposal facilities offsite. Section 5.8.3 below details the types of waste expected and how waste will be managed across all project phases.

Fuel/Chemical Storage and Refuelling

It is anticipated that above ground fuel diesel tanks will be required to supply equipment in the compound. The tanks will be located in a designated refuelling area, will have secondary containment capable of holding 110% capacity and will be locked when not in use. All refuelling using tanks and bowsers will be supervised and refuelling will be conducted in designated areas. Other fuels, oils and chemicals will be securely stored in clearly marked containers in a contained area to prevent pollution.

5.5.2 Phase 2 – Establishment of the Enabling Road and Power Diversion Works

Phase 2 will involve:

- Establishing the SD2 enabling road to provide initial access to the SD2 Infrastructure area for heavy construction vehicles;
- Establishing of routes across the SD2 Infrastructure area for spoil movement**;** and
- Diversion of overhead power cables.

Enabling Road

As Figure 5.5 shows the enabling road will comprise:

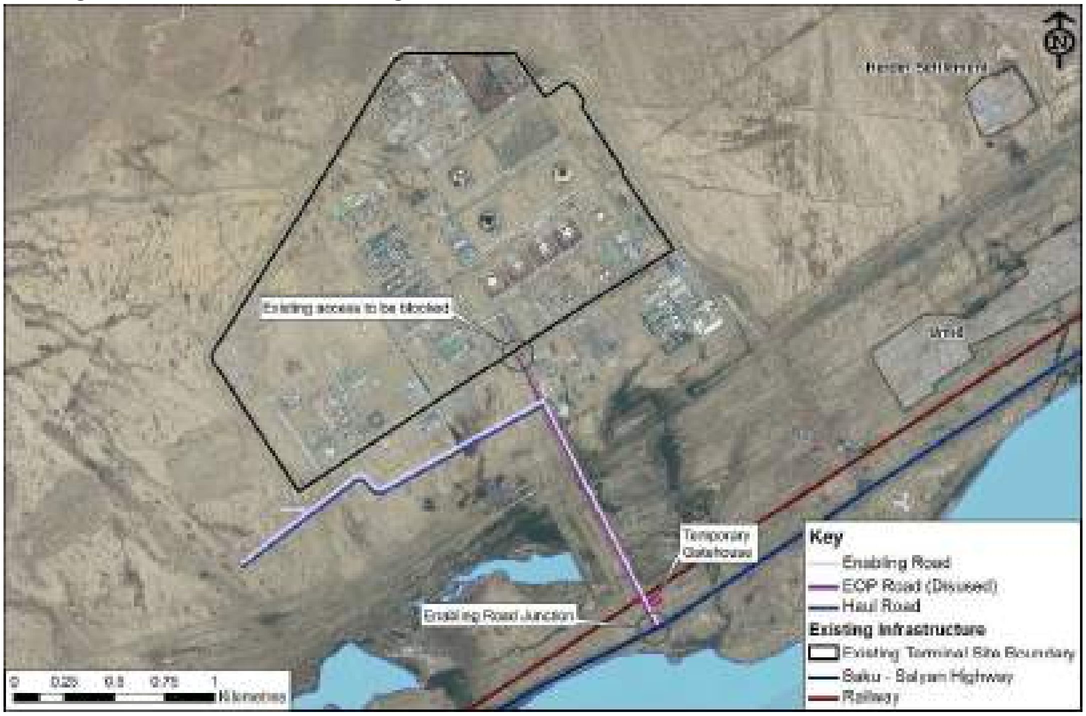
- The former EOP road; and
- A new gravel based haul road joining the former EOP road after it crosses the existing pipeline corridor to the SD2 Infrastructure area.

The enabling road works will commence with the closing of the existing access from the former EOP road to the Terminal. Works will then commence to repair the former EOP road and construct the haul road. Activities will also include:

- Reinstatement and upgrade of the road crossing across the Baku–Tbilisi railway;
- Establishing a junction from the enabling road onto the westbound carriageway of the Baku–Salyan highway;
- Installing a temporary rail crossing gatehouse; and
- Construction of temporary at-grade pipeline crossings.

Should it not be possible for any reason not to re-establish the EOP road as an initial access route, an alternative access track may be used to provide access to the SD2 Infrastructure area prior to completion of the new access road (refer to Sections 5.5.3 and 5.5.4 below). There is currently an access track being built to support non BP pipeline replacement work in the 3rd party pipeline corridor (to the south west of the Terminal, just north of Sangachal Town). This track may be used as an alternative access route in the event of the EOP road is not re-established.

Figure 5.5 Phase 2 - Enabling Road



Overhead Power Cables

Once the enabling road is established, overhead power line works will commence. It is expected that it will be necessary to raise a number of power lines which cross:

- The former EOP road; and
- The new access road route.

It is also planned to divert a number of power lines which currently cross the south west of the SD2 Infrastructure area either around the SD2 Infrastructure area or to:

- Provide connections to supply the SD2 Infrastructure facilities including the north construction camp and south construction facilities;
- Provide for future connection for the SD2 facilities; and
- Enable reconnection to the existing Terminal.

It is intended that the works will be designed and completed by the power line owner, who will be responsible for managing the works including possible interruptions to power supply.

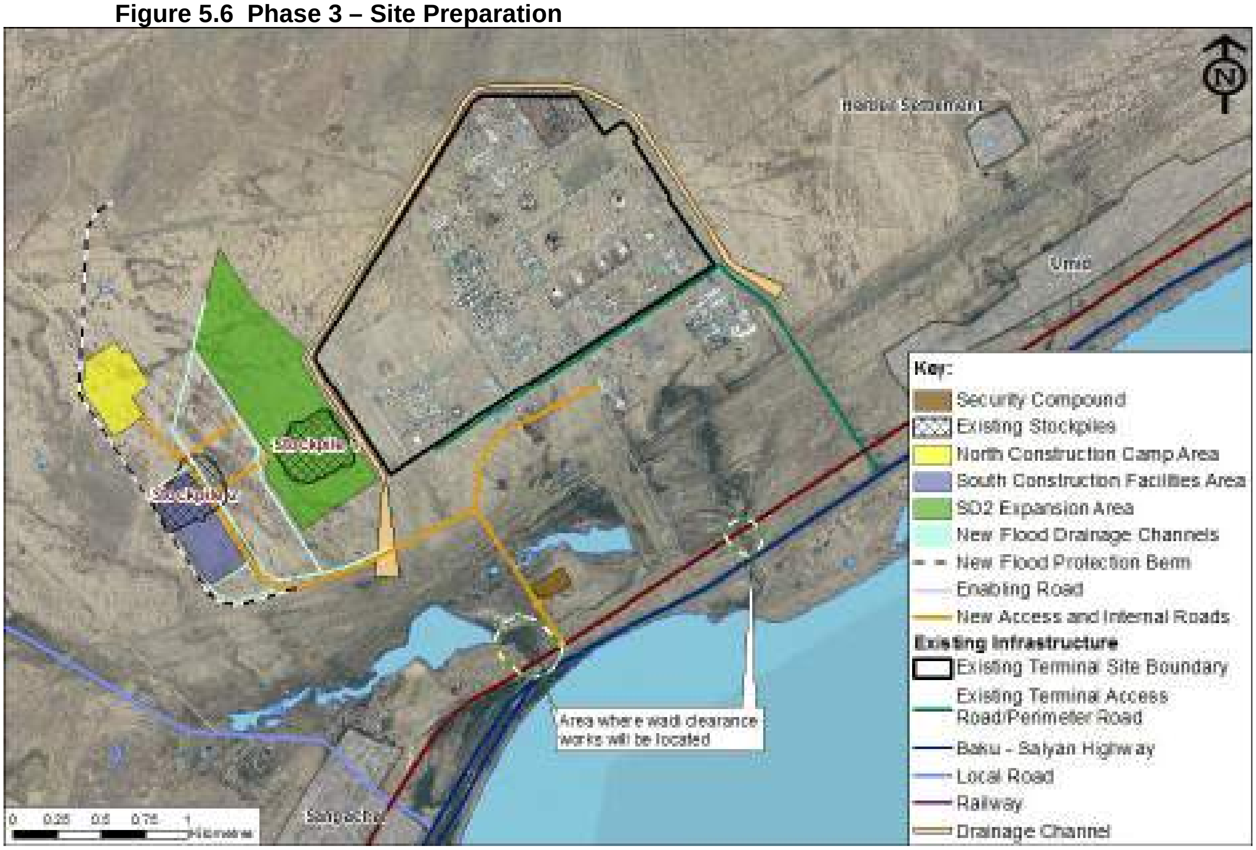
5.5.3 Phase 3 – Site Preparation

Phase 3 comprises:

- Clearance works including:
  - Surface soil layer and vegetation removal; and
  - Removal and redistribution of two existing stockpiles of spoil.
- Construction of the new access road embankments; and
- Construction of the flood protection berm, drainage channel works (including wadi clearance works) and pipeline corridor crossing.

In addition, concrete breaking works may be required within the SD2 Expansion Area to remove existing areas of concrete from previous activities in the area. Figure 5.6 shows the project areas associated with the Phase 3 activities.

Figure 5.6 Phase 3 – Site Preparation



Clearance Works

Clearance works will include:

- **Surface soil layer and vegetation removal** – clearance works will include the removal of vegetation and a planned strip of surface soil to a depth of approximately 0.15m. Stripped vegetation (including the surface layer of earth held together by its roots) will either be reused or mulched and disposed of in a suitable manner. No burning of stripped vegetation onsite will be undertaken. Surface soil will be used onsite, primarily with the flood protection berm (see Figure 5.7); and
- **Spoil stockpile removal** – the main clearance works comprise the redistribution of two existing stockpiles of spoil as shown within Figure 5.6 to provide structural fill.

Environmental survey work in the third-party pipeline area and in the vicinity of the Shachkaiya Wadi has identified areas with oily contaminated soil and surface water (refer to Chapter 6 Section 6.4.4), which may be encountered during the construction work. These areas are outside the existing Sangachal Terminal property boundary. In the event that oily contaminated soil, ground water, surface water or other materials outside of the existing Sangachal Terminal property boundary are encountered and require handling, then the following procedure will be used:

- Soil, surface water, groundwater or other materials will be relocated to an area that is of comparable environmental quality and function;
- Relocation activities will be undertaken in a manner that will not degrade the environment further and will promote the natural degradation of contaminants; and
- The following information will be recorded; contaminants detected, handling methods adopted to prevent further environmental degradation, location and quantity of contaminated material detected.

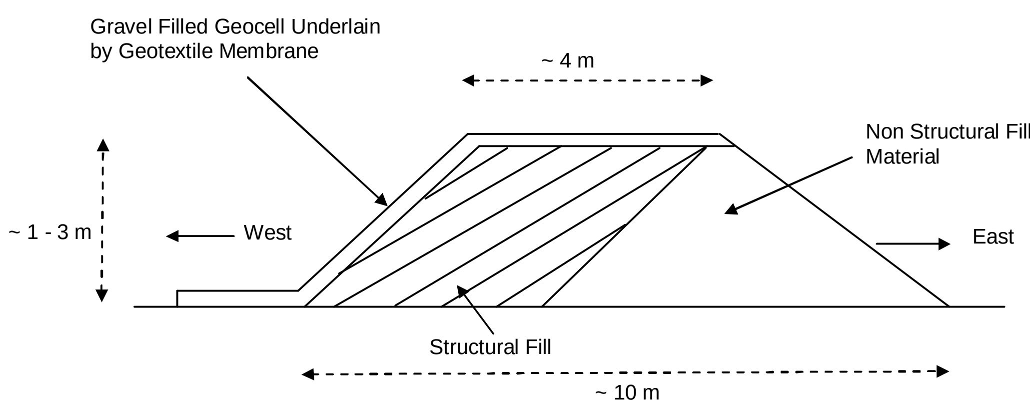
Oily contaminated soil, ground water, surface water or other materials are not anticipated within the existing Sangachal Terminal property boundary however, if contaminated materials within the existing Sangachal Terminal property boundary are encountered, then they will be classified and managed as waste in accordance with existing BP waste management procedures.

It is intended that all non-contaminated clearance materials including stripped surface soil and the spoil stockpiles will be reused. The majority of the materials will be used to construct a flood protection berm to the west of the SD2 Infrastructure area, undertake drainage channel works, construct road embankments and provide base fill materials for project areas e.g. north construction camp and south construction facilities. It is not intended to use stripped surface soil for structural fill (e.g. road embankments).

Flood Protection Berm

A new flood protection berm (refer to Figure 5.6) will be constructed to a height of between 1 to 3m (higher in the section between the construction facilities and construction camp where hydrological modelling has demonstrated flood risk is greatest). A typical cross section is presented in Figure 5.7.

Figure 5.7 Typical Flood Protection Berm Cross Section



As Figure 5.7 shows surface protection measures, in the form of gravel filled geocells and geotextile membranes, will be taken to protect the exposed structural earthworks of the berm. An emergency access route (minimum 3m in width) will be provided along the top of the berm.

Drainage Channel and Wadi Clearance Works

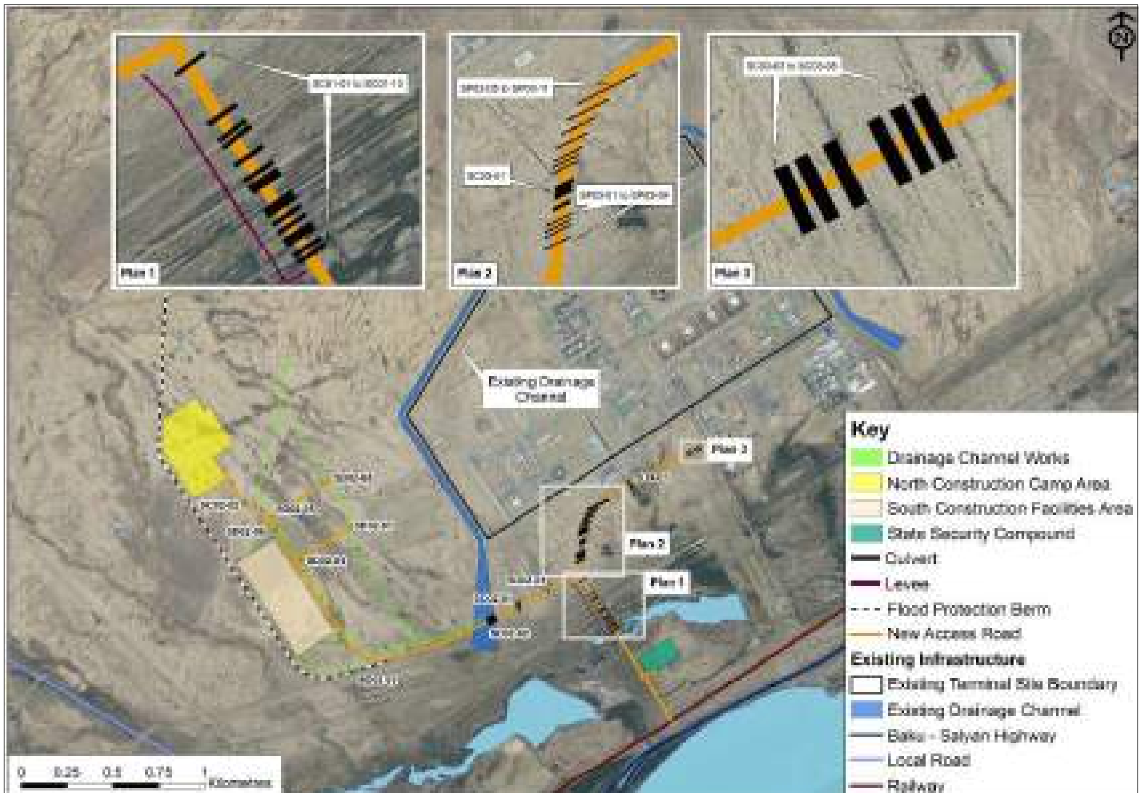
These will comprise the following:

- **Wadi clearance works** – Obstructions including rock, vegetation and silt in the existing Western and Central wadi sea outfalls, which have been partially blocked, will be removed;
- **Drainage management –** A low level flood levee will be constructed to the west side of the EOP road, adjacent to the culverts shown in plan 1 of Figure 5.8. This levee is designed to regulate low water flow to the western drainage outfall and prevent regular flooding of the land to the east; and
- **New drainage channel works** - New drainage channels as shown within Figure 5.8 will be constructed. These will incorporate ditches and bunds, lined (with concrete or geotextile) or profiled depending on their location and soil conditions. Protection measures to prevent scour will be incorporated into the design in the vicinity of pipeline crossings. It is planned that the final design of the drainage system will be informed by detailed hydrological modelling based on a 100 year return period flood flows and the results of ongoing geotechnical survey works. The approximate location of culverts to be constructed under the new access road and internal roads

to accommodate the new drainage channels are shown in Figure 5.8. The culverts will be constructed during Phase 4 (refer to Section 5.5.4 below)

Any contaminated materials or spills encountered during drainage channel and wadi clearance works will be managed in same way as contaminated materials or spills encountered during vegetation, surface soil and spoil stockpile removal as described above.

Figure 5.8 Drainage Channel Works, Indicative Culvert and Pipeline Crossing Locations



Notes: SC = Service Culverts SP = Pipe Crossing SD = Drainage Culvert

It is intended to use uncontaminated excavated materials from wadi clearance works and the new drainage channel works as structural fill material, where possible.

Road Embankments

It is planned that the majority of road embankments will be constructed from reused materials. Where additional surface protection of the embankment is required, gravel or geotextile will be used or the area will be vegetated. In areas prone to flooding, imported materials (e.g. crushed rock gravel) may be required as local soils are known to be prone to water softening.

All new permanent roads will be constructed within a minimum embankment height of 0.4m to protect the roads and associated pedestrian walkways from surface runoff.

Summary of Spoil Reuse

Table 5.1 summarises the estimated volumes of spoil materials generated during Phase 3 and their intended reuse.

Table 5.1 Estimated Volumes of Spoil Materials and Intended Reuse

Material	Estimated Volume of Materials (m^3)	Intended Reuse
Stripped vegetation	500	Used for re-vegetation (preferred option) or mulched and disposed of offsite
Stripped surface soil	140,000	Within flood protection berm
Existing spoil stockpiles	440,000	Structural fill material for • Access road and internal road embankments • Flood protection berm • Construction camp and construction areas
Materials arising from wadi clearance works	1,000	
Excavated materials during drainage channel realignment and new drainage channel works	18,000	
TOTAL:	599,500	

Mobile water bowsers will be available throughout the site preparation works to control dust generation. It is assumed the Terminal water supply or treated sewage will be used to replenish these bowsers.

A spoil and landscape management plan will be developed by the appointed contractor to address the potential issues associated with surface soil removal/movement of spoil (e.g. dust generation, soil erosion and runoff). Further details are provided within Chapter 12.

5.5.4 Phase 4 – Main Civils Works

Phase 4 includes:

- Installation of culverts and crossings;
- Completion of the new Terminal access road and other permanent internal roads;
- Utility works including water and drainage pipework and power connections;
- Construction of SD2 support facilities including SD2 STP facilities;
- Construction of the temporary security compound and associated buildings; and
- Preparation of the Pipeline Landfall Area.

During this phase it is intended that the highway junction works will also take place. These comprise building of slip roads, a bridge over the highway and a connection to the new Terminal access road, passing over the railway line.

As stated within Section 5.1, detailed design and construction of the Baku-Salyan Highway Junction will be the responsibility of the Azerbaijan Highways Authority.

Installation of Crossings

Works will include the installation of the culverts and crossings under the access road and internal roads as shown within Figure 5.8. The crossings, constructed from concrete, will include sufficient headroom to allow for future maintenance inspection of the utilities, which include gas, oil and water pipelines associated with the existing Terminal and 3rd parties. Crossings will also be installed along the proposed route of the future SD2 pipelines including the proposed routing for the future connection from the existing Terminal to the SD2 STP. Crossings located within the state pipeline corridor immediately to the south of the Terminal are expected to require the use of a mini piling system[2].

It is intended to incorporate sufficient headroom and width in the design of one of the pipeline crossings to allow local herders to cross under the new access road.

[2] A type of piling used in locations where there is restricted headroom.

Completion of Roads

All permanent roads (i.e. the access road and internal roads) will be completed with a layer of imported gravel and finished to a standard appropriate for construction traffic. It is planned to install permanent lighting along the length of the access road across the state pipeline corridor and adjacent to the construction facilities area.

Utility Works

Utilities works will be undertaken to connect the construction camp and construction facilities. It is planned to install water supply and drainage pipework and cabling (power supply and telecommunications) adjacent to the access road and internal roads where possible. There are no planned connections to the municipal sewage network or public telecommunication systems. Offsite power connections are discussed in Section 5.5.2 above. Connections with the mains water supply will be managed in liaison with the utility owner.

SD2 Support Facilities

Works are planned to include:

- **Sewage Treatment Plant** – it is planned to construct and commission a modular type STP, sized to accommodate sewage generated from:
  - North construction camp and south construction facilities;
  - SD2 Terminal Expansion Area; and
  - Existing Terminal areas (note that connection between existing facilities and the new STP is not within scope of the SD2 Infrastructure Project).

  The STP will be designed to treat up to approximately 900m^3/day of domestic water (including grey and black water) to applicable standards (See Table 5.2).

Table 5.2 STP Design Standards

Parameter	Units	Limit Value[1, 2]
pH	-	6-9
Residual Chlorine	mg/l	<1[3]
		<0.2[4]
BOD	mg/l	20
COD	mg/l	100
Total Suspended Solids (TSS)	mg/l	30
Total Coliforms	MPN/100ml	<400

Notes: 1. All limit values are maximums i.e. not be to be exceeded. 2. Unless otherwise stated, limit values are consistent with those agreed for current ACG and SD projects. 3 Applicable to treated sewage used for irrigation or dust control. 4. Applicable to treated sewage discharged to the environment.

  Under routine conditions it is planned that treated sewage will be either:

  - Discharged to the Shachkaiya Wadi; or
  - Used for irrigation purposes or for dust control where practicable and required.

  The STP design does not include sludge treatment and it is planned that, once operational, sludge will be collected. Sewage sludge will be stored in designated containers for collection and disposal to an appropriately licensed facility. No sewage sludge shall be discharged.

- **Waste transfer facility** – an area of approximately 3,000m^2 is allocated within the south construction facilities area for a new waste transfer facility where waste will be segregated and stored prior to transport offsite. It is anticipated that the facility design will be similar to the existing facility at the Terminal.

- **Vehicle refuelling facility** – a dedicated facility will be constructed (approximately 300m^2) for vehicle refuelling. The area will include lined bunds, sized to contain 110% of the stored fuel capacity. Drainage in the area will be routed to a dedicated oil water separator system, designed to treat water to applicable oil water standards[3]. Once the refuelling facility is operational it is intended that plant and vehicles associated with the SD2 Infrastructure Project will either be refuelled at the facility or in the location they are operating via mobile fuel bowsers. Strict procedures will be followed when refuelling to minimise the risk of spills to the environment.

- **Vehicle wash facility** - a fixed vehicle wash facility will be constructed and bunded with drainage routed to dedicated holding tanks. It is expected the majority of wastewater from the vehicle wash facility will be recycled with the remainder including silt, oil and detergent residue collected into a tank and removed using road tankers.

- **Potable water plant** - designed to treat mains water to potable water standards.

While not included within the Base Case Design, space has been allocated for a concrete batching plant, designed to provide up to 100m^3/hour of concrete when operational, and an associated area for materials and precast storage.

Security

Temporary construction security facilities and associated temporary buildings will be installed. Construction areas will be temporarily fenced to segregate construction activities from external publically accessible areas.

Pipeline Landfall Area

Preparation works for the Pipeline Landfall Area during this phase will include access road preparation, surface soil removal and ground stabilisation. Facilities sized for up to 80 people (to include a water day tank, diesel generators for power supply, a septic tank for sewage, office and welfare facilities) will be sited in an area of hardstanding within the Pipeline Landfall Area.

5.5.5 Phase 5 – Earthworks Profiling

Phase 5 includes the main profiling of earthworks for the SD2 Expansion Area (Figure 5.9).

The works involve the preparation by cut, fill and compaction of existing ground within the SD2 Expansion Area into three terrace levels for the future SD2 onshore facilities. A fourth terrace level will be formed but left unprepared. From preliminary calculations it is estimated the cut and fill works will involve approximately 350,000m^3 of material. No import of material is anticipated.

At outline design these terraces cover the following estimated areas:

- Upper terrace (unprepared) 13.85ha;
- Upper terrace (prepared) 10.93ha;
- Middle terrace 18.00ha; and
- Lower terrace 25.63ha.

During the earthworks, it is planned to complete a number of piling trials to investigate the suitability and preliminary pile design for the main SD2 Terminal construction. It is anticipated that piles will be either precast driven or bored cast in-situ concrete. Piling locations will be either within the SD2 Expansion Area or within 100m of the SD2 Expansion Area boundary.

[3] Less than 10 mg/l as a monthly average and less than 19 mg/l on a daily basis.

Figure 5.9 Phase 5 – Earthworks Profiling

5.5.6 Phase 6 – Completion and Fit Out of Construction Camp and Construction Facilities

Phase 6 comprises the completion and fit out of the north construction camp and south construction facilities, which involves:

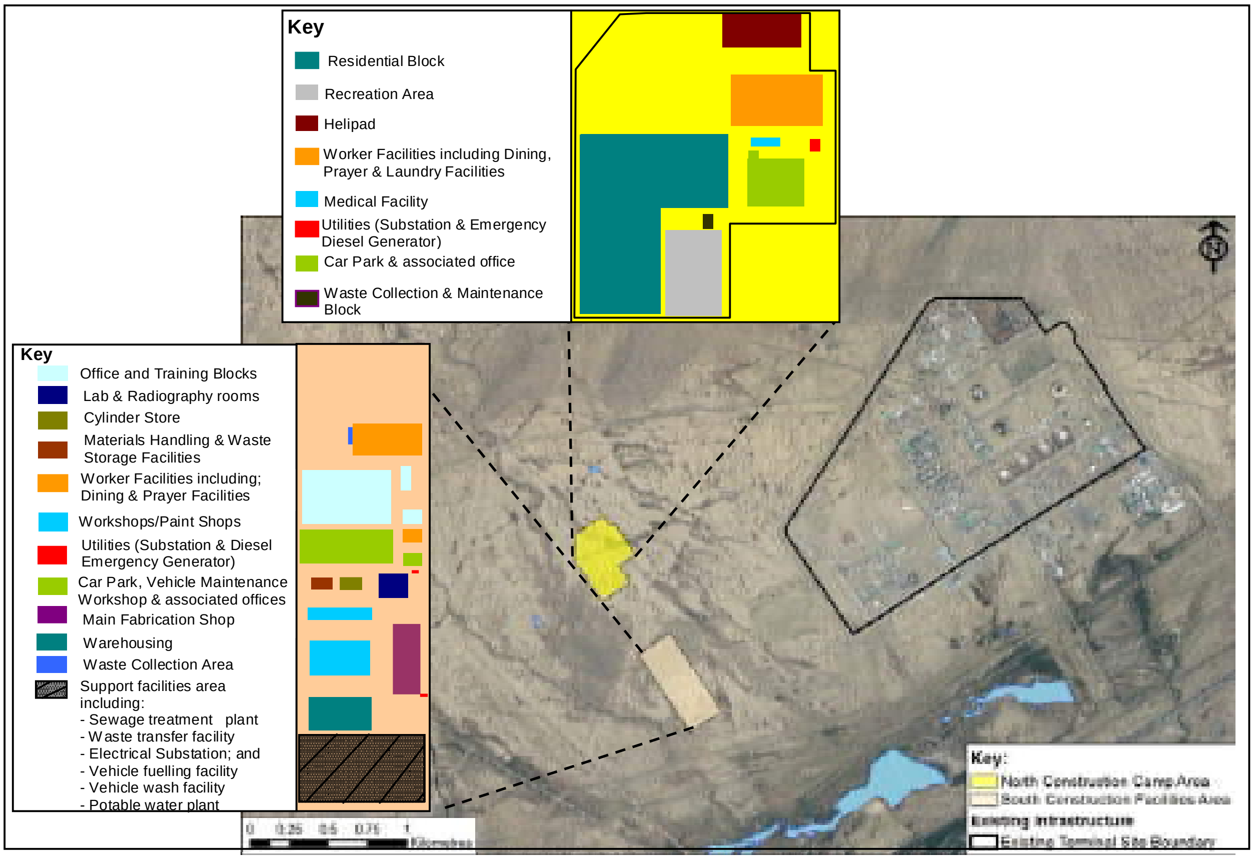
- The north construction camp - located to the north west of the SD2 Expansion Area. The camp will comprise:
    - Accommodation (for 600 persons);
    - Laundry;
    - Communications and information technology facilities;
    - Washrooms;
    - Security facilities;
    - Lockers; and
    - Welfare and dining facilities.

- The south construction facilities - located to the south west of SD2 Expansion Area. The area will comprise:
    - Offices (for 500 persons);
    - Warehouses;
    - Workshops;
    - Laydown areas;
    - Fabrication areas;
    - Laboratory;
    - Cylinder and fuel store;
    - Vehicle maintenance;
    - Dining facilities (sized to cater for 5,000 persons over staggered sittings);
    - Maintenance and radiographics facilities; and
    - Medical, welfare and changing facilities.

The new STP, refuelling facility, electrical substation, waste transfer facility, vehicle wash facility and potable water plant will be located to the south of the main construction facilities.

Figure 5.10 shows the location of the construction camps and the conceptual layout of both camps. It is planned to construct the construction camp and construction facilities as part of the SD2 Infrastructure works. However, if any residual elements of the construction camp or construction facilities are still to be built at the end of the Infrastructure works, the works will be passed to and become the responsibility of the Main SD2 Construction Works contractor.

Figure 5.10 Phase 6 – North Construction Camp and South Construction Facilities Conceptual Layouts



It is expected that the construction camp and construction facilities buildings will be either of a flat pack design (to be assembled on site) or pre-engineered metal buildings. All structures are expected to be no more 10m high once assembled. Typical equipment used in the construction process will be tracked cranes, mechanical diggers, concrete mixers, various power tools and heavy goods vehicles for deliveries (refer to Section 5.7).

When operational all vehicular access into the construction camp and construction facilities will be from the new access road. The road will extend into the camps running south to north, and terminate at the shuttle bus pick-up and drop-off point. The road will also provide access for the staff car parking area.

Construction Camp and Construction Facility Utilities

The construction camp and construction facilities include provision of connections for utilities such as water supply, sewage treatment, power supply and telecommunications. Works undertaken to establish these connections are provided in Section 5.5.4.

Utilities associated with the camp and facilities areas include:

- **Power** – once operational, supplied from the mains supply or the existing Terminal. Emergency back-up by diesel generators will be provided to the construction camp and the construction camp facilities. When required, the generators will be refuelled from the dedicated refuelling facility by mobile bowsers. Prior to electrical tie-in works, power will be provided from portable diesel powered generator equipment;
- **Water –** non-potable water supplied from the mains water supply. Potable water provided from the potable water plant (see Section 5.5.4). It is expected that the total demand for water (potable and non potable) will be approximately 1,600m^3 water/day during the main SD2 construction works;
- **Sewage –** sent to the new STP (refer to Section 5.5.4 above). Septic tanks will be also located in the construction camp and construction facilities to provide contingency when the STP requires maintenance[4]; and
- **Drainage** – the drainage system within the construction camp and construction facilities area will be designed to:
  - Route rainwater run off to the wadi system via the new drainage channels;
  - Route drainage from parking areas and bunding around hazardous areas (e.g. areas for chemical/fuel storage) to dedicated oil water separator systems, designed such that discharges meet applicable oil in water standards[5]; and
  - Route canteen waste water to the STP via a dedicated system to separate fats, oil and grease to the standard required to minimise potential fouling of the STP.

It is anticipated that pipework associated with the construction camp drainage system will be leak tested and may be superchlorinated. Discharge from the pipework testing and chlorination will meet the applicable sewage[6] and oil water standards[6].

It is expected that high level lighting, designed in accordance with international standards e.g. ILE requirements, will be erected at the construction camp and construction facilities areas.

5.5.7 Phase 7 – Closure of Enabling Road and at-Grade Rail Crossings

Phase 7 of the works will comprise (refer to Figure 5.11):

- Closure of the enabling road (following completion of the Baku-Salyan Highway Junction);
- Decommissioning of the enabling road at-grade railway crossing; and
- Decommissioning of the connection between the enabling road and the Terminal perimeter road.

[4] It is anticipated that the contents of the septic tanks will be tankered off site during maintenance
[5] Less than 10 mg/l as a monthly average and less than 19 mg/l on a daily basis
[6] pH (6-9), 5 day BOD of less than 20mg/l, total coliforms <400MPN (Most Probable Number) per 100ml, COD of less than 100mg/l, suspended solids of less than 30mg/l and residual chlorine less than 1mg/l.(used for irrigation) or less than 0.2mg/l.(discharge to the environment)

Figure 5.11 Phase 7 - Enabling Road Closures

Barriers, which are likely to include earth mounds, will be established at the junction of the enabling road with the Baku-Salyan Highway to prevent access. The at-grade rail crossing will be decommissioned and the connection point for the enabling road with the Terminal perimeter road will also be blocked to prevent vehicles on the perimeter road turning into it.

5.6 Construction Materials

SD2 Infrastructure Project construction materials are expected to comprise:

- Stripped vegetation and surface soil;
- Excavated materials and existing stockpile spoil;
- Hazardous liquids including fuels, oils, paints, solvents and bitumen;
- Precast concrete structures;
- Cabling;
- Geocell structures e.g. for the flood protection berm;
- Gravel (for permanent road and construction area surfacing);
- Cement;
- Plastic and stainless steel piping (for water and sewage);
- Modular structures e.g. the security compound building;
- Pre-cast steel buildings and structures e.g. workshops within the construction facilities area and safety barriers along road embankments;
- Chain link fencing; and
- Other prefabricated elements such as the STP.

Table 5.3 summarises the principles that will be adopted with regard to storage of potentially hazardous materials.

Table 5.3 Potentially Hazardous Material Storage Principles

Potential Hazardous Material	How and where it will be stored
Stripped surface soil	No storage anticipated. Uncontaminated surface soil to be used directly within flood protection berm.
Stripped vegetation	Either separated from surface soil and subsoil stored until re-vegetation activities commence or mulched and handled as waste (refer to Section 5.8.3 below).
Excavated materials and existing stockpile spoil	Separated from surface soil and stockpiled on site until required in accordance with spoil and landscape management plan (refer to Chapter 12).
Fuels and Oils in containers	Within secondary containment capable of holding 110% of the stored volume.
Bitumen, paint, solvents, grease	Within a site storage container or on hardstanding away from sensitive areas (e.g. watercourses).
Bags and sacks of materials (e.g. cement)	Off the ground on pallets and protected from the weather.

Any oily contaminated soil, ground water, surface water or other materials encountered inside or outside of the existing Sangachal Terminal property boundary during the works that requires handling will be managed in accordance with the principles described in Section 5.5.3. All other materials will be secured and appropriately stored until required for the construction works.

5.7 Construction Plant/Vehicles/Equipment

5.7.1 Numbers of Onsite Plant/Equipment/Vehicles

The estimated number of construction plant and vehicles expected to be used onsite during each phase of the SD2 Infrastructure works is presented in Table 5.4.

Table 5.4 Estimated Number of Onsite Construction Plant and Vehicles

Construction Equipment	Capacity/ Specification	Estimated Number of Plant/Equipment per Phase						
		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7
Bulldozer	D6/D8/D9/D10	1	1	6	6	6		
Wheeled loader	25 tonnes	2	2	5	5	5		
Tracked excavator	27 tonnes	1	1	5	5	5		
Dump truck	25 tonnes	2	2	38	38	38		1
Motor grader	25 tonnes	1	1	2	3	5		
Road roller	10 tonnes				2	1		
Sheep footed roller/vibro roller	13 tonnes	1	1	2	1	3	3	
Asphalt paver					3			
Road lorry	25 tonnes	8	4	28	28	28	11	
Diesel generator	50/100 kVA	1	2	7	7	7	9	1
Mechanical water bowser	20,000 litres	1	7	7	7	8	8	
Tracked mobile crane	115 tonnes		2	2	2	1	4	
Mobile telescopic crane	25 tonnes		1	2	3	1	1	
Earthworks compactor / roller	10 tonnes			7	7	7		
Large lorry concrete mixer	200 litres		1	2	3	2	1	
Fork lift truck	5 tonnes	1	3	3	3	3	1	
Water pump	20 kW	1	2	6	6	2	1	
Concrete pump	110 m^3			2	3	1	2	
Air Compressor	8/20 m^3/min	1	2	2	2	2	1	1
Backhoe loader	10 tonnes		4	3		2	2	
Welding set		1	1	2	2	2	2	1
Compactor plate			1	2	2	2	6	
JCB tractor		1	1	2	2	2	4	1
Tilting drum mixer	80 litres		1	1	1	1	4	1
Fuel bowser	10,000 litres	1	1	1	1	1	1	1
Basis of estimate: Typical equipment expected per phase based on expected activities Number of plant/equipment based on expected duration of works.								

5.7.2 Numbers of Offsite Vehicles and Routing

The estimated number of daily vehicle movements associated with the SD2 Infrastructure Project on the public road network are presented in Table 5.5.

Table 5.5 Estimated Number of Daily Offsite SD2 Infrastructure Vehicle Movements

		Estimated Number of Daily Movements				
Vehicle		Months 1 –2	Months 3 –4	Months 4 –10	Months 11 –17	Month 18
Low loader	In	1	3	1	1	
	Out	1	3	1	1	
Road lorry 25 T	In	1	2	20	2	
	Out	1	2	20	2	
Minibus (18-20 Seater)	In	3	15	30	30	3
	Out	3	15	30	30	3
7.5 Tonne Flat Bed	In	1	2	2	2	
	Out	1	2	2	2	
4x4 Pickup Truck	In	4	8	8	8	4
	Out	4	8	8	8	4
Private Car	In	5	20	20	20	10
	Out	5	20	20	20	10

All the vehicles detailed within Table 5.5 will travel along the Baku-Salyan Highway. Until the procurement strategy has been determined it is not possible to confirm likely vehicle routing. Current traffic flows on the highway area are discussed within Chapter 7.

5.8 Emissions, Discharges and Waste

5.8.1 SD2 Infrastructure Project Emissions

Table 5.6 summarises the GHG (i.e. CO_2 and CH_4) and non GHG emissions predicted to be generated during the SD2 Infrastructure Project from key sources which include:

- Onsite construction plant, vehicles and generators; and
- Offsite vehicles.

Table 5.6 Estimated GHG and Non GHG Emissions Associated with SD2 Infrastructure Activities

	CO_2 (ktonne)	CO (tonne)	NOx (tonne)	CH_4 (tonne)	NMVOC (tonne)	GHG (ktonne)
TOTAL	137	502	2,120	7	220	137

See Appendix 5A for detailed emission estimate assumptions.

5.8.2 SD2 Infrastructure Project Discharges

Planned routine discharges during the SD2 Infrastructure Project will comprise:

- **Storm/rain water drainage** – all project areas will be designed such that rainwater is discharged to the wadi system via the new and existing Terminal drainage channels to prevent flooding and ponding of water on site. Material storage locations (e.g. spoil stockpiles, cement) will be selected to minimise the potential for entrainment into the drainage system;
- **Discharge from oil water separator systems** – oil water separator systems (associated with drainage from parking areas, refuelling area and hazardous areas where fuels and chemicals are stored) will be designed such that discharges to the wadi system meet the applicable oil in water standards[7];

[7] Less than 10 mg/l as a monthly average and less than 19 mg/l on a daily basis.

- **Construction camp drainage pipework testing** – it is planned to leak test the pipework associated with the construction camp drainage system. In addition super chlorination may be undertaken. Discharges from testing and chlorination (which meet the applicable sewage (see Table 5.2) and oil in water[8] standards) will be either:
  - o Discharged to the Shachkaiya Wadi; or
  - o Used for irrigation purposes or for dust control where practicable and required.
- **Treated effluent (from the new STP) -** The STP is designed to treat approximately 900m^3/day. Treated sewage (which meets the applicable project standards (refer to Table 5.2) from the new STP (once operational) will be either:
  - o Discharged to the Shachkaiya Wadi; or
  - o Used for irrigation purposes or for dust control where practicable and required.

5.8.3 SD2 Infrastructure Project Hazardous and Non Hazardous Waste

The estimated quantities of non-hazardous and hazardous waste generated during the SD2 Infrastructure Project programme are provided in Table 5.7.

Table 5.7 Estimated Hazardous and Non-Hazardous Waste Associated with SD2 Infrastructure Activities[1]

Type	Waste Category	Sub Category	Estimated Volume (tonnes)[2]
Non hazardous waste	Non-hazardous non - recyclable waste	General Waste	**2,335**
		Canteen waste	
	Recyclable waste	Cooking oil	**1,750**
		Electrical cable	
		Paper and card	
		Plastics	
		Scrap metal	
		Tyres	
		Wood	
	Total (Non-hazardous)		**4,085**
Hazardous waste	Solid hazardous waste	Cartridges	**80**
		Oily soil/sludge	
		Oily rags	
		Paint sludge	
		Other solids requiring pretreatment for landfill	
		Other solids not requiring pretreatment for landfill	
	Hazardous liquid waste	Chemicals	**50**
		Oily water	
		Paint thinners	
		Used oil/diesel	
	Total (Hazardous)		**130**

1 Treatment and disposal routes are detailed in Table 5.8.
2 Types and estimated volumes of waste based on actual waste volumes recorded during previous ACG projects and the proposed SD2 Infrastructure Project schedule and activities.

Waste produced during each phase of the SD2 Infrastructure works will be segregated and temporarily stored onsite prior to transportation to the existing Sangachal Terminal Central Waste Accumulation Area (CWAA) or the new SD2 waste transfer facility once complete. Waste management plans and procedures, including requirements and the responsibilities of the construction contractor and BP, are detailed within Chapter 12. The planned destination of each SD2 Infrastructure waste stream is presented in Table 5.8.

[8] Less than 10 mg/l as a monthly average and less than 19 mg/l on a daily basis

Table 5.8 Construction Waste Streams

Category	Sub Category	Destination
Non-hazardous non-recyclable waste	General Waste	Non-hazardous landfill – current facility has been designed and constructed to EU standards.
	Canteen waste	
Recyclable waste	Cooking oil	Recycling contractors – SOFAZ to receive revenue from waste with inherent remaining value e.g. steel.
	Electrical cable	
	Paper and card	
	Plastics	
	Scrap metal	
	Tyres	
	Wood	
Solid hazardous waste	Cartridges	Treatment/disposal by MENR licensed, BP approved contractor or storage pending availability of appropriate contractor.
	Oily soil/sludge	
	Oily rags	
	Paint sludge	
	Other solids requiring pre-treatment for landfill	
	Other solids not requiring pre-treatment for landfill	
Hazardous liquid waste	Chemicals	Treatment/disposal by MENR licensed, BP approved contractor or storage pending availability of appropriate contractor.
	Oily water	
	Paint thinners	
	Used oil/diesel	

5.9 Training and Employment

It is estimated that the SD2 Infrastructure works are likely to employ between 450 to a peak of 700 people. It is expected that 30% of the workforce will comprise professional staff. A Workforce Welfare and Local Employment Plan will be produced; the key aim of which will be to maximise the employment opportunities for local people (refer to Chapter 12 for details).

5.10 Working Hours and Night-time Working

Construction working hours are assumed to be:

- 07:00 to 19:00 Monday to Saturday.

While not planned, night and Sunday working may be required depending on the progress of the works. If working during the hours of darkness, temporary lighting may be required. The contractor will be required to produce a lighting strategy to minimise light spillage and glare to the community, road users and the shoreline while not comprising safety (refer to Chapter 12).

5.11 Management of Change Process

During the detailed design and execution stages of the SD2 Infrastructure Project, there may occasionally be a need to change a design element or a process. The project intends to implement a formal process to manage and track any such changes, and to:

- Assess their potential consequences with respect to environmental and socio-economic impact; and
- In cases where a new or significantly increased impact is anticipated, to inform and consult with the MENR to ensure that any essential changes are implemented with the minimum practicable impact.

All proposed changes will be notified to the Project HSE team, who will review the proposals and assess their potential for creating environmental or socio-economic interactions.

Changes which do not alter existing interactions or impacts, or which give rise to no new interactions or impacts, will be summarised and periodically notified to the MENR, but will not be considered to require additional approval.

If internal review and assessment indicates that a new or significantly increased impact may occur, the following process will be applied:

- Categorisation of the impact using ESIA methodology;
- Assessment of the practicable mitigation measures;
- Selection and incorporation of mitigation measures; and
- Re-assessment of the impact with mitigation measures in place.

In practical terms, the changes that will require prior engagement and approval by the MENR are those that:

- Result in a discharge or disturbance to the community that is not described in the SD2 Infrastructure ESIA; and
- Result in the discharge of a chemical not referenced in the ESIA and not currently approved by the MENR for use in the same application by existing AGT operations.

Once the changes (and any appropriate mitigation) have been assessed as described above, a technical note will be submitted to the MENR describing the proposal and reporting the results of the revised impact evaluation. Where appropriate, this may include the results of environmental testing and modelling. Following submission of the technical note, the Project HSE team will engage in meetings and communication with the MENR in order to secure formal approval. Once approved, each item will be added to a register of change. The register will include all changes, including those non-significant changes notified in periodic summaries, and will note any specific commitments or regulatory requirements associated with those changes.

6 Environmental Description

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6.1 Introduction

This Chapter describes the terrestrial and coastal environments associated with the SD2 Infrastructure Project. These are defined as (refer to Figure 6.1):

- **Terrestrial**: The areas to the east, west and north of the Sangachal Terminal and the area to the south between the Terminal and the Baku-Salyan Highway, which includes the wetland areas to the south of the Terminal; and
- **Coastal**: The zone between the Baku-Salyan Highway and the Caspian Sea shoreline[1].

6.2 Data Sources

A large number of environmental surveys and investigations have been undertaken in the area surrounding the Terminal and adjacent coastal areas.

Between 1994 and 2004, environmental surveys have focused on investigating baseline conditions for flora and fauna, air quality, noise and contamination. Since 2004, the Integrated Environmental Monitoring Programme (IEMP) has collected data on:

- Ambient air quality at selected receptors in the vicinity of the Terminal;
- Soil, groundwater and surface water conditions from boreholes and surface water sampling points in the vicinity of the Terminal;
- Flora, fauna, vegetation and soil stability within the Terminal surrounds; and
- Ongoing birds survey in and around Sangachal Bay.

The primary aim of the IEMP is to develop reliable and consistent time series data for each location within a clearly defined survey area to enable long-term trends to be identified.

Under the SD Production Sharing Agreement (PSA), responsibility for the preparation and approval of environmental surveys associated with the IEMP rests with the Environmental Sub-Committee (ESC), which carries out an annual review of planned survey activities. The ESC comprises representatives of key stakeholders such as the State Oil Company of Azerbaijan (SOCAR), the Council of Ministers, the Ministry of Ecology and Natural Resources (MENR) and the Azerbaijan National Academy of Sciences (ANAS). Practical supervision and review of ongoing activities is delegated to the ACG & SD Environmental Monitoring Technical Advisory Group (EMTAG), which comprises environmental specialists representing these organisations.

In addition to the ongoing IEMP surveys, a number of specific surveys have been undertaken to gather additional environmental data. These include noise, odour, visual context and light surveys.

A list of all relevant surveys completed since 1992 is provided in Table 6.1.

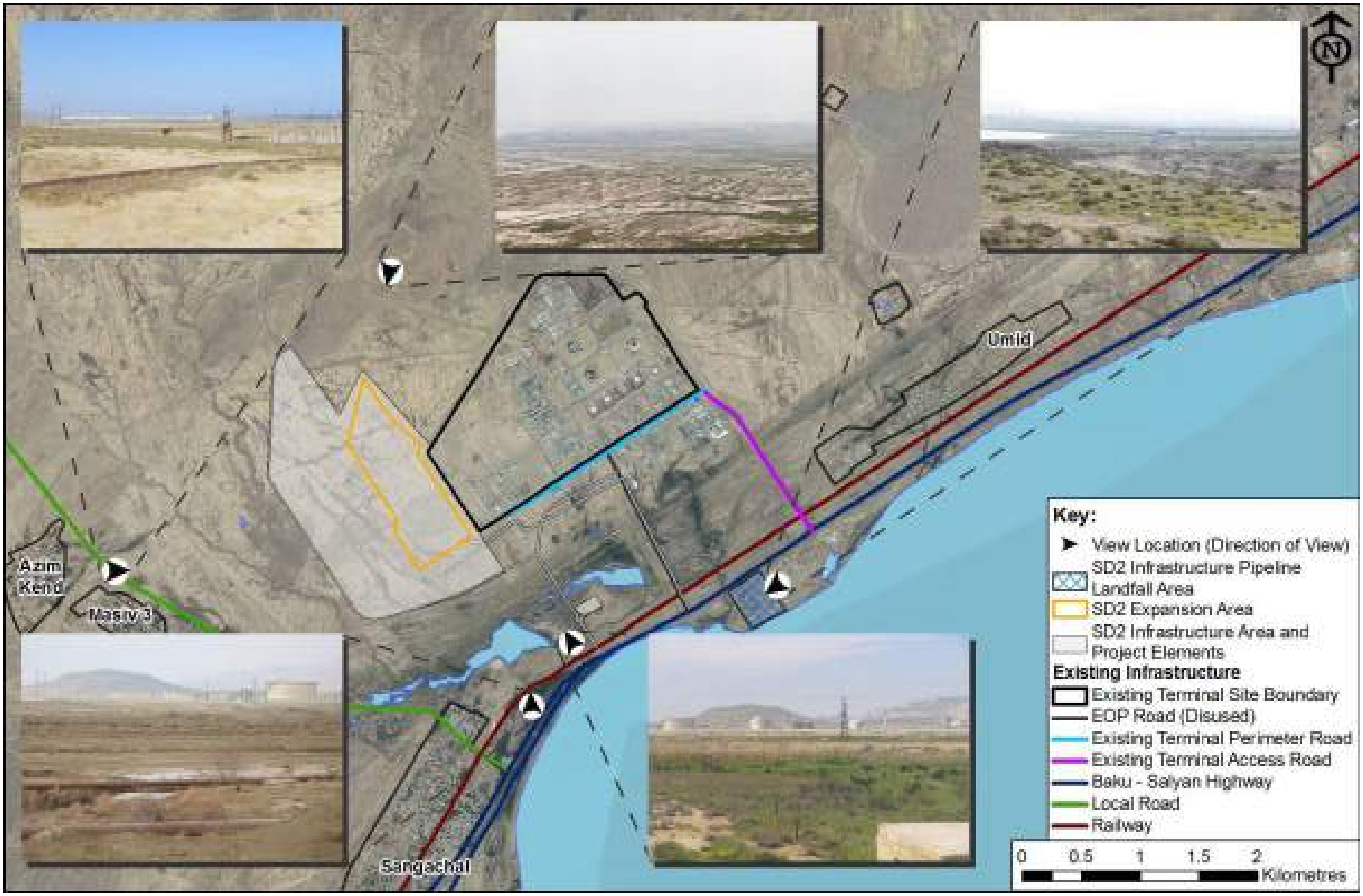
A geotechnical survey within the areas to the west and south of the existing Terminal (including the SD2 Infrastructure area) is ongoing. The scope of the survey includes the collection of soil and groundwater samples. In addition, an archaeological survey is planned for 2011 covering the SD2 Infrastructure area (refer to Section 6.6). The results of previous surveys completed during preparation of previous ACG Phases 1-3 and SD Environmental and Socio-Economic Impact Assessments (ESIAs) are referenced in sections of this chapter where relevant.

[1] The wider Western Caspian coastal region is described with regard to overwintering and migrating bird species

Table 6.1 Relevant Baseline and Monitoring Surveys Completed to Date

Date	Title of Survey
Terrestrial Surveys	
1996	EOP Sangachal Terminal Survey
2001	Terrestrial Soil and Groundwater Survey
2001	Breeding Bird Monitoring Survey Sangachal
2001	Phase 1 Terrestrial Survey
2002	Phase 2 Terrestrial Survey
2003	Sangachal Terminal Watershed Analysis
2003	Sangachal Wetlands Survey Summer/Autumn 2002
2004	Breeding Bird Monitoring Survey Sangachal
2004	Integrated Terrestrial Ecosystem Monitoring Survey - Spring
2004	Integrated Terrestrial Ecosystem Monitoring Survey – Autumn
2005	Integrated Terrestrial Ecosystem Monitoring Survey - Spring
2005	Integrated Terrestrial Ecosystem Monitoring Survey – Autumn
2005	Breeding Bird Survey, Sangachal
2006	Sangachal Terminal Ambient Air Quality Monitoring
2006	Sangachal Terminal Terrestrial Monitoring Survey - Spring
2006	Sangachal Terminal Terrestrial Monitoring Survey - Autumn
2006	Ambient Ground and Surface Water Monitoring
2006	Onshore Ambient Monitoring (Sangachal): Hydrology & Hydrogeology – Phase I
2007	Sangachal Terminal Ambient Air Quality Monitoring
2007	Sangachal Terminal Terrestrial Monitoring Survey - Spring
2007	Sangachal Terminal Terrestrial Monitoring Survey - Autumn
2008	Sangachal Terminal Ambient Air Quality Monitoring
2008	Onshore Ambient Monitoring (Sangachal): Hydrology & Hydrogeology – Phase II
2008	Sangachal Terminal SD2 Expansion Area Flora and Fauna Survey
2008	Sangachal Terminal – Surface and Subsurface Water and Landscape Management Study
2008	Hydrological Survey Report
2008	Onshore Ambient Monitoring (Sangachal) Bird Monitoring Survey Report
2009	Sangachal Terminal Ambient Air Quality Monitoring
2009	Onshore Ambient Monitoring (Sangachal) Bird Monitoring Survey Report
2009	Onshore Ambient Monitoring (Sangachal):Terrestrial Monitoring Survey Spring & Autumn 2009
2010	Sangachal Wetland Survey Report*
2010	Onshore Ambient Monitoring (Sangachal) Bird Monitoring Survey Report*
2010	Sangachal Terminal Baseline Noise Survey
2010	Sangachal Terminal Visual Context Baseline Survey Report & Road Route Photographic Survey
2010	Sangachal Terminal Odour Assessment
2010	Sangachal Terminal Light Baseline Survey Report
2010	Sangachal Terminal Ambient Air Quality Monitoring*
2011	Sangachal Terminal Noise Surveys
Coastal Surveys	
1996	Pipeline Landfall Survey: Sediments and Macrobenthos
1996	Sangachal Coastal Environmental Survey, 1996
2000	Sangachal Coastal Environmental Survey, 2000
2002/2003	Overwintering Bird Survey, Absheron to Kura
2004	Overwintering Bird Survey, Absheron to Kura
2004	Winter Waterfowl Monitoring Study. Absheron to Kura
2005	Winter Waterfowl Monitoring Study. Absheron to Kura
2006	Winter Waterfowl Monitoring Study. Absheron to Kura
2010	Sangachal Subsea Pipeline Landfall Area Rehabilitation and Monitoring Survey Report
2010	Sangachal Bay Shoreline Photographic Survey Report
* IEMP survey – report not yet issued	

Figure 6.1 Terrestrial and Coastal Areas Associated with the SD2 Infrastructure Project



6.3 Physical Environment

6.3.1 Seismicity

The Caspian region, which is part of the Eurasian continental plate, has a convergent plate boundary with the Arabian and Indian continental plates. This has led to the destruction of an ocean (Tethys), which lay, between Eurasia to the north with Africa and India forming its southern shores. The mountain chains of the Alps, Caucasus and the Karakorum/Himalayas are composed of upthrusted rocks formed in, and around, this ancient ocean. Convergent plate movements are associated with relatively high levels of seismic activity and typically accompanied by earthquakes and volcanism.

Azerbaijan is known for its seismic activity, particularly in the Greater and Lesser Caucasus Mountains. Five earthquakes with a magnitude greater than 6.0 on the Richter scale have occurred since 1842; the most recent measured 6.5 on 25 November 2000 with an epicentre 30km east-north east of Baku. More detailed information on the seismicity and tectonics of the area can be found in the ACG Phase 1 ESIA[2].

6.3.2 Climate

Climatic data, with the exception of wind and rainfall data, for the period 1977 to 2000 has been collected from the meteorological station at Alyat which is located approximately 25km south of Sangachal.

6.3.3 Temperature

The onshore Sangachal area is classified as being warm, semi-arid desert, with an annual mean air temperature of 14.4 degrees Celsius (°C). July is the warmest month of the year with a 23-year mean average air temperature of 26.4°C between 1977-2000. January is the coldest month with an average of 0°C. Temperature extremes of –16°C and 41°C have been recorded historically in January and July, respectively.

6.3.4 Precipitation

The onshore Sangachal area is one of the driest in Azerbaijan. Rainfall data is collected from Alyat, Baku and Mashtaga[3]. Mean annual rainfall in Baku from 1992 to 2006 was 263mm. The highest monthly rainfall from 2002 to 2006 was 184mm in December 2002. October to February are wet months which receive an average of 41 to 79mm/month, with drier months occurring during from July to August which receive an average of 1 to 5mm/month.

Table 6.2 presents average monthly rainfall data from the meteorological station at Baku from 2002 to 2006.

Table 6.2 Average Monthly Rainfall Data (Baku) 2002 to 2006

	J	F	M	A	M	J	J	A	S	O	N	D
Average monthly rainfall (mm)	41	43	25	31	20	10	5	1	24	46	46	79

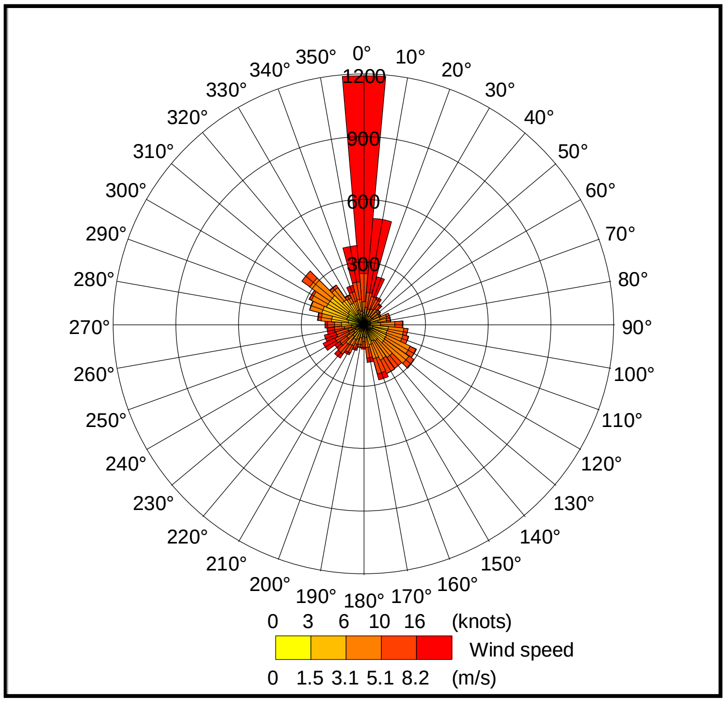
[2] ACG1 ESIA, 2002
[3] Refer to Appendix 9E: Hydrological Modelling of this ESIA

6.3.5 Wind

The wind regime in Sangachal Bay is generally consistent with that for the Absheron Peninsula, although it is recognised that there is a local thermally driven wind system. The effects of the local system are most noticeable offshore within the Bay, resulting in a slight (1m/s to 2m/s) offshore wind during the early hours of the morning, which reduces and becomes a stronger onshore wind as the land heats up during the warmer months of the year. This thermal influence, coupled with the meteorological dynamics of the region, can result in strong winds occurring with little forewarning.

Figure 6.2 shows a wind rose compiled from data collected during 2007 at Sangachal Terminal and supplemented by data from Baku Airport for the year (2007)[4]. The predominant wind direction is north occurring approximately 15% of the year. North-northwesterly and north-northeasterly winds account for approximately 10-12% of other winds. Wind speeds typically range from 0.5m/s to 12m/s with approximately 30% of winds being greater than 8m/s.

Figure 6.2 Annual Wind Rose (Sangachal Terminal), 2007



6.4 Terrestrial Environment

6.4.1 Setting

The Terminal, occupying an area of approximately 5.5km^2, is sited on a plain sloping gently towards the south east and to the Caspian Sea. The elevation of the Terminal site is around 15m to 20m below Mean Sea Level (MSL) (the mean level of the Caspian Sea is about 27 to 28m below MSL). There are a number of steeper hills to the north and north east of the Terminal rising to over 300m to the north and 400m around Mount (Mt) Qaraqush, a large mud volcano, which last erupted in 2000. The nearest hills lie to the northwest with a mean height of 70m to 85m above MSL.

[4] The anemometer is located 10m above ground level

There are four main settlements in the vicinity of the Terminal (Figure 6.1) the largest being Sangachal Town located approximately 2.5km south. The Umid Settlement lies less than 1km to the east of the Terminal, and Azim Kend and Masiv 3 are located approximately 2.7km to the southwest.

Umid and Sangachal Town are adjacent to the Baku-Salyan Highway, a four lane hard-surfaced road that runs parallel to the Caspian Sea coastline. A raised railway line (2m to 4m above ground level) runs parallel to the highway, between the highway and the Terminal. Multiple underground and aboveground pipelines (oil, water and gas pipelines) also run parallel to the highway between the railway and Terminal.

Other nearby industrial developments includes the state-owned power station located between the Terminal and Sangachal Town which started operation at the end of 2008. The Sangachal Power Station has been designed to produce electricity using generators powered by gas combustion with the option of using heavy fuel oil.

Water courses in the Terminal vicinity include:

- Shachkaiya Wadi - Flows from the Shachkaiya hills north of the Terminal and passes to the west of the Terminal area towards the Caspian Sea; and
- Umid Wadi - Located east of the Terminal.

A drainage channel has been constructed around the northern, western and eastern perimeters of the Terminal to protect it from potential flooding. The channel diverts floodwaters into existing natural drainage lines which exist between the Terminal and the Caspian Sea.

The SD2 Infrastructure area to the west and southwest of the Terminal (refer to Figure 6.1) is generally flat and includes areas (closer to the Terminal boundary) which have undergone significant disturbance associated with earlier Terminal construction works. This has resulted in the creation of two significant spoil heaps located in this area. Towards the south of the SD2 Infrastructure area, land which has been disturbed by works within the existing pipeline corridor, is often waterlogged due to poor drainage (see Section 6.4.2 below), slopes towards the Caspian Sea.

6.4.2 Hydrology

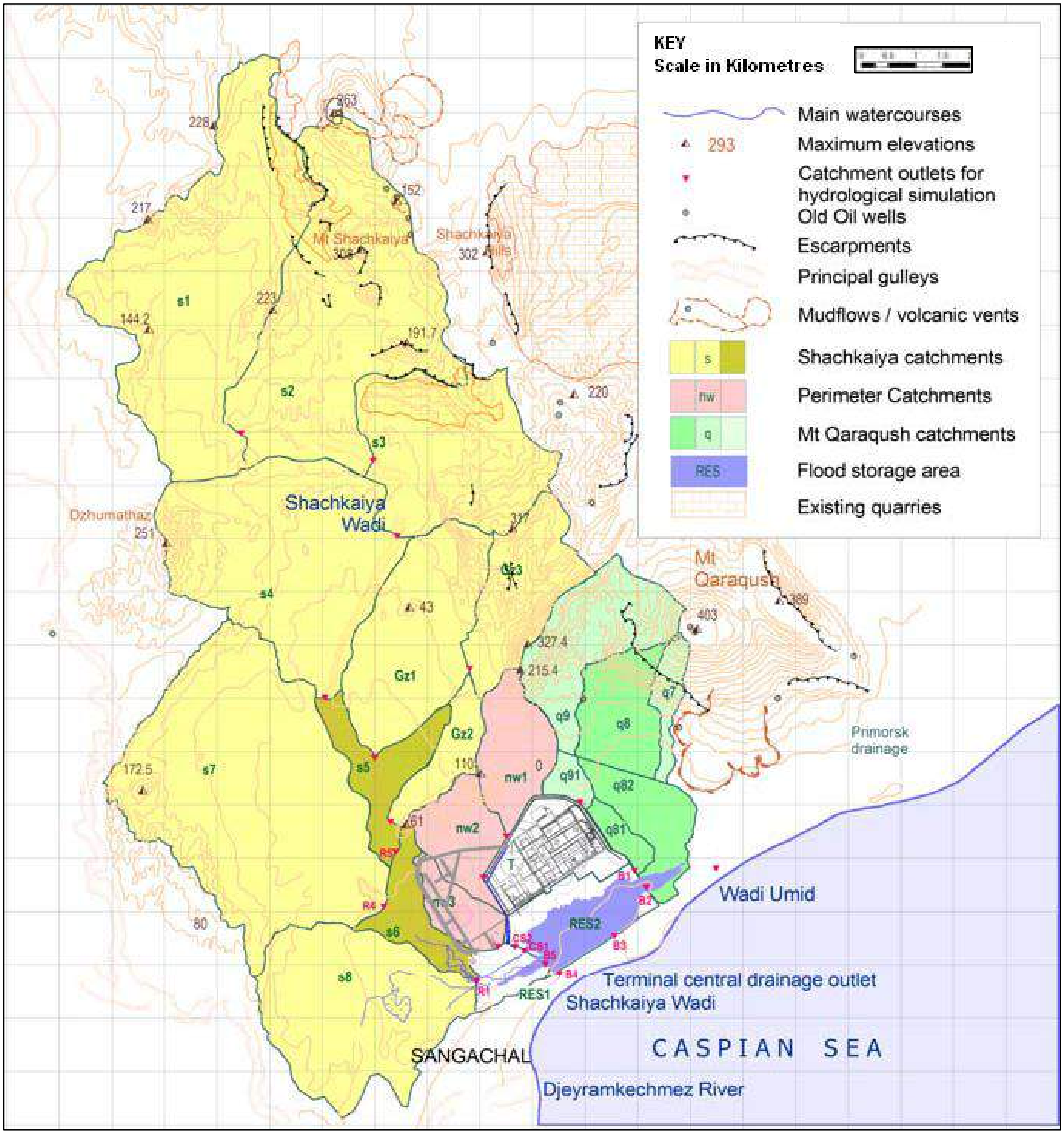
The hydrology of the Terminal area is complex due to its position within a number of drainage catchment areas (refer to Figure 6.3) which are:

- Shachkaiya catchment areas (the Shachkaiya Wadi and its western tributaries);
- Northern and western perimeter catchment areas;
- Flood storage areas between the Terminal and railway embankment;
- Mt Qaraqush catchment areas which comprise:
    - Western Qaraqush slopes and north east perimeter channel;
    - Central Qaraqush slopes and Umid Wadi outlet; and
    - Eastern Qaraqush slopes and rubbish dump draining towards Primorsk.

The above main catchment areas have been divided into 23 sub-catchment areas to allow the drainage of the Terminal to be characterised in a detailed hydraulic model[5]. The Terminal is directly affected by runoff from sub-catchments ‘nw1’, ‘nw2’ and ‘nw3’ to the west and northwest and ‘q81’, ‘q9’ and ‘q91’ which lie to the northeast and east of the Terminal (refer to Figure 6.3). Catchments ‘q7’, ‘q8’ and ‘q82’ drain the western slopes of Mt Qaraqush and enter flood storage area ‘RES2’ through culverts beneath the existing Terminal access road.

[5] Refer to Appendix 9E: Hydrological Modelling of this ESIA

Figure 6.3 Main Drainage Catchment Areas in the Vicinity of the Terminal



© Water Resource Associates Ltd. Based on Soviet mapping at 1:50,000 scale, with WRA data added.

The Shachkaiya Wadi and its tributaries comprise 77% of the total drainage area of 137km^2. The wadi flows into the Caspian Sea via 'RES1' through bridges 'B4' and 'B3' (refer to Figure 6.3) beneath the railway embankment east of Sangachal Town, and then continues through culverts beneath the coastal highway. Outflows from sub-catchments 'nw1', 'nw2' and 'nw3' join the lower Shachkaiya Wadi channel in a low lying area which includes a complex system of over-ground pipes, ditches and spoil heaps.

The lower reaches of the Shachkaiya Wadi are usually wet and appear to have a small permanent water flow which sustains a significant area of reed, scrub and other marsh vegetation. It is likely that this flow is a combination of ephemeral surface drainage from the

Terminal and, also, waste water streams from Azim Kend, Masiv 3 and Sangachal Town with possibly a small additional contribution from leaking water supply pipes[6].

The existing flood protection drainage channel around the Terminal is designed to divert floodwaters towards the Caspian Sea to the east. The northern arm of this flood protection drainage channel carries a small, but steady, stream of water which is understood to be partly derived from treated sewage effluent discharges generated at the Terminal. No flow has been observed in the channel to the west during dry weather periods.

Flows from 'RES1' into 'RES2' combine with stormwater drainage water from the Terminal and also from the northern and eastern perimeter channels. The combined flow drains beneath the railway embankment at bridge 'B3' and under the coastal highway through a culvert towards the Caspian Sea.

Field inspections and hydrological modelling have suggested that soils within the catchment area are relatively impermeable. A 'baked crust' is created and maintained by the cyclic process of rainfall and drying which impedes infiltration during storm events. Approximately 50% of the rainfall landing on the soil runs off during floods, and the wadis respond rapidly to rainfall.

A number of ephemeral streams surrounding the Terminal have the potential to cause flooding. While these streams do not flow all year round, they can carry significant volumes of flood runoff following short-duration, intense storms.

Hydrological modelling undertaken (refer to Appendix 9E) used a combination of statistical analysis of annual maximum flows from river gauging stations, local-rainfall data and a unit hydrograph approach to estimate flood hydrographs and runoff volumes.

The Shachkaiya Wadi and flood protection drainage channel has been hydraulically modelled as a linear flood corridor with three spill sections which allow water to move out the flood protection drainage channel and into a floodplain storage area. Water is shown to pond behind the old railway embankment between Sangachal Power Station and the Terminal ('RES1'), before moving into a large storage area formed by construction of the main railway line ('RES2'). Finally, water enters a narrow strip of low-lying land between the railway and Baku-Salyan Highway which offers further floodwater storage. There is a total floodwater storage capacity of more than 3 Mm^3 in the three areas of floodplain.

Sensitivity

The existing drainage route from the Terminal to the Caspian Sea reflects many years of modification by human activities, in particular the laying of third-party pipelines and earthmoving activities for road and railway construction activities. Hydrological modelling undertaken in 2002 demonstrated that the design capacity of the Terminal drainage channel and associated culverts were sufficient to accommodate flows from a 1 in 100 year, 18-hour flood event (major flood event). However, the potential for silt deposition to affect the drainage route and an increase in the area subject to ponding during high rainfall was identified.

The recent hydrological modelling (see Appendix 9E) confirmed that Sangachal Town and Sangachal Power Station are sited on elevated ground and would be unaffected by a major flood event.

A Caravanserai is located approximately 960m east from Sangachal Town and set back approximately 80m from the highway towards the Terminal (refer to Section 6.6). The land where it is located is at an average elevation of -20.1 m above MSL, reducing to an elevation of -21.2 mMSL at the lowest point within the Caravanserai complex. This lowest level lies just above the modelled major 100 year flood event level of -21.3 mMSL in this location. There are a number of uncertainties within the modelling[7] and it is therefore considered that some parts of the Caravanserai are likely to be at risk of shallow flooding from a major event.

[6] Presence of leaking water pipes confirmed during walkover in June 2011
[7] Uncertainties are associated with the model input data and the inherent uncertainties in the model itself – refer to Appendix 9E

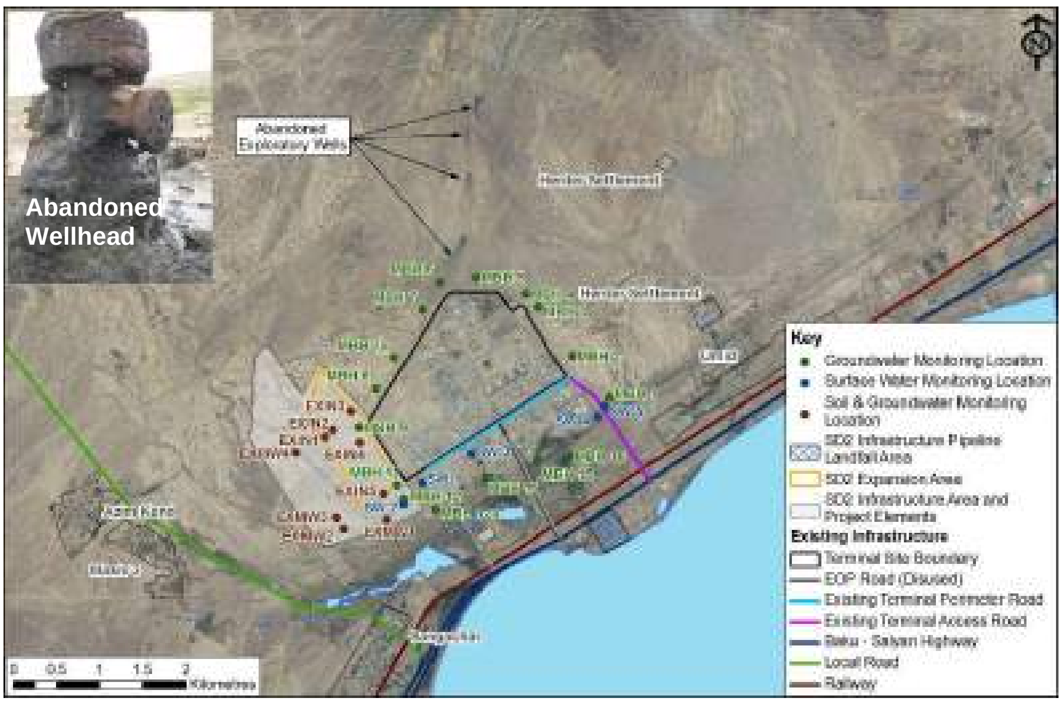
The effect of a major flood event on the Baku-Salyan Highway was also modelled. It was shown that the highway would be affected by flooding at culvert 'B6' which is located about 1km east of the road to Sangachal from the highway. During the major flood event, water would surcharge the box culverts at this point and flow over the highway.

The large volumes of flood water that currently reach the central storage area, 'RES2', drain through bridge 'B3' under the railway embankment. Under present conditions, modelling showed that for the 100 year flood a 250m length of the railway track at this point could be flooded to a depth of up to 0.26m across the rails and up to 0.87m across the ballast. Such overtopping might cause scour of the railway embankment and possible failure, risking damage to both the railway line and to the coastal highway with a large volume of sediment laden water having the potential to cause significant damage.

6.4.3 Geology, Soils and Historical Pollution

A number of boreholes have been drilled since 1995 to investigate soil and groundwater quality. The locations of boreholes included within the 2006 and 2008 monitoring programme are illustrated in Figure 6.4[8]. A number of these boreholes were re-sampled in 2010 and are discussed below, where relevant.

Figure 6.4 Locations of Abandoned Exploratory Drilling Wells and Position of Soil and Groundwater Monitoring Boreholes



In general terms, while the surveys have indicated that strata underlying the Terminal and the adjacent SD2 Infrastructure area is characterised by low permeability estuarine clays, water does still permeate through it. Regional geological conditions suggests that the strata continue to a depth of 50m, however, the results of borehole drilling have only proven estuarine clays down to a depth of 20m.

Subsurface geology recorded by the 2006 survey indicates that strata comprises stiff to very stiff, light brown to brown, laminated clayey-silt sequence with occasional seams of fine to medium grained sands which vary in thickness.

[8] Note that EXIN wells are no longer monitored.

Analysis of soil samples collected during the 2006 survey indicate that Total Petroleum Hydrocarbon (TPH) was present at various depths from all boreholes, up to a maximum concentration of 91 mg/kg at MBH5 collected at a depth of 18-19m. The boreholes located close to, or within, the SD2 Infrastructure area (MBH6, MBH9, MBH11, MBH12 and MBH12a) indicate that TPH is greatest at a depth of 8 to 12m.

The presence of four abandoned exploratory wells to the north of the Terminal can clearly be identified in Figure 6.4 (abandoned wellhead also shown) where surface staining is visible from each well location. Surface staining is observed continuing down the topographic slope towards the northern boundary of the Terminal. The source of TPH concentrations across areas investigated in 2006 are likely to be linked to previous Soviet era hydrocarbon exploration activities.

The analytical results of the 2008 survey completed within the SD2 Infrastructure area (EXMW and EXIN boreholes within Figure 6.4) are summarised within Table 6.3.

Table 6.3 SD2 Infrastructure Area Soil Sample Results, 2008

Parameter (mg/kg)	Monitoring Wells				Boreholes					Standard (mg/kg)	Standard Reference
	EXMW1	EXMW2	EXMW3	EXMW4	EXIN1	EXIN2	EXIN3	EXIN4	EXIN5		
TPH	4.5	14.4	4.3	<2.5	-	-	-	-	-	5,000	
Arsenic	2.9	8.4	5.2	7.7	10.0	15.3	7.7	11.1	9.8	1.6	USEPA RSL
Barium	246	250	252	254	376	578	172	510	312	22,000	UK
Cadmium	0.17	0.22	0.17	0.16	0.39	0.24	0.29	0.28	0.26	230	UK
Chromium	49.4	42.8	52.3	49.8	67.2	66.7	62.0	107	60.8	8,840	UK
Copper	36.5	22.9	26.8	27.9	45.3	43.4	33.9	54.9	32.3	41,000	USEPA RSL
Iron	28,900	25,800	2,800	30,100	35,000	40,700	31,800	50,800	32,800	720,000	USEPA RSL
Lead	22.6	15.9	17.8	18.0	14.4	20.4	12.1	23.4	15.5	800	USEPA RSL
Mercury	0.04	0.03	0.04	0.03	0.04	0.04	0.05	0.05	0.04	310	USEPA RSL
Zinc	64.0	60	68.4	68.0	83.5	92.4	68.7	113	76.7	310,000	USEPA RSL

Analysis of soil samples collected from the 2008 boreholes indicates:

- Arsenic concentrations in soil exceeded the USEPA Regional Screening Level (RSL) across all the EXMW and EXIN boreholes (Figure 6.4 and Table 6.3) that lie to the west of the Terminal. High Arsenic concentrations appear to be naturally occurring within soils across the region and are not linked to operations at the Terminal;
- High concentrations of iron in soil were detected which are typical of general soil conditions;
- TPH concentrations were generally low; and
- Results from the analysis of Conductivity, Carbonate content, Gypsum, pH and Total Organic Carbon (TOC) within soil were within normal ranges expected for the saline soils which are typically found in the vicinity of the Terminal.

Sensitivity

The existing data on geology and soils indicates strata across the Terminal and SD2 Infrastructure area exhibits a low permeability which results in groundwater having a low vulnerability from surface spills and leaks of hazardous substances.

The level of pollution detected by the 2006 and 2008 surveys indicate that there has not been a significant impact to soil quality from previous Soviet era hydrocarbon exploration activities. Surveys indicate that to date, activities at the Terminal have not impacted the quality of soil at the locations investigated.

6.4.4 Groundwater and Surface Water

Groundwater

The quality of groundwater and surface water was investigated by the 2006 and 2008 surveys (Table 6.1). Groundwater is expected to be present in small quantities within the occasional seams of fine to medium grained sands which are known to vary in thickness, although there is no significant groundwater-bearing unit within a depth of 20m.

From the 2006 survey, groundwater was present at only 7 monitoring well locations:

- North of the Terminal (MBH4, MBH5, MBH6 and MBH7); and
- South of the Terminal along the 3rd party corridor route (MBH12, MBH14 and MBH16).

The highest TPH value in groundwater in the 2006 survey was recorded from 122µg/l (MBH7) to the north of the Terminal.

Groundwater was only detected in 2 monitoring wells during the 2008 survey within the SD2 Infrastructure area: EXMW1 and EXMW3. TPH and heavy metal concentrations within groundwater in each location were all below criterion limits (refer to Table 6.4).

Table 6.4 TPH and Heavy Metal Results of Groundwater Samples from 2008 Survey

Parameter	EXMW1	EXMW3
TPH (µg/l)	21	99
Heavy metals (mg/l):		
Arsenic	0.11	0.01
Cadmium	0.003	0.009
Chromium	0.04	0.07
Copper	0.10	0.12
Iron	67.5	53.2
Mercury	0.00006	0.000012
Manganese	2.5	2.7
Nickel	0.08	0.09
Lead	0.16	0.17
Selenium	<0.005	<0.005
Zinc	0.11	0.01

The 2008 water quality data indicates that concentrations of heavy metals for Cadmium, Copper, Iron, Manganese, Nickel, and Lead all exceeded USEPA criterion values. The source of these heavy metals is not known, however levels of Chromium, Copper, Mercury, Manganese, Nickel and Lead recorded in 2010 at EXMW1 were all lower than those recorded in 2008 by between 6 (Mercury) to 1,000 times (Manganese).

Surface Water

A total of five surface water samples were collected in 2006 to the south of the Terminal and analysed for TPH, BTEX compounds (benzene, toluene, ethylbenzene, and xylenes), PAH (polyaromatic hydrocarbons) and heavy metals. All samples exceeded US EPA drinking water standards for TPH and zinc was exceeded at SW5, however the concentration is abnormally high compared with other results and may be a result of contamination of the sample or laboratory error. Small concentrations of BTEX compounds were detected in SW3 and PAH exceeded USEPA criterion values in SW4 (refer to Table 6.5).

Table 6.5 Results of Surface Water Samples from 2006 Survey

Parameter	SW1	SW2	SW3	SW4	SW5
TPH (µg/l)	113	297	40	280	65
BTEX (mg/l)	<0.02	<0.02	0.462	<0.02	<0.02
16 PAH (total) (µg/l)	0.016	0.016	0.117	0.353	0.098
Arsenic	<5	<5	<5	<5	<5
Barium	18	41	144	30	52
Cadmium	<1	<1	<1	<1	<1
Chromium	<10	<10	<10	<10	<10
Copper	8	3	3	<1	2
Iron	<10	<10	11	<10	14
Mercury	0.014	0.011	0.011	0.020	0.011
Lead	<10	<10	<10	<10	<10
Zinc	<10	<10	<10	<10	7,860

Wetland

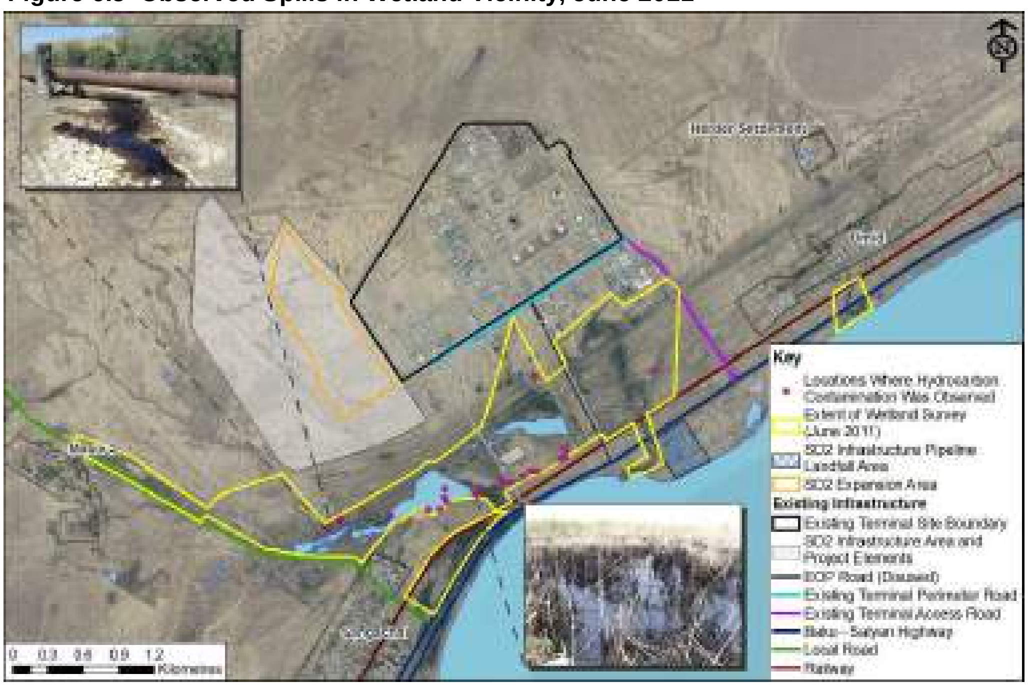
Water and soil quality within reedbeds located in the wetlands have been investigated by surveys completed in 2002 and 2010. Water samples collected in 2002 indicated high levels of cadmium, PAH and THC from the reedbeds. Soil samples collected from the same location also featured high levels of THC, PAH and phenols.

A comparison of the 2002 and 2010 data indicates that the concentration of the following key parameters has changed:

- Cadmium in water has decreased from 0.43 mg/l to less than 0.001mg/l;
- THC in water has decreased from 217 µg/l to 28 µg/l;
- PAH in soil has remained at a similar level; 120 µg/kg and 85 µg/kg in 2002 and 2010 respectively; and
- THC in soil has remained at a similar level; 63 µg/kg and 66 µg/kg in 2002 and 2010, respectively.

A walkover of the wetlands undertaken in June 2011 identified a number of spills within the wetland area (refer to Figure 6.5).

Figure 6.5 Observed Spills in Wetland Vicinity, June 2011



Further water and soil quality surveys are planned to characterise the spills (including, where possible, identifying the source of the spill) and determine the extent of any contamination. From observation, all spills appeared to be hydrocarbon with the surface of some areas covered with weathered crude. The majority of the observed hydrocarbons appeared to originate from a large spill at 'RES1' which was traced through 'RES2' to the outfall at 'B3' (Figure 6.3). Other spills occurred in the vicinity of pipelines, however no visible leaks were observed.

Sensitivity

***Groundwater**:* There is no substantial groundwater-bearing unit within 20m below ground surface. The survey results to date indicate previous hydrocarbon exploration activities have not resulted in a significant impact to groundwater quality.

Surface water: TPH concentrations (40 to 290 µg/l) are in the same magnitude as TPH recorded in groundwater (highest at MBH7 122µg/l).

Wetlands: The results of the 2002 and 2010 water and soil quality surveys indicate that the wetland area is characterised by high concentrations of some heavy metals and hydrocarbons within both soil and groundwater. Whilst the overall quality of groundwater within the wetland area was shown to have improved between the 2002 and 2010 survey, PAH levels in soil were shown to have slightly increased. The walkover survey undertaken in 2011 recorded a number of hydrocarbon spills, suggesting potential areas of contamination in the wetland.

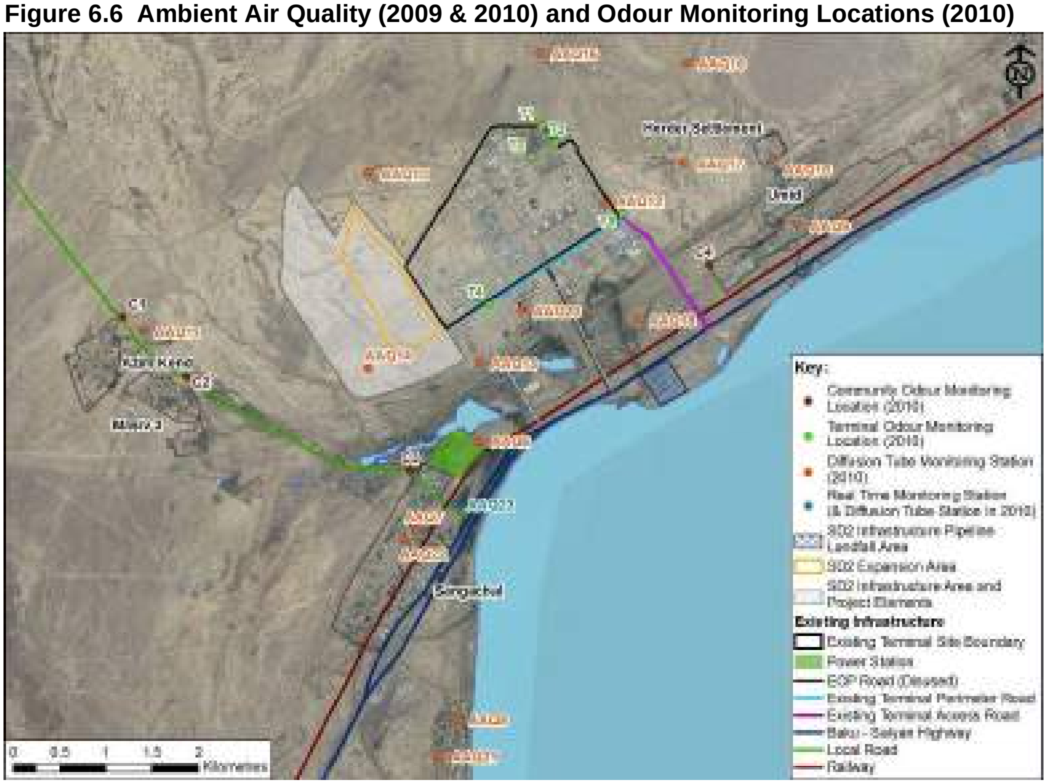
6.4.5 Air Quality

Ambient air quality monitoring has been undertaken around the Terminal since 1997, prior to the EOP activities commencing at the Terminal. The monitoring locations, parameters recorded and analytical methodology used has varied across the monitoring surveys. The most recent air quality monitoring surveys were undertaken during 2009 and 2010.

Concentrations of SO_X, benzene, VOC and NO_2 were monitored at seventeen locations using passive diffusion tubes. Hourly real-time monitoring data (for NO, NO_2, NO_X, SO_2 and PM_{10}) was also collected at an automatic monitoring station (station AAQ23) between February - May 2009 and May – December 2010[9]. Odour monitoring was also undertaken in 2010 based on a "sniff test" approach as recommended by UK Environment Agency Guidance[10].

Figure 6.6 presents the location of monitoring stations used in the 2009 and 2010 air quality and odour surveys. The figure also shows the location of the Sangachal Power Station which commenced operation in December 2008. It is understood the Sangachal Power Station is designed to be primarily gas fired.

Figure 6.6 Ambient Air Quality (2009 & 2010) and Odour Monitoring Locations (2010)



[9] Interruptions to the monitoring station power supply prevented further data from being obtained.
[10] Odour monitoring was undertaken separately to the 2010 air quality monitoring and does not form part of the IEMP.

Ambient air quality measurements were assessed against IFC[11] and World Health Organisation Guidelines[12] (WHO), and in the case of benzene, the European Union (EU) Guidelines.[13,14,15]

NO_2 Concentrations

Measured NO_2 concentrations are shown in Table 6.6, based on three rounds of monitoring in 2009 and four rounds of monitoring in 2010. The table also includes the automatic monitoring station data recorded in 2009 and 2010 (location AAQ23).

Table 6.6 Average NO_2 Air Quality Concentrations, 2009 and 2010 ($\mu g/m^3$)

	Diffusion Tube Survey Results		Automatic Monitoring Station Results	
Monitoring Location	2009 Concentration (av. of 3 rounds)	2010 Concentration (av. of 4 rounds)	February - May 2009	May-December 2010
AAQ 6	14.0	13.5	n/a	n/a
AAQ 7	11.7	12.3		
AAQ 8	10.1	9.5		
AAQ 9	7.8	8.7		
AAQ 10	9.0	10.2		
AAQ 11	3.6	3.9		
AAQ 12	7.7	9.5		
AAQ 13	19.1	12.0[1]		
AAQ 14	3.9	6.4		
AAQ 15	4.0	4.8		
AAQ 16	3.8	3.9		
AAQ 17	4.8	2.4		
AAQ 18	5.4	7.8		
AAQ 19	4.9	4.6		
AAQ 20	5.5	9.2		
AAQ 21	11.2	10.2		
AAQ 22	10.3	8.9		
AAQ 23	NA	18.7[2]	22[3]	33[3]
Applicable Limit	40 $\mu g/m^3$ (annual average)[4]	40 $\mu g/m^3$ (annual average)[4]	200 $\mu g/m^3$ (1 hour average)[5] 150 $\mu g/m^3$(24 hour average)[6]	

1 Only one round of results was available at AAQ13 in 2010. **2** 2010 survey included diffusion tube monitoring at the AAQ23 location. **3** Average of 1 hour results obtained over sampling period. **4** EU/WHO/IFC annual average standard. **5** EU/IFC 1 hour average standard. **6** WHO maximum 24 hour average standard.

Annual average limit values for NO_2 were not exceeded at any of the diffusion tube stations. Concentrations ranged between 6% and 48% of the annual average air quality standard for NO_2, with the highest concentration reported in 2009 at station AAQ13, situated approximately 0.75km south of the existing Terminal and approximately 1km to the northeast of Sangachal Power Station. Average hourly concentrations recorded at the automatic monitoring station during 2009 and 2010 did not exceed the relevant 1 hour average and 24 hour limit values.

SO_2 Concentrations

The measured SO_2 concentrations in 2009 and 2010, based on four rounds of monitoring each year, are shown in Table 6.7.

[11] IFC Environmental, Health and Safety Guidelines. General EHS Guidelines: Environmental, Air Emissions and Ambient Air Quality (2007).
[12] World Health Organisation Guidelines (1999).
[13] European Union Guidelines (2005).
[14] No guidelines were available for total VOC.
[15] Historically in Azerbaijan ambient concentrations of NO_2, SO_2, CO and PM_{10} have also been assessed against 24 hour and 1 hour standards. These standards were not derived using the same health based criteria as the IFC, WHO and EU guideline values and the standards derived are not widely recognised.

Table 6.7 Average SO_2 Air Quality Concentrations, 2009 and 2010 ($\mu g/m^3$)

Monitoring Location	Diffusion Tube Survey results		Automatic monitoring station results	
	2009 Concentration (av. of 4 rounds)	2010 Concentration (av. of 4 rounds)	February - May 2009	May-December 2010
AAQ 6	10.0	11.2	n/a	n/a
AAQ 7	7.6	3.6		
AAQ 8	3.3	5.1		
AAQ 9	9.0	4.2		
AAQ 10	3.5	4.4		
AAQ 11	1.8	21.6		
AAQ 12	8.5	4.7		
AAQ 13	3.3	1,100[1]		
AAQ 14	2.3	5.3		
AAQ 15	0.8	5.0		
AAQ 16	0.8	13.9		
AAQ 17	2.1	11.9		
AAQ 18	0.9	3.1		
AAQ 19	4.7	3.0		
AAQ 20	2.1	10.7		
AAQ 21	5.3	1.7		
AAQ 22	0.8	5.7		
AAQ 23	NA	7.3[2]	2[3]	4[3]
Applicable Limit	50 $\mu g/m^3$ (annual average)[4]		125 (max. 24 hour average)[5]	

1 Only one round of results was available at AAQ13 in 2010. **2** 2010 survey included diffusion tube monitoring at the AAQ23 location. **3** Average of 1 hour results obtained over sampling period. **4** Former World Bank annual average standard. **5** EU/WHO/IFC maximum 24hr average.

The annual average air quality standard for SO_2 was not exceeded at any station in 2009. Concentrations ranged between 1% and 20% of the applicable air quality standard, with the highest concentration (10.0$\mu g/m^3$) reported at station AAQ6 (adjacent to the Sangachal Power Station). No exceedances were recorded at the automatic monitoring station during 2009 (AAQ23).

The annual average standard for SO_2 was exceeded at one monitoring station in 2010 (AAQ13) although the use of just one round of monitoring data is not considered representative of annual average conditions. The measured concentration at AAQ13 is also abnormally high compared with other results and may be a result of contamination of the sample or laboratory error. No other exceedance of the annual average standard was recorded at any of the monitoring locations, or during any of the monitoring rounds during 2009 and 2010. In addition, no exceedances of the 24 hour average limit were recorded at the automatic monitoring station during 2010.

Benzene and VOC Concentrations

The measured benzene and total Volatile Organic Carbon (VOC) concentrations for 2009 and 2010 are shown in Table 6.8.

Table 6.8 Average Benzene and VOC Concentrations, 2009 and 2010 ($\mu g/m^3$)

Monitoring Location	Benzene (2009)	Benzene (2010)	VOC (2009)	VOC (2010)
AAQ 6	9.1[3]	6.4[1]	297	209
AAQ 7	20.8[3]	68.3[3]	687	1,858
AAQ 8	2.1	3.4	69	85
AAQ 9	3.7[2]	3.1	93	87
AAQ 10	4.1[2]	2.8	102	86
AAQ 11	2.2	2.4	45	68
AAQ 12	3.4[2]	3.8[1]	205	241
AAQ 13	3.6[2]	2.8[4]	132	73[4]
AAQ 14	3.3	2.7	64	57
AAQ 15	3.1	2.3	56	52
AAQ 16	3.5	3.5	62	45
AAQ 17	2.6	1.8	46	41
AAQ 18	4.0	2.6	128	65
AAQ 19	2.9	2.4	39	46
AAQ 20	8.0[1]	4.0[1]	672	273
AAQ 21	2.5	2.3	95	86
AAQ 22	4.4[1]	4.7[2]	120	143
AAQ23	NA	3.5[5]	NA	90[5]
Applicable Limit	5 $\mu g/m^3$ (annual average)[6]		-	-

1 One of the rounds of results exceeded the applicable limit. **2** Two or three rounds of results exceeded the applicable limit. **3** Each of the four rounds of results exceeded the applicable limit. **4** Only one round of results was available at AAQ13 in 2010. **5** 2010 survey included diffusion tube monitoring at the AAQ23 location. **6** EU annual average standard.

The average 2009 concentration of benzene and VOC ranged between 2.1 - 20.8 µg/m^3 and 39 - 687 µg/m^3 respectively. The highest benzene measurements were recorded at AAQ7, a monitoring location within Sangachal Town. The annual average air quality standard for benzene was exceeded at three locations during 2009: AAQ6, AAQ7 and AAQ20. The standard was also exceeded during individual measurement rounds at 6 other stations. This does not infer a breech of the limits as the annual mean concentration at these 6 locations complied with the standard.

Of the three stations where the annual average concentrations exceeded the air quality standard, one is located within Sangachal Town (AAQ7), with the other two situated between Sangachal Town and the Terminal (AAQ6, AAQ20), as shown in Figure 6.7. Monitoring station AAQ22 is situated close to these stations and only narrowly complied with the air quality standard for benzene. Stations closer to the Terminal (e.g. AAQ13 and AAQ14) however, complied with the applicable limits.

The average 2010 concentrations for benzene and VOC ranged between 1.8 - 68.3 µg/m^3 and 41 - 1858 µg/m^3 respectively. The highest benzene measurements were again recorded at AAQ7. The consistently high concentrations recorded at AAQ7 indicate it is very likely that a local emission source is influencing benzene and VOC results at this location.

The air quality standard for benzene was exceeded at two locations according to 2010 monitoring data: AAQ6 and AAQ7. Exceedances were recorded during individual measurement rounds at 3 other stations, though this does not infer a breech of the limits as the mean annual concentrations at these 3 locations complied with the relevant limit.

Concentrations of benzene and VOCs are consistently higher at locations in, and adjacent to, Sangachal Town (AAQ6, AAQ7 and AAQ22) and at AAQ20 which lies immediately downwind of the Terminal. Concentrations at AA23 (in 2010), which is also located within Sangachal Town, were not elevated.

An odour assessment was undertaken in 2010 along the Terminal boundary and in locations within the four communities surrounding the Terminal (see Figure 6.7). The primary odour detected was a tarry, oily smell from the Terminal produced water ponds, which are located to the north eastern of the Terminal. The odour was reported to be strong around the produced water ponds (locations T1, T2 and T3) and faintly detectable (under northeasterly wind conditions) at Sangachal Town (location C3). It is possible that evaporation of volatile compounds from produced water ponds may contribute to the high benzene and VOC concentrations recorded downwind of the Terminal. Odours that are associated with nearby farming activities were detected at location C2.

PM_{10} Concentrations

The measured PM_{10} concentrations for 2009 and 2010 are shown in Table 6.9. Results were obtained from the automatic monitoring station (location AAQ23).

Table 6.9 PM_{10} Concentrations, 2009 and 2010 (µg/m^3)

Month	PM_{10} Concentrations (µg/m^3)	
	2009	2010
February	102	-
March	52	-
April	26	-
May	115	51
June	-	56
July	-	33
August	-	125
September	-	146
October	-	118
November	-	160
December	-	180
Average	74	109
Applicable Limits	40µg/m^3 (annual average)[1], 50 µg/m^3 (24 hour standard)[2]	
1. EU annual average standard. **2**. WHO, IFC and EU 24 hour standard		

The average monthly PM_{10} concentration ranged between 26 µg/m^3 in April 2009 and 180 µg/m^3 in December 2010, with considerable variance between the months, as shown in Table 6.9. The average PM_{10} concentration for the 4-month monitoring period in 2009 was 74 µg/m^3 and 109 µg/m^3 in 2010. This exceeds the EU annual average standard of 40 µg/m^3. In addition, the PM_{10} results also exceeded the WHO, IFC and EU 24 hour standard of 50 µg/m^3 for all months excluding March and April 2009 and July 2010.

PM_{10} is defined as airborne particles (i.e. dust) which have a diameter less than 10 microns (µ) and is routinely monitored for the protection of human health. In semi-arid and arid environments, ambient PM_{10} concentrations often exceed international air quality standards regardless of the presence of local man-made activities due to the natural entrainment of dust in the atmosphere which is typical of dry, windy conditions.

The PM_{10} results recorded in 2009 and 2010 show no clear trend although higher concentrations were recorded during winter months when wind conditions are stronger. Given the semi-arid nature of the region, it is considered likely that natural conditions are the most likely cause of the variations shown in PM_{10} data.

Sensitivity

Air quality concentrations have been regularly monitored at locations in the Terminal vicinity since 2006 and the results from 2009 and 2010 surveys are presented above. The results of air quality monitoring during 2006 and 2007 surveys were included in the COP ESIA[16]. While survey locations and methods have varied, it is possible to compare the earlier results to those obtained in 2009 and 2010. For example, NO_X results at location AAQ07 range between 11 and 13 µg/m^3 with the exception of an anomalous result in 2007 during a period when the Terminal was shutdown.

The results for SO_2 concentrations in the same location have varied between 1.6 µg/m^3 (in 2007) and 7.6 µg/m^3 (in 2009). No trends indicating deteriorating air quality are evident since results in 2006 were higher than those in 2007, and the 2010 results were lower than the data recorded in 2009. There is also no trend evident from PM_{10} data which has consistently varied throughout the available data set.

With the exception of PM_{10} (discussed above), air quality data is consistently below applicable limit values. The data did not indicate any negative effect associated with the Sangachal Power Station as there is no significant change in air quality recorded before/after the start of operation. It is considered likely that local factors, such as the generation of dust and wind conditions, influence local air quality to a greater extent than emissions associated with operations at the Terminal and at Sangachal Power Station.

6.4.6 Noise

Ambient noise monitoring surveys have been completed to inform the previous ACG and SD ESIAs. The most recent surveys were completed in 2010 and 2011. The 2010 noise survey included 5 locations (R1 to R5) which are located adjacent to, or within, Azim Kend, Masiv 3, Sangachal Town and Umid.

Monitoring locations during the 2011 noise survey included:

- Sensitive receptors within local communities and recreational areas (including the 2010 R1 to R5 locations and locations R8, R11, R12, A1, A3 and A4 – refer to Table 6.10 for receptor types); and
- Locations immediately adjacent to the highway – selected to measure baseline traffic noise (R9, R10, R11 and A3).

The 2010 and 2011 monitoring locations are shown in Figure 6.7.

[16] COP ESIA, (2010)

Figure 6.7 Noise Survey Locations, 2010 and 2011

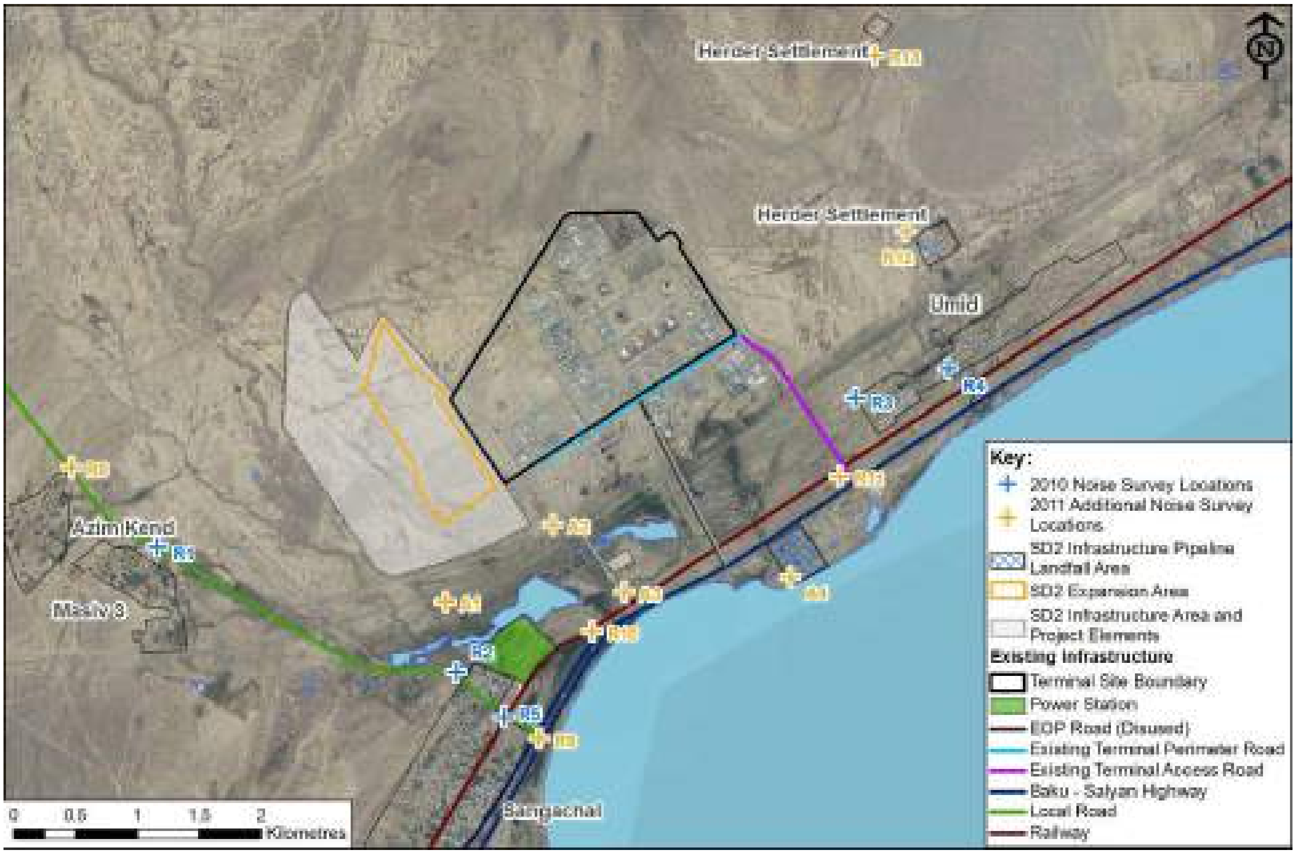


Table 6.10 presents the noise levels recorded (as LAeq[17]) during daytime and night time periods at sensitive receptors and at locations adjacent to the Baku-Salyan Highway (measured as LA_{10}).

Measurements were recorded during May 2010 and March 2011. During each survey, weather conditions were fair, with winds predominantly from the north. Monitoring results obtained when winds speeds exceeded 5m/s were excluded as, under these conditions, results are affected by wind noise.

Observations were made throughout the surveys to record the noise sources and identify dominant sources in each location. Operational data was obtained to confirm that the Terminal was operating under normal operations (i.e. there was no emergency flaring or other abnormal noise generating activity at the Terminal).

[17] The average ambient noise level including all potential sources (e.g. the Terminal, Sangachal Power Station, traffic, animals).

Table 6.10 2010 and 2011 Noise Survey Results at Sensitive Receptors and Roadside Monitoring Locations

ID	Location	Receptor	2010		2011		
			Measured Ambient Noise Range (Daytime) dB LAeq	Measured Ambient Noise Range (Night Time) dB LAeq	Measured Ambient Noise Range (Daytime) dB LAeq	Measured Ambient Noise Range (Night Time) dB LAeq	Traffic Noise dB LA10 (Daytime)
Sensitive Receptors							
R1	Azim Kend / Masiv 3	Low rise residences	44 – 56	46 – 48	50 - 53	39 - 51	
R2	Sangachal	Low and high rise residences	48 – 66	46 – 59	62 - 70	52 - 53	-
R3	Umid West	Low rise residences	48 – 66	49 – 53	49 - 58	45 - 55	-
R4	Umid East	Low rise residences	56 – 62	52 – 58	51- 54	*	-
R5	Sangachal Railway Crossing	Shops and low rise residences	62 – 69	49 – 59	55 - 63	*	-
R8	Azim Kend	Low rise residences	-	-	43 - 50	39 - 49	-
A1	East of Power Station	Walled residence	-	-	67 - 68	*	-
A3	North of Highway	One residence about 50m north of the highway	-	-	69	*	
A4	Beach	Amenity space	-	-	50 - 51	*	-
R11	South Side of Highway	New residential / hotel developments, some nearing completion, some still at skeleton stage	-	-	65 - 66	*	-
R12	Herder Settlement	Low rise residences	-	-	45 - 47	*	-
Highway Traffic Noise Monitoring Locations							
R9	South of highway – west	-	-	-	-	-	71 - 76
R10	South of Highway – middle	-	-	-	-	-	76 - 78
R11	South of highway – east	-	-	-	-	-	68 - 69
A3	North of highway – middle	-	-	-	-	-	73 - 74

Notes:
*Night time noise measurements were not undertaken in this location.
- Noise measurement not taken at this location.

Daytime noise levels recorded during the 2010 and 2011 surveys reflect the movement of road traffic along the Baku-Salyan Highway. Road traffic noise from the use of local roads at Sangachal Town affected noise levels recorded at one location (R2) only. Daytime measurements did not detect noise generated from operation of the Terminal at any of the 2010 or 2011 locations.

Night time measurements in 2011 detected noise generated from operation of the Terminal at Azim Kend and Umid West. In addition, a consistent low-frequency noise could be identified at Sangachal Town and Azim Kend/Masiv 3 which was derived from the Sangachal Power Station. Night time road traffic noise from the Baku-Salyan Highway was audible at all 2010 and 2011 monitoring locations.

Both data sets for the 2010 and 2011 surveys indicate a large range in recorded dB which is typical of surveys influenced by road traffic noise. Given the range of noise levels recorded at R1 to R5 during daytime and night-time periods, there were no significant differences between noise levels recorded during the 2010 and 2011 surveys.

Sensitivity

The noise environment within the local communities is generally quietest at night with the lowest noise levels consistently recorded at Azim Kend. During daytime and night-time periods, traffic noise (associated with the Baku Salyan Highway) is audible at all locations, resulting in significant noise levels at those locations closest to the Highway (e.g. location ‘A1’, ‘R2’, ‘A3’, and ‘R11’). In these locations daytime noise levels are approaching and, in some cases, above the recommended noise standard of 65dB(A) (as stated within British Standard 5228[18]) when noise associated with construction work has the potential to impact the local community[19]. This guidance value differs from limit values associated with operational noise[20] as construction noise is recognised as being temporary and has different characteristics to operational noise. Nevertheless, the survey results show that noise levels in the locations nearest to the Highway are generally high.

Other noise sources recorded during the surveys included helicopters, animal noise and the occasional passing of construction vehicles. The noise environment at all locations is generally dominated by consistent low-mid pitch background noise.

6.4.7 Terrestrial Ecology

A number of habitat surveys have been undertaken in the vicinity of the Terminal since 2001. The methodology, monitoring locations and species included in the surveys has varied. Since 2006, annual spring and autumn flora surveys of the terrestrial areas surrounding the Terminal have been undertaken to identify change using ecosystem indicators. A survey was completed in 2008 which aimed to identify the status of flora and fauna within a section of the SD2 Infrastructure area. A full list of the surveys completed to date is provided in Table 6.1.

6.4.7.1 Habitats

The Terminal is situated within a desert environment and comprises a complex array of bare ground, desert and semi-desert vegetation. Vegetated areas are dominated by low perennial shrubs (particularly *Salsola nodulosa, Salsola dendroides, Suaeda dendroides, Salsola ericoides*) interspersed with the perennial grass *Poa bulbosa*. Within the SD2 Infrastructure area, locations heavily modified by human activity are categorised as ‘disturbed ground’. In addition, livestock movements and grazing has impacted the soil and vegetation in some areas surrounding the Terminal.

Results of the terrestrial monitoring survey undertaken in 2009 identified that, in general, ecological conditions improve with greater distance from the Terminal with the greatest diversity located to the west (towards the south of the SD2 Infrastructure area). Other habitat types in the areas surrounding the Terminal include chal-meadow (to the north and south of the SD2 Infrastructure area which was surveyed) associated with topographic depressions. Figure 6.8 shows the distribution of habitats around the Terminal and Figure 6.9 shows the major vegetation types in the section of the SD2 Infrastructure area included within the 2008 survey.

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[18] BS5228:2009, ‘Noise and Vibration Control on Construction and Open Sites’
[19] Note there is no equivalent limit value for traffic noise
[20] 45dB(A) during night and 55dB(A) during daytime (LA_{eq})

Figure 6.8 Approximate Distributions of Plant Community Types (Habitats) Around the Terminal

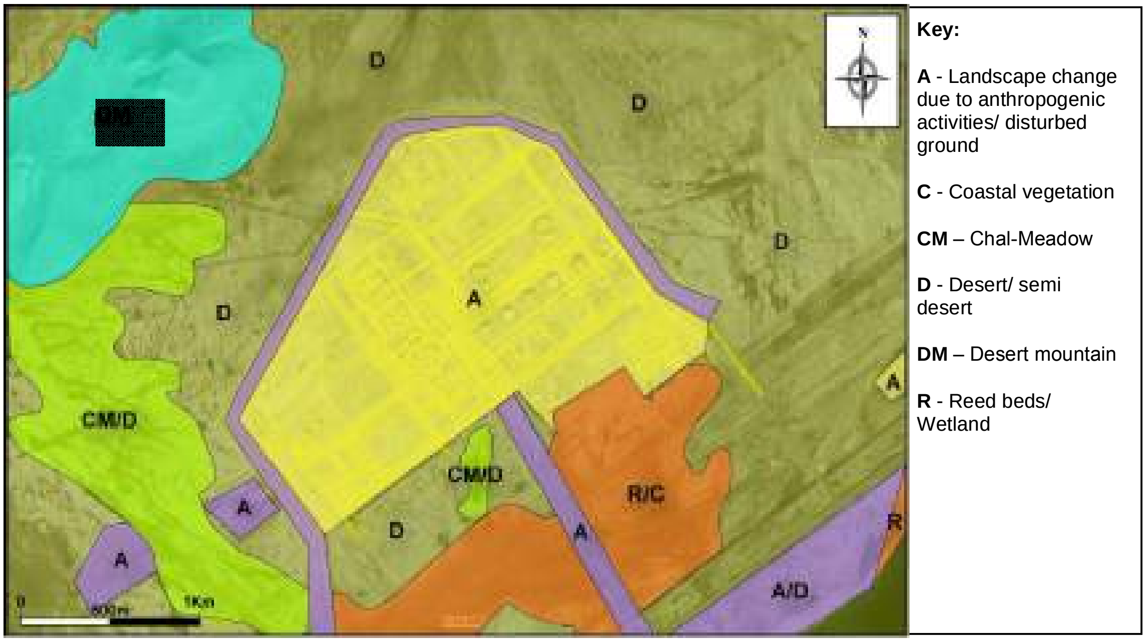
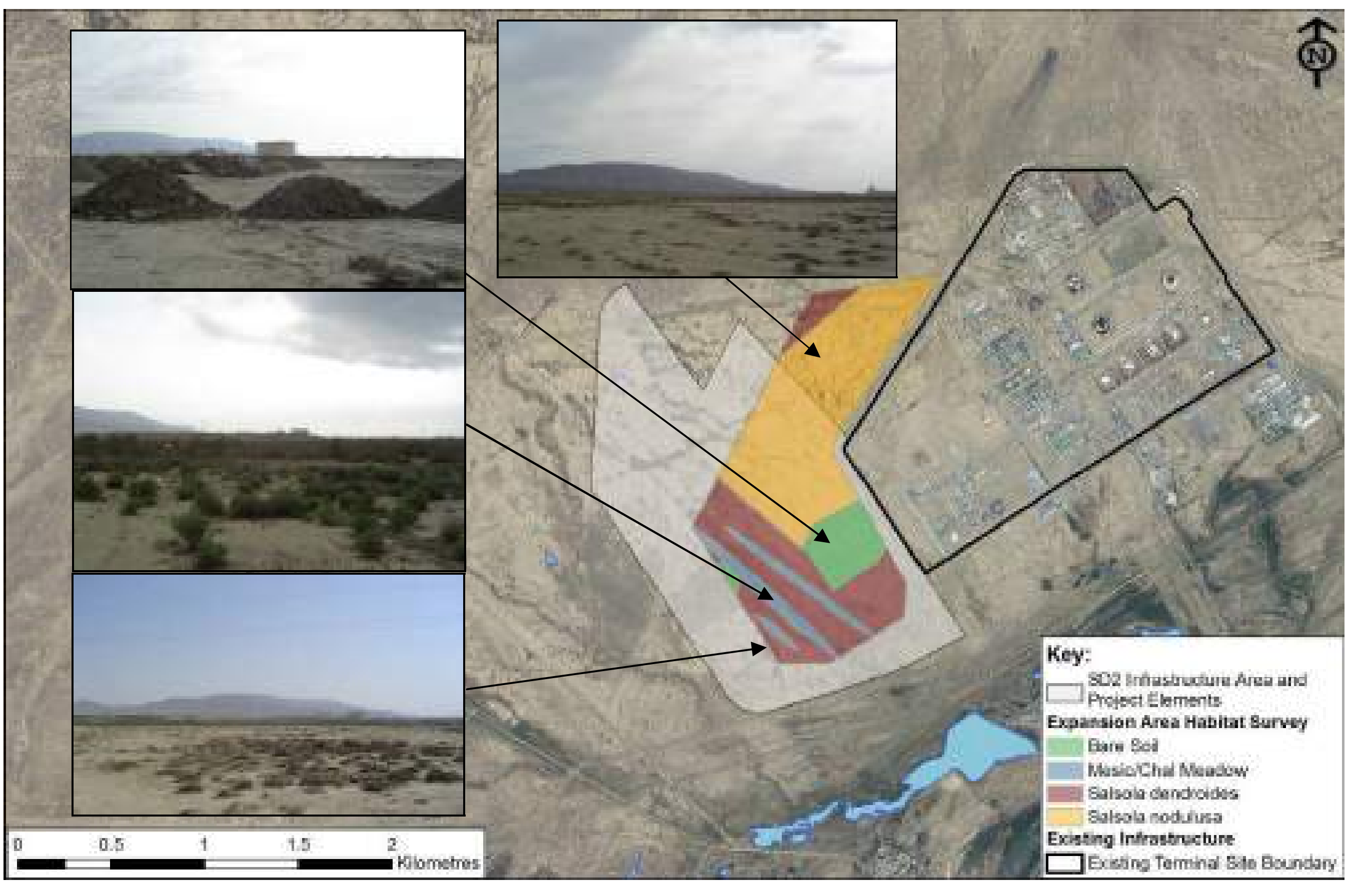


Figure 6.9 Major Vegetation Types within SD2 Infrastructure Area (as surveyed), 2008



Disturbed Ground – Areas of disturbed ground exist primarily to the west of the Terminal and result from previous Terminal construction activities (refer to Figure 6.9 above). The 2008 survey undertaken within the SD2 Infrastructure area showed very little vegetation present in these areas. In 2005 and 2006, areas of disturbed ground were included within the terrestrial survey monitoring. Surveys were undertaken to establish the extent of re-vegetation of the areas in the period between the surveys. It was shown that regrowth was focused in locations which were previously subject to surface water ponding and more recently in areas where heavy machinery has been used. Rainwater collected in the indentation left in the ground by the machinery.

It was shown that most of the regrowth was focused at locations which were previously subject to surface water ponding or had been subject to minor changes in topography such as the indents which collect rainwater left from the use of machinery.

The results indicated that the rate of natural regeneration was generally low, with some areas featuring zero regrowth. Observations made during a site walkover in May 2011 indicated that the rate of natural regeneration within the disturbed/bare soil areas (see Figure 6.9) remains low with sparse growths of *Salsola nodulosa* and *Poa bulbosa*.

Desert/Semi-desert - The majority of the habitat surrounding the Terminal is desert/semi-desert. The SD2 Infrastructure area (as surveyed within 2008) comprises a variety of elements including:

- Exposed silt/bare soil;
- Silt with a growth of lichens and algae (a microbiotic crust);
- Sparse growth of perennial shrubs (desert vegetation); and
- Patches of perennial shrubs with a closed cover of grasses and annual species (semi-desert vegetation).

The extent of variation between these elements is highly variable across the SD2 Infrastructure area. The presence of a microbiotic crust encourages the germination and growth of perennial grasses by causing seeds to collect and retain surface moisture following rainfall for longer periods, when compared with areas of exposed silt. The 2001 survey provided information associated with the key species of lichens and algae which comprises the ‘microbiotic crust’ and included[21]:

- *Diploschistes gupsaceus;*
- *Squamaria lentigera;*
- *Callema crispum;*
- *Fulgensis fulgens;*
- *Toninia coeruleonigricanus; and*
- *Psora lurida.*

The main vegetation assemblages in the vicinity of the Terminal are dominated by low perennial shrubs (*Salsola nodulosa*, *Salsola dendroides, Suaeda dendroides*, *Salsola ericoides* and *Artemisia lerchiana*) including coastal zone variants and others in association with grasses. None of the species present identified within the desert/semi-desert habitats area is included in the Azerbaijan Red Data Book (AzRDB) or classified as vulnerable/threatened by IUCN.

The desert habitats in the SD2 Infrastructure area are generally heavily grazed, although the areas immediately surrounding the Terminal may have seen some recent reduction in grazing following the erection of a partial fence, which is not yet completed, in the west.

Chal-Meadows – Areas of chal-meadow are found to the west and south of the Terminal (Figure 6.8) and specifically towards the centre of the SD2 Infrastructure area as surveyed (Figure 6.9). The distribution of this vegetation community-type is linked to the temporary retention of surface water following rainfall (i.e. within depressions in the land) and comprise

[21] Shah Deniz Stage 1 ESIA, 2002

higher vegetative cover when compared with desert/semi-desert vegetation. Chal-meadow has a distinct species composition and is dominated by *Tamarix meyeri* scrub with, *Lycium ruthenicum*, *Alhagi pseudalhagi*, *Hordeum leporinum* and *Medicago minima*.

Wetland – the primary wetland area is located to the south of the Terminal. The wetland appears to be primarily fed by ephemeral watercourses (or wadi) including the Shachkaiya Wadi which is located adjacent to the boundary of the SD2 Infrastructure area (refer to Section 6.4.2 above), together with other surface water runoff and some contribution from leakages in water pipes and discharges from Sangachal water treatment works. Wetland surveys were undertaken in 2002 (as reported within the ACG Phase 1 ESIA[22]) 2010 and 2011.

In general, the wetlands are considered to comprise a complex mixture of habitats, which developed following construction of the Baku-Salyan Highway, adjacent railway line and the pipeline corridor between the railway line and the Terminal. The wetlands experience high rates of siltation which has resulted in an impeded water flow that causes water to be retained across a series of topographical depressions (see Section 6.4.2). Variations in topography determine the boundaries of the wetland and the vegetation types occurring.

The main surface-water dependent habitats within the wetlands are tall reedbeds (*Phragmites australis*), which occur along the edge of the wetland closest to Sangachal, within the pipeline corridor and in other locations where deeper water occurs. In shallower permanent water, stands of reedmace (*Typha angustifolia*) and extensive marshes dominated by sea rush (*Juncus maritimus*) and sea club-rush (*Bolboschoenus maritimus*) are prominent. At the edges of the swamp/marsh areas, a scrub of Tamarisk (*Tamarix meyeri*) with alhagi (*Alhagi pseudoalhagi*) typically occurs, together with areas of mudflat, frequently colonised by glasswort (*Salicornia europaea*).

Additional habitats which occur in the wetlands include wadi channels with flat terraces that support vegetation which is similar to that of chal-meadow and includes Tamarisk shrubs (*Tamarix meyeri*) and low growing grasses (e.g. *Poa bulbosa*) and herbaceous species. Permanent pools also occur in certain locations, with vegetation such as Charophytes (aquatic multicellular algae) and water buttercup (*Ranunculus* sp.) which require permanent water.

None of the species present within the wetlands area are included in the AzRDB or classified as vulnerable/threatened by IUCN.

Sensitivity

The monitoring surveys completed to date (between 2006 and 2010) have focused on identifying potential changes and trends in floral species present and vegetation cover.

With regard to desert/semi-desert vegetation assemblages, no significant change in their distribution or status over time has been observed. Disturbed ground has shown a poor level of natural recovery over time with faster re-vegetation observed in areas where temporary surface water has been present after rainfall events.

The surveys do indicate that there has been a change in vegetation cover within the area surrounding the Terminal. In general, the extent of plant cover appears to be increasing over time and there appears to be a decrease in the number of sites which have a measurable microbiotic crust. The reason for the decline in the abundance of microbiotic crust is not known, but it may be related to difficulty in observing the crust, given recent increases in grass cover.

Some deterioration in vegetation cover has been observed in the immediate vicinity of the Terminal where diverted runoff and construction/other activities have been ongoing during the time period covered by the surveys. Sites distant from the Terminal to the north, west, and

[22] ACG1 ESIA, 2002

southwest feature the highest quality of vegetation cover which may be related to a more favourable topography.

With the exception of physical activities e.g. earthworks, there have been no observed changes to the habitats around the Terminal as a result of the Terminal operations.

6.4.7.2 Flora

As discussed above, vegetation in the Terminal vicinity is dominated by desert and semi desert vegetation. The following species however, which are included in the AzRDB or classified as vulnerable/threatened by IUCN, were noted as having been previously recorded 'in the area' (term 'area' is undefined) by the 2004 terrestrial survey:

- *Ferula persica* (AzRDB) - a herbaceous perennial plant of the Family Apiaceae which grows in arid climates, typically occurring on lower habitats;
- *Cladochaeta candidissima* (IUCN, Indeterminate) – which occurs within coastal sands, rubbly places, dry stream beds and in plains;
- *Glycyrrhisa glabra* (AzRDB) - (European licorice) shrub/semi-shrub in arid habitats;
- *Nitraria schoberii* (AzRDB) – a wood shrub perennial; and
- *Ammochloa palaestina* (AzRDB) – which is found at sandy, arid habitats.

The following two species have been recorded in the vicinity of the SD2 Infrastructure area:

- *Astragalus bakuensis* (AzRDB) - Shrub/semi-shrub coastal (recorded in the 2001 Baseline Report survey report and 2006 Pipeline Landfall Monitoring Report; and
- *Iris acutiloba* (AzRDB) - Arid, sandy habitats recorded in the 2001 Baseline report survey and the 2005, 2008 and 2009 flora surveys. The 2009 survey recorded this species at monitoring location SS1-2 which lies to the north east of the Terminal.

None of the above species were recorded during a botanical survey undertaken within the SD2 Infrastructure area carried out in 2008 and it is considered highly unlikely that colonisation of these species would have occurred within this area since this date.

Sensitivity

Whilst the results of previous surveys have indicated the presence of floral species included in the AzRDB or IUCN lists within the regional area, the latest 2008 data indicates that none of these species are located within the SD2 Infrastructure area. Local vegetation is therefore characterised by floral species which are typical for the area and are neither rare nor threatened.

6.4.7.3 Fauna

Terrestrial and wetland faunal surveys in the Terminal vicinity have been undertaken between 2001 and 2010.

During the 2002 wetland survey, four species of reptile were recorded: *Bufo viridis*; *Hyla arborea*; *Rana ridibunda* and *Mauremys/Emys orbicularis*. None of these species are included in the AzRDB, however two species (*Emys orbicularis* and *Hyla arborea*) are classified as Lower Risk/Near Threatened by IUCN. A number of reptiles were also recorded during the 2002 wetland survey.

The 2005 fauna survey identified the presence of:

- *Phrynocephalus helioscopus* - lizard (not included in AzRBD); and
- *Testudo graeca* - spur-thighed tortoise (included in the AzRDB).

The survey also identified the presence of Euphrates jerboa (*Allactaga euphratica*) and grey hamster (*Cricetulus migratorius*) which are IUCN Lower Risk/Near Threatened; and the marbled polecat (*Vormela peregusna*) which is included in the AzRDBand Conservation Dependent according to IUCN. In addition, wolf (*Canis lupus*) was recorded which does not have a designated conservation status in Azerbaijan.

Sensitivity

While faunal surveys have been completed, it is not possible to identify trends over time in relation to the total numbers of geographical distribution, due to the highly variable identification within previous surveys. With regard to the spur thighed tortoise (which is a AzRDB listed species) seasonal sensitivity (breeding and incubation) is presented within Table 6.11.

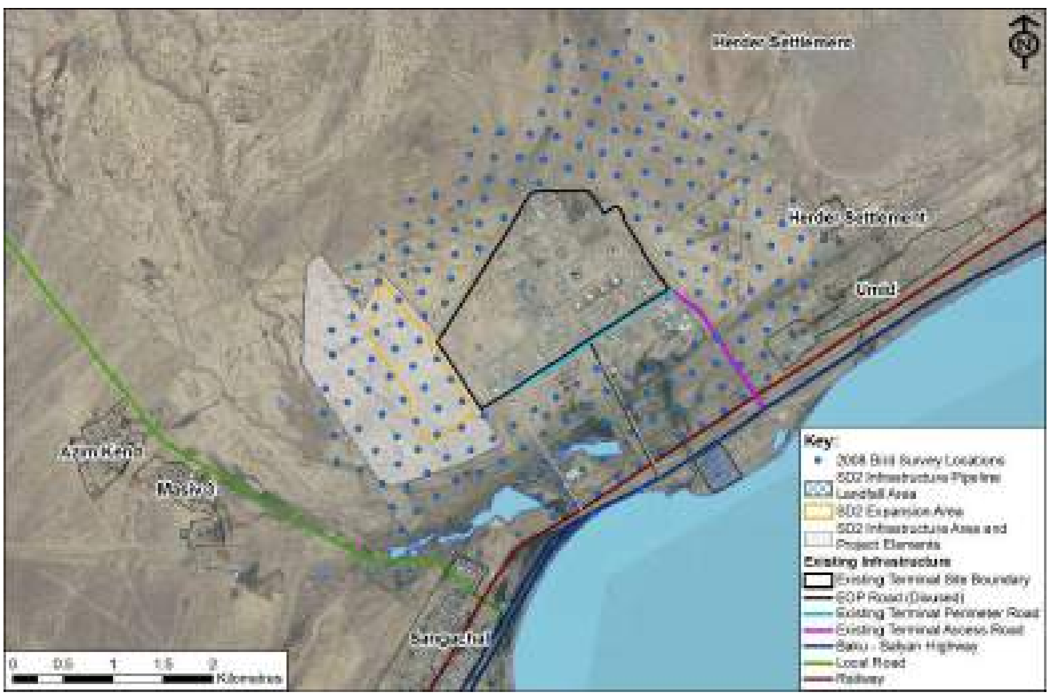
Table 6.11 Breeding and Incubation Periods of the Spur-Thighed Tortoise

Common Name	Event	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Spur-thighed tortoise	Breeding				■	■	■						
	Incubation						■	■	■				

6.4.7.4 Breeding Birds

Breeding bird surveys have been undertaken in the Terminal vicinity since 2001 with the most recent surveys completed in 2008, 2009 and 2010. The sampling locations used during the later surveys, which used a fixed-point sampling grid and point sampling techniques, are shown in Figure 6.10.

Figure 6.10 Bird Monitoring Locations Around the Terminal (2008, 2009 and 2010)



Over the 2008, 2009 and 2010 surveys, 132 species of birds were identified, of which 86 species occurred in 2010. Of these, 23 were resident species (i.e. species that normally remain within the Sangachal area throughout the year). The remaining 63 species were migratory species. This pattern of a larger number of migratory species, and a limited resident breeding fauna, is reflected in the earlier survey results from 2005 onwards.

The most widespread species occurring during the surveys (recorded at more than 25 recording locations) included *Apus apus* (Common Swift), *Coturnix coturnix* (Common Quail), *Delchion urbica* (House Martin), *Hirundo rustica* (Barn Swallow), and *Oeanthe isabellina* (Isabelline Wheatear). All of these are common breeding birds and are not included in the AzRDB or classified by IUCN.

In 2008 the bird survey results specific to the SD2 Infrastructure area (as defined within Figure 6.10 above) were analysed. It was reported that, in 2008, a total of 47 species of birds during 6 survey cycles were recorded. However, for individual monitoring cycles the total number of species observed was considerably less than 47 and species composition changed with time. Although 47 species were observed in the area, the greatest number of bird species observed at any single site during the year was 19, south of the SD2 Infrastructure area where denser vegetation cover occurs.

The surveys found that bird species diversity and numbers progressively reduced from the SD2 Infrastructure area towards the north, averaging approximately 4.25 per monitoring site.

During the 2009 and 2010 bird surveys, the following species which are of conservation significance were recorded in the Terminal vicinity:

- 2009 bird survey:
    - Mute Swab (*Cygnus olor*) which is included in the AzRDB; and
    - Pygmy Cormorant (*Phalacrocorvax pygmaeus*) which is IUCN Least Threatened.
- 2010 bird survey:
    - Pallid Harrier (*Circus macrourus*) which is IUCN Near Threatened and included in the AzRDB;
    - European Roller (*Coracias garrulous*) which is IUCN Near Threatened;
    - Red-footed Falcon (*Falco vespertinus*) which is IUCN Near Threatened; and
    - Black-bellied Sandgrouse (*Pterocles orientalis*) which is included in the AzRDB.

Sensitivity

Surveys to date have shown that there has been little change in bird species richness and numbers over time, and concluded that results have been affected to a greater extent by the distribution of suitable habitat in the general area than by operations at the Terminal. Key sensitivity for breeding birds is during the breeding season which typically starts in mid-March and continues until the end of August.

6.5 Coastal Environment

6.5.1 Setting

The coastal zone, between the Baku-Salyan Highway and the Caspian Sea shoreline, comprises a platform of layers of limestone and marine sediments. The landward slope has been quarried away for sand/aggregate. To the seaward there is a limestone platform sloping down to the water's edge, with small areas of exposed finer material.

6.5.2 Coastal Habitat

The area previously quarried, as discussed in Section 6.5.1, within the coastal zone supports desert vegetation similar to that of disturbed habitat around the SD2 Infrastructure area and is dominated by sparse *Salsola nodulosa*. The platform to the seaward also supports *Salsola*, with other species, including Suaeda, Artemesia and Armeria species. The area where the previous ACG/SD pipelines were installed has been rehabilitated using live plants. The results of surveys undertaken in 2007 and 2010 indicate that this effort has been successful with up to 57% vegetation cover by perennial species identified in 2010.

Sensitivity

Surveys completed to date show that following rehabilitation, the disturbed coastal habitat is recovering following the pipeline works completed between 2001 and 2006. There are no rare or threatened species present and bird habitat is typical of the area within the Terminal vicinity.

6.5.3 Coastal Birds

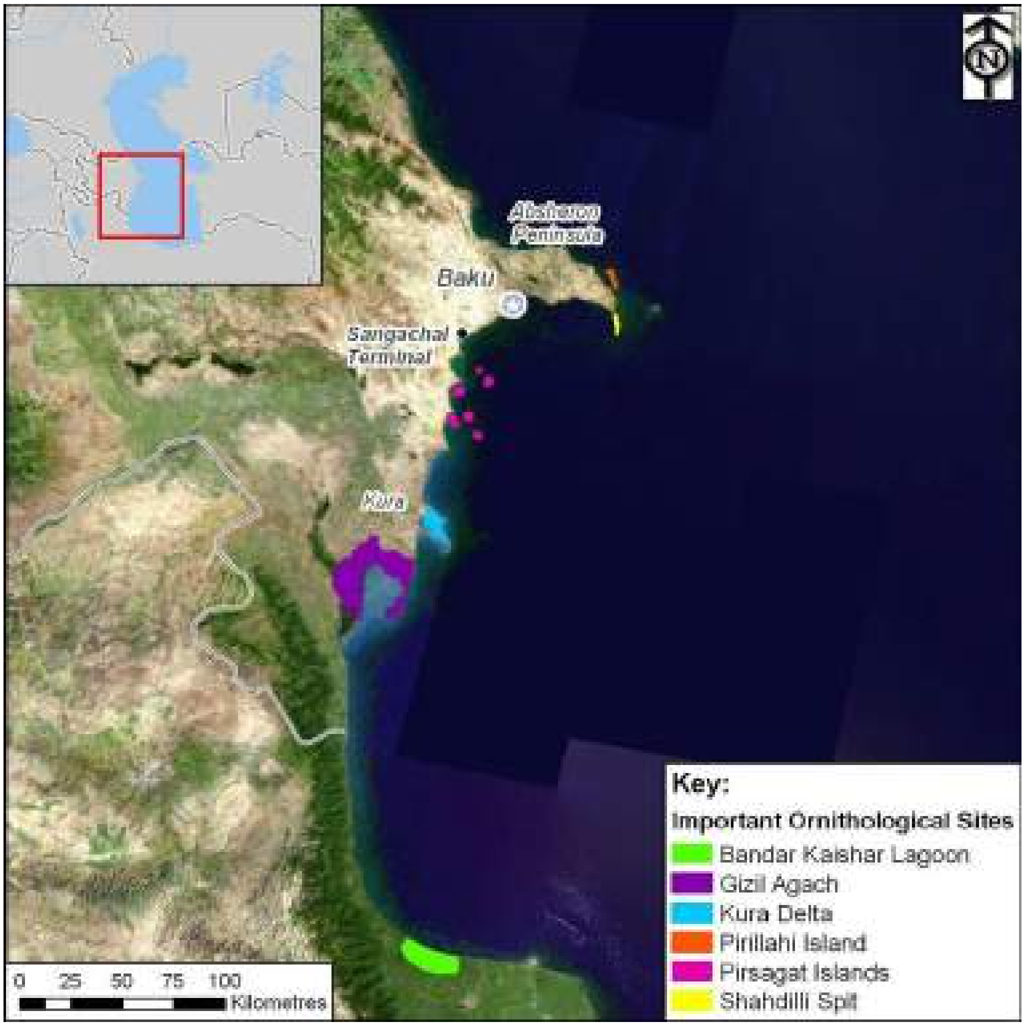
At a regional level, the coastal zone of the Caspian Sea has been identified as an area of ornithological importance as it supports both internationally and nationally significant numbers of migrating and overwintering birds. Important ornithological sites, located on the Caspian Sea's southwest coast, include (refer to Figure 6.11):

- **Kura Delta** – which supports large populations of waders during the spring migration (approximately 92km south of the Terminal);
- **Kyzyl-Agach State Nature Reserve** – established in 1929 for the protection of wintering and migratory waterfowl, waders and steppe birds. It is estimated that there are 248 bird species within the reserve, a number of which are protected species (approximately 105km south of Baku);
- **Pirsaget Islands** – which supports important bird colonies (approximately 37km south of the Terminal);
- **Shahdili spit and Pirilahi Island**[23] – the Shahdili spit is designated as a sanctuary, and together with Pirilahi Island has been identified as a candidate Ramsar site (approximately 77km and 98km respectively north east of Terminal); and
- **Bandar Kaisher Lagoon and mouth of Sefid Rud** – this area is an important staging and wintering area for a wide variety of migratory wildfowl (approximately 317km south of Terminal).

Details of species and numbers found in these locations are provided within the COP ESIA[24].

23 Now declared the Absheron National Park.
24 COP ESIA (2010).

Figure 6.11 Important Ornithological Sites Located on the Southwest Caspian Coast

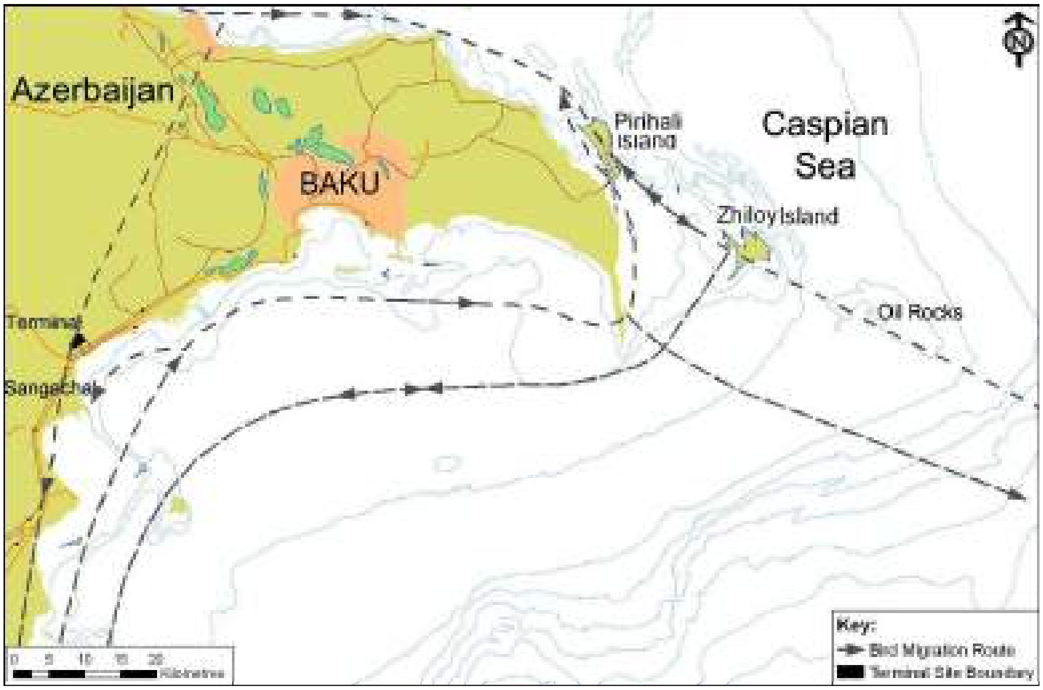


A desktop study was undertaken in January 2010 which reviewed the number and species of birds observed in surveys between 2002 and 2006 along the coastlines of the Shahdili spit, Pirilahi Island, and within the ACG Contract Area[25]. The review highlighted that the breeding season of birds on the Shahdili and Pirilahi coastline commences at the end of April and early May and continues until mid-July. At the end of July and beginning of August, birds leave their nesting places and disperse. During the breeding season, 18 species were recorded along the Pirilahi coastline and 16 species along the Shahdili coastline.

The Shahdili and Pirilahi coastlines are located within a major migratory route for migrating waterfowl and coastal birds, who nest in the European parts of Russia, western Siberia, and north-western Kazakstan and migrate to the southern coast of the Caspian Sea, the Kur-Araz lowland, Turkmenistan, southwest Asia and Africa for the winter. The migration routes are indicated in Figure 6.12. The autumn migration commences in the second half of August and continues until mid-December, with the most active period during November, while the spring migration starts in the second half of February and ends in April, with the most active period during March.

[25] COP ESIA, 2010

Figure 6.12 Bird Migration Routes



Sensitivity

There are no important ornithological sites located on the southwest Caspian coast that are located within close proximity to the SD2 Infrastructure area.

6.6 Archaeology and Cultural Heritage

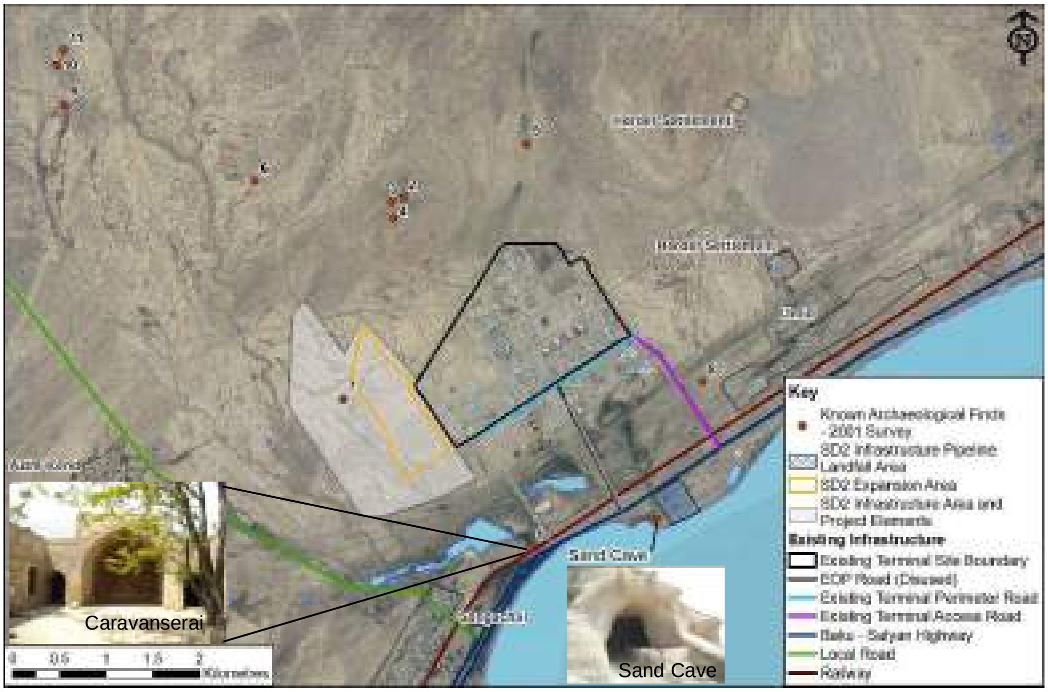
A non-intrusive archaeology and cultural heritage field survey was undertaken in 2001 for the Shah Deniz Stage 1 (SD1) Project[26] and covered an area within a 2.5km radius of the Terminal. Key finds within the survey area are detailed within Table 6.12 and shown on Figure 6.13. A second survey in 2002 conducted by a team of UK archaeologists confirmed the presence of several archaeological sites (ID2-4 within Figure 6.13) in the area north of the current Terminal.[27]

Table 6.12 Summary of 2001 Archaeological Survey Finds/Cultural Heritage Sites

ID	Find/Site	Comment
1	Caravanserai	Medieval inn. Protected state monument.
2	1st and 2nd Sangachal Settlements	Medieval and Antique structural remains and extensive habitation area. Reportedly dating back to 2nd century BC. Rock art found within one rockshelter.
3	3rd Sangachal Settlement	Structural remains noted in 3rd Sangachal Settlement. Glazed and unglazed pottery shards indicating potential medieval settlement of between 2-20 hectares.
4	4th Sangachal Settlement	
5	5th and 8th Sangachal Settlements	This medieval settlement may cover several hectares. Structural remains were recorded in 8th Sangachal.
6	6th Sangachal Settlement	This possible medieval settlement includes the remains of several structures a variety of domestic ceramics.
7	9th Sangachal	Glazed and unglazed pottery shards indicating potential medieval settlements of between 2-20 hectares.
8	Sangachal Gochdash Memorial	
9,10 & 11	Sangachal cemetery and Sophi-Hamid Sepulcher	Approximately 20 hectares. Reported to contain burials from 13th century towards the north of the cemetery footprint.
n/a	Sand Cave	Cave with man-made interior walls. Protected state monument.

[26] SD1 ESIA,2002
[27] Desmond et al. 2002

Figure 6.13 Archaeological Survey Finds/Cultural Heritage Sites, 2001



These surveys identified several monuments or archaeological sites in the vicinity of the Terminal that date from the Medieval period; several of the archaeological sites also date from the Antique period. One of these (ID7 within Figure 6.13) is located in the SD2 Infrastructure area. This archaeological site is referred to as 9th Sangachal[21].

A walkover reconnaissance survey of the SD2 Infrastructure area was conducted in 2011. The locations within the following areas were surveyed:

- SD2 Infrastructure area;
- Areas west of the SD2 Infrastructure area;
- The Pipeline Landfall Area; and
- The vicinity of the Caravanserai.

The SD2 Infrastructure area is located on a broad alluvial fan at the foot of Mt. Qaraqush (refer to Section 6.4.1). The landform terminates at the Caspian littoral. Remnant platforms of limestone are located near the shoreline at the SD2 Pipeline Landfall Area and adjacent to the Caravanserai. Vegetation in the Terminal vicinity is very sparse (refer to Section 6.4.7.1), affording close to 100% surface visibility. As stated in Section 6.4.2, a wadi passes to the west of the SD2 Infrastructure area. An examination of the banks of the wadi to the south and west of the Terminal indicated that the alluvium measures a minimum of 4m in thickness.

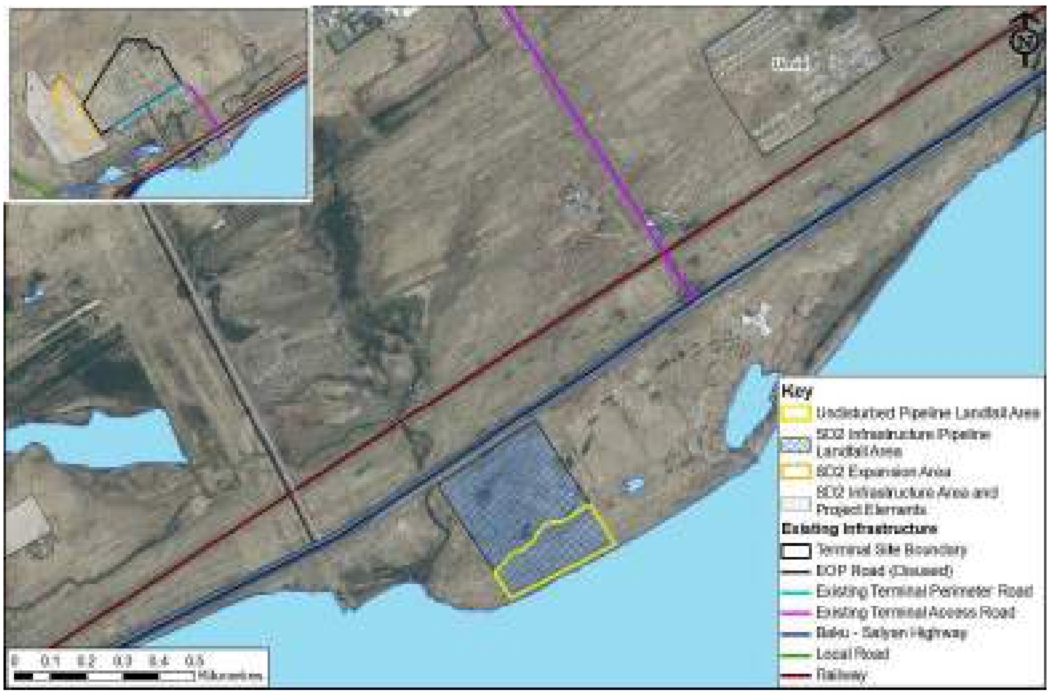
The SD2 Expansion Area has undergone significant disturbance and has resulted in the creation of two significant spoil heaps in the area (refer to Section 6.4.7.1). A variety of linear disturbances, including earthen berms, pipeline, fences and roads were observed to the south and west of the Terminal.

The sub-surface impacts of the linear disturbances appear to be relatively limited and unlikely to have been sufficient to damage any potential archaeological features which may remain intact under them. While it was not possible to characterise the degree of sub-surface impact below the spoil heaps, it can be expected that earth moving activities that created these spoil heaps will have significantly impacted any archaeological features that may have been located in these areas.

Approximately 60-80% of the SD2 Pipeline Landfall Area has been thoroughly disturbed by quarrying. An approximate 80-100m wide remnant of a limestone platform remains intact, sloping up from the Caspian shoreline in a series of limestone ledges. There is a thin veneer of soil remaining at the crest of this landform. Any archaeological sites in this area would be found on the surface. The broad expanses of exposed limestone also have the potential to contain rock carvings. During the reconnaissance survey no archaeological sites or rock carvings were observed. A cave, referred to by the Ministry of Culture and Tourism (MoCT) as Sand Cave, is located approximately 100m west of the Pipeline Landfall Area. The MoCT has informed BP that this is a protected State monument.[28]

Figure 6.14 illustrates the SD2 Pipeline Landfall Area and where there is the potential for archaeological resources and rock carvings to remain. Within the area quarried there is no potential for archaeological remains.

Figure 6.14 The SD2 Pipeline Landfall Area and the Area Undisturbed Through Quarrying



The 2011 reconnaissance survey included a closer examination of the Caravanserai monument (Figure 6.13). The building is of block masonry construction with a two-storey façade and two wings that surround a central courtyard (Figure 6.15). The building is part of a larger compound that includes several other utilitarian structures and a fenced garden. Two of the associated structures appear to serve as wells or springhouses; they lie on a terrace margin adjacent to the wetland. Steps lead down into the waters of the wetland. The presence of these structures and their orientation to the wetland suggests that the wetland feature may pre-date the construction of the adjacent railway line. The entire complex measures approximately 0.54ha. The Caravanserai building appears to be structurally sound. It does not appear to currently be in use; herders were using it for rest and shade at the time of the reconnaissance survey. Domestic artefacts, kitchen glass and pottery shards, were noted in the area around the building. A notable array of graffiti in a number of different scripts was recorded carved into the limestone blocks near the building's entrance.

[28] Personal communication, meeting between BP and MoCT on 2nd June 2011

Figure 6.15 Courtyard Interior of the Caravanserai

Sensitivity

The 2001 survey for SD1 Project indicated that 9th Sangachal may represent a settlement extending over several hectares. Each of the archaeological sites identified during the survey was categorised as of high importance. The 9th Sangachal is described as of republic importance.

No archaeological remains were noted during the 2011 reconnaissance survey. The likelihood of encountering extensive settlement remains in this area appears to be relatively low, because of the lack of permanent water sources. Although the previously known site within the SD2 Infrastructure area (9th Sangachal) identified in the 2001 survey was not relocated during the reconnaissance survey, a further detailed survey will be undertaken to confirm its presence as well as the potential presence of small archaeological sites[29].

[29] Note that an archaeological walkover survey of the SD2 Infrastructure area was undertaken in 4Q 2011 by URS and the Azerbaijan Institute of Archaeology and Ethnography (IoAE). The results of the survey are pending however, it is understood that no significant archaeological finds were encountered.

7. Socio-Economic Description

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7.1 Introduction

This Chapter describes the socio-economic baseline conditions relevant to the SD2 Infrastructure Project. The scope of the chapter has been informed through the scoping process described in Chapter 8, where the following socio-economic interactions were identified as a result of SD2 Infrastructure Project activities:

- Disruption or restriction of access to natural resources;
- Employment creation and de-manning;
- Training and skills development;
- Procurement of goods and services;
- Offsite construction vehicle movements; and
- Road and rail works.

The key socio-economic receptors that may be impacted by the Project and are described in this Chapter include:

- Local and regional communities;
- Herders, recreational and commercial fishermen and recreational users of the shoreline;
- Users of road and rail infrastructure; and
- Local, regional and national businesses.

The following socio-economic information is presented in this Chapter to allow assessment of socio economic impacts associated with the SD2 Infrastructure Project:

- Population and Demographics;
- Land Use and Ownership;
- Infrastructure;
- Education and Training;
- Health;
- Employment and Livelihoods;
- Income and Expenditure;
- Amenity and Living Conditions; and
- BP Community Investment Programmes.

Where relevant, information is presented at the following geographical levels:

- **National** - relevant to the Republic of Azerbaijan;
- **District** - relevant to the Garadagh District; and
- **Local** - relevant to the local communities in the Terminal vicinity; Sangachal Town, Umid, Azim Kend and Masiv 3.

This Chapter has been prepared using the initial findings of the Stakeholder and Socio-Economic Survey (SSES) which are due to be reported in full by 3Q 2011[1].

7.2 Geographic Context

The SD2 Infrastructure Project is located adjacent to the Terminal and lies within the Garadagh District, which includes Baku and then extends south along the Caspian coast to the south of Alyat. The Garadagh District was established in 1923 and comprises five city settlements including Lokbatan which is the administrative centre. The extent of the Garadagh District and the location of the local communities in relation to the Terminal are shown in Figure 7.1.

[1] Refer to Chapter 8 for further details regarding the scope of the SSES.

Figure 7.1 Garadagh District, the Terminal and Surrounding Communities

The Garadagh District Executive Power (the Executive Power) is the authority responsible for administration[2] within the region. The key responsibilities of the Executive Power include safeguarding the rights and freedom of its citizens, safeguarding statutory and other interests, and providing support to the population in terms of economic, social and cultural development.

The Executive Power manages the Garadagh District's education, culture, public health, sport institutions and the budgets of 11 municipalities whose members are elected by residents living in the communities. Sangachal Town and Umid are both municipalities and responsible for their own provision of housing, roads, electricity, water, sanitation, waste collection, heating infrastructure and gas supply. The communities of Masiv 3 and Azim Kend fall under the municipality of Sangachal.

7.3 Data Sources

Socio-economic data presented in this Chapter has been taken from the following primary and secondary sources of data:

- **Primary data** - collected during the SSES; and
- **Secondary data** - collected from recognised institutions including the United Nations, International Monetary Fund, Statistical Committee of the Republic of Azerbaijan and the Garadagh Executive Power.

A list of the primary and secondary data sources is provided in Table 7.1.

[2] ERM (2009) Garadagh Cement Project New Dry Kiln 6: ESIA

Table 7.1 Relevant Data Sources

Date	Title of Document/Survey
2006	ACQUIRE, Reproductive Health & Services in Azerbaijan 2005: Results of a Baseline Survey in Five Districts, E&R Study #6
2006	USAID, Country Profile
2007	UNDP, Gender Attitudes in Azerbaijan: Trends and Challenges, Azerbaijan Human Development Report
2007	USAID, Country Health Statistical Report Azerbaijan
2008	International Monetary Fund, Republic of Azerbaijan: Statistical Appendix 2007
2008	State Statistical Committee of the Republic of Azerbaijan, Demographic & Health Survey 2006
2009	Garadagh Cement Project New Dry Kiln 6 ESIA 2009
2009	Gizildash (Qizildas) Cement Factory ESIA, NORM, 2009
2010	United Nations Azerbaijan, United Nations Development Assistance Framework 2011-2015
2010	AIOC Chirag Oil Project ESIA,2010
2010	International Crisis Group (ICG) Global 2010 Report
2010	State Statistical Committee of the Republic of Azerbaijan, Socio-economic Development of the Settlements of Baku City
2010	ICG, Azerbaijan: Vulnerable Stability Europe Report No.27
2010	Agents of Change: Reflections on a working partnership between BP Azerbaijan and the International Institute for Environment and Development (IIED)
2011	Data provided to BP from Garadagh District Executive Power
2011	SD2 Project Stakeholder and Socio-Economic Survey (SSES) – Preliminary Findings[3]

7.4 Socio-Economic Conditions

7.4.1 Population and Demographics

Population

Population data for Azerbaijan from 1990 to 2010 is provided in Table 7.2.

Table 7.2 Azerbaijan Population 1990 to 2010[4]

	1990	1995	2000	2005	2009	2010
Azerbaijan Republic ('000)	7,131.9	7,643.5	8,032.8	8,447.3	8,896.9	8,997.4
Male (%)	48.8	49.1	48.8	48.9	49.0	49.1
Female (%)	51.2	50.9	51.2	51.1	51.0	50.9
Urban population ('000)	3,847.3	4,005.6	4,116.4	4,477.6	4,818.3	4,866.6
Rural population ('000)	3,284.6	3,637.9	3,916.4	3,969.7	4,078.6	4,130.8

The data indicates that in 2010, the population of Azerbaijan was 8,997,400 with a gender distribution of 49% male and 51% female. The urban population in both 1990 and 2010 was 54% indicating that the proportion of urban citizens (as compared to rural citizens) has remained constant over the past 10 years.

Of those living in urban areas, 42% live in Baku. There are indications, however, that the actual population of Baku may be significantly higher than official figures suggest. Many people who move to Baku for employment on a temporary or permanent basis, may retain their registration in their place of origin. The United Nations Development Programme (UNDP) has suggested that the greater Baku metropolitan area may be home to approximately three million people, or 35% of the national population[5].

In the early 1990s, Internally Displaced Persons (IDPs) were displaced as a result of the occupation caused by conflict with Armenia in and around Nagorno Karakakh region of the Republic of Azerbaijan. Many of these people were forced to relocate and it is estimated that

[3] Refer to Chapter 8 for further details regarding the scope of the SSES and current status
[4] State Statistical Committee of the Republic of Azerbaijan (2010) Demographic Indicators
[5] United Nations Development Programme (UNDP) Azerbaijan, 2007: Converting Black Gold into Human Gold: Using oil Revenues to Achieve Sustainable Development.

there are currently 10,521 IDPs living in Garadagh District (Table 7.3 below)[6] which have increased from 2006 to 2010. In addition, there were approximately 2,400 refugees in 2006. The number of IDPs in Garadagh currently accounts for 10% of the District population.

Table 7.3 Number of IDPs Within the Garadagh District

	2006	2007	2008	2009	2010
Number of IDPs	10,271	10,290	10,357	10,487	10,521

At the local level, Umid and Sangachal Town have significant populations of IDPs. Umid was originally established in 1999 to house 250 IDPs from the Nagorno Karakakh conflict and today, Umid has around 2,000 inhabitants, of which 75% are IDPs. In Sangachal Town in 2001, 645 out of 4,500 (14%) inhabitants were IDPs.

In Azerbaijan, the population in urban areas is generally older (refer to Table 7.4[7]), both in percentage and absolute terms, than in rural areas. There is a larger proportion of people in the age range 45-69 years in urban areas. Overall, however, the dependency ratio (the proportion of the population which is not economically active) is higher in rural areas (33%) than in urban areas (29%).

Table 7.4 National Age Profile, Urban and Rural, 2010

Age	Total		Urban		Rural	
	('000)	%	('000)	%	('000)	%
0-4:	748.6	8%	369.7	4%	378.9	4%
5-9:	582.3	7%	283.3	3%	299.0	3%
10-14:	657.0	7%	311.7	4%	345.3	4%
15-19:	911.0	10%	470.6	5%	440.4	5%
20-24:	928.8	10%	506.7	6%	422.1	5%
25-29:	795.2	9%	442.0	5%	353.2	4%
30-34:	666.4	7%	366.0	4%	300.4	3%
35-39:	624.7	7%	329.9	4%	294.8	3%
40-44:	671.1	8%	360.5	4%	310.6	4%
45-49:	700.7	8%	405.3	5%	295.4	3%
50-54:	559.9	6.2%	338.8	3.8%	221.1	2.5%
55-59:	355.0	4%	226.5	2.5%	128.5	1.4%
60-69:	360.8	4%	227.1	2.5%	133.7	1.5%
70 and over:	435.9	5%	228.5	2.5%	207.4	2.3%
Total:	8,997.4	100%	4,866.6	54%	4,130.8	46%

Between 2004 and 2009 birth rates and the natural fertility rate increased in parallel with a decline in maternal and infant mortality rates. By 2009, average life expectancy was 73.5 years[7] (70.9 years for men and 76.1 years for women). This represents a significant positive change since 1990 when average life expectancy was 71.1 years (67.0 for men and 74.8 years for women).

Key population indicators for the Garadagh District are presented in Table 7.5 for the period 2005 to 2010[8].

[6] ERM (2009) Garadagh Cement Project New Dry Kiln 6: ESIA
[7] State Statistical Committee of the Republic of Azerbaijan (2010) Demographic Indicators
[8] Garadagh Executive Power (2011).

Table 7.5 District Population, In-Migration , Death and Fertility Rates, 2005-2010

	2005	2006	2007	2008	2009	2010
Population	101,100	102,600	104,191	105,997	107,819	111,035
In-migration	82	59	34	116	50	85
Number of Deaths	534	559	554	790	518	468
Number of Births	1,706	2,125	1,259	3,261	2,097	2,126
Note: Data regarding out-migration is not available						

The data indicates that the population of the Garadagh District increased by 10% between 2005 and 2010. This appears to be due to a moderate increase in in-migration (4%), an increase in the number of births (25% higher in 2010 than in 2005) and a significant decline in the number of deaths (12% lower by the end of the period). Some caution should be used in interpreting these figures: there is, for example, an unexplained spike in in-migration, deaths and births in 2008. No data was available regarding out-migration. Population data for Sangachal Town, Umid, Azim Kend and Masiv 3 is currently unavailable.

Ethnicity

The majority of the national population (91% in 1999) are ethnically 'Azeri', with the remaining 9% made up of a range of ethnic groups including Lezghin, Tatar, Russian and Ukranian[9].

7.4.2 Land Use and Ownership

Land use within the vicinity of the Terminal is dominated by the four local communities, the Baku-Salyan Highway, the railway, and the presence of industrial facilities (refer to Figure 7.2). There are, in addition, two herder settlements located to the north east of the Terminal. Open land is characterised by areas for animal herding (primarily cattle, goats and sheep) and by local, generally unsealed, access roads. A distinct wetland area is present near the highway and railway line.

Land to be acquired for the SD2 Infrastructure Project is understood to be 100% state owned and it is understood that there are no buildings or similar features present within the areas where acquisition is planned.

Due to poor soils and arid climate, there is no arable agriculture in the area although it is understood that land in the vicinity of the Terminal is used by herders. Households within the local communities are understood to use small garden areas situated immediately adjacent to their housing blocks, mainly for subsistence agriculture. Data from the SSES indicates that 35% of the households surveyed have land for agricultural production, which includes feedstock for animals and areas to house poultry.

Along the shoreline area between Sangachal Town and Umid, recreational and commercial fishing activities occur, along with some recreation use (e.g. walking).

Between the coastline and highway to the east of the Pipeline Landfall Area, a small number of buildings are under construction. It is understood that these comprise approximately seven holiday homes. The majority of the construction sites comprise one, or more, buildings that are partially complete and some are without roofs or finished walls. During a walkover survey in June 2011, it was observed that one of the buildings is currently inhabited by a single family although their legal right to reside in this building is unclear.

[9] ERM (2009) Garadagh Cement Project New Dry Kiln 6: ESIA

Figure 7.2 Land Use within the Vicinity of Terminal

7.4.3 Infrastructure

Road Transport

Azerbaijan's public road network was primarily developed during the Soviet era and in many areas roads are now in a poor condition. However, the Baku-Salyan Highway is well-maintained and provides a rapid link from Baku to Astara. Existing traffic flow levels along the highway are estimated to be between 10,000 to 20,000 vehicles per day[10].

The internal roads within the local communities are in poor condition and, following heavy rain, the roads can become impassable until soil has dried out. Data gathered by the SSES indicates that the majority of residents interviewed in Azim Kend and Masiv 3 (88% and 64%, respectively) consider the condition of local access roads as 'poor'. Roads connecting the communities of Sangachal Town and Umid were perceived more favourably by local residents; 75% and 62% respectively considered roads conditions to be 'good'.

Public Transport

There are several bus routes that provide public transport to the local communities, as summarised in Table 7.6. With the exception of Sangachal Town, there are no direct bus services to Baku.

[10] Per comms, Head of the Technical Division, Azerbaijan Highway Authority, 2010

Table 7.6 Bus Routes Serving the Communities within the Terminal Vicinity

Communities	Bus Number	Route	Frequency	
			AM	PM
Sangachal Town	195	Alyat - Baku	Every 15 minutes	
Sangachal Town	46	Jeyildagh - Lokbatan	9.00am	4.00pm
Masiv 3			8.50am	4.10pm
Azim Kend			8.40am	4.20pm
Umid	164	Sadarak mall - Sahil - Umid	Every 30 minutes	

The railway runs parallel to the Highway and connects Baku with Astara and Tbilisi. The Baku to Hajikabul passenger train stops twice a day (9am and 4.30pm) at Sangachal Train Station.

Data gathered by the SSES (refer to Table 7.7) indicates that the condition of existing public transport is perceived to be 'poor' with the exception of Umid which is rated as 'excellent' (62%).

Table 7.7 Perceived Conditions of Public Transport in the Communities within the Terminal Vicinity

Rating	Sangachal Town	Umid	Azim Kend	Masiv 3
Excellent	2%	62%	0%	0%
Good	2%	22%	0%	12%
Satisfactory	5%	8%	12%	20%
Poor	89%	6%	88%	68%
Don't know	2%	2%	0%	0%

Local Utilities

Access to Electricity and Gas

Data collected by the SSES indicates that all households surveyed have access to electricity 24 hours a day. Access to a mains gas supply varies with the following levels reported:

- Sangachal Town (100%);
- Umid (98%);
- Masiv 3 (80%); and
- Azim Kend (8%).

Potable Water and Sanitation

There have been a number of recent initiatives to improve the water supply and sanitation infrastructure within Azerbaijan. A World Bank loan of US $230 million was approved in June 2007 [11]to build on the Greater Baku Water Supply Project and continue the World Bank's long term support to the improvement of Azerbaijan's water and sanitation sector. The Project focuses on the rehabilitation of water supply and sanitation facilities in and around urban centres of the country. The Project also supports key reforms to modernise sector institutions in order to improve their capacity, institutional and operational effectiveness and commercial and financial viability. By Q3 2013, at least 700,000 people from the Baku area, Greater Baku area, Absheron Peninsula and across 20 other regions in Azerbaijan are expected to have improved access to clean, safe and reliable piped water supply and to wastewater collection and disposal services.

At a local level, potable water is piped directly to the local communities. Data collected by the SSES indicates that potable water is predominately available from either inside the home, or from the yard (refer to Table 7.8). However, a significant minority of households in Masiv 3 purchase potable supplies from water vendors.

[11] World Bank loan ID P096213 , June 2007

Table 7.8 Source of Potable Water in the Communities within the Terminal Vicinity

Source of Potable Water	Sangachal Town	Umid	Azim Kend	Masiv 3
Water available inside the house	76%	52%	0%	12%
Water available from a distribution point in the yard	24%	48%	88%	72%
Water available from elsewhere (neighbour or other location)	0%	0%	8%	4%
Water purchased in containers from vendors	0%	0%	4%	12%

Additional data was collected on the reliability and quality of the water supply, which is presented in Tables 7.9 and 7.10. Again, the data shows a marked disparity across the local communities. Respondents in Sangachal Town, Umid and, to a lesser degree Azim Kend, considered the reliability of their water supply to be at least 'satisfactory', while 68% of respondents in Masiv 3 perceive the reliability of their water supply to be 'poor'.

Table 7.9 Perceived Reliability of the Water Network in the Communities within the Terminal Vicinity

Rating	Sangachal Town	Umid	Azim Kend	Masiv 3
Excellent	3%	0%	0%	0%
Good	75%	62%	52%	0%
Satisfactory	12%	30%	16%	28%
Poor	9%	6%	32%	68%
Don't know	1%	0%	0%	4%
Not available	0%	2%	0%	0%

The highest ratings for water quality were reported in Azim Kend (where nearly half of all respondents reported that their water quality was 'good'), Sangachal Town and Umid. Significant minorities in all local communities, however, reported that their water quality was 'poor'.

Table 7.10 Perceived Quality of the Potable Water Supply in the Communities within the Terminal Vicinity

Rating	Sangachal Town	Umid	Azim Kend	Masiv 3
Good	26%	22%	48%	4%
Satisfactory	42%	48%	28%	56%
Poor	29%	28%	24%	36%
Don't know	1%	0%	0%	4%
Not available	2%	2%	0%	0%

Problems associated with the need to use pumps to increase water pressure into the household were reported during Community Focus Groups held in Sangachal Town.

In Sangachal Town it is understood that enclosed canals transport sewage to a collection point near to the sea where it is discharged without any treatment. Data collected by the SSES associated with the condition of the drainage and sewage infrastructure is presented in Table 7.11 and the level of satisfaction with waste disposal is provided in Table 7.12.

Table 7.11 Perceived Condition of Drains and Sewage Infrastructure in the Communities Within the Terminal Vicinity

Rating	Sangachal Town	Umid	Azim Kend	Masiv 3
Good	59%	76%	0%	0%
Satisfactory	12%	16%	0%	0%
Poor	5%	2%	8%	28%
Don't know	23%	4%	92%	72%
Not available	1%	2%	0%	0%

Table 7.12 Level of Satisfaction with Existing Waste Disposal Arrangements in the Communities Within the Terminal Vicinity

Rating	Sangachal Town	Umid	Azim Kend	Masiv 3
Good	49%	52%	0%	0%
Satisfactory	20%	16%	0%	0%
Poor	11%	20%	16%	44%
Don't know	20%	10%	84%	56%
Not available	0%	2%	0%	0%

The data indicates that the condition of drains and sewage infrastructure is perceived as 'good' in Sangachal Town and Umid. The data also indicates that drainage and sewage infrastructure in Azim Kend and Masiv 3 is not an issue of concern, based upon the response that the majority of residents are not aware of the current status of their waste disposal facilities.

7.4.4 Education and Training

The Azerbaijan education law guarantees the right to education for all its citizens irrespective of race, nationality or sex. In 2008, approximately 2.2 million people were students and education providers at various institutions throughout the country. In the age range of 6 to 16 years, school enrolment rates were approximately 84% of the population. In 2008 86% of workers in the national economy had received an education to secondary level or above, and there was almost universal literacy.

The majority of school age children and teenagers in the Garadagh District attend school, or undertake vocational training/education[12]. Within the Garadagh District, approximately 23,500 children and students study at 22 secondary schools and 3,400 children and students study at 5 specialist schools. There are 24 primary schools in the Garadagh District and one boarding school, with 370 pupils.

The schools and kindergartens in the vicinity of the Terminal include:

- Sangachal Town: 1 secondary school (Number 222), 2 kindergartens (Numbers 299 and 20);
- Umid: 1 secondary school (Number 294); and
- Masiv 3 and Azim Kend: 1 secondary school which serves both communities (the Absheron Azim Kend Secondary School).

Data obtained from Executive Power indicate that the gender distribution of secondary school students in the Garadagh District for 2010 is 55% female which is greater than the 2008 national average which was 48%.

There are currently 28 students in Sangachal Town and ten students in Umid who are studying in higher educational institutions in Baku.

[12] Asian Development Bank (2009) Garadagh Cement Project New Dry Kiln 6: ESIA

7.4.5 Health

All residents in the Garadagh District have access to free medical services which is provided through the following facilities:

- Seven public hospitals;
- Two GP clinics;
- Two emergency medical stations, operating eleven ambulances; and
- Seven first aid posts[13].

In 2009 there were a total of 326 doctors and 735 medical staff working in the medical institutions throughout the Garadagh District which equates to 31.1 doctors and 70.1 other medical staff per 10,000 people[14].

There are no health facilities in Azim Kend or Masiv 3. Health facilities provided in Umid and Sangachal Town comprise:

- Sangachal Town: An outpatient department (Number 23) of Baku City Hospital and an emergency station (Number 20) with 1 ambulance; and
- Umid: A medical station (Number 23) of Baku City Hospital (Number 20) and a new pharmacy (at the time of writing had not opened).

Data collected by the SSES provides information on the types of health care infrastructure used by households (refer to Table 7.13).

Table 7.13 Type of Healthcare Infrastructure Used by Households in the Communities within the Terminal Vicinity

Healthcare Type	Sangachal Town	Umid	Azim Kend	Masiv 3
State clinic	71%	64%	76%	56%
Private clinic	8%	12%	4%	0%
State hospital	11%	18%	20%	36%
Private hospital	3%	4%	0%	8%
Emergency station	2%	0%	0%	0%
Call local doctor to house	4%	2%	0%	0%
Get medical care abroad	1%	0%	0%	0%

The data indicates that the majority of households depend on State clinics or hospitals and relatively few use private healthcare facilities.

An indication of local health problems at each of the local communities experienced during the previous four weeks prior to the survey was recorded during the SSES (undertaken in June 2011). The results are presented in Table 7.14.

[13] Garadagh Executive Power (2011).
[14] Asian Development Bank (2009) Garadagh Cement Project New Dry Kiln 6: ESIA

Table 7.14 Most Reported Health Problems in Communities Surrounding the Terminal during Four Week Period (May – June 2011)

Most Reported Health Problem	Four Week Total
Respiratory problems	32
Gastrointestinal problems	31
Cardiological (heart) problems / hypertension	26
Nervous system problems	24
Kidney problems	16
Diabetes	10
Female disorders	10
Cough	9
Allergy	7
Eye/ear diseases	6

The data shows the most frequently reported health problems by the local communities during the previous four weeks were respiratory, gastrointestinal, cardiological and nervous system disorders.

7.4.6 Employment and Livelihoods

According to the data provided by the State Statistical Committee for 2009, a total of 4,071,600 people are classified as being employed in Azerbaijan which includes persons who are self-employed, business owners or working in family farms[15]. A larger figure, a total of 4,331,800 people, is reported to be 'economically active', a term which includes both people who are employed and people who are unemployed but available for work.

The registered unemployment rate in Garadagh District in 2007 was 56%[16]. However, this may have increased in recent years as between 2007 and 2009 large numbers of local workers were discharged following completion of construction works at the Terminal and the construction yard used during the ACG and SD projects. In September 2008, there were approximately 400 people officially registered as unemployed in the Garadagh District, about half of whom were receiving social support. The total number of job vacancies in September 2008 was approximately 1,550[16]. According to the Garadagh District, young people with low qualifications and people over the age of 55 years were most likely to be unemployed[17].

The SSES collected data on the employment status of heads of households in the local communities in the Terminal vicinity. The results indicated that 34% considered themselves to be employed and 66% unemployed. The 66% level of unemployment reported lies above 56% which was recorded in 2007 for the Garadagh District. For employed persons, the location of their employment is provided in Table 7.15.

[15] State Statistical Committee of the Republic of Azerbaijan (2010) Demographic Indicators.
[16] ERM (2009) Garadagh Cement Project New Dry Kiln 6: ESIA.
[17] Garadagh Executive Power (2011).

Table 7.15 Employment Locations for Households Surveyed in the Communities within the Terminal Vicinity

Employment Location	Sangachal Town	Umid	Azim Kend	Masiv 3	Total
In this community	19	13	2	5	39
Sahil community of Garadagh District	1	6	1	4	12
In other communities outside of central Baku	2	1	1	2	6
In central Baku	2		1	1	4
Sangachal Town of Garadagh District			1	2	3
In Sangachal Terminal				1	1
Absheron Khojasan community of Absheron region		1			1
Wherever can get a job (casual earnings)	1				1
Guba region			1		1
Total					**68**

The results indicate that the majority (57%) of people are employed within their community and a further 18% are employed in Sahil; less than 1% were employed in Baku.

In relation to local livelihoods, a visual inspection of the two herder settlements completed in May 2011 indicated the following:

- Herder Settlement 1 (northeast of the Terminal) – characterised by empty buildings, some of which are occupied during the winter grazing period. At the time of the survey, it is understood this family has moved to summer grazing lands to the north. It is understood that this family was historically resettled within the Terminal vicinity during previous works at the Terminal; and
- Herder Settlement 2 (east of the Terminal) – characterised by a number of buildings, some of which are occupied e.g. one building is owned by a family of seven. It is understood this family have been grated legal rights to 5 hectares of land by Baku City Executive Committee.

It is not known whether herding is a primary or secondary source of income for families located at the herder settlements.

A visual inspection of fishing activities completed in June 2011 indicated the following:

- Fishing activities (both commercial and recreational) were observed on the shoreline to the south of the Terminal and Sangachal Town (refer to Figure 7.2);
- It is estimated that approximately 20-30 people are involved in commercial fishing using small vessels fitted with outboard motors. When the boats are not in use they are stored on the beach. It is understood that some commercial fishermen have a contract with two public companies (Caspian Fish and Fish-breeding Plant in Sahil settlement) and that fishing is their primary source of income. Fish are also, on occasion, sold to local people;
- Fishing huts and nets were observed in the area shown in Figure 7.2 however, it is unknown whether they are currently in use and whether or not they are connected with recreational or commercial fishing; and
- It is understood that fishing activities tend to decrease during the winter period when weather conditions are less favourable.

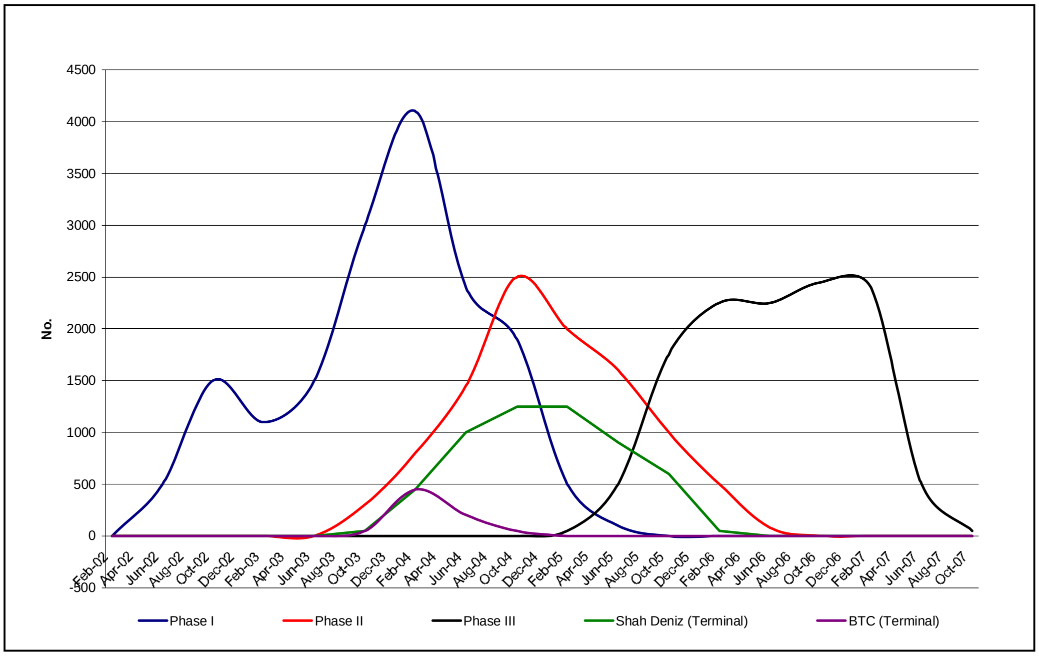
Figure 7.2 indicates where herding activities has been observed along with locations where fishing boats, huts and nets were present during the June 2011 survey along the shoreline.

Additional surveys are planned to further understand how the areas around the Terminal and along the coastline are used by the herders and fishermen.

Previous BP Projects Employment and Training

Historically BP projects (construction and operations) have had a significant impact on local and regional employment levels[18]. Total construction employment from combined projects peaked at approximately 5,500 workers in mid-2004. Total employment for the ACG Phase 3 project peaked during 2006 with 2,500 jobs (onshore and offshore construction)[19]. Following completion of these previous projects, there has been a significant decrease in employment opportunities available to the local communities. This is confirmed by the SSES where a number of respondents commented on the reduction in employment since 2007. Figure 7.1 illustrates the construction workforce for ACG Phase 1, 2 and 3, Shah Deniz (Terminal only) and BTC (Terminal only) projects.

Figure 7.3 BP Projects Construction Workforce, 2002 to 2007



To maximise the positive impact from employment, the ACG Phase 1, 2 and 3, Sangachal Terminal and BTC construction projects adopted the following measures[18]:

- **Targets:** BP were contractually committed to specific national content targets through each of the projects. By September 2003 85% of the construction workforce was Azerbaijani[18];
- **Preference in Recruitment:** BP recruitment policy gave priority to local residents in the Garadagh District and by September 2003, 53% of the construction workforce was from the Garadagh District;
- **Information Centres:** Local community information centres were established in Sangachal Town, Umid and Sahil to enable local people to register for employment and the Centres developed a database of approximately 18,000 potential employees by September 2003; and
- **Training:** Extensive training programmes were implemented both prior to and during employment of the construction workforce. Training focused on HSE, language and computer skills, driving and certified courses including painting, lifting, scaffolding and welding. In one yard alone over 270,000 training hours of HSE training; over 244,000

[18] BP Azerbaijan Sustainability Reports 2006 - 2007
[19] As reported by the ACG Phase 1-3 construction contractors

hours of craft training; and nearly 28,000 hours training in management, administration and computing skills were provided. Over 1,200 externally recognised qualifications were awarded to the yard's workforce during the period.

It is understood that the majority of the workforce employed and trained in the ACG Phase 1, 2 and 3, Sangachal Terminal and BTC construction projects, are now employed elsewhere in Azerbaijan and abroad. Anecdotal evidence suggests that many have used their skills and experience to gain employment in State-run construction yards, in the Baku construction industry and in the oil and gas sector in Kazakhstan and elsewhere. This represents a significant benefit in terms of increasing technical skills and experience within the Azerbaijan workforce.

7.4.7 Economic Activity

Azerbaijan has experienced impressive economic growth since 2005 which has been driven by the oil sector. Since 2005, the Garadagh District economy has also expanded. In 2007, the total output of products nationally had increased by 79% in comparison with 2003 and equalled 481.2 Million AZN (US$ 594,100,100). From 2003 to 2007 the national production of manufactured goods increased by 56%[20].

Economic activities in the Garadagh District are dominated by the industrial sector, primarily oil and gas. There are around 180 registered companies, firms and co-operatives in the Garadagh District which include 15 foreign and joint venture companies. Areas along the coastline southwest of Baku have experienced a significant increase in the growth of heavy industry and this recent trend is expected to continue[20].

As a result of progressive economic development and general improvement in living conditions between 2003 and 2007, the number of people settling as new residents in the Garadagh District is approximately twice that of the number of people migrating outwards during the same period[21].

7.4.8 Income and Expenditure

There are significant differences between urban and rural incomes in Azerbaijan. At a national level in 2006, employment accounted for 31% of all income in Azerbaijan but 42.4% of income in urban households and only 17.4% in rural households.

Self-employment accounted for 29% of income in urban households and 19% in rural areas. In contrast, agriculture accounted for 36% of rural incomes. Although the importance of rural employment increased substantially during the period 2000 to 2006, access to formal employment opportunities and significantly lower salaries in agriculture, remain significant factors in explaining the differences in income levels between urban and rural areas.

The average monthly household income in the Garadagh District in 2009 was about 400 AZN[22] (approximately 365 EURO). This figure is just above the average monthly income reported by households in the four local communities covered by the SSES, which was 393 AZN (358 EURO). A breakdown of the monthly income (AZN) for each of the local communities is presented in Table 7.16.

[20] ERM (2009) Garadagh Cement Project New Dry Kiln 6: ESIA
[21] Per comms, Head of the Technical Division, Azerbaijan Highway Authority, 2010
[22] Garadagh Executive Power (2011).

Table 7.16 Monthly Incomes in the Communities within the Terminal Vicinity

Monthly Income (AZN)	Sangachal Town	Umid	Azim Kend	Masiv 3
Minimum	100	50	120	60
Maximum	1,500	1,500	400	700
Average	439	418	228	297

The data shows that households in Azim Kend and Masiv 3 have, on average, significantly lower monthly incomes than those in Sangachal Town and Umid. The average household income in Sangachal Town and Umid lies above the average for the Garadagh District.

Primary and secondary sources of income (AZN) are presented by community, in Table 7.17 and Table 7.18.

Table 7.17 Primary Sources of Income in the Communities within the Terminal Vicinity

Primary Source of Income (AZN)	Sangachal Town	Umid	Azim Kend	Masiv 3
Employment in government	59%	22%	48%	44%
Employment in the oil and gas sector	11%	16%	0%	4%
Employment in another private sector	14%	32%	4%	12%
Raising livestock	0%	0%	12%	4%
Provision of services (e.g. tutoring, child care, transport, repairs etc.)	2%	4%	12%	4%
Entrepreneurship (not street trade)	1%	2%	0%	0%
Street trade/market	1%	0%	0%	4%
Pension and other social allowances	7%	10%	4%	12%
Support from relatives	4%	0%	4%	12%
Casual earnings (workman)	1%	14%	16%	4%

Table 7.18 Secondary Sources of Income in the Communities within the Terminal Vicinity

Secondary Source of Income	Sangachal Town	Umid	Azim Kend	Masiv 3
No secondary sources of income	52%	44%	72%	52%
Employment in government	1%	2%	0%	0%
Employment in the oil and gas sector	1%	6%	0%	0%
Employment in another private sector	6%	2%	0%	8%
Raising livestock	0%	0%	12%	0%
Provision of services (e.g. tutoring, child care, transport, repairs etc.)	3%	8%	0%	4%
Street trade/market	0%	0%	0%	4%
Pension and other social allowances	25%	22%	4%	12%
Support from relatives	6%	2%	4%	4%
Casual earnings (workman)	11%	22%	12%	8%
Serving in a religious office (mullah)	0%	0%	0%	4%

Combining the above data into a single set for all of the local communities indicates that over 50% of surveyed households do not have a secondary source of income. The data also indicates that there are significant differences in the sources of income between the local communities. Sangachal Town and Azim Kend are heavily reliant on government jobs for a primary source of household income which could be linked to the relatively high frequency of pensions from past roles in the public sector. The level of government employment in Umid and Masiv 3 is relatively low and the percentage of households that draw a pension or other social allowance is also low.

Raising livestock is a source of primary and secondary income at Azim Kend and casual earnings are important at Umid and Azim Kend.

Data collected by the SSES provided an insight into the monthly household expenditure for food, utilities, land/rental costs, healthcare, education and transport. The results are presented in Table 7.19.

Table 7.19 Monthly Household Expenditure in the Communities within the Terminal Vicinity

Monthly Household Expenditure (AZN)	Food	Utilities	Land and/or house rental	Healthcare	Education	Transport
Minimum	50	2	1	5	5	2
Maximum	750	150	220	800	350	300
Average	237	48	27	63	51	57

The data shows that, in addition to food purchases, relatively equal proportions of average monthly household expenditure are dedicated to utilities, healthcare, education and transport. The cost of housing is comparatively low.

Data from the SSES collected information associated with the source of food purchases and this is presented in Table 7.20.

Table 7.20 Source of Food Purchases in the Communities within the Terminal Vicinity

Food Purchase	Sangachal Town	Umid	Azim Kend	Masiv 3	Total
Store or stall near your house	82	31	2	20	135
Store in Sahil community	23	33	6	8	70
Store in Gobustan community	10	1	18	2	31
Market in the community	5	5	3	3	16
From private traders who deliver foodstuff to the community by cars	4	2			6
Store in Sangachal Town			4		4
Store in the central Baku	2				2
Parents supply with foodstuff from rural area	1				1
Store in Masiv-3 community			1		1

The data indicates that more than 59% of households report that they purchase food from stores, stalls or markets within their own community, and a further 26% of households purchase food in Sahil. Very few households in Azim Kend buy food in their local area; more than half rely on stores in Gobustan community and a further 33% buy food in Sahil, Sangachal Town or Masiv 3.

7.5 Community Investment

The ACG, Shah Deniz, BTC, SCP and associated projects have played an important role in social development within the region. In addition to the direct economic benefit gained through local employment and use of local, regional and national businesses by BP, these previous projects have been implemented in parallel with substantial community development projects. These projects aim to support socio-economic development in the local communities, strengthening civil society through the active participation of local Non

Governmental Organisations (NGOs) and community-based organisations, and improve the relationship between local government and local populations.

BP is currently engaged in a variety of community investment programmes which use NGOs and other organisations as 'implementing partners'. Organisations which are currently implementing community investment programmes in partnership with BP within the Garadagh District are:

- GABA (Ganja Agribusiness Association);
- UMID (Human Development & Sustainable Income Generation Public Union);
- EPF (Eurasia Partnership Foundation);
- Center for Innovations in Education;
- Azerbaijan Community Development Research, Training & Resource Center (CD Center); and
- World Vision Azerbaijaned.

A community investment programme recently completed was entitled: "The Youth Employment and the Expansion of Economic Opportunities Expansion Initiative". This initiative covered Sahil, Umid and Sangachal Town and focused on training young people in practical employment skills. The initiative lasted three years and ended in August, 2010. A total of 214 young people completed training courses. From this total, 145 were subsequently employed and 45 were enabled by Jump Start Economic Project grants to set up their own business. The budget of the project was US$439,090, of which US$66,404 was spent in 2010.

BP reported a gross social spend in Azerbaijan, by BP and its co-ventures, of approximately US$M 42.2 between 2002 and 2010 (refer to Table 7.21)[23].

Table 7.21 BP / AIOC Social Spend 2002 to 2009 (US$)

2002	2003	2004	2005	2006	2007	2008	2009
600,000	2,710,000	8,640,000	6,290,000	6,750,000	7,390,000	6,430,000	3,398,650

7.6 Local Content Development

BP and its co-venturers' operations and projects expenditure in Azerbaijan in 2010 totalled $1.03 billion, the same as 2009 (Table 7.22). This included a rise of 11% in direct spend with small and medium enterprises (SME) to $147 million, an increase of 14% in spending with joint ventures to $365.5 million, a fall of 4% in expenditure with state-owned companies to $27.7 million and a decline of 11% to $486 million in indirect local spend through foreign suppliers working in Azerbaijan.

The optimisation of suppliers in 2009 resulted in a focus on total cost ownership leading to cost reductions with joint ventures (JVs) who focused on value creation. This value creation will enable the JVs to provide sustainable business for many years and provide additional growth opportunities for national suppliers. In total, BP and its co-venturers did business with 281 companies in Azerbaijan in 2010, of which 221 (79%) were SMEs.

Table 7.22 Local Content Spend 2006 to 2010 (US$M)

	2006	2007	2008	2009	2010
Small and Medium-Sized Enterprises (SMEs)	77	111	128	132	147
State-Owned Enterprises	60	43	37	30	28
Joint Ventures	520	450	408	321	366
Foreign Suppliers In-Country	826	891	737	546	486
Total	**1,483**	**1,495**	**1,310**	**1,029**	**1,027**

[23] BP Azerbaijan Sustainability Reports, 2004-2009.

8. Consultation and Disclosure

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8.1 Introduction

Stakeholder consultation is an important element of the Environmental and Socio-Economic Impact Assessment (ESIA) process. Soliciting, collating and documenting the opinions of potentially affected people and interested parties ensures that project design and the ESIA reflects the collective views of the stakeholder base.

This Chapter presents an overview of the consultation and stakeholder engagement relevant to the Shah Deniz 2 (SD2) Infrastructure Project and the process for ESIA disclosure.

Phased expansion of the Terminal has been undertaken over the past 10 years as part of the Azeri-Chirag-Guneshli (ACG) Phase 1, 2, 3 and SD Stage 1 Projects (refer to Chapter 1 Table 1.1). For each of these projects, extensive consultation with stakeholders and residents of the local communities was undertaken. Lessons learnt from previous projects' consultation has informed the SD2 Infrastructure Project consultation programme.

8.2 Overview of Consultation and Disclosure Process

The SD2 Infrastructure Project ESIA stakeholder consultation has:

- Made use of the consultation framework and methods established for other BP projects in Azerbaijan;
- Been developed with reference to accepted international guidance on expectations of ESIA consultation and disclosure;
- Considered the extent of consultation and disclosure undertaken in recent years;
- Incorporated recommendations made from a "lessons learned" review of earlier consultation programmes; and
- Acknowledged the requirement to engage with the following during the ESIA process:
    - National state bodies including:
        - The Ministry of Ecology and Natural Resources (MENR);
        - The Ministry of Culture and Tourism (MoCT); and
        - The Institute of Archaeology and Ethnography (IoAE).
    - The local community and other local stakeholders through a Stakeholder and Socio-Economic Survey (SSES);
    - BP AGT Region Teams; and
    - The SD2 Infrastructure Design Team.

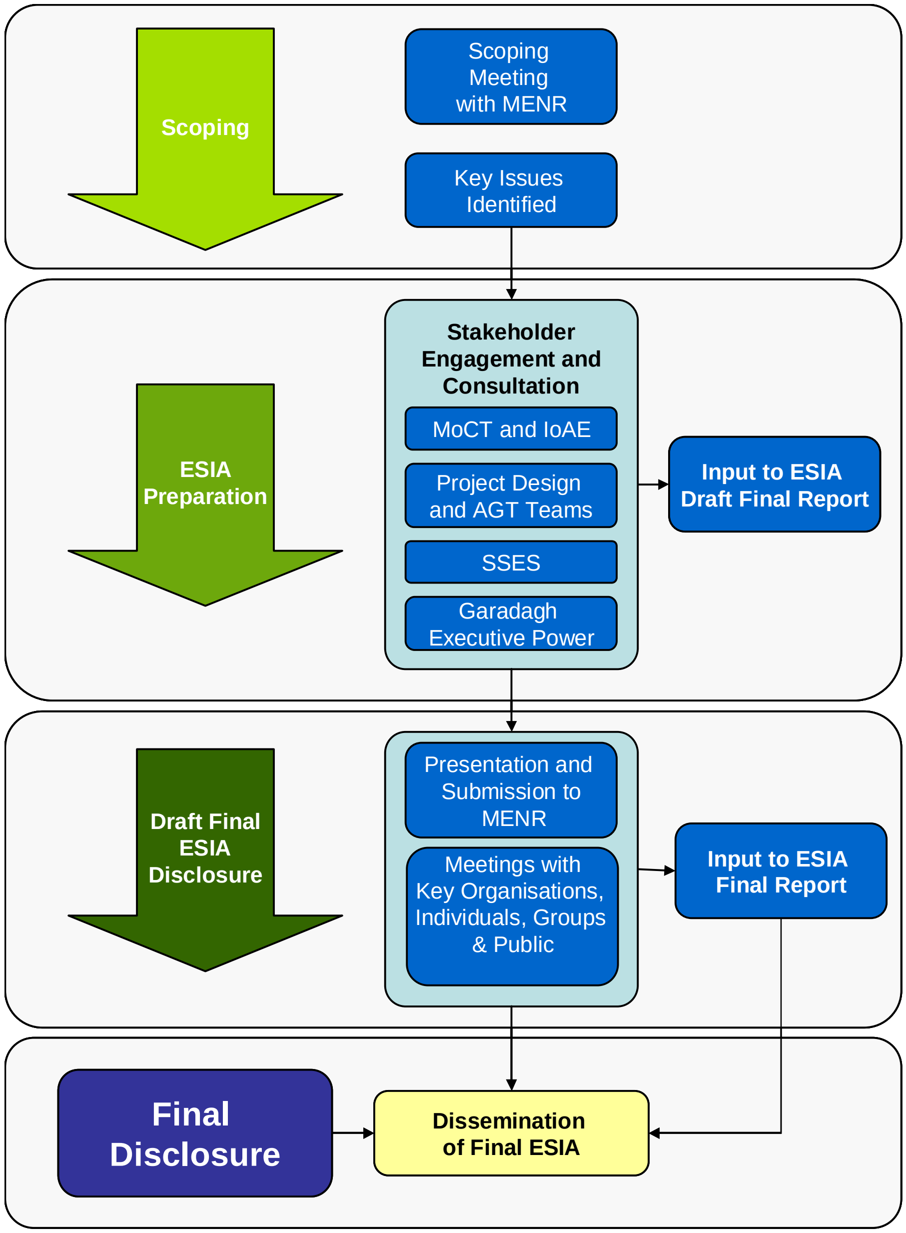
Figure 8.1 below illustrates the SD2 Infrastructure Project ESIA consultation and disclosure process.

A Public Consultation and Disclosure Plan (PCDP) has been prepared for the main SD2 Project, which also covers the SD2 Infrastructure Project ESIA. The PCDP outlines the consultation and disclosure objectives and the national and international regulatory regime that project consultation and disclosure will follow, to ensure best practice approaches for the project.

The PCDP also sets out the:

- Process by which stakeholders are identified and consulted;
- Roles and responsibilities of the ESIA team of consultants and BP; and
- Process for lodging and responding to complaints.

Figure 8.1 SD2 Infrastructure Project ESIA Consultation and Disclosure Process



8.3 Scoping, Initial Stakeholder Engagement and Consultation

8.3.1 MENR Consultation

A meeting was held with the MENR on 17th March 2011 where an overview of the SD2 Infrastructure Project was presented including key activities, phasing and schedule. During the meeting the MENR confirmed that an ESIA should be prepared for the project and that the ESIA should ensure that the potential for cumulative impacts with other projects planned or under construction in the vicinity of the Terminal should be assessed. The MENR did not define the projects which the ESIA should include as part of the cumulative assessment.

8.3.2 Ministry of Culture and Tourism and Institute of Archaeology and Ethnography

An initial meeting was held with the IoAE on 12th May 2011. This was followed by a meeting on 2nd June 2011 which was attended by MoCT representatives and included a site visit to a number of locations in the Terminal vicinity including the Caravanserai. At both meetings an overview of the proposed project activities and areas potentially affected were discussed.

The key issues raised from the meetings were:

- It was agreed that an archaeological walkover survey of the SD2 Infrastructure area should be completed pre-construction to confirm the presence/absence of any archaeological assets following the initial survey completed in 2001;
- The presence of a sand cave (located along the shoreline to the south of Terminal), a known protected monument, was highlighted. Potential project impacts and associated mitigation should be considered; and
- It was confirmed that BP will require MoCT approval for the project.

8.3.3 AGT Region Teams

The scope of the ESIA has been informed by the AGT Region Environmental Team's extensive knowledge of existing environmental conditions in the Terminal vicinity. Monitoring has been ongoing since 1996 and formed part of the Integrated Environmental Monitoring Programme (IEMP) since 2004. The Environmental Team have therefore provided input to identify the key environmental issues of concern and inform the requirement for additional survey work to be completed as part of the ESIA.

8.3.4 SD2 Infrastructure Design Team

Consultation with SD2 Infrastructure Design Team has been ongoing throughout the preparation of the ESIA.

An Environmental Impacts Identification (ENVIID) workshop was held in May 2010 based on the early SD2 Infrastructure Project design and options being considered. The workshop was led by the design contractor's environmental advisor and attended by members of the BP Project Team and the ESIA Team. During the workshop, aspects and impacts, existing control measures and recommendations for additional mitigation (where necessary) were identified based on a review of the road and camp options being considered at the time.

An equivalent Social Impacts Identification (SOCIID) workshop, following a similar methodology to the ENVIID but focused on potential socio-economic aspects and impacts, was held in September 2010. This workshop was held in Azerbaijan and attended by members of the AGT Region Communications and External Affairs (C&EA) Team. The resulting ENVIID and SOCIID registers have been used to inform the scope of this ESIA.

8.3.5 Stakeholder and Socio-Economic Survey

A SSES was completed during preparation of the draft ESIA with the following objectives:

- Provide comprehensive and up-to-date socio-economic data for the SD2 Infrastructure Project and main SD2 Project ESIAs to enable a credible and technically robust ESIA to be conducted that meets BP Group and international best practice standards;
- Enable a clear understanding of prevailing demographic and socio-economic conditions; local development needs, capacities, priorities and concerns within the 4 communities of Sangachal Town, Umid, Azim Kend and Masiv 3;
- Identify the potential for and extent of, physical resettlement and economic displacement associated with the SD2 Infrastructure Project;
- Enable an assessment of the current and future role local stakeholder organisations could have in relation to BP partnering opportunities and community investment programmes;

- Disclose information associated with the SD2 Project to enable credible discussion of the impact to local people associated with industrial operations (including Terminal operations); and
- Establish a basis against which to monitor: (i) social change during the lifetime of the SD2 Project; and (ii) the effectiveness of impact management strategies designed during the ESIA process.

The SSES, undertaken by in country socio economic specialists, involved the following activities:

- **Household surveys**: Completion of 200 household surveys in Umid (25), Sangachal (100), Azim Kend (25) and Masiv 3 (25). The aim of the survey is to collect socio-economic and perception data directly from project-affected households, and to provide information on family conditions; access to community services and infrastructure; economic activity and livelihoods; and views on BP's historical community relations process;

- **Focus Groups:** Completion of 12 Community Focus Groups (3 in each of the 4 settlements). The topic areas for the Community Focus Groups include:
    - General community issues;
    - Women's issues; and
    - Youth issues.

- **Stakeholder Interviews:** A stakeholder identification process was undertaken to determine potentially affected stakeholders at a local, regional and national level. The SSES included 66 completed interviews with key stakeholders including national and local government, local business and non governmental organisations (NGOs). The aim of the interviews was to gather information associated with stakeholder roles and capacities and local development needs and priorities. Industrial facilities in the vicinity of the Terminal were also asked to provide details regarding emissions and discharges and future plans for expansion or upgrade.

Information disclosed publicly during the SSES included:

- Displaying posters in Azeri language in public information centres, municipality offices and community centres to request attendance at future community briefings;
- Using slide presentations at community briefings held in public buildings in Sangachal, Umid, Azim Kend and Masiv 3; and
- Distribution of community information leaflets to all individuals attending community briefings and those participating in community focus groups and household surveys.

The concerns raised by local people were recorded during the SSES and taken into consideration during preparation of the draft SD2 Infrastructure Project ESIA.

8.3.6 Key Issues Raised During Initial Consultation

Key issues raised during the SD2 Infrastructure Project ESIA initial consultation are listed in Table 8.1 below.

Table 8.1 Key Issues Raised During Initial Consultation

Concern	Raised By	Chapter Reference where Addressed
Potential cumulative impacts associated with other projects planned or under construction in the vicinity of the Terminal.	MENR	Chapter 11 Section 11.3
Preconstruction archaeological assessment	MoCT and IoAE	Chapter 9 Section 9.7
Impacts to sand cave	MoCT and IoAE	Chapter 9 Section 9.7
Dust and odour impacts	Local residents as part of SSES	Chapter 9, Table 9.2 and Section 9.3.2
Poor access to and availability of employment	Local residents as part of SSES	Chapter 10, Sections 10.4 , 10.5 and 10.9
Poor condition of local roads	Local residents as part of SSES	Chapter 10, Section 10.7

8.4 Draft ESIA Report Consultation

As per the UNDP Handbook for EIA Process in Azerbaijan, the Draft ESIA report was submitted to the MENR and simultaneously released to public and stakeholder groups for comment. As part of the Draft ESIA consultation process, public meetings were held in Azim Kend ,Sangachal Town and Umid during October 2011. The public meeting comments were recorded and are provided as Appendix 8A.

Copies of the Draft ESIA Report, in English, Russian and Azeri, were also made publicly available at locations including:

- BP website;
- Public information centres at Sangachal, Umid and Sahil;
- Aarhus Public Environmental Information Centre, Baku;
- Baku Information Education Centre;
- Public libraries in Sangachal and Sahil;
- BP Hyatt, Natavan and Villa Petrolea receptions, Baku;
- BP Energy Centre at Sangachal Terminal;
- M.F.Akhundov State Library, Baku; and
- Scientific Library of the Academy of Sciences of Azerbaijan.

Comments received on the Draft ESIA report were collated, analysed and responses issued where relevant. The ESIA was subsequently revised and finalised for MENR approval.

8.5 Consultation Under the Espoo Convention

As a signatory to the Convention on Environmental Impact Assessment in a Transboundary context (i.e. the Espoo Convention), the Azerbaijan Government is obliged to provide early notification to countries that may be subject to transboundary impacts as a result of a development within Azerbaijan.

Potential transboundary impacts, including potential impacts associated with GHG emissions are presented in Chapter 11 of this ESIA and will be discussed with the MENR as part of the ESIA disclosure process.

9. Environmental Impact Assessment, Mitigation and Monitoring

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9.1 Introduction

For all phases of the Shah Deniz 2 (SD2) Infrastructure Project, Activities and Events have been determined based on the Base Case Design described in Chapter 5: Project Description; and the potential for Interactions with the environment identified.

In accordance with the impact assessment methodology (see Chapter 3), ESIA Scoping has been undertaken to identify selected Activities that may be "scoped out" from the full environmental impact assessment process based on Event Magnitude and the likely Receptor Interaction. In addition, existing controls and mitigation have been identified. These include:

- Existing operational procedures which are applicable to the SD2 Infrastructure Project and procedures for similar projects used to ensure that activities are consistent with environmental expectations; and
- Feedback from previous ACG and SD construction projects (which have included works at the Terminal) including ambient monitoring of environmental performance and/or impacts during these projects.

Those Activities that have not been scoped out have been assessed on the basis of Event Magnitude and Receptor Sensitivity, taking into account the existing controls and mitigation, and impact significance determined. Monitoring and reporting undertaken to confirm that these controls are implemented and effective, as well as additional mitigation and monitoring to further minimise impacts, are also described.

Assessments of socio-economic, cumulative and transboundary impacts and accidental events have also been undertaken and are provided in Chapters 10 and 11 respectively. The structure of the impact assessment within this ESIA is provided within Table 9.1 below.

Table 9.1 Structure of SD2 Infrastructure Project Impact Assessment

Chapter	Title	Content

9	Environmental Impact Assessment, Mitigation and Monitoring	• Scoping Assessment of SD2 Infrastructure Project Activities, Events and Interactions.
		• Identification of existing controls, mitigation, monitoring and reporting.
		• Environmental impact assessment of SD2 Infrastructure Project activities based on:
		  o Event Magnitude; and
		  o Receptor Sensitivity.
		• Identification of any additional mitigation measures.

10	Socio-economic Impact Assessment, Mitigation and Monitoring	Assessment of socio-economic impacts.
11	Cumulative, Transboundary and Accidental Events	Assessment of cumulative and transboundary impacts (including impacts associated with greenhouse gas (GHG) emissions) and impacts arising from accidental events (including oil spills and spill management).
12	Environmental and Social Management	Description of the SD2 Infrastructure Project Environmental and Social Management Plans including waste management plans and procedures.

9.2 Scoping Assessment

The SD2 Infrastructure Project Activities and associated Events that have been "scoped out" due to their limited potential to result in discernable environmental impacts are presented in Table 9.2 (see Appendix 9A for all SD2 Infrastructure Project Activities, Events and Interactions). The scoping process has used judgement based on prior experience of similar Activities and Events, especially with respect to earlier ACG and SD construction activities at the Terminal. In some instances, scoping level quantification/numerical analysis has been used to justify the decision. Reference is made to relevant quantification, analysis, survey and/or monitoring reports in these instances.

Table 9.2 "Scoped Out" SD2 Infrastructure Project Activities

ID	Activity / Event	Phases	Ch. 5 Project Description Reference	Justification for "Scoping Out"
A2-R	Construction vehicle movements (offsite) (noise)	All Phases	-	• Construction traffic associated with the SD2 Infrastructure Project is expected to use the Baku-Salyan Highway during the construction period. • Project contribution to traffic flows estimated to peak at 162 vehicle movements per day between May and October 2012 (Chapter 5 Table 5.5), which represents approximately 1.62% of existing traffic flows. • Screening undertaken (refer to Appendix 9D) indicates the estimated increase in noise levels at sensitive receptors[1] will be no more than 1 dB(A), which will not be perceptible. • A Community Interaction and Social Impact Management Plan will be implemented and maintained as a mechanism of communicating with the community and responding to community grievances. • Increase in traffic noise due to offsite construction vehicles associated with the SD2 Infrastructure Project likely to be indiscernible at sensitive receptors[1].
A5-R	Drainage management works associated with wadi clearance and new drainage channels - alterations to surface water	Phase 3	5.5.3	• Drainage management works and above ground structural groundworks associated with the SD2 Infrastructure Project will result in alterations in surface water flows in the vicinity of the Terminal. • Hydrological modelling has been undertaken to determine the flow conditions and flood risk prior to and following the SD2 Infrastructure works in the Terminal vicinity (refer to Appendix 9E). • Modelling has shown that both prior to and following the SD2 Infrastructure works, Sangachal Town and Sangachal Power Station, which both lie significantly above the level of a major flood event[2], are not at risk of flooding. • Under existing conditions, sections of the railway and highway are currently at risk of flooding during a major flood event. Modelling showed that the SD2 Infrastructure project works not increase the likelihood or severity of the existing flood risk in these locations. • The Caravanserai, a State protected monument located to the south of the Terminal, was shown to be located in an area which, at its lowest point, is very close to the level of a major flood event. The modelling demonstrated that the SD2 Infrastructure works are predicted to result in a negligible change to flood levels at this location (<2mm increase). • Overall, risk of flooding at key receptors was shown to either marginally reduce or remain largely unchanged following the SD2 Infrastructure works.
A6-R	Above ground structural groundworks including construction of road embankments, flood protection berm and culvert works - alterations to surface water	Phases 3 & 4	5.5.3 & 5.5.4	
A6-R	Above ground structural groundworks works including construction of road embankments, flood protection berm and culverts - visual impact	Phases 3, 4 & 6	5.5.3, 5.5.4 & 5.5.6	• Above ground structural works will include the flood protection berm and access road embankments (elevated across the low lying wetland area to provide at-grade access to the Terminal). Culverts will be located under the access road and therefore will not be visible at distance. • Berm and elevated access road expected to be indiscernible in the view from sensitive receptors[1]. • No permanent or temporary structure planned to be more than 10m in height. • Structures associated with construction camp and construction facilities will be highest (<10m). • Analysis undertaken to determine visibility from Azim Kend, Masiv 3, Sangachal and Umid (Appendix 9B)[3]. • Demonstrates that structures will not visible from either Sangachal Town or Azim Kend. • Very limited visibility of structures from Umid and Masiv 3. The areas where the analysis shows there may be some visibility are predominately located at the furthest point from the Terminal and would be obstructed by buildings between the community and the new structure.
A11-R	Erection of temporary structures (e.g. temporary rail crossing gatehouse, security facilities, initial site compound offices) - visual impact			
A12-R	Erection of permanent structures (e.g. construction camp/facility structures) - visual impact			

[1] Sangachal Town, Umid, Azim Kend and Masiv 3.
[2] Major flood event is defined as 1 in 100 year flood.
[3] The analysis is limited to terrain and does not take account of existing structures therefore providing a worst case assessment.

ID	Activity / Event	Phases	Ch. 5 Project Description Reference	Justification for "Scoping Out"
A9-NR	Sewage treatment discharges (following commissioning of SD2 STP)	Phase 4	5.5.4	• Prior to completion of the STP, sewage will be sent to septic tanks and collected by road tanker for treatment and disposal to a licensed municipal STP plant. • The new STP will commence operation following completion and commissioning. The STP is designed to serve the SD2 construction area and facilities. • During the SD2 Infrastructure Project the STP will treat sewage generated by the SD2 Infrastructure workers (maximum of 700 people). • Sewage will be treated to comply with applicable project standards 4. • Treated sewage will be used for irrigation or dust control (preferred option) (residual chlorine content less than 1mg/l) or discharged to the wadi system (residual chlorine content less than 0.2mg/l). • Residual chlorine content will be measured daily. • Samples are taken from the sewage discharge outlet and analysed monthly for applicable project standard parameters[4]. • Sewage sludge will be stored in designated containers for collection. No sewage sludge shall be discharged. • Sewage and sludges will not be stored for longer than five days and sludge will not be allowed to become septic. • Results from effluent monitoring will be submitted to the MENR at an agreed frequency.
A10-R	Construction plant/vehicle refuelling	All Phases	-	• Vehicle refuelling will be undertaken in designated areas or using mobile bowsers. • A refuelling procedure will be used which details the pre-checks, level indication monitoring, provision of temporary containment and drip trays, communication, training and spill kit requirements. • The dedicated refuelling area associated with the project will be located within a bund capable of holding 110% capacity.
A13-R	Grit blasting and painting of construction camp/facility structures	Phase 6	5.5.6	• Grit blasting and painting are required for the construction camp/facilities structures. • Grit-blasting activities where practical shall be undertaken in enclosed buildings fitted with an air filtration system with the filters being regularly cleaned. • Preference to use garnet for grit blasting which is inert, non-hazardous and suitable for disposal under EU legislation in a non-hazardous landfill.
A14-R	Use of temporary lighting	All Phases	-	• Under normal conditions, work areas will not be lit outside of working hours unless for safety/security reasons. • The existing Terminal is heavily lit (refer to Appendix 9B) and the existing lighting located around its perimeter would dominate any light associated with the main SD2 Infrastructure Project. • Except for the access road works, no significant works are proposed immediately adjacent to the main Highway. • The existing topography in the Pipeline Landfall Area limits the potential for light spill to the shoreline and Sangachal Bay. • A lighting strategy will, however, be implemented which will include measures to minimise light spillage, glare to the community, road users and the shoreline.
A15-R	Waste generation	All Phases	-	• Waste will be segregated at source, stored and transported in fit for purpose containers. • Waste will be managed in line with the principles described in Chapter 12. • Waste Minimisation and Management Plans will be established and all waste transfers controlled and documented. • BP will manage the collection, transportation, treatment, disposal and storage of waste generated during the project - the destinations of the waste types is provided in Chapter 5, Table 5.8.

[4] pH (6-9), 5 day BOD of less than 20mg/l, total coliform <400MPN (Most Probable Number) per 100ml, COD of less than 100mg/l, suspended solids of less than 30mg/l and residual chlorine less than 1mg/l (used for irrigation) or less than 0.2mg/l (discharge to the environment).

ID	Activity / Event	Phases	Ch. 5 Project Description Reference	Justification for "Scoping Out"
A16-R	Discharge from oil/water separator systems to wadi system			• Runoff from parking areas, the refuelling area and hazardous areas (e.g. fuel/chemical areas) will be routed to dedicated oil water separation systems. • The oil water separation systems will be designed to treat water to applicable oil water standards[5].
A17-R	Leak test of construction camp drainage pipework	Phase 6	5.5.6	• It is possible that leak testing and super chlorination of the construction camp drainage pipework may be undertaken. • Effluent from the pipework testing and chlorination will meet the applicable sewage[6] and oil water standards[5]. • Following completion of leak testing, effluent will be preferentially used for dust suppression or discharged to the wadi system.
A18-R	Installation and use of permanent lighting (access road, construction camp and construction facilities)	Phase 6	5.5.6	• Permanent lighting will be installed along the access road and around the construction camp and construction facilities. • Lighting scheme should be consistent with ILE lighting guidelines. • The existing Terminal is heavily lit (refer to Appendix 9B). Lighting associated with the SD2 Infrastructure Project would be indistinguishable from the current lighting environment.

The SD2 Infrastructure Project routine and non-routine Activities and their associated Events assessed in accordance with the full impact assessment process are presented in Table 9.3.

Table 9.3 "Assessed" SD2 Infrastructure Project Activities

ID	Activity	Phases	Ch. 5 Project Description Reference	Event	Event Category
A1-R	Operation of construction plant and vehicles including diesel generators (onsite)	All phases	-	Emissions to atmosphere (non GHG)[1] Noise Indirect effect/disturbance to wildlife	Onsite construction plant and vehicles
A2-R	Construction vehicle movements (offsite)	All phases	-	Emissions to atmosphere (non GHG)[1] Indirect effect/disturbance to wildlife	Offsite construction vehicles
A3-R	Removal of surface soil layer and vegetation	Phases 1 & 3	5.5.1, 5.5.3	Disturbance/indirect effect to wildlife Loss of habitat Potential disturbance/damage to cultural heritage Dust generation	Surface soil layer removal and spoil movement
A4-R	Movement and temporary storage of spoil	Phase 3	5.5.3	Disturbance/indirect effect to wildlife Dust generation Potential mobilisation of contamination	
A5-R	Drainage management works associated with wadi clearance and new drainage channels	Phase 3	5.5.3	Potential disturbance/damage to cultural heritage Potential mobilisation of contamination Disturbance/indirect effect to wildlife Loss of habitat	Drainage management works
A7-R	Piling associated with installation of pipeline crossings	Phase 4	5.5.4	Noise Potential disturbance/damage to cultural heritage	Piling activities
A8-R	Test piling	Phase 5	5.5.5	Noise Potential disturbance/damage to cultural heritage	
Notes: [1]GHG emissions are discussed in Chapter 11.					

[5] Less than 10 mg/l as a monthly average and less than 19 mg/l on a daily basis.
[6] pH (6-9), 5 day BOD of less than 20mg/l, total coliforms <400MPN (Most Probable Number) per 100ml, COD of less than 100mg/l, suspended solids of less than 30mg/l and residual chlorine less than 1mg/l.(used for irrigation) or less than 0.2mg/l.(discharge to the environment).

9.3 Impacts to the Atmosphere

9.3.1 Emissions From Onsite and Offsite Construction Plant and Vehicles

9.3.1.1 Event Magnitude

Onsite Construction Plant and Vehicles are discussed in Chapter 5: Project Description Section 5.7.1. Table 5.4 presents the estimated number and type of onsite construction plant and vehicles for each phase of the SD2 Infrastructure work.

Offsite Construction Traffic is discussed in Chapter 5: Project Description Section 5.7.2. Table 5.5 presents the estimated number of daily 2-way offsite road vehicle movements associated with the SD2 Infrastructure Project.

Existing controls associated with emissions from onsite and offsite construction plant and vehicles include:

- Construction plant and vehicles shall be modern and well maintained in accordance with the written procedures based on manufacturer's guidelines, applicable industry code, or engineering standard to ensure efficient and reliable operation.
- Where practicable, mains electricity shall be used instead of mobile generators as a power source.
- All construction plant and vehicles shall be switched off whilst not in use and not left to idle.
- A Community Interaction and Social Impact Management Plan will be implemented and maintained as a mechanism of communicating with the community and responding to community grievances.

The atmospheric dispersion modelling undertaken for Onsite and Offsite Construction Plant and Vehicles is presented in Appendix 9C. The modelling focuses on NO_X (which comprises nitrous oxide (NO) and nitrogen dioxide (NO_2)) as the main atmospheric pollutant of concern, based on the larger predicted emission volumes as compared to other pollutants (i.e. SOx and PM_{10}). Modelling of SO_2 and particulates was not deemed necessary as concentrations are expected to be very low (approximately 10 times less than NO_2 concentrations) based on efficient plant and vehicle operation, regular maintenance and planned use of good quality, low sulphur diesel.

Long term and short term NO_2 concentrations were modelled to assess the contribution of emissions from the onsite construction plant and vehicles in the context of the relevant standards for NO_2[7]. These standards are relevant to locations where humans are normally resident (i.e. residential locations) and do not apply to commercial locations and workers, which are subject to standards under separate occupational health requirements.

The modelling assessment was undertaken for the period January – September 2012 (i.e. when the largest and greatest number of plant will be operational). The assessment also conservatively assumed all plant would be operating at full load for each working day. The predicted NOx emission rate from all the plant was entered into the model as an area source, distributed across the centre of SD2 Infrastructure area. The background concentration of NO_2 (6 µg/m^3) was determined from the air quality monitoring undertaken in the vicinity of Sangachal (refer to Chapter 6 Section 6.4.5).

The modelling demonstrated that, during the onsite construction activities, an increase in the mean annual and 1 hour NO_2 concentrations is predicted at the nearby receptor locations of less than 0.1 µg/m^3 due to onsite construction plant and vehicle activities. This represents less than 0.25 % of the annual average NO_2 limit value and less than 2% of the background NO_2 concentration.

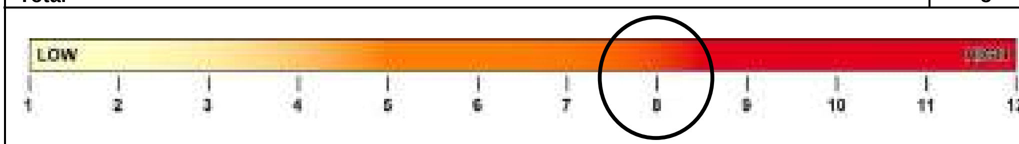
[7] Applicable 1 hour average (short term) and annual average (long term) standards for NO_2 are 40 µg/m^3 and 200 µg/m^3 respectively.

Emissions associated with offsite vehicles were assessed considering the expected change in NO_2 concentrations due to the increase in traffic flows along the Baku-Salyan Highway associated with the project. The period when the highest offsite traffic flows are expected (May-October 2012) were modelled and it was conservatively assumed these traffic flows would continue for a calendar year. Concentrations were modelled at the nearest residential receptor to the highway to provide a worst case assessment, which is approximately 20m from the south-bound carriageway and 65m from the north-bound carriageway within Sangachal Town. The additional vehicle movements due to the SD2 Infrastructure Project were predicted to lead to a maximum increase in mean annual NO_2 concentration of 0.9 $\mu g/m^3$ at the nearest residential receptor to the highway in Sangachal Town, which represents 2.2% of the applicable air quality limit value[8,9]. At a distance of 150m from the highway, increases in NO_2 concentrations were predicted to be less than 0.1 $\mu g/m^3$.

Table 9.4 presents the justification for assigning a score of 8, which represents a Medium Event Magnitude.

Table 9.4 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Emissions associated with the project activities will not affect ambient air quality (i.e. increase concentrations by more than 0.1 $\mu g/m^3$) more than 500m from the SD2 Infrastructure works (onsite plant and vehicles) or more than 150m from the highway (offsite construction vehicles)	1
Frequency	Emissions will occur continuously.	3
Duration	Emissions will continue throughout the construction period.	3
Intensity	Modelled short and long term concentrations of key pollutant, NO_2, are predicted to be significantly below (i.e. more than 50 times below) relevant ambient air quality standards.	1
Total		**8**



9.3.1.2 Receptor Sensitivity

Human Receptors

The nearest receptors to the Terminal (refer to Chapter 6 Figure 6.6) include residents of:

- Sangachal Town, approximately 1 km south west of the nearest SD2 Infrastructure works and within 20m of the Highway (at the closest residential location);
- Azim Kend/ Masiv 3, approximately 2.5 km west of the nearest SD2 Infrastructure works and more than 2 km from the Highway; and
- Umid, approximately 1 km south east of the nearest SD2 Infrastructure works and within 230m of the Highway (at the closest residential location).

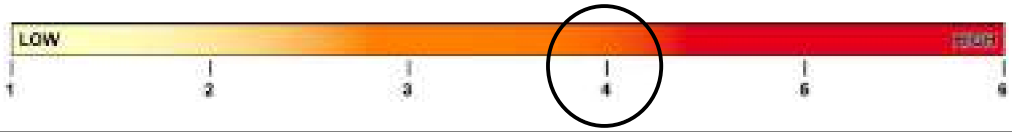
Table 9.5 presents the justification for assigning a score of 4 to human receptors, which represents Medium Sensitivity.

[8] Applicable 1 hour average (Short term) and annual average (long term) standards for NO_2 are 40 $\mu g/m^3$ and 200 $\mu g/m^3$ respectively.

[9] Historically in Azerbaijan ambient concentrations of NO_2, SO_2, CO and PM_{10} have also been assessed against specific 24 hour and 1 hour standards. These standards were not derived using the same health based criteria as the IFC, WHO and EU guideline values and the standards derived are not widely recognised. However, Appendix 9C includes an assessment of expected air quality concentrations against these standards for completeness. The modelling demonstrated that none of these standards would be exceeded during SD2 Infrastructure Project activities.

Table 9.5 Human Receptor Sensitivity

Parameter	Explanation	Rating
Presence	Nearest residential receptors (within Sangachal Town) are located within 500m of the highway (to be used by project construction traffic) and approximately 1km from the nearest SD2 Infrastructure works.	3
Resilience	Modelling results have confirmed that emissions from onsite and offsite construction plant and vehicles sources will not exceed air quality standards and local receptors are not considered to be vulnerable – existing NO_2 concentration are well below applicable standards.	1
Total		**4**



9.3.1.3 Impact Significance

Table 9.6 summarises impacts on air quality associated with onsite construction plant and vehicles.

Table 9.6 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Emissions associated with onsite and offsite construction plant and vehicles	Medium	(Humans) Medium	**Moderate Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures as listed in Section 9.3.1.1.above and therefore no additional mitigation is required.

9.3.2 Dust Due to Surface Soil Layer Removal and Spoil Movement

9.3.2.1 Event Magnitude

Surface soil layer removal and spoil movement is discussed in Chapter 5: Project Description Section 5.5.3.

Existing controls associated with control of dust due to the SD2 Infrastructure works include:

- Vehicles shall travel at speeds that minimise dust and unpaved roads/tracks and road speeds will be established for different road surfaces.
- Speed limits shall be adhered to at all times.
- Construction activities shall be suspended if excessive dust arises and measures shall be taken to control ground prior to resuming activities.
- All onsite vehicle routes to be marked on the road surface.
- Off-road driving shall be prohibited outside of designated areas unless specifically authorised.
- The loads of all construction vehicles entering the site shall be covered.
- Drivers of onsite construction vehicles shall be provided with dust management training.
- Where off road access is required, routes will be chosen to minimise damage and return journeys will be made along the same routes.
- Where unsurfaced, the main access routes will be created using compacted well graded granular fill, appropriately designed to ensure good drainage to minimise the potential for erosion.
- All unsurfaced routes shall be regularly maintained to ensure the surface remains stable and compacted.
- All hardstanding areas (including paved roads) shall be regularly inspected to ensure as are kept clean of dust and mud.

- Dust management options will be assessed and will include recommendations for monitoring. Periodic audits will be undertaken to confirm effectiveness of measures to minimise dust. The audits will include observations of meteorological conditions including wind speed, direction and general weather conditions.
- A wheel washing facility shall be used for construction vehicles leaving the site.
- Spoil heaps to be inspected regularly to assess condition and potential to generate dust.
- Quantity and duration of spoil exposure will be minimised as far as possible and ground disturbing activities shall be sequenced to minimise the area disturbed at one time.
- Temporary or permanent stabilisation of exposed soils will be provided to prevent washout of spoil by rainfall and generation of dust.

The atmospheric dispersion modelling undertaken for the Surface Soil Layer Removal and Spoil Movement activities are presented in Appendix 9C. The modelling focuses on dust and PM_{10} as the main atmospheric pollutant of concern. Dust refers to both suspended and deposited particulate matter up to 75 micros (µm) in diameter and has the potential to create a public nuisance, through deposition of dust e.g. on vehicles, window sills etc. PM_{10} is defined as particulate matter with an aerodynamic diameter of less than 10 microns (µm) and is the result of a combination of man-made (construction work) and natural processes such as natural entrainment of particles by the wind periods of extended dry weather.

The potential drift distance of airborne particles is governed by the initial injection height of the particle, the terminal settling velocity, and the degree of atmospheric turbulence. Particles larger than about 100 microns (µm) are likely to settle within 6 to 9 metres (m) from the emission source, with particles 30-100 µm in diameter settling within 50-100m. Smaller particles, such as PM_{10}, can travel several hundreds of metres from the source, sometimes up to 1km[10].

The modelling undertaken assumed an emission rate of 100 milligrams dust per square metre per second ($\mu g/m^2/s$) based on USEPA factors[11] and 20 $\mu g/m^2/s$ per PM_{10} based on UK guidance[12]. It was estimated, based on Chapter 5 of the ESIA, that the most significant works would occur within the central part of the SD2 Infrastructure area over an area of approximately 140 hectares. PM_{10} concentrations and dust deposition rates at receptors were then calculated by the model based on the expected emissions arising from this central area.

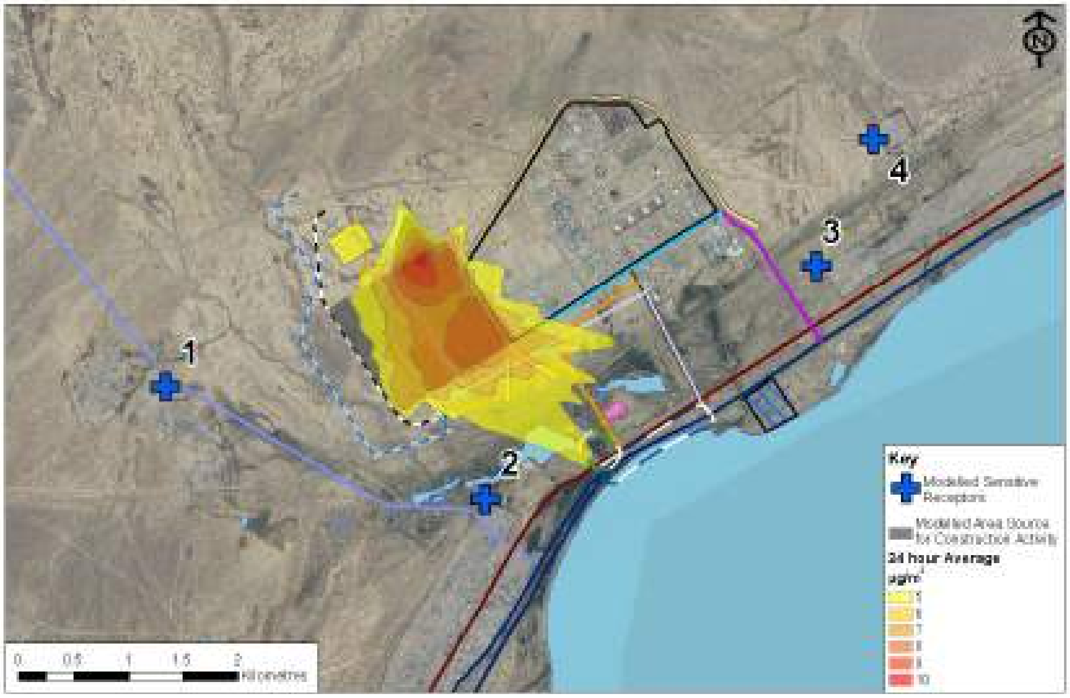
Modelled PM_{10} concentrations were compared against applicable limit value and existing background concentrations. Dust deposition rates were compared to international guidance levels[13].

PM_{10} Concentrations

The predicted increase in long term annual PM_{10} concentrations at the nearest sensitive receptors are expected to range between 0.1- 0.3 $\mu g/m^3$. This is between 0.5% and 1.5% of the limit value concentration. The increase in short term (24 hours) PM_{10} concentrations (modelled as the 99^{th} percentile) is slightly higher, due to the shorter averaging period associated with this limit value. Concentration increases between 1.17 and 3 $\mu g/m^3$ are predicted. Figure 9.1 shows the predicted increase in short term PM_{10} emissions at ground level due to construction activities.

[10] United States Environmental Protection Agency (US EPA). AP 42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources. Chapter 13.2 Fugitive Dust Sources.
[11] For heavy construction works within a semi-arid climate assuming soils with medium silt content.
[12] Quality of Urban Air Review Group (QUARG) (1996); Airborne Particulate Matter in the United Kingdom.
[13] Most stringent guidance levels of 133 $\mu g/m^2/day$ were used sourced from Australian guidance. No single international value exists.

Figure 9.1 Modelled Increase in Short Term (24 hour) PM_{10} Emissions at Ground Level Due to Surface Soil Layer Removal and Spoil Movement



The figure shows that while the predominant wind direction is north (refer to Chapter 6 Figure 6.2), PM_{10} concentrations at ground level appear to be influenced by wind from the north west. The sensitivity analysis undertaken within the modeling (refer to Appendix 9C) showed that high (e.g. 15m/s) and low (e.g. 5m/s) wind speeds result in similar short term PM_{10} concentrations at receptors while average wind conditions (around 7-8m/s) result in higher concentrations (by a factor of 5). As Figure 6.2 shows, these average wind conditions tend to occur more frequently from the north west.

Worst case PM_{10} concentrations, i.e. the highest concentrations obtained throughout the year (the 100th percentile) were also modelled and the results showed, under worst case conditions, there would be an estimated increase in the daily PM_{10} concentration of 1.3 - 6.0 µg/m^3 at the modelled nearby sensitive receptor locations. This is well below the short term limit value of 50 µg/m^3.

The impact on PM_{10} concentrations associated with construction activities is therefore considered insignificant, and would be imperceptible in comparison with the background PM_{10} concentration of 109 µg/m^3.

Dust Deposition

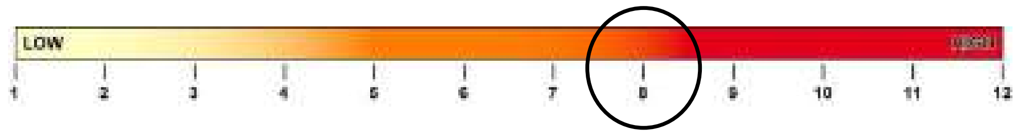
Annual average and maximum dust deposition rates were modelled. On an annual basis the modelling estimated a daily average dust deposition rate at sensitive receptors of between 1.7 and 9.8 mg/m^2/day, which represents 1.2 – 7.4% of the guidance level (133 mg/m^2/day). The maximum daily dust deposition rate was calculated as 132 mg/m^2/day at Sangachal Town. This rate is comparable to the guidance limit value, however the modelling did not take into account the existing controls associated with dust minimisation as discussed above such as limiting vehicle speeds on unsurfaced roads, use of water to control dust from exposed surfaces and suspension of work should excessive dust levels arise. It is expected that, in general, the dust generated by the construction works will be imperceptible in the context of the existing, background levels of dust deposition that generally occur in semi-arid areas (estimated to be between 495-896 mg/m^2/s)[14].

[14] Wanquan Ta and Tao Wang (2004); 'Measurements of dust deposition in arid and semi-arid regions, China', American Society of Civil Engineers (ASCE) pp. 1-10.

Table 9.7 presents the justification for assigning a score of 8, which represents a Medium Event Magnitude.

Table 9.7 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	It is predicted that the PM_{10} concentration and dust emissions from construction activities will be imperceptible at sensitive receptors	1
Frequency	Emissions will occur continuously.	3
Duration	Emissions will continue throughout the construction period.	3
Intensity	Modelled contribution to long and short term concentrations of key pollutant, PM_{10} is predicted to be significantly lower (more than 15 times lower) than applicable limit values.	1
		8



9.3.2.2 Receptor Sensitivity

In terms of Emissions to Atmosphere, Receptor Sensitivity is considered to be the same as per Section 9.3.1.2 above; therefore Receptor Sensitivity is Medium, for human receptors.

9.3.2.3 Impact Significance

Table 9.8 summarises impacts on air quality (i.e. PM_{10} concentrations) and dust nuisance impacts associated with surface soil layer removal and spoil movement.

Table 9.8 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Emissions & dust associated with surface soil layer removal and spoil movement	Medium	Medium	**Moderate Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures as listed in Section 9.3.2.1 above and therefore no additional mitigation is required. A dust monitoring programme will be established prior to and during construction works and the results provided.

9.4 Impacts to the Terrestrial Environment (Noise)

9.4.1 Construction Noise

9.4.1.1 Event Magnitude

Onsite Construction Plant and Vehicles

Onsite Construction Plant and Vehicle activities are discussed in Chapter 5: Project Description, Section 5.7.1. Table 5.4 presents the types of construction plant expected to be used during the SD2 Infrastructure Project. Figure 5.4 presents the indicative project schedule.

Existing controls associated with noise due to operation of onsite construction plant and vehicles include:

- Construction plant and vehicles shall be modern and well maintained in accordance with written procedures based on the manufacturer's guidelines, applicable industry code, or engineering standard to ensure efficient and reliable operation.
- Where practicable, mains electricity shall be used instead of mobile generators as a power source.

- A Community Interaction and Social Impact Management Plan will be implemented and maintained as a mechanism of communicating with the community and responding to community grievances.
- All construction plant and vehicles shall be switched off whilst not in use and not left to idle.
- Where possible communities shall be warned in advance of any particularly noise activities to be undertaken; when unavoidable, noisy operations shall be undertaken during normal daylight working hours.
- Onsite personnel will be trained in how to minimise noise.
- All vehicles and mechanical plant equipment will be fitted with effective exhaust silencers.
- Noisy plant will be located as far as possible from sensitive receptors and where appropriate and practical will be located behind barriers (for example, site huts, acoustic partitions etc.) to provide shielding in order to reduce noise levels at sensitive receptors.
- Compressors will be fitted with properly lined and sealed acoustic covers that are kept closed whenever in use and pneumatic percussive tools will be fitted with mufflers or silencers.
- Continuous noise emitting machinery will be housed in a suitable acoustic enclosure.
- Where practicable, rotary drills and bursters actuated by hydraulic, chemical or electrical power will be used for excavating hard or extrusive material.
- When selecting large plant that is used for extended periods preference will be given to plant that is compliant with EU Noise Directives 2000/14/EC and 2005/88/EC where possible.

Modelling was undertaken to estimate the increase in noise levels at receptors in the Terminal vicinity due to the onsite plant and vehicles (refer to Appendix 9D for full modelling assessment) at sensitive receptors (i.e. residential locations). The assessment was undertaken in accordance with guidance provided within BS5228:2009[15]. Source noise levels for the proposed onsite plant and vehicles were also derived from BS5228: 2009.

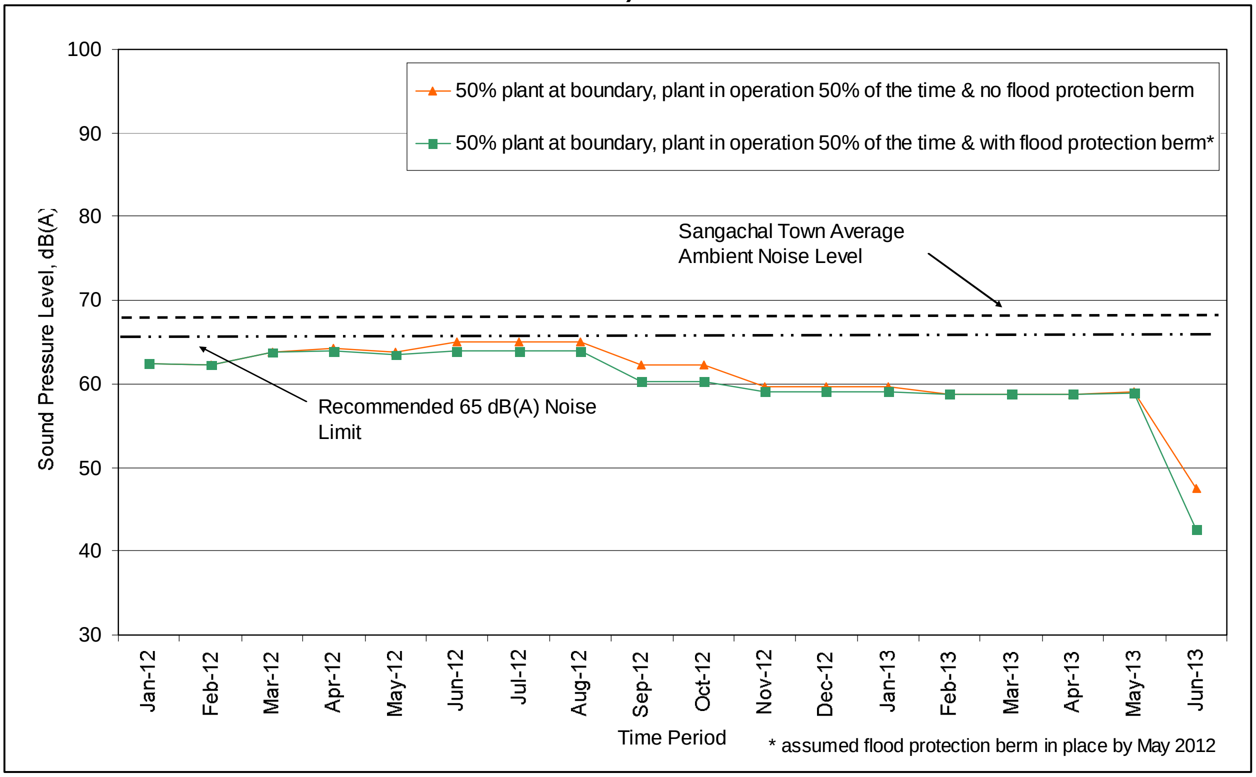
Modelling was undertaken based on a realistic scenario which reflects the expected typical construction activities (i.e. 50% of the plant and vehicles are operating at the works boundary and 50% within the centre of the SD2 Infrastructure area). Noise levels were determined with and without the flood protection berm in place. Based on the indicated schedule it is assumed that the flood protection berm will be in place from May 2012.

Noise levels were predicted across the construction period and results were compared to the existing ambient noise levels at the receptors (refer to Chapter 6 Section 6.4.6) and the noise limit value of 65dB, determined from BS5228: 2009[16].

The results of the modelling showed that no exceedances are predicted at Azim Kend, Masiv 3, Umid or Sangachal Town. Highest noise levels were predicted at Sangachal Town (refer to Figure 9.2), where the noise limit value of 65dB is predicted to be just met. The noise limit value predicted however was lower than the existing average ambient noise level of 67dB(A). This implies that construction noise would not be significantly noticeable in the context of the existing noise levels in this location.

[15] British Standards Institute (BSi), (2009): ‘BS5228 – Noise Vibration Control on Construction and open Sites’, BSi, London.
[16] 65dB limit applicable Monday – Friday daytime (07:00 to 19:00) and Saturday (07:00 to 13:00).

Figure 9.2 Predicted Noise Levels (Realistic Scenario) at Sangachal Town (Onsite Construction Plant and Vehicles)



Concrete Batching Plant

Noise associated with the concrete batching plant[17] was also modelled and the expected increase in noise levels at a sensitive receptors due to the plant operation calculated. The assessment showed, that even under worst case assumptions (100% load, 10 hours per day operation and plant located at the boundary of the SD2 Infrastructure area closest to the receptor), noise levels at receptors would range from 33dB(A) and 46dB (A) (at Umid and Sangachal Town respectively) and would not exceed current ambient levels or the 65dB noise limit at any receptor.

Piling Activities

Piling activities are planned to comprise:

- Bored piling associated with installation of crossings under the new access road within the 3rd party pipeline corridor immediately to the south of the Terminal (refer to Chapter 5 Figure 5.8); and
- Piling trials either within or 100m from the boundary of the SD2 Expansion Area (refer to Chapter 5 Section 5.5.5).

Noise modelling has been undertaken (refer to Appendix 9D) to assess the impact of the piling activities to local receptors. The piling associated with access road crossings was assessed assuming use of up to 3 bored piling rigs and pneumatic hammers and an air compressor in location 1 (where the access road crosses the 3rd party pipeline corridor) and location 2 (in the vicinity of the western drainage channel outfall). It was conservatively assumed that the rigs would be operational 100% of the working day. Noise levels were predicted at Azim Kend, Umid and Sangachal Town.

[17] Not part of the Base Case Design but space is allocated should the decision be made to incorporate one into the design –see Chapter 5 Section 5.5.4.

Noise associated with piling trials was assessed based on the following four scenarios:

- Tubular piling at a location 100m from the north west corner of the SD2 Expansion Area;
- Pre cast concrete piling at a location 100m from the north west corner of the SD2 Expansion Area;
- Tubular piling at a location 100m from the south west corner of the SD2 Expansion Area; and
- Pre cast concrete piling at a location 100m from the south west corner of the SD2 Expansion Area.

The results obtained from the assessments are presented in Table 9.9.

Table 9.9 Noise Levels at Sensitive Receptors Associated with Piling Activities

Scenario	Type of Piling	Location	Predicted Noise Level (dB(A))			Limit Value (dB(A))
			Azim Kend	Umid	Sangachal	
Bored Piling Associated with Pipeline Culverts						
1	Rotary Bored	Location 1	54	52	60	65
2		Location 2	52	54	58	
Trial Piling						
1	Tubular	North west	45	39	45	65
2	Pre Cast Concrete		46	40	46	
3	Tubular	South west	44	40	49	
4	Pre Cast Concrete		45	41	50	

The modelling results indicate that no exceedances of the construction noise limit (65dB(A)) are predicted at any of the modelled receptors associated with piling activities.

Concrete Breaking

It is anticipated that concrete breaking works may be required within the SD2 Expansion Area to remove existing areas of concrete from previous activities in the area (Chapter 5 Section 5.5.3). Modelling of expected noise levels at receptors associated with this activity was undertaken (refer to Appendix 9D) assuming both screening and no screening of the works. The results showed that the highest noise levels were estimated to be 50dB(A) (with screening) and 55dB(A) (without screening) at Sangachal Town and no exceedances of the construction noise limit (65dB(A)) were predicted at any of the modelled receptors.

All Construction Noise

An assessment was undertaken to determine the likely worst case impacts should the period of highest onsite construction plant and vehicle activity, concrete breaking and the piling activities coincide (refer to Appendix 9D). Table 9.10 presents the results obtained.

Table 9.10 Worst Case Construction Noise Levels at Receptors (All Construction Activities)

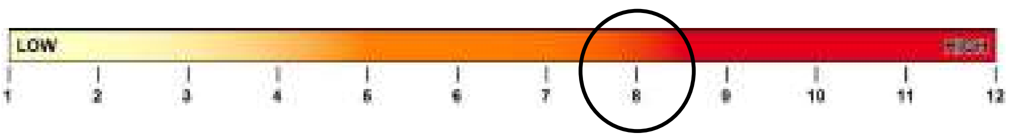
Activity	Predicted Noise Level, dB(A)		
	Azim Kend (R1)	Sangachal (R2)	Umid (west) (R3)
Onsite construction plant and vehicles[1]	62	65	60
Concrete breaking within the SD2 Expansion Area	51	55	49
Pipeline crossing piling	54	60	52
Trial Piling (within the SD2 Expansion Area)	54	60	52
Overall Noise Level	**63**	**67**	**61**
Existing Average Ambient Noise Level	***52***	***67***	***55***
1. Includes concrete batching plant			

The assessment showed that, under worst case assumptions, the limit value of 65 dB(A) would be met at Azim Kend and Umid but would be exceeded at Sangachal Town. At this receptor, however, it is predicted that the worst case noise level would be comparable to the existing ambient noise level of 67 dB(A), implying that construction noise would not be significantly noticeable in the context of the existing noise levels in this location. Noise levels, while below the relevant noise limit, are more likely to be noticeable at Azim Kend and Umid where existing ambient noise levels are lower.

Table 9.11 presents the justification for assigning a score of 8 to activities associated with construction noise, which represents a Medium Event Magnitude.

Table 9.11 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Noise from construction works will travel to receptors greater than 1km from source. However, noise levels will be either similar to ambient levels or within the applicable noise limit value of 65dB. With existing control measures in place, it is expected that noise will not significantly affect locations greater than 500m from the boundary of the works.	1
Frequency	Noise will occur continuously.	3
Duration	Noise will continue throughout the construction period (with highest noise levels expected June – August 2012).	3
Intensity	Applicable noise limits or ambient noise levels (which ever is the greatest) will be met at all sensitive receptors throughout the construction works.	1
		8



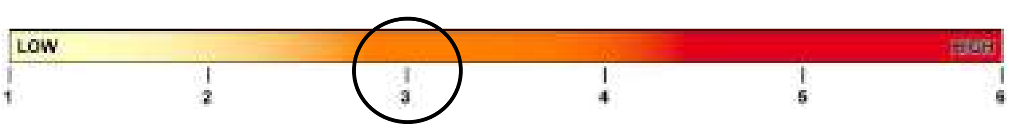
9.4.1.2 Receptor Sensitivity

Human Receptors

Table 9.12 presents the justification for assigning a score of 3 to human receptors, which represents Medium Sensitivity.

Table 9.12 Human Receptor Sensitivity

Parameter	Explanation	Rating
Presence	Nearest residential receptors (within Sangachal Town) are located between 500m to 1km of the SD2 Infrastructure works.	2
Resilience	Modelling results have confirmed that construction noise, even under worst case assumptions, will not exceed applicable noise limits or ambient noise levels (which ever is the greatest). Local receptors are not considered to be vulnerable as the existing noise environment is considered typical of an industrial area.	1
Total		**3**



Biological/Ecological Receptors

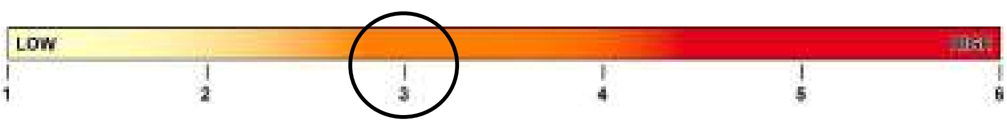
Noise from onsite plant and vehicles has the potential to impact breeding birds. Of the bird species recorded during the 2008 and 2009 bird surveys in the Terminal vicinity (refer to Chapter 6 Section 6.4.7.4), a total of 23 species (approximately 50% of all species recorded) are considered to be resident (breeding and occurring all year round). Of these, five species[18] are ground nesting, and have been recorded in the semi-desert habitat in the vicinity of Sangachal Terminal and the SD2 Expansion Area. While the data collected during the 2008 and 2009 surveys does not include the precise locations of nests, the breeding bird species recorded do not tend to nest in the same location each year. It is therefore not appropriate to state the number of breeding individuals that use the SD2 Infrastructure area as this will vary from year to year. There is no evidence within the surveys completed to date to indicate that the habitat within the SD2 Infrastructure Area is of unique value to breeding birds.

Breeding birds are most sensitive to disturbance during the breeding season (typically mid March – end August). They are most sensitive to sudden unexpected and loud noise such as hammering. Studies have shown however that birds frequently become habituated to anthropogenic noise including construction noise with no recorded effect on behaviour or breeding success[19]. Equally impacts to breeding success due to noise impacts have also been recorded. The survey results obtained within the Terminal vicinity suggest that the breeding birds are habituated to the industrial noise from the Terminal and Highway traffic noise may likely also therefore adapt to construction noise.

Table 9.13 presents the justification for assigning a score of 3 to biological/ecological receptors, which represents Medium Receptor Sensitivity.

Table 9.13 Biological/Ecological Receptor Sensitivity

Parameter	Explanation	Rating
Presence	23 species of residential birds have been recorded during surveys in 2008 and 2009 in the Terminal vicinity; approximately 22% of these species are breeding birds. Of these, 5 ground nesting breeding bird species were identified. None of these species are rare or threatened.	1
Resilience	While ground nesting birds have been identified within the areas affected by the works there is no evidence to indicate that areas have unique value to these species. It is likely that birds in the area are already tolerant to existing industrial noise and would become habituated to construction noise. It is expected that any disturbance to ground nesting bird breeding would stabilise as they adapt to the construction noise and the ecological functionality of the overall ground nesting bird population will be maintained.	2
Total		**3**



9.4.1.3 Impact Significance

Table 9.14 summarises impacts on noise associated with construction activities.

Table 9.14 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Noise associated with construction activities	Medium	(Humans) Medium	**Moderate Negative**
		(Biological/Ecological) Medium	**Moderate Negative**

[18] These include Chukar *Alectoris chukar,* Red-capped lark *Calandrella cinerea,* Lesser short-toed lark *Calandrella rufescens,* Calandra lark *Melanocorypha calandra* and Crested lark *Galerida cristata.*

[19] Melissa Anne Lackey, (2009), Avian Response To Road Construction Noise With Emphasis On The Endangered Golden-Cheeked Warbler.

The assessment of total construction noise (Section 9.4.1.1 above) provides an estimate of the contribution of the planned project activities to construction noise levels from each project activity. The existing control measures presented above are focused on best practice measures to control noise from onsite construction plant and vehicles (the greatest contributor to noise at receptors as shown in Table 9.10). To appropriately control noise associated with planned piling and concrete breaking activities the following measures will also be adopted:

- Where practicable, portable acoustic screens will be used around pneumatic hammers used when undertaking concrete breaking; and
- The local community (Sangachal Town, Azim Kend and Masiv) will be informed of the proposed schedule and works prior to commencement of the trial piling activities with driven piles.

No additional measures to those listed in Section 9.4.1.1 are considered necessary. A noise monitoring programme will be established prior to and during construction works and the results provided externally.

9.5 Impacts to the Terrestrial and Coastal Environment (Ecology)

9.5.1 Impacts to Ecology Due to Earthworks

9.5.1.1 Event Magnitude

Earthworks associated with the SD2 Infrastructure Project comprise surface soil layer removal and spoil movement, drainage management works and Pipeline Landfall Area preparation.

Chapter 5 indicates that the surface soil layer and associated vegetation will be removed from:

- The footprint of the Initial Site Compound during Phase 1;
- The route of the Enabling Road (not including the existing EOP road) during Phase 2;
- The route of the new Terminal access road during Phase 3; and
- The SD2 Expansion, North Construction Camp and South Construction Facilities areas during Phase 3.

It is anticipated that the surface layer will be removed to a depth of approximately 0.15m and a total surface area of approximately 70 hectares (ha) of desert and semi-desert habitat will be affected.

While it is planned to use the stripped surface soil as non-structural fill material within the flood protection berm, it is intended that stripped vegetation (including the surface layer of earth held together by its roots) will be stored separately and where practicable used for re-vegetation. Where not practicable vegetation will be mulched and disposed of in a suitable manner.

As part of the works it is intended that the two existing stockpiles of soil (approximately 440,000m^3 in total) which are located within the SD2 Infrastructure area (refer to Figure 5.6), will be redistributed during Phase 3 to provide structural fill for the:

- Access road and internal road embankments;
- Flood protection berm; and
- Construction camp and construction areas.

It is intended to move spoil directly to the point of use where practicable to avoid double handling.

The removal of the 70 hectares of surface soil represents a loss of existing habitat[20]. Where the areas will be subsequently developed (e.g. the footprint of the SD2 Expansion, North Construction Camp and South Construction Facilities areas and the route of new access road) the loss will be permanent. Where use of the area is temporary (initial site compound, Enabling Road and parts of the Pipeline Landfall Area) the loss will be temporary. Reinstatement of areas for temporary use is included within the project Base Case Design.

Drainage management works to be undertaken during Phase 3 include:

- Installation of new drainage channels within the SD2 Infrastructure area (refer to Figure 5.8); and
- Wadi works including clearance of the existing western and central wadi sea outfalls (expected to include the removal of obstructions such as rocks, vegetation and silt).

It is planned to use the excavated materials as structural fill materials where possible. It is estimated that a maximum of up to 19,000m^3 of material will be excavated. The works are anticipated to extend across an area of less than 5 hectares.

Removal of surface soil layer and vegetation from the Pipeline Landfall Area (refer to Chapter 5 Figure 5.6) is planned to occur during Phase 4 of the works. Excavation works will be undertaken to level the area (approximately 15 hectares). It is assumed, as a worst case, that the whole area will be stripped, all existing vegetation will be removed and excavated materials will be stored on site for re-use when required. It is understood that following the preparation works and the subsequent pipeline installation works (not included within the scope of this ESIA) the area will be reinstated.

Existing controls measures associated with terrestrial and coastal ecology include:

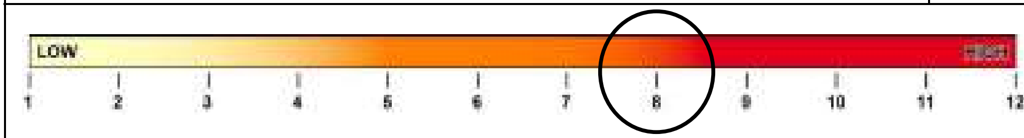
- When off road access is required, return journeys shall be made along the same routes where practicable to minimise disturbance.
- A construction corridor will be established along the access road route and the perimeter of the corridor defined. Works within the wetland area outside this perimeter, with the exception of planned wadi clearance works, will be strictly controlled by BP in order to minimise the area of ground disturbed.
- Surface soil layer removal and vegetation clearance near to wetlands, rivers or stream banks shall be minimised.
- Prior to removal, vegetation shall be inspected to detect presence of wildlife and activities ceased until appropriate action is taken to ensure any wildlife encountered is not harmed.
- Areas for laydown of soil or loose construction materials shall be identified to minimise impact to habitats and potential for erosion and sedimentation into watercourses or drains.
- Daily checks for wildlife shall be undertaken of excavations prior to work commencing. Where practical excavations should be covered overnight.
- Records will be maintained of all landscape management works.
- A Spoil and Landscape Management Plan will be prepared and will include details of the amount of spoil generated, reused, disposed of and the contamination potential of the spoil. The Plan will also cover details of a Biorestoration Plan.
- The Biorestoration Plan will be developed and implemented to restore all areas of disturbed land used on a temporary basis during the SD2 Infrastructure works to their preconstruction condition.
- A Wildlife Management Plan will be developed and implemented to manage the relocation of any mammals, reptiles or any IUCN or Azerbaijan Red Data Book listed species encountered within the areas affected by the SD2 Infrastructure works.

Table 9.15 presents the justification for assigning a score of 8, which represents a Medium Event Magnitude.

[20] Areas that have already been disturbed e.g. the footprint of the existing stockpiles have been excluded from this total.

Table 9.15 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	It is anticipated that surface soil and vegetation will be removed from an area of approximately 85 hectares in total which comprises desert and semi desert habitat. This represents a permanent loss for the majority of the area affected. An additional 5 hectares will be affected by excavations due to drainage management works.	2
Frequency	Once.	1
Duration	The removal of the surface soil and vegetation will be permanent in the majority of locations.	3
Intensity	Part of the loss of habitat due to surface soil removal will be permanent (more than 50%). The remainder will be reinstated. Habitat affected is not considered to be particularly sensitive or critical.	2
	Total:	**8**



9.5.1.2 Receptor Sensitivity

Construction activities have the potential to impact habitats and flora, fauna and breeding birds.

Local vegetation in the vicinity of the SD2 Infrastructure area (refer to Section 6.4.7.1) is characterised by floral species which are typical for the area surrounding the Terminal and are neither rare nor threatened. The main vegetation assemblages are dominated by low perennial shrubs (*Salsola nodulosa*, *Salsola dendroides, Suaeda dendroides*, *Salsola ericoides* and *Artemisia lerchiana*). One Azerbaijan Red Data Book listed species (*Iris acutiloba)* was recorded during surveys in 2004, 2005 and 2008. This species was found at survey locations to the north east of the Terminal (i.e. not within areas likely to be affected by the SD2 Infrastructure works).

Other than through direct disturbance as a result of ongoing activities immediately adjacent to the Terminal, monitoring has shown no significant change in the distribution or status of desert/semi-desert vegetation over time. Disturbed ground has shown a poor level of natural recovery over time with faster re-vegetation observed in areas where temporary surface water has been present after rainfall events.

The area around the locations for the wadi clearance works comprises wetland vegetation. The main wetland habitats are reedbeds, reedmace, rush dominated marshes and tamarisk/alhagi scrub (chal-meadow). The area is dynamic in nature and dependant on seasonal water flow through the wadi system in addition to smaller contributions from local sources (e.g. existing leaks from water pipelines in the 3rd party corridor as observed during the June 2011 wetland walkover - refer to Chapter 6 Section 6.4.7). Other than this seasonal change, surveys undertaken during 2002, 2010 and 2011 have not shown any significant alteration in the wetlands over time (e.g. in terms of species present and extent of wetlands), other than as a direct result of 3rd party construction activities. The habitat is not considered unique and the area affected by the works is not critical to the function of the habitat as a whole.

The coastal zone where the Pipeline Landfall Area preparation works are proposed supports desert vegetation dominated by sparse *Salsola nodulosa,* with occasional specimens of other species, including *Suaeda, Artemesia* and *Armeria*. The surveys undertaken show that there are no rare or threatened plant species present and the habitat is typical of that throughout the coastal zone. The area where the previous ACG/SD pipelines were installed has been rehabilitated using live plants. The results of surveys undertaken in 2007 and 2010 indicate that this effort has been successful with up to 57% vegetation cover by perennial species identified in 2010. Reinstatement associated with the SD2 Infrastructure Project will take into account lessons learnt from this earlier work.

The results of bird surveys undertaken in the Terminal vicinity are discussed in Section 9.4.1.2 above. The surveys have demonstrated that breeding birds have been identified within the Terminal vicinity. However, the habitat within the SD2 Infrastructure area is not considered critical as they have been recorded throughout the area surrounding the Terminal and use no area exclusively for feeding or nesting.

Faunal surveys have confirmed the presence of the following in the Terminal vicinity:

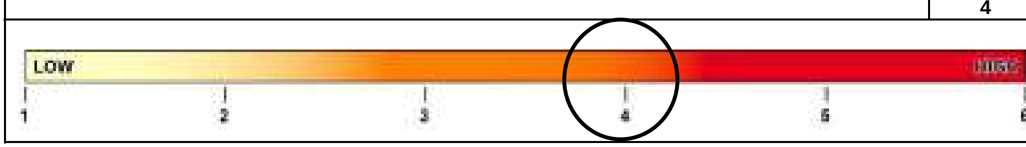
- Euphrates jerboa (*Allactaga euphratica*) - IUCN Lower Risk/Near Threatened.
- Grey hamster (*Cricetulus migratorius*) - IUCN Lower Risk/Near Threatened.
- Marbled polecat (*Vormela peregusna*) - AzRDBand Conservation Dependent.
- Wolf (*Canis lupus*) - no designated conservation status in Azerbaijan.
- Lizard (*Phrynocephalus helioscopus*) - no designated conservation status in Azerbaijan.
- Spur-thighed tortoise (*Testudo graeca*) - IUCN Red Data List Vulnerable and Azerbaijan Red Data Book listed.

These species have all been found in low numbers (one or two individuals on any occasion) and, with the exception of the spur-thighed tortoise, have not been recorded consistently in surveys undertaken between 2002 and 2010. While spur-thighed tortoise have been consistently recorded in the area, the precise distribution of spur-thighed tortoise has not been determined. The likely reason for the consistent records of this species is due to the relocation programme that was undertaken prior to and following the previous ACG and SD projects where spur-thighed tortoise were collected prior to the works and then reintroduced once the works were completed. The majority of suitable habitat (i.e. areas which have a mixture of scrub and short vegetation, offering both protection and food supplies) for this species lies outside the area to be affected by the SD2 Infrastructure works. The areas to be affected are not considered to be critical or particular importance. Spur-thighed tortoise are most sensitive during the breeding and egg laying periods which are between April and July.

Table 9.16 presents the justification for assigning a score of 4 for Biological/Ecological Receptor Sensitivity, which represents Medium Receptor Sensitivity.

Table 9.16 Biological/Ecological Receptor Sensitivity

Parameter	Explanation	Rating
Presence	No rare or protected plant species or breeding bird species have been recorded in the areas to be affected by the SD2 Infrastructure works during recent surveys undertaken in 2004, 2005, 2008 & 2009 (refer to Chapter 6 Table 6.1). Surveys have recorded a number of faunal species with conservation status including the spur-thighed tortoise, which is classified as vulnerable in the IUCN Red Data List, and also included within the Azerbaijan Red Data Book.	2
Resilience	**Habitat** will be lost due to surface soil removal and wadi clearance works. In areas for temporary use vegetation will be temporarily impacted. Reinstatement of these areas would lead to vegetation recovery (including the microbiotic crust) in over 20 years[21]. Within the pipeline landfall area, reinstatement works for the previous ACG/SD projects suggests vegetation recovery may be more rapid (3-5 years). The ecological functionality of all habitats would be maintained in the long term. Surveys have shown that the areas affected by the works are not critical to **ground nesting birds,** which have been recorded in the Terminal vicinity (refer to Section 9.4.1.2). The effects of the nesting areas lost would stabilise, and ecological functionality of breeding bird populations will be maintained. Six **faunal species** (including four with conservation status) have been recorded in low numbers in the Terminal vicinity. Direct effects are not expected assuming existing control measures are followed, however spur thighed tortoise are known to be regularly present and are particularly during the breeding season (April - July). The area affected is however not optimal and not considered critical to the existing population. The works would contribute to no more than minor temporary change. Ecological functionality of the faunal species populations will be maintained.	2
		4



[21] Biological Soil Crusts: Ecology and Management, US Department of the Interior, 2001.

9.5.1.3 Impact Significance

Table 9.17 summarises impacts on terrestrial ecology associated with the construction works.

Table 9.17 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Surface soil layer removal and spoil movement	Medium	Medium (Biological/ecological receptors)	**Moderate Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures as listed in Section 9.5.1.1 above and no further mitigation is required.

9.6 Impacts to the Terrestrial Environment (Soil, Groundwater and Surface Water)

9.6.1 Excavation Works and Ground Disturbance

9.6.1.1 Event Magnitude

Surface soil layer removal and redistribution of spoil within existing stockpiles is discussed in Chapter 5: Project Description Sections 5.5.1, 5.5.2 and 5.5.3. The areas where surface soil layer removal will occur, the intended use of the stripped soil and the planned use of the two existing stockpiles is described in Section 9.5.1.1 above.

Drainage management works are discussed in Chapter 5: Project Description Section 5.5.3 and include the construction of new drainage channels during Phase 3. These new drainage channels comprise ditches and bunds that are lined (with concrete or geotextile) or profiled depending on their location and soil conditions and have a depth up to 1m below ground. The location of new drainage channels are shown in Figure 5.8.

While the monitoring to date (refer to Chapter 6 Section 6.4.3) has not indicated any significant or widespread contamination in the SD2 Infrastructure area, it is possible that localised areas of contaminated surface soil and spoil are present which may become mobilised by physical disturbance[22].

Wadi clearance works within the wetland area to the south of the Terminal are planned to comprise clearance of the existing western and central wadi culverts to remove obstructions such as rocks, vegetation and silt. As discussed in Chapter 6 Section 6.4.4, results of the analysis from water and soil samples collected within the wetland area, including the area where the wadi clearance works are proposed, have indicated high level of Total Hydrocarbon Content (THC) and Polyaromatic Hydrocarbons (PAH) in addition to cadmium (within groundwater samples) and phenols (within soil samples). During the wetland survey undertaken in June 2011, a number of spills were identified in the wetland area (refer to Figure 6.5). All the spills appeared to be hydrocarbon; however the source was not evident.

In the event oily contaminated soil, ground water, surface water or other materials outside of the existing Sangachal Terminal property boundary are encountered and require handling:

- The soil, surface water, groundwater or other materials will be relocated to an area that is of comparable environmental quality and function;
- The relocation will be undertaken in a manner that will not degrade the environment further and will promote the natural degradation of contaminants; and

[22] Contaminative status of SD2 Infrastructure Area will be further defined following completion of ongoing geotechnical assessment – refer to Chapter 6 Section 6.2.

- The following details will be recorded; contaminants detected, handling methods adopted to prevent further environmental degradation, location and quantity of contaminated material detected.

Oily contaminated soil, ground water, surface water or other materials are not anticipated within the existing Sangachal Terminal property boundary. However, if encountered, contaminated materials within the existing Sangachal Terminal property boundary will be classified and managed as waste in accordance with existing BP waste management procedures.

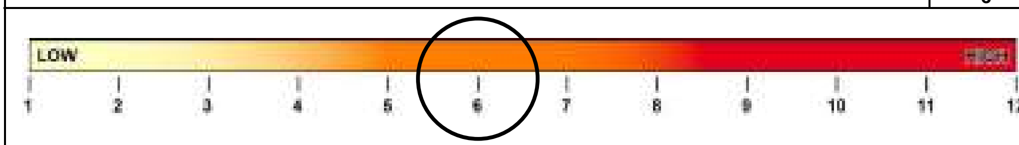
Other controls associated with minimising mobilisation of contamination during earth works include:

- Vehicle wash facilities shall be located at least 10m from permanent water features.
- Spoil heaps shall not be stockpiled close to surface water.
- Stockpiles will be appropriately shaped and compacted to avoid erosion and sedimentation of nearby open water courses or drains.
- A transfer note system shall be used to control the movement of spoil across the site. This shall include the point of excavation, destination and waste classification.
- Site drainage and pollution hazards maps shall be maintained that show potential sources of pollution (e.g. storage areas), pathways (e.g. drains) and receptors (e.g. the Caspian Sea).
- Designated areas will be established away from watercourses for waste cement/ concrete, which will be contained and collected as a waste once solidified.

Table 9.18 presents the justification for assigning a score of 6 to earthworks which represents a Medium Event Magnitude.

Table 9.18 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	It is anticipated that areas of contamination within the SD2 Infrastructure area will be limited. Within the wetland area there are known areas of contamination however good construction management will be adopted to minimise the potential for mobilisation of contamination.	1
Frequency	Once.	1
Duration	Earthworks will take place over the whole construction period.	3
Intensity	Good construction management is expected to minimise potential for mobilisation.	1
		6



9.6.1.2 Receptor Sensitivity

Relevant receptors include soil and surface water in the vicinity of the SD2 Infrastructure area and the areas where wadi clearance works are planned. Monitoring undertaken to date (Chapter 6 Section 6.4.4) has confirmed there is no groundwater bearing unit within 20m of the surface.

As reported within Chapter 6, recent soil quality survey results in and adjacent to the SD2 Infrastructure area (during 2006 and 2008) indicate no significant contamination. Analysis of soil samples have shown no significant exceedances of relevant standards or limit values (with the exception of elevated levels of arsenic and iron, which is considered to be naturally occurring).

Elevated levels of TPH and heavy metals were detected in surface water samples (taken in locations to the south of the Terminal). These were considered to be due to previous Soviet era hydrocarbon exploration activity.

Within the wetland area where the wadi clearance works are planned, high levels of contamination have been recorded in surface water and soil samples taken and hydrocarbon spills have been observed.

Tables 9.19 and 9.20 present the justification for assigning a score of 3 to soil and 4 to surface water which represents Medium Sensitivity.

Table 9.19 Receptor Sensitivity (Soil)

Parameter	Explanation	Rating
Presence	Affected area has moderate value as it is used for local grazing	2
Resilience	Soil quality is expected to be largely unaffected by earthworks. No significant existing contamination present within the SD2 Infrastructure area. Within the wetlands, high levels of contamination are present however the planned clearance works are not expected to result in significant mobilisation of contamination.	1
Total		**3**

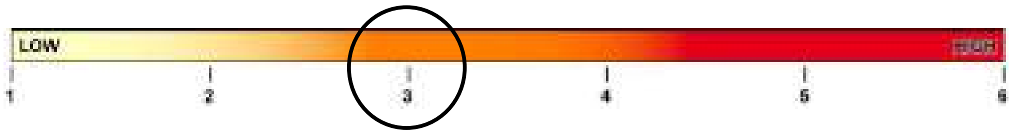
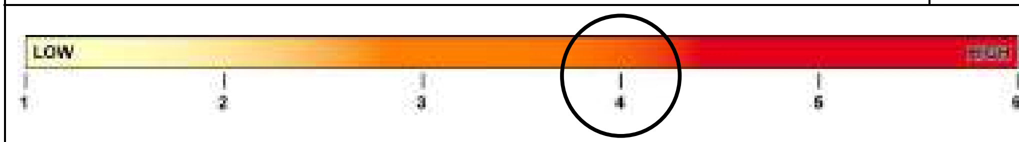


Table 9.20 Receptor Sensitivity (Surface Water)

Parameter	Explanation	Rating
Presence	Surface water bodies not used for public water supply. Used seasonally by herders for watering animals.	2
Resilience	Water quality is expected to be largely unaffected by earthworks. Moderate to high levels of existing contamination currently present within the wetland area.	2
Total		**4**



9.6.1.3 Impact Significance

Table 9.21 summarises the impact on soil and surface water from the SD2 Infrastructure works.

Table 9.21 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Excavation works and ground disturbance	Medium	(Soil) Medium	**Moderate Negative**
		(Surface Water) Medium	

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures as listed in Section 9.6.1.1 above and no additional mitigation is required.

9.7 Impacts to the Terrestrial & Coastal Environment (Cultural Heritage)

9.7.1 Impacts to Cultural Heritage Due to Earthworks and Piling

9.7.1.1 Event Magnitude

Earthworks

The removal of the surface soil layer and redistribution of spoil within existing stockpiles is discussed in Chapter 5: Project Description Sections 5.5.1, 5.5.2 and 5.5.3. The surface soil layer will be removed from a depth of 0.15m at the following locations:

- Initial site Compound established in Phase 1;
- Route of the Enabling Road in Phase 2;
- SD2 Expansion Area in Phase 3;
- North Construction Camp area in Phase 3; and
- South Construction Facilities area in Phase 3.

Material within the two existing stockpiles of spoil (Figure 5.6) will also be removed and redistributed during Phase 3 clearance works to provide structural fill. The Pipeline Landfall Area will be stripped and levelled.

While a non-intrusive archaeological survey, undertaken in 2001, in the Terminal vicinity identified one find within the SD2 Infrastructure area, a subsequent walkover in 2011 indicated that the likelihood of encountering extensive settlement remains in this area appears to be relatively low. There is potential, however, that the physical removal of the upper layer of surface soil and movement of spoil may impact cultural heritage resources if present. The areas beneath the existing spoil heaps are likely to be substantially impacted as a result of past activity in the area. Nearly 75% of the Pipeline Landfall Area was disturbed previously by aggregate or limestone quarrying. It is considered that there is no potential for archaeological remains in the area disturbed by previous quarrying.

Drainage management works are planned to include the construction of new drainage channels and wadi clearance works in the vicinity of the Western and Central drainage channel outfalls (refer to Chapter 5 Figure 5.8). The new drainage channels are planned within the SD2 Infrastructure area whereas the wadi clearance works will include subsurface groundworks in the vicinity of engineering features north and east of the Caravanserai (a State protected monument to the south of the Terminal – refer to Chapter 6 Section 6.6).

Existing controls associated with cultural heritage include:

- A watching brief shall be maintained to identify any artefacts of archaeological importance and a chance finds procedure shall be in place.
- Any findings will be reported immediately and any corrective measures required will be agreed with an archaeological specialist in liaison with the Ministry of Culture and Tourism and the Institute of Archaeology and Ethnography.
- In the event archaeological resources are found during excavation work an assessment will be made by the archaeological watching brief on what controls and changes to the excavation work are required and whether work in the area needs to be suspended to allow for a more detailed archaeological assessment of the area.

Within the draft SD2 Infrastructure Project ESIA it was repored that cultural heritage baseline surveys were planned in liaison with the MoCT and IoAE to supplement the earlier 2011 walkover survey to comprise:

- A comprehensive archaeological walkover of the areas affected by the SD2 Infrastructure area; and
- A photo survey and mapping of the Caravanserai to confirm condition and extent.

These surveys have been completed by URS and the Azerbaijan Institute of Archaeology and Ethnography (IoAE) in 4Q 2011. The results of the survey are pending and will inform the Archaeology and Cultural Heritage Management Plan (refer to Chapter 12 Table 12.1). In general it is understood that no significant archaeological finds were encountered and the structural condition of the Caravanserai was considered to be good.

Piling

Piling activities are planned to include driven pile trials in the SD2 Expansion Area and bored piles at the pipeline crossings (refer to Section 9.5.1.1 above). Piling activities, especially driven piles, can generate vibrations within soil and rock matrices that have the potential to impact cultural heritage structures, such as the Caravanserai. The driven piles trials are planned to be located west of the SD2 Expansion Area more than 1km from the

Caravanserai. The areas where the bored pipeline crossings are planned are located a minimum of 250m from the Caravanserai. As vibrations from piling activities are not expected to travel more than 50m from the source it is considered unlikely that the Caravanserai would be affected by piling activities.

Table 9.22 presents the justification for assigning a score of 6 to earthworks and piling activities which represents a Medium Event Magnitude.

Table 9.22 Event Magnitude

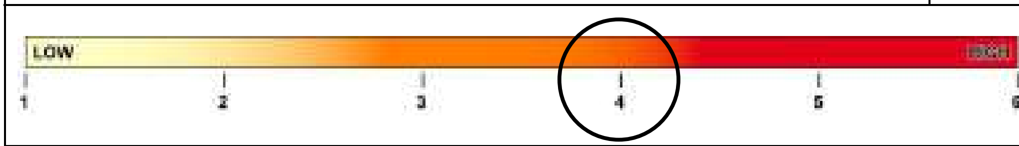
Parameter	Explanation	Rating
Extent/Scale	**Surface soil removal** - The extent of surface soil to be removed is relatively shallow (0.15m) but will cover a broad area. Although significant archaeological features are not expected to be present within this upper layer of surface soil, or under existing stockpiles of spoil, limited impacts are possible. **New drainage channels** - The extent of material to be removed for construction of new drainage channels represents a small area, but one that transects much the SD2 Infrastructure area. **Wadi clearance works** - The extent of material to be removed for the wadi clearance groundworks represents a small area, however the works are located less than 500m from the Caravanserai, which is a State protected monument. **Piling** - The piling activities are of limited extent but are located less than 500m from the Caravanserai.	2
Frequency	Damage to cultural heritage sites are not expected to occur because the planned archaeological baseline survey is expected to identify those sites greater than 0.5 hectares in extent.	2
Duration	Damage to cultural heritage sites is not expected to be of long duration because watching brief will prevent substantive damage.	1
Intensity	Low intensity event as no damage to cultural heritage is expected to occur.	1
		6

9.7.1.2 Receptor Sensitivity

Table 9.23 presents the justification for assigning a score of 4 to cultural heritage which represents Medium Sensitivity.

Table 9.23 Receptor Sensitivity

Parameter	Explanation	Rating
Presence	There are no State protected monuments or other cultural heritage sites known to occur within the SD2 Infrastructure Area. However wadi clearance works and piling works are planned within 500m of the Caravanserai.	3
Resilience	It is anticipated that the status of cultural heritage will be unaffected by the proposed work.	1
Total		**4**



9.7.1.3 Impact Significance

Table 9.24 summarises impacts on cultural heritage from earthworks and piling.

Table 9.24 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Impact to cultural heritage from earthworks and piling	Medium	Medium	**Moderate Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (which includes the use of a watching brief and a chance finds procedure) and no additional mitigation will be warranted.

9.8 Summary of SD2 Infrastructure Project Residual Environmental Impacts

For all environmental impacts assessed it has been concluded that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures and the development and implementation of an environmental social management system during the construction works (refer to Chapter 12 for further details).

Table 9.25 summarises the residual environmental impacts.

Table 9.25 Summary of SD2 Infrastructure Project Residual Environmental Impacts

	Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from onsite and offsite construction plant and vehicles. Emissions from surface soil layer removal and spoil movement.	Medium	(Humans) Medium	**Moderate Negative**
Noise	Noise emissions associated with construction activities.	Medium	(Humans) Medium (Biological/ Ecological) Medium	**Moderate Negative**
Impact to the Terrestrial and Coastal Environment (Ecology)	Surface soil layer removal and spoil movement, drainage management works and Pipeline Landfall Area preparation.	Medium	(Biological/ Ecological) Medium	**Moderate Negative**
Impact to the Terrestrial Environment (Soil, Groundwater and Surface Water)	Excavation works and ground disturbance.	Medium	(Soil) Medium	**Moderate Negative**
			(Surface Water) Medium	**Moderate Negative**
Impact to the Terrestrial and Coastal Environment (Cultural Heritage)	Impacts to cultural heritage due to earthworks and piling.	Medium	(Physical Resource) Medium	**Moderate Negative**

10. Socio-Economic Impact Assessment, Mitigation and Monitoring

Contents

List of Tables

10.1 Introduction

This Chapter describes the socio-economic impacts, and mitigation and monitoring measures, associated with the SD2 Infrastructure Project.

In accordance with the impact assessment methodology (see Chapter 3), ESIA Scoping was undertaken to identify selected Activities and associated Events that might impact the socio-economic environment or, alternatively, that might be excluded from the full socio-economic impact assessment process. The scoping assessment determined impact significance by considering the expected likelihood of impacts, magnitude of events, nature of interactions and the sensitivity of socio-economic receptors against existing controls and mitigation measures. This Chapter sets out the requirements for monitoring to confirm that those controls and mitigation measures are implemented and effective.

10.2 Scoping Assessment

The scoping process has used judgement based on prior experience of similar Activities and Events, especially with respect to earlier ACG and SD construction activities at the Terminal. In some instances, scoping level quantification/numerical analysis has been used to justify the decision. Reference is made to relevant quantification, analysis, surveys and/or monitoring reports in these instances.

The scoping process excluded a number of SD2 Infrastructure Project Activities and associated Events due to their limited potential to result in discernable socio-economic impacts, or if they were already covered in other Chapters of the ESIA. The activities and associated events excluded from the socio-economic impact assessment are presented in Table 10.1 (see Appendix 10A for all SD2 Infrastructure Project Activities, Events and Interactions).

Table 10.1 "Scoped Out" SD2 Infrastructure Project Routine and Non-Routine Activities

ID	Activity / Event	Ch. 5 Project Description Reference	Justification for "Scoping Out"
S1-R	Land Acquisition	5.2	• It will be necessary to acquire up to 302 hectares of land in the immediate vicinity of the Terminal. • It is understood that this land is currently owned by the State Government and there is no existing income to the Government from this land. • The area of land to be acquired is small in a regional and national context of land ownership. **Conclusion**: Very limited potential for impact from land acquisition.
S6-R	Operation of construction plant and vehicles onsite and offsite, movement of spoil, subsurface and above ground structural works and erection of buildings/structures - Community Disturbance (e.g. noise, dust).	N/A	• Community disturbance impacts assessed within Chapter 9.
S9-R	Connections to mains water supply - Disruption to freshwater supply.	5.5.4	• Mains water supply connections planned during Phase 4. • Connection to mains water supply to be managed in liaison with utility owner. • Utility owner required to manage any potential disruptions to community. **Conclusion:** Potential disruption to local community associated with water supply connections to be managed by utility owner. No discernable impact anticipated.
S10-R	Connections to mains power supply- Disruption to freshwater supply.	5.5.2	• Power at initial site compound, temporary security compound, Pipeline Landfall Area and at construction camp/facilities prior to tie in to be provided by diesel generators. • Diversion of power lines in the vicinity of the SD2 Infrastructure Area and mains power supply connections planned during Phase 2. • Connection to mains power supply and power line diversions to be managed by utility owner. • Utility owner required to manage any potential disruptions to community. **Conclusion:** Potential disruption to local community associated with power supply connections to be managed by utility owner. No discernable impact anticipated.
S11-R S12-R S13-R S14-R	In-migration of workers resulting in increased pressure on community infrastructure (utilities, waste & sewage, goods & services, employment and health services).	N/A	• It is anticipated that the workforce will comprise between 450 and 700 persons. • It is expected that the majority of workers will be resourced from the vicinity of the Terminal. Local targets (for professionals and non professionals) will be determined to maximise employment as far as practical for the existing residents of Sangachal Town, Umid, Azim Kend or Masiv 3, which will be verified by the prospective employee's identification card. • Workers will be transported to and from site daily. No workers will be resident at the construction site. • In migration of workers expected to be very low and consequently there is little potential for impacts to occur to community utilities, waste and sewage facilities, local goods and services and employment from in influx of non resident workers. • A Community Health Plan will be developed and implemented to address and monitor community health risks associated with the infrastructure construction work. **Conclusion:** Very limited potential for impacts to community utilities, waste and sewage facilities, local goods and services, employment and health services due to in migration of non resident workers during SD2 Infrastructure Project.

The SD2 Infrastructure Project routine and non-routine Activities and associated Events included in the scope of the socio-economic impact assessment are presented in Table 10.2.

Table 10.2 "Assessed" SD2 Infrastructure Project Routine and Non-routine Activities

ID	Activity	Phases	Ch. 5 Project Description Reference	Event	Event Category
S2-R	Disruption/access restrictions to natural resources and recreation	Phases 2-6	5.5.2-5.5.6	Disruption/access restrictions to grazing land around terminal.	Land Use and Access
				Disruption/access restrictions to wetland area.	
				Disruption/access restrictions to fishing areas.	
S3-R	Employment creation	All Phases	5.9	Job creation.	Employment
S4-R	Training and skills development	All Phases	5.9	Workforce training and skills development.	Training and Skills Development
S5-R	Procurement of goods and services	All Phases	5.3	Increased economic flows.	Procurement
S7-R	Construction vehicle movements (offsite)	N/A	N/A	Disruption to road users and community safety.	Road and Rail
				Deterioration of public roads/highway.	
S8-R	Road/rail works	Phases 2-7	5.5.2-5.5.7	Disruption to road users.	
				Disruption to railway users.	
S15-R	De-manning	Phase 7	5.9	Loss of jobs.	De-manning

10.3 Land Access

10.3.1 Disruptions / Access Restrictions to Natural Resources and Recreation

The project activities from the establishment of the initial site compound during Phase 1 (Chapter 5 Section 5.5.1) to the closure of the EOP Road and the At-Grade Railway Crossing during Phase 7 (Chapter 5 Section 5.5.7) will all involve disruption to the land within the footprint of the SD2 Infrastructure area. This includes the Pipeline Landfall Area and temporary and permanent access restrictions to natural resources and recreational areas.

It will be necessary to fence each area temporarily during the construction works for safety and security reasons. It is likely that the Pipeline Landfall Area will remain fenced following the preparation works for security reasons. In addition, while the access road crossings incorporate sufficient space for herders to cross underneath during construction works, the area around the access road during these works will be temporarily unavailable.

Probability

The change in land access may impact:

- **Local herders** - economic displacement may be experienced due to an increase in the travel time required to reach favoured grazing areas, and a reduction in the total amount of land accessible for grazing;
- **Recreational fishermen** – fishing from the shoreline area in front of the Terminal is understood to be for recreational purposes (refer to Chapter 7 Section 7.4.6);
- **Commercial fishermen** – fishing may be impacted by restricted access to the Pipeline Landfall Area;
- **Recreational users –** potential impact to those who use the beach area for recreation use e.g. walking; and
- **Shoreline properties (under construction)** (refer to Chapter 7 Section 7.4.2) – there is the potential for property values to be reduced from increased industrialisation of the area.

The probability for impacts to occur depends upon the receptor. It is considered ‘highly likely’ that impacts to herders, fishermen (recreational and commercial) and recreational users will occur as the temporary or permanent access restrictions and disruption to land associated with the project will occur in, or immediately adjacent to, areas used by these groups at present.

Impacts to the value of partially constructed shoreline properties are considered to be ‘unlikely’. The properties are yet to be fully completed and it is understood their likely use is as occasional homes (e.g. summer homes). They are located immediately to the south of the Terminal with the Highway to the north and their location is not considered sensitive to change. No change to access is expected as a consequence of the project.

Magnitude

The magnitude of the expected impacts is evaluated as follows:

- **Local herders** – As stated within Chapter 7 Section 7.4.6, herding of cattle, goats and sheep is undertaken in the area surrounding the Terminal. There are two herder settlements located to the east of the Terminal (refer to Figure 7.2). Herders from these settlements are known to use the land in the Terminal vicinity particularly during the winter months. It is understood that herding activities associated with the local communities is undertaken throughout the year. There is a partial fence located to the west of the Terminal, however this does not provide full exclusion to this area or completely restrict access into the SD2 Expansion Area. It is anticipated that for the duration of the project the majority of the land associated with the SD2 Infrastructure area (including the Pipeline Landfall Area) will be inaccessible to herders as temporary fencing is erected to prevent unauthorised access to the construction areas. Following the project completion the developed areas associated with the project (e.g. SD2 Expansion Area, Construction Camp, Construction Facilities and the route of the new access road) will no longer be available for herding. This equates to approximately 115 hectares. No permanent fencing is proposed as part of the works.

- **Recreational and commercial fishermen –** As stated within Chapter 7 Section 7.4.6 recreational and commercial fishing is undertaken to the east of the Pipeline Landfall Area and generally occurs during the summer months. It is anticipated that the preparation works associated with the Pipeline Landfall Area will be undertaken during Phase 4 (i.e. between March 2012 and June 2013 - refer to Chapter 5 Section 5.4). It is therefore anticipated that works within the Pipeline Landfall Area may impact these activities during the summer months only. The Pipeline Landfall Area however is not known to be used for fishing and therefore the impact would be limited to indirect impacts e.g. potential disruption. It is understood, from informal discussions with local fishermen, that there are a number of individuals undertaking recreational fishing and approximately 20-30 individuals are involved in commercial fishing. None of the 200 household surveyed by the SSES undertake fishing activities.

- **Recreational users –** The shoreline area is known to be used on an occasional basis as a local amenity. Potential impacts to access will occur following the erection of temporary fencing around the Pipeline Landfall Area.

- **Shoreline properties (under construction) -** A total of 7 properties are in various stages of construction north east of the Pipeline Landfall Area (refer to Chapter 7 Section 7.4.2) and will not be directly impacted by the shoreline works. It is not anticipated that there will be any change to access to these properties. The properties closest to the Pipeline Landfall Area are enclosed within a high wall and access is provided via a dedicated road.

Receptor Sensitivity

Receptor sensitivity is evaluated as:

- **Local herders** – considered to be 'high' as livestock is anticipated to be an important source of primary and secondary household income;
- **Recreational fishermen** – considered to be 'low' as fishermen do not rely on catch from recreational fishing activities as a source of primary or secondary income, and will be able to seek out alternative fishing grounds for informal use as they are mobile;
- **Commercial fishermen** – considered to be 'medium' as while it is understood that fishing along the shoreline constitutes a primary source of household income, the areas where commercial fishing is known to occur is to the east of the Pipeline Landfall Area. No direct impacts are expected;
- **Recreational users** – considered to be 'low' as users will not experience a reduction in household income, and can easily seek out alternative areas for recreational use; and
- **Shoreline properties (under construction)** – considered to be 'low' as access to the partially-constructed buildings is not expected to be directly impacted.

Table 10.3 presents the justification for assigning moderate-major impact significance to disruption and access restrictions to natural resources and recreation associated with local herders and negligible significance to recreational fishermen, recreational users of the shoreline and value of shoreline properties and negative significance to commercial fishermen.

Table 10.3 Socio Economic Impact Significance for Disruption/Access Restrictions to Natural Resources and Recreation

Event	Magnitude		Probability	Receptor Sensitivity	Significance
	Spatial Scope	Timing and Duration			
Disruption and access restrictions (SD2 Infrastructure Area)	Local	All SD2 Infrastructure area will be temporarily fenced during works to prevent unauthorised access. Temporary	Highly likely	Local herders – High	**Moderate – major negative**
		Up to approximately 115 hectares will be permanently removed from use for herders. Permanent			
Disruption and access restrictions (Pipeline Landfall Area)	Local	The majority of the SD2 Infrastructure Area will be temporarily fenced during works (between March 2012 and June 2013). Temporary	Highly likely	Recreational fishermen - Low	**Negligible**
			Highly likely	Commercial fishermen - Medium	**Negative**
			Highly likely	Recreational users - Low	**Negligible**
			Unlikely	Shoreline property values - Low	**Negligible**

It is considered that impacts to recreational fishermen, recreational users and the value of the shoreline properties are minimised as far as practicable and necessary. No additional mitigation is required.

10.4 Employment

It is anticipated that the project will employ between 450 and 700 people over the duration of the works (Chapter 5 Section 5.9).

The construction contractor will be required to implement a Workforce Welfare and Local Employment Plan which aims to maximise the employment opportunities for local people (refer to Chapter 12 for full details).

The existing controls associated with employment to the local communities are:

- Information will be provided to local communities by the construction contractor undertaking the work on the nature and levels of employment required;
- At all times the individual recruited will be the person who is most suited to the particular post, based on the applicant's abilities, qualification, experience and merit as measured against the job description and person specification;
- Measures will be implemented to maximise employment as far as practical from residents of local communities in the vicinity of Sangachal Terminal, to achieve, or improve if practical, the local content percentages achieved for the previous ACG and SD construction projects;
- Where local employment (professionals and non professionals) falls below the specified target, the reasons for this non-compliance will be investigated and practical measures developed and undertaken to meet the targets;
- A grievance procedure for managing all community complaints related to the recruitment process will be established; and
- The process and outcomes of all recruitment, including the number of applications, numbers accepted for interview and numbers offered employment, will be monitored and recorded. A record will also be made of the level of employment from local communities and employment from outside of this local area.

The construction contractor will be required to report records of applications received, interviews held and jobs offered. The numbers of people who apply and are employed from the local communities, will be recorded. All employment-related grievances, including those associated with recruitment processes, will be recorded and reported, along with details of measures taken to resolve the concerns raised.

Probability

Employment within the local communities is considered 'highly likely'. The benefits of employment to individuals are expected to include a rise in their socio-economic status, increased household expenditure particularly on education and healthcare and, also, their general well-being. Workers from households in Azim Kend and Masiv 3 are likely to experience the greatest positive change in socio-economic status, due to their current low levels of expenditure on education and healthcare when compared with households in Sangachal and Umid (refer to Chapter 7 Section 7.4.8).

Employment creation may benefit a greater number of individuals than the total workforce, as the increased household income will likely benefit relatives, partners and children.

On a regional level, it is expected that employment is considered 'likely', specifically as workers may be recruited from the wider region to fill specific roles that cannot be resourced from the local area.

Magnitude

The total number of people employed is expected to increase to a maximum of 700. It is reasonable to assume that this will likely coincide with the greatest period of activity on site (i.e. the period when most phases overlap). This is anticipated to be between April 2012 and November 2012.

Receptor Sensitivity

As reported within Chapter 7 Section 7.4.6 in September 2008, 400 people in the Garadagh region were registered as unemployed. Within the households surveyed during the June 2011 Stakeholder and Socio-Economic Survey (SSES), 66% respondents considered themselves to be unemployed. It is therefore considered that there is a strong demand for employment in the local communities.

On the basis on the reported high level of unemployment in the local communities and the expectation that BP and its contractors will provide preferential employment to local people during the project (as reported within the community focus groups conducted as part of the SSES), the sensitivity of the local communities is considered 'High'.

The sensitivity of the wider region, where the expectation for jobs associated with the project is lower, is considered to be 'Medium'.

Table 10.4 presents justification for assigning a Moderate-Major Positive impact significance to employment creation at a local level, and a Positive impact at a regional level.

Table 10.4 Socio Economic Impact Significance for Employment Creation

Event	Magnitude		Probability	Receptor Sensitivity	Significance
	Spatial Scope	Timing and Duration			
Employment creation	Local	Employment will occur throughout the project, and is expected to peak between April 2012 and November 2012 Temporary impact	Highly likely	Local community - High	**Moderate-Major Positive**
	Regional		Likely	Regional community – Medium	**Positive**

It is considered that local and regional impacts associated with employment are maximised as far as practicable through the existing controls listed above. No additional measures are required.

10.5 Training and Skills Development

Training and Employment is discussed in Chapter 5 Section 5.9.

The existing controls associated with training and skills development are:

- The construction contractor will be required to put a Training Plan in place which describes training programmes that are expected to be similar in content to those implemented for previous ACG and SD projects (refer to Chapter 7 Section 7.4.6.1). The aim of the Training Plan will to provide training and skill development opportunities, with a particular emphasis on the training of Azerbaijani citizens;
- A formal system of competency assurance will be implemented and records maintained of competency testing and training activities completed;
- A self-verification system will be implemented to monitor performance of all training and competency assessment activities against the Training Plan, with any deficiencies rectified through appropriate actions;
- Where required by Azerbaijani law, approval from the appropriate authority will be obtained for training courses and trainers;
- The training and competency plans will be monitored through regular audits, which aim to determine the effectiveness of the Training Plan. Any changes to the Training Plan will be approved; and
- Recognition will be given to the diversity of language used by workers. Supervision will be assisted by suitably qualified and experienced interpreter who will speak

English and the native languages of the workforce. Tool-box talks will be translated into the native languages of the workforce to aid communications.

Probability

It is considered 'highly likely' that workers from both the local and regional area will undertake training and skills development activities, and will benefit from the programmes provided. It is also considered likely that income gained through employment may also be used to fund external training and other skills development activities, either during or following completion of their employment

Magnitude

Training and skills development will occur prior to the commencement of project activities as workers will be required to undergo training to undertake the works to the required standard. As in the case of the previous ACG and SD projects, training is expected to encompass technical skills in addition to Health and Safety, information technology and administration skills. Training and skills development is expected to be ongoing throughout the project, and will provide workers with skills that can be used to obtain alternative employment in future roles.

Receptor Sensitivity

Receptor sensitivity to training and skills development is 'high' as there is a strong expectation among the local communities that training and skills development activities will be provided. This is, in part, as a result of the previous training provided for ACG and SD projects. Sensitivity in the regional area is expected to be 'medium' due to this expectation.

Table 10.5 presents the justification for assigning Moderate-Major positive significance and Positive significance to training and skills development for local and regional workers respectively.

Table 10.5 Socio Economic Impact Significance for Training and Skills Development

Event	Magnitude		Probability	Receptor Sensitivity	Significance
	Spatial Scope	Timing and Duration			
Training and skills development	Local	Training will commence prior to the project activities and continue throughout the project. Permanent	Highly likely	Local community – High	**Moderate-Major positive**
	Regional		Highly likely	Local community – Medium	**Positive**

It is considered that local and regional impacts associated with training and skills development are maximised as far as practicable through the existing controls listed above. No additional mitigation is required.

10.6 Procurement

As stated within Chapter 5 Section 5.3, preference will be given to source equipment (such as plant and construction vehicles) and materials (such as gravel) which meet the required project specifications from Azerbaijan wherever possible.

Probability

It is anticipated that the procurement of materials, equipment, goods and services from local, regional and national businesses is ‘highly likely’ and these businesses will experience an associated increase in their turnover as a result. As a minimum, this is expected to benefit business owners and existing staff if their current levels of remuneration are increased.

Magnitude

The procurement of materials, equipment, goods and services will commence prior to the commencement of project activities and will continue throughout the project. The anticipated benefit to businesses cannot be quantified with confidence at present as the procurement strategy and award of construction contracts has been not been made. It is however, assumed the aggregate materials (if suitable for project use) will likely be available locally given the location of a number of quarries within 30km of the Terminal. In addition given the substantial number of construction projects within and near to Baku and in the wider area, it is expected that construction plant and vehicles are likely to be available in country. It is not currently known whether the construction plant and vehicles available meets project specifications.

Receptor Sensitivity

It is considered that receptor sensitivity is ‘high’ on the basis that:

- There is a strong expectation amongst local, regional and national business owners that a significant proportion of the total procurement will be allocated to in-country suppliers; and
- The use of local, regional and national businesses to supply goods and materials will contribute towards socio-economic development.

At a national level, receptor sensitivity is considered to be ‘Medium’ given the lower awareness and expectations associated with the project.

Table 10.6 presents the justification for assigning a Moderate-Major positive significance to the procurement of goods and services at a local and regional level; and Positive Significance at a national level.

Table 10.6 Socio Economic Impact Significance for Procurement of Goods and Services

Event	Magnitude		Probability	Receptor Sensitivity	Significance
	Spatial Scope	Timing and Duration			
Procurement of goods and services	Local, and Regional	Procurement will take place throughout the project and benefits will cease shortly after the project finishes Temporary	Highly likely	Local and regional businesses - High	**Moderate-Major positive**
	National			National businesses - High	**Positive**

It is considered that local, regional and national impacts associated with the procurement of goods and services are maximised as far as practicable and no additional measures are required. In line with the procedures of previous projects (Chapter 7 Section 7.6) records to monitor national spend will be kept of all goods and services purchased in-country, including the value of spend.

10.7 Construction Vehicle Movements (offsite)

10.7.1 Disruption and Community Safety

The estimated number of construction vehicle movements (offsite) is discussed in Chapter 5 Section 5.7.2. The contribution of daily vehicle movements to existing traffic flows on the Baku-Salyan Highway is expected to peak at 162 (between May 2012 and October 2012). As stated within Chapter 5, traffic associated with the project will initially use the existing Terminal access road (during Phase 1). The EOP road and an associated junction on the northern side of the Highway will then be used as the main access route for SD2 Infrastructure Project construction traffic until the new Highway Junction is completed by the Highways Authority.

The existing controls associated with construction vehicle movements (offsite) are:

- All received grievances associated with traffic will be logged and appropriate corrective action determined which will be recorded in the Transportation and Traffic Management Plan. The focus of the Plan will be on ensuring that drivers and their vehicles are safe when on the road and adopt safe driving behaviours. The Plan will include a requirement to adhere to strict driver management standards which will be strictly enforced, and describe the procedures adopted when transporting abnormal loads;
- Off-road driving outside of designated areas will be prohibited; and
- Prior to the transportation of oversized and heavy loads, a risk assessment will be undertaken to include an inspection of the transport route for obstructions and hazards, any requirement for traffic diversion and lifting, loading and rigging. The Azerbaijan Ministry of Transport and the police will be notified prior to the scheduled movement. Once approved for movement, oversized and heavy loads will be accompanied by front and back escort vehicles equipped with appropriate warning signage and/or lights.

Probability

The expected probability of disruption and impact to community safety associated with project related traffic is considered ‘unlikely’ based on measures incorporated within the Transportation and Traffic Management Plan.

Magnitude

Construction vehicle movements (offsite) will commence in Phase 1 and will continue throughout the project. The maximum daily project-related contribution to traffic will peak at 162 vehicles per day. This represents a total traffic flow increase of approximately 1.62%.

Receptor Sensitivity

Receptor sensitivity is considered to be ‘high’ as the daily movement of construction vehicles (offsite) will pass close to and through local communities where there is increased potential for impacts to community safety.

Table 10.7 presents the justification for assigning negative significance to Construction Vehicle Movements (offsite).

Table 10.7 Socio Economic Impact Significance for Construction Vehicle Movements (offsite)

Event	Magnitude		Probability	Receptor Sensitivity	Significance
	Spatial Scope	Timing and Duration			
Disruption and impact to community safety associated with construction vehicle movements (offsite)	Local	Offsite traffic movements will take place throughout the project. Temporary	Unlikely	Road users and local community – High	**Negative**

To further minimise the potential impact associated with offsite traffic movements to the local communities, it will be necessary to communicate the potential hazards associated with offsite traffic movements, as part of ongoing community liaison.

It is considered that impacts to the local communities associated with offsite construction vehicle movements are minimised as far as practicable. No additional mitigation is necessary.

10.7.2 Road Conditions

It is expected that the Baku-Salyan Highway will be the primary route that is used for the transport of construction materials. However, the exact transport routes used will not be determined until the procurement strategy is in place and the construction contract has been awarded.

The existing controls associated with road conditions are:

- Prior to construction works commencing, a survey to determine the condition of public roads used will be undertaken to investigate the suitability of roads and identify any improvements required; and
- Following the completion of construction works, the condition of the public roads used will be resurveyed. If results indicate that road damage occurred during the construction works then the road will be restored to its pre-construction state as soon as possible.

Probability

The probability of a change in road condition is ‘unlikely’ as any changes in the condition of the local road network will be identified and repaired as soon as it is possible to do so.

Magnitude

Construction vehicle movements will occur along the Highway and access roads and it is considered that there will be no need to use local roads. Any local roads that are used will be subject to a pre- and post-condition survey, so that any deterioration is highly localised and short in duration.

Receptor Sensitivity

Receptor sensitivity depends on the type of road being used:

- Local roads – considered to be ‘high’ as the current condition is perceived by the majority of households surveyed during the SSES to be in a ‘poor’ condition; and
- Main highway – considered to be ‘low’ as this major road network is in a good condition, well-maintained and was originally designed to cope with the demands associated with heavy vehicles.

Table 10.8 presents the justification for assigning negative significance to Deterioration in Road Condition.

Table 10.8 Socio Economic Impact Significance for Deterioration in Road Condition

Event	Magnitude		Probability	Receptor Sensitivity	Significance
	Spatial Scope	Timing and Duration			
Deterioration in Road condition	Local	Changes to road condition from the transportation of construction materials will take place throughout the project and will cease after the project finishes. Temporary	Unlikely	Local Roads - High	**Negligible**
				Main highway – Low	**Negligible**

It is considered that impacts to road condition associated with construction vehicle movements are minimised as far as practicable. Any changes to the condition of local roads will be identified and repairs will be made to restore its condition. There is no change in the future condition of the main highway expected from construction traffic. No additional mitigation is required.

10.8 Road and Rail Works

It is anticipated that disruption to road and railway users are likely to occur as a result of road and rail works. These are likely to occur throughout the project, particularly during Phases 2 and 7 where the EOP road junction will be established and then closed (refer to Chapter 5). In addition, it is possible there may be occasional short-duration closures and road diversions due to movements of goods.

The existing controls associated with road and rail works are:

- Procedures will be established to manage any road closures requirements and/or disruption to the rail services to duration, timings and options considered to minimise disruption. The Azerbaijan Ministry of Transport and the emergency services will be notified in advance of the road closure. Activities that may affect the railway and associated timings will be agreed with the Azerbaijan rail authority; and
- All grievances received associated with traffic and transport will be logged and appropriate corrective action determined which will be recorded in the Transportation and Traffic Management Plan.

Probability

The road and rail works are 'highly likely' to result in an impact to other road users (commercial and non-business road traffic) and railway users. Road and rail users may include passengers and business owners who rely, or benefit from, the transport of goods on the networks.

Magnitude

Road and rail works are expected to occur throughout the project. However, measures will be taken to minimise impacts through liaison with the relevant authorities to minimise the disruption caused.

Receptor Sensitivity

Receptor sensitivity is considered to be 'high' as the road and railway network is a key transport link that connects Salyan to Baku. The railway is both a freight and passenger train route.

Table 10.9 presents the justification for assigning negative significance to the road and rail works.

Table 10.9 Socio Economic Impact Significance for Road and Rail Works

Event	Magnitude		Probability	Receptor Sensitivity	Significance
	Spatial Scope	Timing and Duration			
Road and rail works	Local, and regional	Road and rail works are expected throughout the project but disruption is expected to be of short duration. Temporary	Highly likely	Local, regional and national businesses – High	**Negative**

It is considered that local and regional impacts associated with Road and Rail Works are minimised as far as practicable. No additional mitigation is required.

10.9 De-manning

Training and Employment is discussed in Chapter 5 Section 5.9. As activity reduces towards the end of the project, employment levels will be reduced.

The existing controls associated with de-manning are:

- Planning for the conclusion of worker contracts will start at the outset of the SD2 Infrastructure Project through implementation of the Training Plan (discussed in Section 10.6); where it is anticipated that workers will learn new skills that make them more attractive in the job market; and
- Staff communications will ensure that the workforce is aware of project progress and expected completion dates.

Probability

Within the local community:

- There are unlikely to be enough vacancies available locally that can immediately absorb the large numbers of workers, many of whom will have similar non-professional skills sets to offer the (same) employment market. This is reflected by the currently high levels of unemployment in the local communities;
- The non-professional workforce taken from the local communities will be a result of ‘targeted employment’ and workers may not have the skills (or motivation) to pro-actively seek-out new employment; and
- A significant proportion of the workforce may not have secondary sources of household income, or have been able to save from their previously salary.

De-manning has the potential to lead to an increase in psychological stress associated with the uncertainty associated with future sources of household income, a reduction in general well-being, quality of life, and reduced access to private healthcare. Such changes may disrupt family life, personnel relationships and, potentially, affect the welfare of children. However, it is understood that the works associated with the main SD2 Project will begin immediately following the completion of the SD2 Infrastructure Project. The SD2 Project will provide further opportunities for employment and therefore the probability of impacts associated with de-manning are considered ‘unlikely’.

Magnitude

Impacts associated with de-manning will likely commence prior to end of the project as manning levels decrease due to decrease in project activities. Workers able to seek alterative employment, or return to their previous role before employment may only experience a temporary change in household income. Workers who are unable to seek alternative sources of work may experience de-manning impacts across a longer timescale.

Receptor Sensitivity

Receptor sensitivity is considered to be 'high' as a significant proportion of the workforce will have been specifically targeted for employment, and some workers may not be able to obtain alternative employment.

Table 10.10 presents the justification for assigning negative significance to de-manning.

Table 10.10 Socio Economic Impact Significance for De-manning

Event	Magnitude		Probability	Receptor Sensitivity	Significance
	Spatial Scope	Timing and Duration			
De-manning	Local	De-manning will likely commence prior to end of the project as manning levels decrease however it is expected that the main SD2 Project will provide relevant employment opportunities for workers. Permanent	Unlikely	Local community – High	**Negligible**

It is considered that local impacts associated with de-manning are minimised as far as practicable and no additional measures are required. Employment opportunities generated with the SD2 Project will likely reduce the impact of the de-manning of the SD2 Infrastructure Project.

10.10 Indirect Impacts

In addition to the direct socio-economic impacts from the project, it is anticipated a number of indirect impacts may occur. These are induced impacts that do not directly arise from the SD2 Infrastructure Project itself but may occur as a result of the project and may be due to a combination of direct impacts.

10.10.1 Local Economic Impacts

The combination of significant increases in local employment and payment of monetary compensation to people whose livelihoods have been impacted, will result in a rapid and temporary increase in local capital flows. Whilst affected individuals and business owners will typically consider this to be a positive change, there is a potential for local inflation to occur through a sudden increase in the demand for the same types of good and services. Business owners may also seek to maximise the local rise in household income by increasing prices to take full advantage of increased capital available.

The requirement for professional staff to be taken from the local communities may divert individuals from existing professional roles, to the SD2 Infrastructure Project with the aim of securing higher paid employment. For example, if large numbers of professional public workers (such as health care staff, teachers for example) depart their current employment then such changes may have negative consequences to the local community, particularly to the quality of education and social support provided to vulnerable groups.

10.10.2 Social Conflict

There is the potential for conflict to occur from (perceived or actual) competition between individuals seeking jobs. Such conflicts could occur between members of the same settlement, between individuals from the local communities, or between 'local' and 'non-locals'. Such conflicts may be exacerbated by pre-existing tensions between groups of people and in particular, between non-locals and vulnerable groups (such as IDPs) who may perceive they are being excluded**.**

10.10.3 Anti-Social Behaviour

Increases in local capital flows may result in an increase in anti-social behaviour and family breakdown associated with greater alcohol and substance abuse, prostitution, domestic violence and desertion. This will result in extra demands placed upon local social welfare infrastructure such as first aid centres, educational establishments, social services and the State police.

10.10.4 Mitigation of Indirect Impacts

It is anticipated that the potential increase in inflation, possible social conflict and rise in anti-social behaviour will be mitigated through BP's social investment program. This will be implemented in parallel with the Training Programme to develop workers skills and development to maximise their chances of finding alternative sources of work.

10.11 Summary of SD2 Infrastructure Project Residual Socio-Economic Impacts

For all socio-economic impacts assessed it has been concluded that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures. No additional mitigation is required.

Table 10.11 summarises residual socio-economic impacts.

Table 10.11 Summary of SD2 Infrastructure Project Residual Socio-Economic Impacts

Event	Magnitude		Probability	Receptor Sensitivity	Significance
	Spatial Scope	Timing and Duration			
Direct Impacts					
Disruption and access restrictions (SD2 Infrastructure Area)	Local	All SD2 Infrastructure area will be temporarily fenced during works to prevent unauthorised access. Temporary impact Up to approximately 115 hectares will be permanently removed from use for herders. Permanent impact	Highly likely	Local herders – High	**Moderate – major negative**
Disruption and access restrictions (Pipeline Landfall Area)	Local	The majority of the SD2 Infrastructure Area will be temporarily fenced during works (between March 2012 and June 2013). Temporary impact	Highly likely	Recreational fishermen - Low	**Negligible**
			Highly likely	Commercial fishermen - Medium	**Negative**
			Highly likely	Recreational users - Low	**Negligible**
			Unlikely	Shoreline property values - Low	**Negligible**
Employment creation	Local	Employment will occur throughout the project, and is expected to peak between April 2012 and November 2012. Temporary impact	Highly likely	Local community - High	**Moderate-Major Positive**
	Regional		Likely	Regional community – Medium	**Positive**
Training and skills development	Local	Training will commence prior to the project activities and continue throughout the project. Permanent	Highly likely	Local community – High	**Moderate-Major positive**
	Regional		Highly likely	Local community – Medium	**Positive**
Procurement of goods and services	Local, and Regional	Procurement will take place throughout the project and benefits will cease shortly after the project finishes. Temporary	Highly likely	Local and regional businesses - High	**Moderate-Major positive**
	National			National businesses - High	**Positive**
Disruption and impact to community safety associated with construction vehicle movements (offsite)	Local	Off site traffic movements will take place throughout the project. Temporary	Unlikely	Road users and local community – High	**Negative**

Event	Magnitude		Probability	Receptor Sensitivity	Significance
	Spatial Scope	Timing and Duration			
Deterioration in Road Conditions	Local	Changes to road condition from the transportation of construction materials will take place throughout the project and will cease after the project finishes. Temporary	Highly unlikely	Local Roads – High Main highway - Low	**Negligible**
Road and rail works	Local, and regional	Road and rail works are expected throughout the project but disruption is expected to be of short duration. Temporary	Highly likely	Local, regional and national businesses – High	**Negative**
De-manning	Local	De-manning will likely commence prior to end of the project as manning levels decrease however it is expected that the main SD2 Project will provide relevant employment opportunities for workers. Permanent	Unlikely	Local community – High	**Negligible**

Indirect socio-economic impacts include:

- Potential increases in inflation;
- Possible social conflicts; and
- A rise in anti-social behaviour.

It is anticipated these impacts will be mitigated through BP’s social investments program and through public awareness campaigns, provision of family counselling and financial planning support to employed workers to encourage the income gained from employment to be used in a responsible manner.

11. Cumulative and Transboundary Impacts and Accidental Events

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11.1 Introduction

This Chapter of the Shah Deniz 2 (SD2) Infrastructure Project ESIA discusses:

- Cumulative and Transboundary Impacts; and
- Accidental Events that could potentially occur during SD2 Infrastructure Project works and the control, mitigation and response measures designed to minimise event likelihood and impact.

11.2 Cumulative and Transboundary Impacts

As discussed within Chapter 3, cumulative impacts arise from:

- Interactions between separate project-related residual impacts; and
- Interactions between project-related residual impacts in combination with impacts from other projects and their associated activities.

As outlined in Chapter 1 of this ESIA, the SD2 Project comprises the next stage of development of the SD Contract Area. The SD2 Infrastructure Project includes the works required prior to the construction, installation, commissioning and operation of the onshore SD2 Project facilities within the SD2 Expansion Area at the Terminal.

The existing ACG Phase 1, 2 and 3 and SD1 facilities at the Terminal have been operational since 2007. The effects of these projects on the environmental and socio-economic environments are therefore incorporated into the existing baseline as presented in Chapters 6 and 7. The potential for cumulative impacts with other projects have therefore been determined based on a review of available information relating to projects in the Terminal vicinity, which are of a scale that has the potential to result in cumulative impacts.

11.3 Cumulative Assessment

11.3.1 Cumulative Impact Between Separate Project Impacts

A detailed assessment of environmental and socio-economic project impacts, based on expected activities and events, is presented in Chapters 9 and 10 of the ESIA. The assessment takes into account each activity and the existing controls in place to manage the impact. No requirement for additional mitigation was identified and all impacts were considered to be minimised as far as practicable.

The cumulative effect of activities resulting in air emissions and noise are considered in Sections 9.3 and 9.4 of Chapter 9 respectively. No significant cumulative impact to air quality was identified with increases in concentrations of nitrogen dioxide (NO_2) from onsite and offsite traffic and plant less than 2% of the current background concentration, leading to no expected exceedance of the relevant long term air quality standard ($40 \mu g/m^3$).

The assessment of the cumulative impact associated with noise generating activities was undertaken assuming a worst case scenario where proposed piling activities are undertaken at the same time as the highest on site plant and vehicle activity. It was determined that, with appropriate screening of the pneumatic hammers, and through notification of the local community of the trial piling works, the cumulative effect of noise would be appropriately mitigated.

The cumulative effect of all expected project activities will be managed through the implementation of a number of management plans as described within Chapter 12. For example, a Nuisance Management Plan will be prepared and implemented that details the processes used to prevent nuisance associated with construction noise, light from construction work areas, odours, pests and vermin. In addition a Community Interaction and Social Impact Management Plan will be implemented and maintained as a mechanism of communicating with the community and responding to community grievances.

Given the existing control measures in place, it is considered that the appropriate measures are in place to appropriately mitigate and manage potential cumulative effects between project related residual impacts. No additional mitigation is required.

11.3.2 Cumulative Impact With Other Projects

Based on a review of available information it is understood that the following projects, which have the potential to interact with the impacts of the SD2 Infrastructure Project based on their location and scale, are planned or under construction in the vicinity of the Terminal (refer to Figure 11.1):

- **Qizildas Cement Plant** – new cement plant to be located approximately 4km north of the Terminal. The project incorporates dry kiln technology and will be designed to produce up to 2,000,000 tonnes of cement per annum from raw materials supplied from local quarries in the Garadagh and Absheron regions. A new road to enable construction and operational vehicles to access the plant from the Baku-Salyan Highway is planned and the project also includes a railway spur from the railway line between the Terminal and Umid. Plant construction was initially planned to commence in 2009 and last 28 months although it is understood that this is yet to commence. Construction of the new road is thought to have started although the programme for completion of the road works is not known. Impacts associated with the operational phase of Qizildas Cement Plant have been assessed within an ESIA completed in 2009[1];
- **Garadagh Dry Kiln Project** – project comprises works to upgrade the existing Garadagh cement works which lies approximately 6km to the east, to install dry kiln technology and increase production. It is understood that works commenced in August 2008 are due to be completed by the end of 2011. Impacts associated with the project once operational have been assessed within an ESIA completed in 2009[2]; and
- **New Highway Junction –** a new junction is planned immediately to the south of the Terminal which will connect to the new Terminal access road that forms part of the SD2 Infrastructure works. The junction is planned to include slip roads, a bridge over the highway and connection to the new Terminal access road passing over the railway line. It is expected that the junction will be constructed during Phase 4 of the SD2 Infrastructure Project (March 2011 to June 2012). The design of the junction is the responsibility of the Highways Authority. No ESIA has yet been completed for this project.

In addition to these projects it is understood that traffic flow along the Baku- Salyan Highway has increased in recent years[3]. The Azerbaijan Highways Authority have indicated that traffic flows are expected to increase in the future due to further development to the north and south of Sangachal Town, specifically following the construction of a new port facility near Alyat and a new ship building industry in Silah. To provide capacity for the increased traffic flows, a requirement has been recognised to widen the highway to four lanes in each direction. Full details of the upgrade works to the Baku-Salyan Highway (such as schedule and extent of the works) are not available.

[1] Qizildas Cement Factory ESIA , 2009
[2] ERM (2009) Garadagh Cement Project New Dry Kiln 6: ESIA
[3] Per comms, Head of the Technical Division, Azerbaijan Highway Authority, 2010

Figure 11.1 Location of the Planned or Under Construction Projects in the Terminal Vicinity

Note: Location of Rail Spur is approximate as no clear map is presented in the Qizildas ESIA report.

11.3.3 Approach to Cumulative Assessment

Assumptions

Key assumptions made for the cumulative assessment are:

- The construction programme for the Garadagh Cement Plant upgrade project was provided in the ESIA[4] and it is understood that the project is on target for completion in 2011. Based on this information, the cumulative assessment only considers cumulative impacts associated with the operational phase of this project; and
- The Qizildas Cement Plant ESIA states that the construction programme will be 28 months extending from 2009 to 2011[5], although construction has not yet begun. A recent press release[6] indicates that the operation of the plant is expected in late 2013, however this is unconfirmed. Based on this data it is assumed that there will be no overlap of the SD2 Infrastructure Project with the operation of the Qizildas Cement Plant, but the construction phases are likely to overlap; and
- It is assumed that the construction programme of the Baku-Salyan Highway junction will overlap with the SD2 Infrastructure Project activities between March 2012 and June 2013.

The highways upgrade works have not been assessed as no details are known.

Based on the assumptions, Figure 11.2 shows the potential overlaps of the cumulative projects with SD2 Infrastructure Project.

[4] ERM (2009) Garadagh Cement Project New Dry Kiln 6: ESIA.
[5] Qizildas Cement Factory ESIA, 2009.
[6] Press release: http://www.abc.az/eng/news/52007.html (2011).

Figure 11.2 Potential Overlap Between Planned and Under Construction Project and the SD2 Infrastructure Project

11.3.4 Assessment of Cumulative Impacts

Traffic Disruption

The Baku-Salyan Highway is the main traffic route in the local area and is expected to be used by construction and operational traffic associated with all the planned and under construction projects.

As the Garadagh Cement Plant project involves upgrading existing facilities; changes to the traffic flows are expected to be minimal. A key objective of the Garadagh Cement Plant project is to increase the capacity of the plant (from 2,600 tonnes/day to 4,000 tonnes/day) however, due to internal traffic issues within the site, it is planned to increase the volume of products transported by rail[7]. This has not been quantified within the ESIA, but it is considered likely to result in similar, or fewer, numbers of vehicles from the Garadagh Cement Plant using the Highway compared to present.

Estimated traffic flows associated with construction of the Qizildas Cement Plant and the new Baku-Salyan Highway junction are unknown. However, the SD2 Infrastructure Project will contribute, at the project's peak, 162 vehicles per day which equates to 1.62% of the total traffic flow. Given that the scale of Qizildas Cement Plant is greater than the SD2 Infrastructure Project, it is likely that construction traffic will be of a greater magnitude. As the scale of the works involved for the new Baku - Salyan Highway junction will be smaller than the SD2 Infrastructure Project, it is assumed construction traffic flows will be lower.

Based on these other projects, it is expected that throughout the SD2 Infrastructure Project programme, there will be an increase in the volumes of traffic using the Highway. Assuming construction of the Qizildas Cement Plant commences in 2012, the majority of the increases in traffic flows on the Highway are expected to relate to this project with a smaller contribution expected from the SD2 Infrastructure Project.

As described within Section 12, the SD2 Infrastructure Project construction contractor will be expected to implement a Traffic Management Plan, one of the aims of which will be to minimise impacts to road users and ensure that adherence to BP's strict procedures associated with vehicles and safe driving are enforced. The Traffic Management Plan will be subject to regular review and update and will take into account any changes in traffic flows or routing issues during the project duration. It is assumed that, as for the SD2 Infrastructure Project, any necessary road closures or major roadworks associated with the planned or under construction projects will be notified to the Azerbaijan Highways ahead of the works, to ensure necessary traffic diversion notices and other arrangements, can be put in place. It is

[7] ERM (2009) Garadagh Cement Project New Dry Kiln 6: ESIA.

therefore considered that the SD2 Infrastructure Project's contribution to potential traffic impacts are minimised as far as possible. No additional mitigation is required.

Noise - Traffic

Increases in traffic flow will result in an increase in traffic noise. The SD2 Infrastructure Project is expected to contribute a maximum 1.62% increase in traffic flows along the Highway, leading to an increase in noise levels at receptors of less than 1dB(A). As discussed in Chapter 9 Section 9.4.1 an increase of 25% would be required to increase noise levels by 1dB(A) or more. A 3dB(A) increase would be achieved if traffic flows double. While traffic flows associated with the Qizildas cement plant construction traffic are not known, it is not expected that the contribution will result in a doubling of flows and noise levels at receptors are not expected to increase by more than 3dB(A). The contribution of the SD2 Infrastructure Project to noise impacts associated with traffic is considered to be minimised as far as possible. No additional mitigation is required.

Noise - Construction including Piling

It is likely that activities associated with SD2 Infrastructure Project will overlap with construction of the Highway junction. The extent of works associated with the junction is not known although it is likely that the slip roads and bridge construction will include piling works. These will need to be managed by the relevant construction contractor to minimise the noise impacts at the local communities. As demonstrated within Chapter 9 Section 9.4.1 the SD2 Infrastructure Project activities (onsite plant and vehicles and piling works) have the potential alone to result in noise levels near to the applicable noise limit or current ambient noise levels at receptors if appropriate mitigation is not in place. It will be the responsibility of the Highway Junction construction contractor and the SD2 Infrastructure Project contractor, should works overlap, to liaise to ensure that impacts are minimised through appropriate consultation with the local community, scheduling of works and use of appropriate mitigation.

Impacts to the Atmosphere (GHG Emissions)

Increases in man-made GHG (including carbon dioxide and methane) are widely accepted as contributing to changes in the energy balance of the world's climate system, creating an overall increase in average global temperatures[8].

It is estimated that a total of 137 ktonnes of GHG emissions will be released to the atmosphere as a result of SD2 Infrastructure Project activities (refer to Chapter 5 Table 5.6). The Garadagh Cement Plant is expected to emit approximately 435 ktonnes of GHG emissions across the duration of the SD2 Infrastructure Project[9]. Projected GHG emissions expected to be generated during the construction phase of Qizildas Cement Plant and works on the new Baku-Salyan Highway are not available. However. it is anticipated that GHG emissions for the Qizildas Cement Plant construction are likely to be substantially higher than for the SD2 Infrastructure Project given the scale of the works proposed across a similar timescale (i.e. 2 year construction programme for the Qizildas Cement Plant as compared to 18 months for the SD2 Infrastructure Project).

Projected GHG emissions from SD2 Infrastructure Project activities have been compared against the United Nations Framework Convention on Climate Change (UNFCCC) annual predictions for Azerbaijan[10] and are estimated to constitute approximately 0.15% of Azerbaijan's national GHG emissions during the project programme. This represents an insignificant contribution to the predicted national GHG emissions.

[8] Fourth Assessment Report of the United Nations Intergovernmental Panel on Climate Change - Climate Change 2007, IPCC, 2007.
[9] GHG emissions calculated for 18 month period from data within ERM (2009) Garadagh Cement Project New Dry Kiln 6: ESIA.
[10] UNFCCC forecast GHG emissions for Azerbaijan for 2010 used as basis.

Impacts to the Atmosphere (Non-GHG emissions)

The Qizildas Cement Plant and Garadagh Cement Plant projects are located 4km north and 6km east from the SD2 Infrastructure Project, respectively.

The ESIA for Garadagh Cement Plant project demonstrates that air quality is unlikely to be affected more than 2km from the source of emissions when the plant is operational. In addition, dust impacts are shown to be limited to the immediate vicinity of the plant. This is, in part, due to the technologies used for control of dust from the cement process which includes electrostatic precipitators and bag filters, and the control of particulates from the proposed increase in coal use within the kilns through use of bag filters on the associated coal mill. It is expected, based on air quality modelling, that there will be little change in non-GHG emissions greater than 1km from the construction area. The impacts to air quality from the construction phase of Qizildas Cement Plant are expected to occur within the plant boundary.

On the basis of the assessments undertaken above regarding traffic disruption and traffic noise, it is considered that cumulative impacts associated with non-GHG emissions generated by offsite traffic are likely to be insignificant. Impacts associated with the SD2 Infrastructure Project alone will be appropriately mitigated and managed.

Changes to Hydrology

There are number of sensitive receptors which may be at risk of flooding from modification to the local hydrology:

- Sangachal Town;
- Sangachal Power Station;
- The railway;
- The Baku-Salyan Highway; and
- The Caravanserai located just to the south of the Shachkaiya Wadi channel immediately upstream of railway bridge ‘B4’.

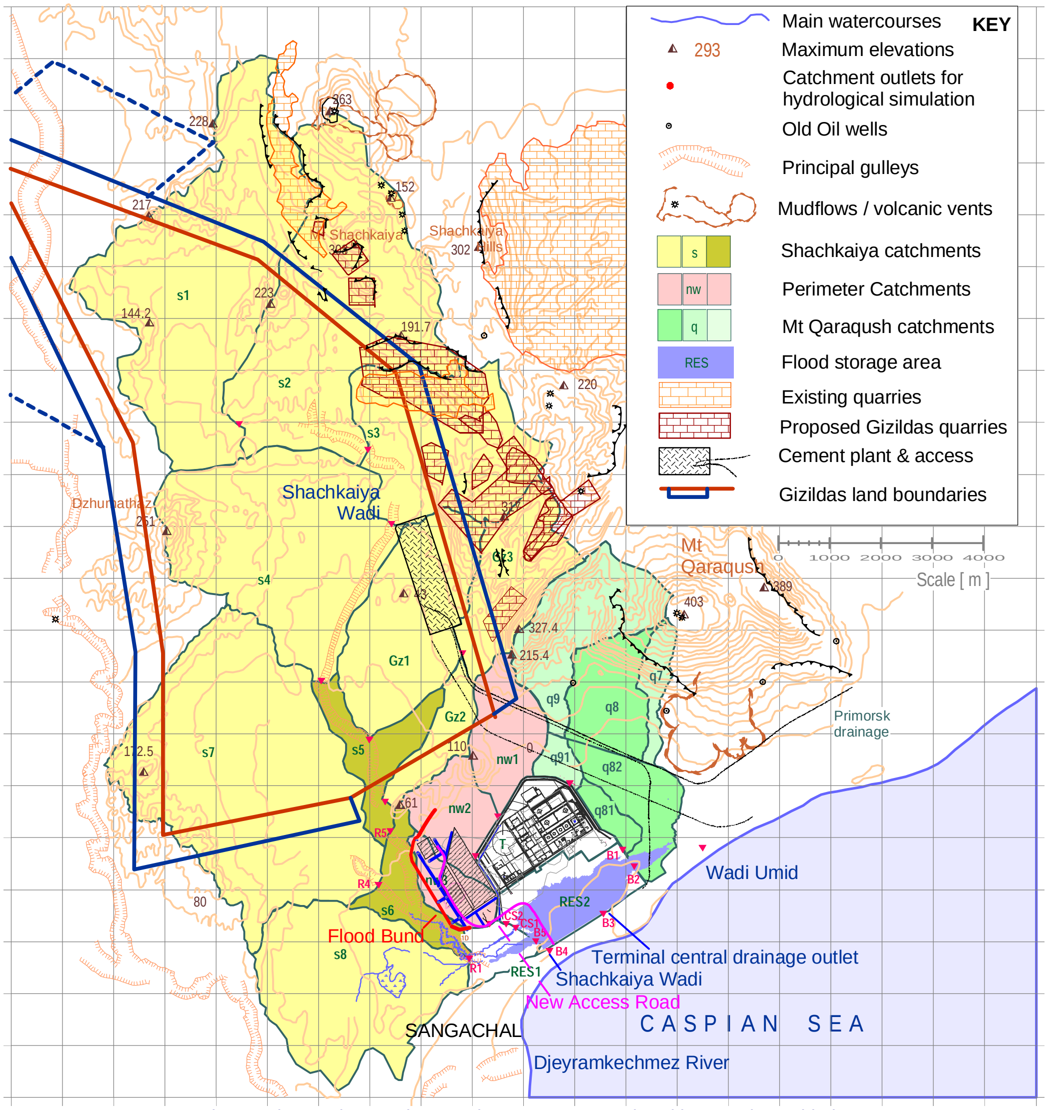
As described in Chapter 5 Section 5.5.3, the SD2 Infrastructure Project includes wadi clearance works which will involve upgrading the existing western and central wadi sea outfalls. These have been partially blocked by silt and other materials.

It is understood that the scope of the Qizildas Cement Plant project includes modifications to a significant part of the upper Shachkaiya Wadi catchment. The exact nature and extent of these planned modifications are not fully known although is expected to involve quarrying for building stone. Such a modification is likely to increase the impermeable extent within the catchment, resulting in increased runoff and shorter response times to rainfall.

Hydrological modelling (refer to Appendix 9E) has been undertaken to assess the impact of the potential modifications (refer to Figure 11.3). The proposed cement plant will have three main impacts on the drainage and runoff in these upper catchment areas:

- Alteration of existing drainage routes and flow patterns;
- Increases in the total impermeable area covered by roads and buildings; and
- Increases in the impermeable areas and runoff rates associated with an expansion of quarrying activities.

Figure 11.3 Main Drainage Catchment Areas in the Vicinity of the Terminal Including Modifications Associated with Proposed Qizildas Cement Plant



© Water Resource Associates Ltd. Based on Soviet mapping at 1:50,000 scale, with WRA data added

Hydrological modelling indicated that the 100 year peak flow of the Shachkaiya Wadi would increase from 61m^3/s to 80m^3/s. As the actual scale of the Qizildas Cement Plant development is not clear, the changes in peak flow predicted use a worst case scenario. The impact of the 100 year peak flows are expected to result in impacts to the following key receptors:

- The flood level of Sangachal Town has the potential to increase by up to 0.4m; and
- The flood level of the Caravanserai has the potential to increase by 0.5m, resulting in inundation of the building and its compound to a depth of 0.4 to 0.5m.

In isolation, the SD2 Infrastructure Project is not expected to have a significant impact to flood levels at any of the key receptors. However, once the project is completed the existing flood risk to the Highway in the vicinity of bridge ‘B6’ will remain. The elevated Highway Junction is planned to be constructed in this location and once complete it will offer an alternative route for highway users in the event that the highway floods.

Employment

The SD2 Infrastructure Project is expected to create between 450 and 700 temporary jobs. Additional temporary jobs will be created by the construction of the Qizildas Cement Plant and the new Baku-Salyan Highway Junction, although the likely workforce requirement is not available.

The Garadagh Cement Plant currently employs approximately 585 workers which is expected to reduce with the increased efficiency of the plant due to the upgrade works, leading to the loss of 82 jobs. The loss will be partially compensated by business expansion in the next 3 years which is predicted to create 54 permanent jobs. The net impact at the Garadagh Cement Plant in the next three years will therefore be a loss of 28 jobs[11].

Despite job losses associated with the Garadagh Cement Plant, there will be a positive impact on employment throughout the duration of the SD2 Infrastructure Project. Jobs associated with the SD2 Infrastructure Project will be temporary, but will provide employees with an opportunity to develop their work skills and experience. Overall, the cumulative impact of the planned projects on local employment is beneficial. This assumes that the local content goals and employment and training initiatives detailed within Chapter 12 for the SD2 Infrastructure Project are also implemented for the Qizildas Cement Plant and the New Baku - Salyan Highway Junction projects.

Economic Benefits

The contribution of the SD2 Infrastructure Project, Garadagh Cement Plant upgrade, Qizildas Cement Plant and the new Baku-Salyan Highway Junction will lead to increased economic flows at a local regional and national level. This cannot be quantified as the expected economic benefits from these projects are not stated. It is likely, however, that the economic benefits from the Garadagh and Qizildas Cement Plants will be more substantial than the SD2 Infrastructure Project.

Community Initiatives

The Garadagh Cement Plant has implemented a Corporate Social Responsibility (CSR) programme which is focused on capacity building, poverty reduction, enabling business environment and the development of social infrastructure[9]. Company employees, their families and local communities with a particular focus on Sahil community, are targeted by the CSR program. The Centre for Disabled Children and Sport School at Sahil are amongst local institutions that receive funding by the CSR programme. Examples of other recent CSR projects are funding of medical facilities (first aid station and hospital in Sahil, national oncology centre), repair of roads in local communities, funding of public events and public health awareness campaigns.

BP's community investment programme is described in Chapter 7, Section 7.5. BP is currently involved in educational programmes which provides support to people from a young age and continues to a university research level. BP also supports the development of local suppliers through training and financing programmes, building skills and sharing BP's internal standards and practices as appropriate. Such activities enable a greater number of local businesses to participate in their supply chain.

The Garadagh Cement Plant and BP have both designed and implemented, long-term community investment programmes. These contributions, together with ongoing and meaningful stakeholder relationship activities, will result in positive impacts at an individual and community level. The cumulative impact from BP's community investment programmes and of the Garadagh Cement Plant CSR programme is complimentary and will have a positive impact upon local communities.

[11] ERM (2009) Garadagh Cement Project New Dry Kiln 6: ESIA.

11.3.5 Conclusion

The assessment of cumulative impacts presented in Section 11.3.4 demonstrates that negative cumulative impacts associated with the SD2 Infrastructure Project and other projects in the vicinity of the Terminal are expected to be limited.

The greatest potential for a negative, cumulative impact to occur is linked to the level of traffic disruption associated with the SD2 Infrastructure Project, assuming that the construction schedule for Qizildas Cement Plant overlaps. There is also potential for cumulative noise impacts at sensitive receptors associated with the SD2 Infrastructure Project and construction works for the new Highway Junction. It is will be necessary for the SD2 Infrastructure Project construction contractors and Highways Authority to ensure these cumulative impacts are minimised, through careful scheduling of works and use of appropriate mitigation measures.

Positive cumulative impacts are expected to occur from employment, increased economic flows and community investment programmes. In addition, construction of the highway will result in a positive impact in relation to flood risk as the junction, when complete, will provide an alternative safe route should the highway be flooded during a major flood event and will not compromise the safety of the Terminal or road users.

11.4 Accidental Events

11.4.1 Overview

Accidental events are considered separately from routine and non-routine activities as they only arise as a result of a technical failure, human error or as a result of natural phenomena such as a seismic event.

This section addresses the potential spills of various types that may occur and the measures to mitigate the spill or the cause of the spill. These include:

- Design measures, where the elements of project Base Case Design have been incorporated specifically to prevent or minimise the spill occurring;
- Construction measures i.e. how the construction methodology has been determined in order to minimise accidental events leading to spills; and
- Procedures and controls to be followed throughout the works to prevent or avoid spills and subsequent impact to the environment.

Spill response and reporting of spills is also discussed.

11.4.2 Potential Accidental Events

Potential accidental events associated with the SD2 Infrastructure Project were identified through a review of:

- Spills that occurred during previous ACG construction projects; and
- Potential for accidental events based on SD2 Infrastructure Project activities.

The type, size and cause, during previous ACG projects were thoroughly documented and give an indication of where spill prevention measures should be focused for the SD2 Infrastructure Project. Such measures are documented in Section 13.7.4.1 of the COP ESIA. The findings of the review were that the root causes of spills were equipment failure (hoses, valves, gaskets etc) and human error. Spills of hydraulic fluid resulting from hose failure accounted for a greater proportion of spills than any other single source. Specific measures associated with maintenance and operator training was therefore identified to address these issues.

Potential accidental events associated with the SD2 Infrastructure Project works include:

- Impact to a pipeline(s) within the existing pipeline corridor during construction activities;
- Loss of containment from fuel tanks within the construction camp/facilities area;
- Loss of containment from a fuel bowser, drum, Intermediate Bulk Container or fuel transfer container;
- Minor spills associated with leaks/small spills;
- Failure of the sewage treatment plant;
- Overflow of underground oil separators or septic tanks;
- Release of concrete into watercourses or the Caspian Sea; and
- Flood events causing silty water runoff from stockpiles and exposed ground.

Minor spill incidents are classified as those which can be handled immediately by on site personnel and are less than 50 litres. They will be managed and controlled as described within Section 11.4.4 below.

11.4.3 Measures to Mitigate Accidental Events

Design Measures

Pipeline Mapping

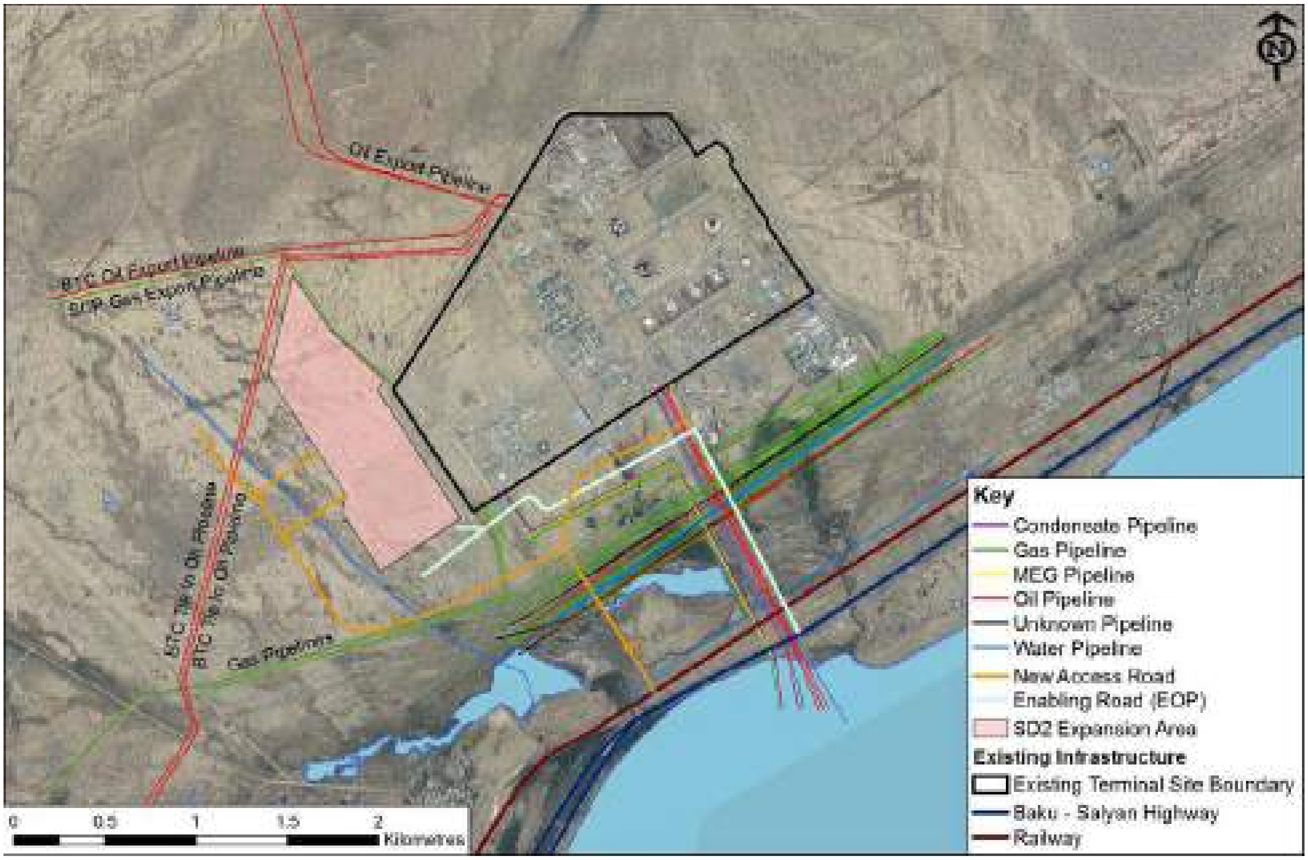
The location of the pipelines in the existing pipeline corridor to the south of the Terminal has been a key issue in informing the project design and construction methodology. A rigorous access road route selection and design process has been followed to minimise the likelihood of disturbance to the existing pipelines (refer to Chapter 4). This process has included a mapping exercise to identify the majority of pipelines, detailing the location, contents, size and the conditions of the existing pipelines (refer to Figure 11.4). Prior to construction, it is planned to undertake a further survey to identify any pipelines that have not yet been identified including depth and conditions.

The following measures have been incorporated into the Base Case Design and construction strategy to minimise potential impacts to existing pipelines:

- The design of the new access road incorporates a 50m exclusion zone around the existing pipelines[12];
- The existing disused railway embankment and existing track and crossing points across the pipelines will be used to avoid unnecessary disturbance;
- Concrete slabs (250mm thick) to be placed across buried pipelines to provide adequate protection from above for temporary construction traffic crossings;
- It is not planned to undertake any excavation of drainage channels or pipelines across any existing pipelines, except where nominal protection against scouring from surface run-off is required; and
- The flood protection berm will be a maximum of 1m deep over the existing pipelines to prevent overloading.

[12] 50m exclusion zone is not applied to SOCAR export pipelines. These will be 5m from extent of the new access road embankment, which will be engineered to avoid loading or disruption to the pipelines.

Figure 11.4 Location of Existing Pipelines



Culverts/Crossings

The new access road design includes culverts and crossings to enable the road to pass over the existing pipeline corridor (refer to Chapter 5 Figure 5.8 for culvert & crossing locations). To minimise any risk of an accidental event during the construction of the road through the use of heavy machinery, it is planned to use pre-cast construction methods. In addition, the crossings used to cross gas pipelines will incorporate vehicle barriers. The purpose of these is to prevent vehicles accidentally striking the pipelines and potentially compromising pipeline integrity.

The state pipeline corridor is located to the south of the Terminal through an area of soft and unstable ground. To provide adequate stability for the new access road, piles may be required in this area. If needed, mini piles will be used; driver or displacement piles will not be used. The piling system to be used will be required to meet the following criteria:

- Minimise ground disturbance during installation;
- Enable installation using light weight equipment;
- Avoid lateral loading;
- Minimise compromising pipeline integrity by undertaking piling by reaching over sensitive pipelines;
- Minimise concreting operations; and
- Minimise heavy lifts.

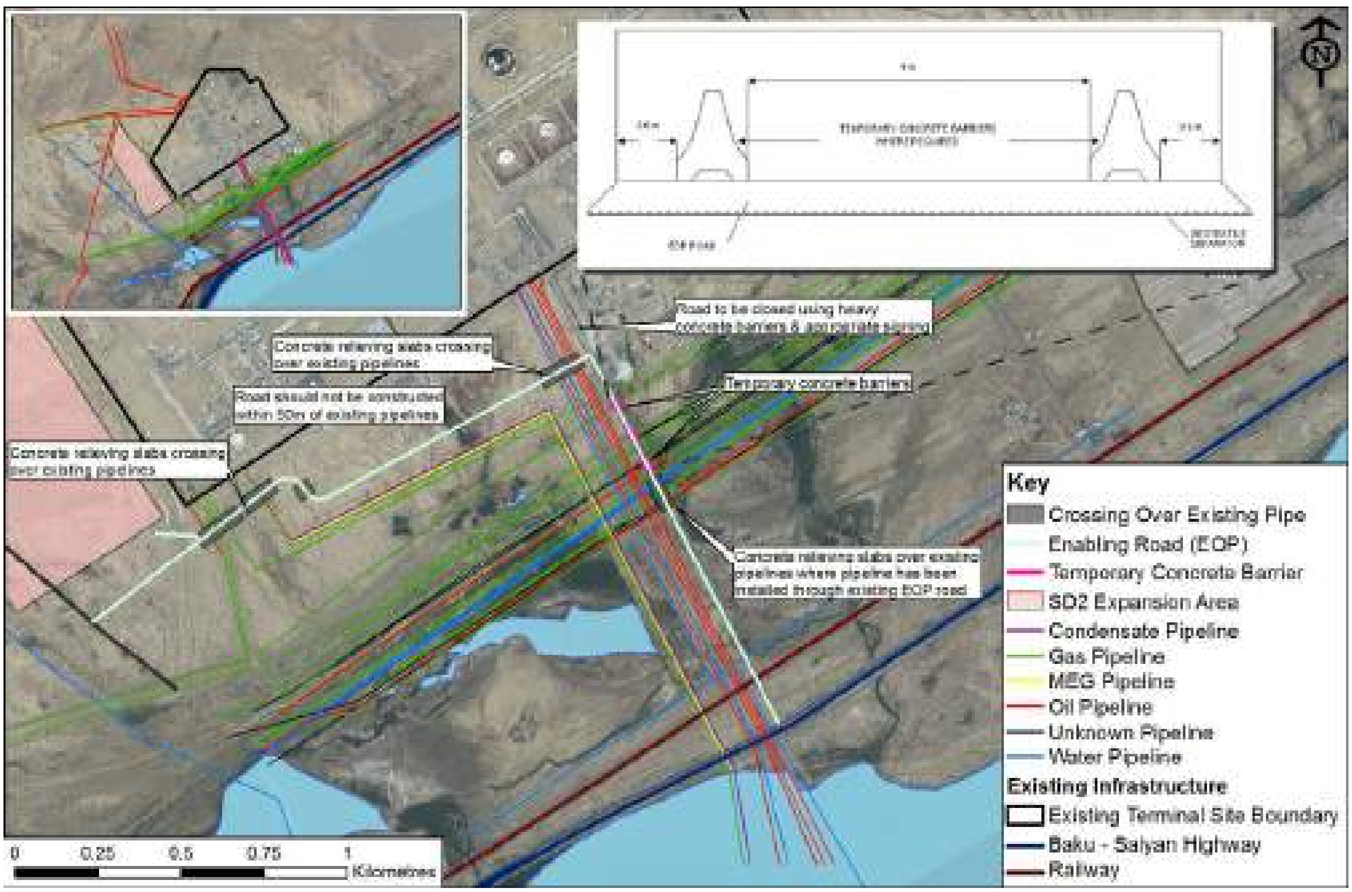
EOP Road - Concrete Barriers and Buried Pipeline Protection

There are a number of exposed gas pipelines located perpendicular to the disused EOP road, which will be reinstated for the SD2 Infrastructure Project and used for access until the new access road has been completed. To protect these pipelines from vehicles accidentally striking the pipelines, modular concrete barriers (refer to Figure 11.5) will be placed along the edge of the EOP road.

Along the EOP road, pipelines have been previously installed through the road. To prevent the pipelines (both buried and above ground) from excessive loads associated with vehicle movements or damage from remediation works the following will be undertaken:

- The position of the pipelines will be clearly marked with suitable flags, stakes and other markers at the crossings; and
- The use of suitable bridging reinforcement concrete relieving slabs will be used.

Figure 11.5 Indicative Locations of EOP Concrete Barriers and Buried Pipeline Protection



Bunding and Containment

Fuel storage and tanker movements in the Construction Facilities Area and in the initial site compound during the early stages of the project, will be undertaken within designated bunded areas. These areas will drain to a dedicated oil water separator which will be designed to ensure that that discharges meet relevant oil in water standards[13].

[13] Oil and grease: Less than 10 mg/l as a monthly average and less than 19 mg/l on a daily basis.

Oil storage areas will be located in the Construction Camp Area, the Construction Facilities Area and initial site compound in an area of concrete hardstanding.

Bunding and containment measures will comprise as a minimum:

- Fuels/oils will be stored in a container which is of sufficient strength and structural integrity to ensure that it is unlikely to burst or leak in its ordinary use;
- Containers for hazardous liquids will be situated within a secondary containment system which satisfies the following requirements:
  - A capacity of not less than 110% of the container's storage;
  - Positioned so as to minimise any risk of damage by impact; and
  - Its base and walls must be impermeable to water and oil;
- Separate bunded areas will be provided for incompatible materials and all containers will be clearly labelled with: the contents, appropriate spill response action and the location of the relevant spill response equipment;
- Bunded, contained areas will be located away from watercourses; and
- Appropriate and sufficient spill response equipment will be available for all substances stored and used on site and what types of spill require the support of offsite specialist spill response contractors.

In addition, to reduce the risk of spill and leaks from underground oil water separators and as a secondary containment for septic tanks, double wall glass reinforced plastic (GRP) will be used.

Underground Tanks and Septic Tank Design

It is planned that septic tanks will be emptied on a daily basis. However for contingency, they will be sized to contain approximately 2-3 days usage. Discharges from canteen areas, parking areas, refuelling areas and hazardous materials storage areas will flow to dedicated underground oil water separator systems. These will be sized based on the expected flowrate and in accordance with manufacturer's requirements (which will include recommended capacity including contingency. Each system will be designed such that discharges from the separator system meets the relevant oil in water standard[14] and residual solid and liquid waste is removed and managed appropriately.

Construction Measures

A number of construction methods have been adopted specifically to minimise the potential for accidental events.

The Base Case Design includes installation of a gravity sewer which will flow from North Construction Area alongside the berm to the new SD2 sewage treatment plant. Options for installing the sewer are under consideration. Methods include installing the sewer over the existing export and distribution pipelines or using horizontal directional drilling methods to route the sewer under the pipelines. The selected option will take into account the need to minimise the potential for damage to the existing pipelines as far as possible.

In the vicinity of the existing pipelines, excavation will be completed by hand or using light weight machinery under highly controlled conditions. The location of known pipeline routes will be identified by hand digging at two locations prior to construction of the permanent works. The soil around and above pipelines will be undisturbed as a far as practicable to reduce the risk of movement of the pipelines.

[14] Oil and grease: Less than 10 mg/l as a monthly average and less than 19 mg/l on a daily basis.

Procedures and Controls

In addition to the design and construction measures listed above, the following key procedures and controls will be implemented:

- An accurate hazardous materials inventory will be maintained and Material Safety Sheets (MSDS) will be provided in the appropriate languages (Azeri and English as a minimum). The inventory will include records of used hazardous substances and materials;
- Site drainage and pollution hazard maps will be produced showing the sources of potential pollution pathways and key receptors;
- A refuelling and hydraulic system filling procedure will be developed and implemented which details the pre-checks, level indication monitoring, provision of temporary containment and drip trays, communication, training and spill kit requirements;
- A risk assessment will be completed for any works required over live lines (including utilities) for approval before works will commence;
- Adequate training in spill response will be provided for all personnel; and
- A spills register will be maintained and submitted on a monthly basis which will include key details of all spills including remediation works, if required. The spill register will clearly identify both closed and outstanding actions, the elapsed time between opening and closing each action, and (in the case of outstanding actions) the proposed date for completion.

11.4.4 Spill Response

Contractor's Spill Response

A spill response plan will be prepared prior to commencing work on the SD2 Infrastructure Project. This document will be aligned with BP's Oil Spill Response Plans (OSRP) and integrate with those plans maintained by the 3rd party pipeline owners that operate those pipelines over which crossings will be installed.

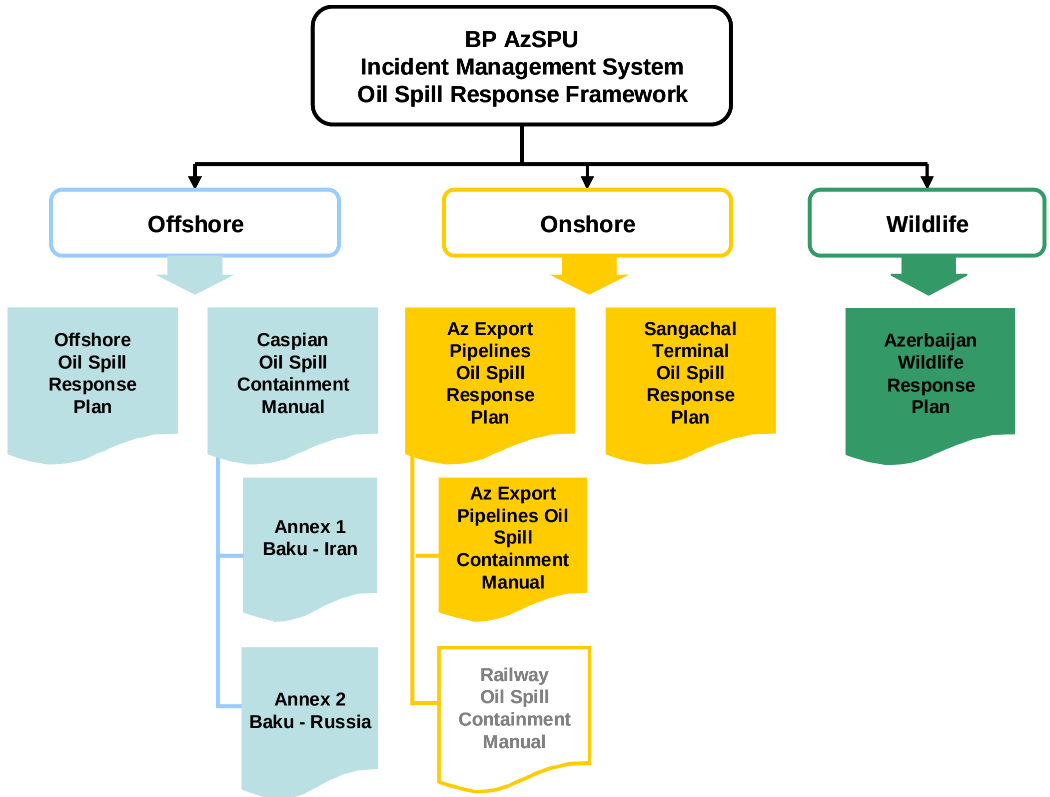
BP's Spill Response

BP, as Operator of the SD PSA, has developed and maintains a range of Oil Spill Response Plans (OSRP) for its offshore and onshore operations in Azerbaijan. These Plans encompass all phases for SD development and establish the notification, response and follow-up actions that must be implemented should an accidental event occur. The relevant OSRP Plans will be expanded to include the SD2 Infrastructure Project and those of the construction contractor that will undertake the work. The contractor will be accountable for emergency and spill response which will be aligned with BP's processes and procedures.

The Sangachal Terminal OSRP sits within the structure of the BP Incident Management System (IMS), as shown in Figure 11.6, which determines the organisational and resource requirements for all incidents, assigns roles and responsibilities, and provides detailed response procedures.

This section provides an overview of BP's systems for the operation of the Terminal. As the construction contractor has yet to be selected it provides an overview of the type of system the construction contractor will develop and implement during the works.

Figure 11.6 BP's Incident Management System



BP's response strategy is based on:

- An in-depth risk assessment of the entire crude oil and gas condensate operations at the Terminal;
- Potential volumetric loss of containment by storage tank;
- Analysis of potential spill movement; environmental sensitivities; and
- The optimum type and location of emergency response resources.

BP supplements its dedicated resources with specialised spill response contractors. The OSRP Plans describe how BP will utilise these resources to protect the environment in which it resides.

The Terminal has adopted the internationally recognised three-tiered approach for classification of oil spills in the design of its oil spill response capability as summarised in Table 11.1.

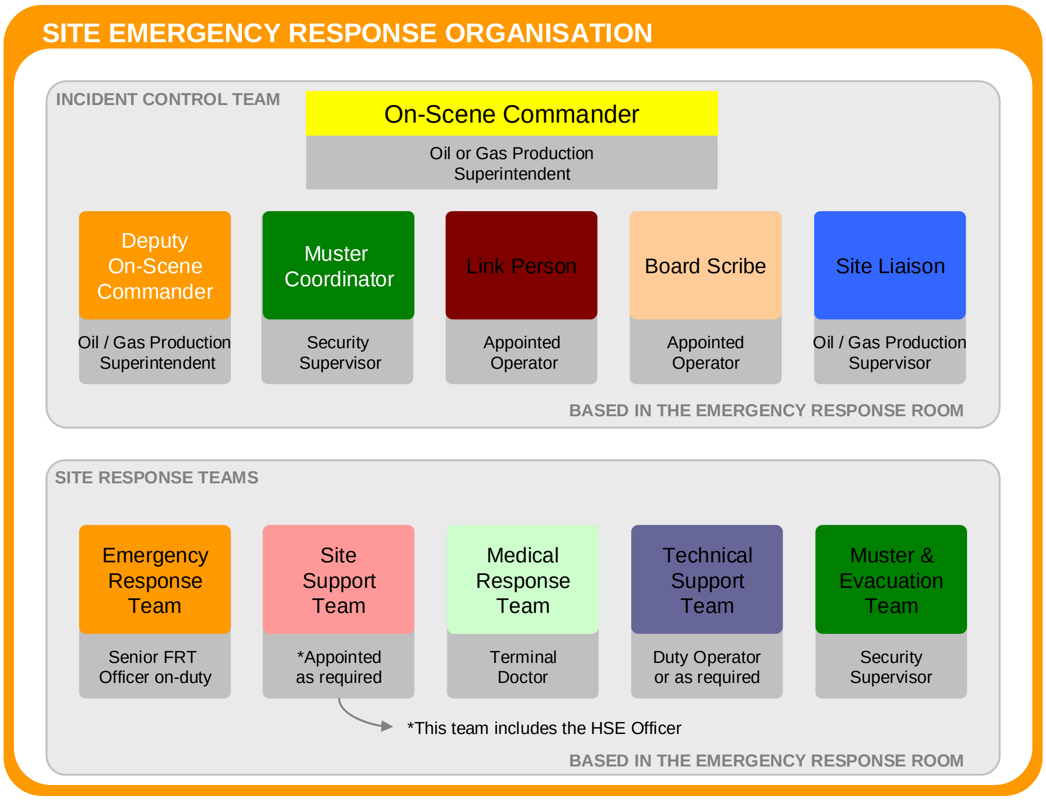
Table 11.1 Oil Spill Response Tiers

Tier 1 (Minor Event)	Involves those incidents which can be handled by onsite personnel and equipment. The Site Response Teams (SRTs) may be activated; spill response equipment deployed and the possible notification of the Incident Management Team (IMT) depending on the situation.
Tier 2 (Major Event)	Operational oil spill, which may involve injury or environmental damage and which may require additional resources and manpower, media coverage or significant resources that may not be available at the facility. The SRTs and IMT will be activated, The SPU Leader will be notified and the Business Support Team (BST) may also be activated.
Tier 3 (Crisis)	Major oil spill that involves fatality, significant environmental damage, or requires assistance from outside Azerbaijan and is likely to impact the community for an extended period. May arouse national or international media interest. The SRT, IMT and BST will be activated and the BP Group HSE Vice President will be notified.

The Sangachal Terminal OSRP covers the Terminal operating area and associated properties, the including the area of land between the Baku-Salyan Highway and the Terminal. The Terminal has in place trained and 24 hour available Site Response Teams (SRTs), dedicated and pre-positioned spill response equipment throughout the Terminal and additional support services pre-identified.

The OSRP defines a precise sequence of actions following an incident, with formal assignment of responsibility as indicated in Figure 11.7. BP maintains contracts with a number of specialist oil spill response contractors, who are equipped to provide 24-hour availability of containment and recovery services, and whose actions are controlled by the BP Incident Management Team On-Scene Commander.

Figure 11.7 Site Emergency Response Organisation



11.4.5 Spill Reporting

All non-approved releases (liquids, gases or solids) including releases exceeding approved limits or specified conditions will be internally reported and investigated.

The internal reporting requirements include the following:

- All spills of 1 litre or more will be reported and spills of less than 1 litre will be deemed reportable if an immediate response is required to prevent further losses, damage to the environment or safety hazards to personnel[15];
- If a spill results in the release of material from secondary containment and results in contamination of soil, ground or surface water, an investigation will be commenced to

[15] Where the status of the spill is unclear (i.e. the nature, type or volume of an unplanned substance loss) the HSE representative will sought for clarification.

determine the extent of contamination and necessary clean-up operations to ensure decontamination is successful; and

- A report will be prepared in accordance with the requirements below:
  - Initial incident notification report within 24 hours:
    - Time & date of incident;
    - Incident Description;
    - Description and properties of substance spilt;
    - Estimated volume;
    - Immediate actions taken; and
    - Corrective/preventative actions.

External notification requirements agreed with the MENR are:

- For liquid releases to the environment exceeding a volume of 50L, notification will be made within 24 hours after the incident verbally and within 72 hours in the written form; and
- If the release to the environment is less than 50L, then information about the release will be included into the BP AGT Region Report on Unplanned Releases and sent to the MENR on a monthly basis.

12 Environmental and Social Management

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12.1 Introduction

Under the Shah Deniz Production Sharing Agreement (PSA), BP as the Operator is responsible for the environmental and social management of the Shah Deniz (SD) activities, to ensure that project commitments are implemented, and that the project's performance complies with applicable environmental and social legal, regulatory and corporate requirements.

This Chapter provides an overview of the systems that will be used to manage the environmental and social issues associated with SD2 Infrastructure Project.

12.2 Contractor Selection

The SD2 Infrastructure works will be performed by key contractors, appointed by BP. A rigorous contractor selection process will be in place to ensure that key contractors used during the SD2 Infrastructure Project have effective HSSE Management Systems that align with BP expectations.

Companies invited to tender for contracts will be provided with detailed information on BP and AGT Region environmental and social expectations and standards. The environmental and social capability of the companies and their ability to comply with the expectations and standards will be an element in tender evaluation and award. Companies will be required to present detailed proposals for establishing and operating a compliant HSSE Management System throughout the duration of their contracts.

12.3 Contractor's Management System

12.3.1 Approach

The appointed contractor(s) will be required to develop, implement and monitor environment and social requirements through the HSSE Management System. These requirements will be drawn from relevant HSSE contract clauses, developed to ensure that the commitments of the ESIA are implemented and managed throughout the SD2 Infrastructure Project.

The HSSE Management System will be enforced through a HSSE Plan which will be reviewed by the SD2 Infrastructure Project Team prior to implementation and regularly updated. The HSSE Plan will cover:

- Leadership and Commitment;
- Legislative Compliance;
- Training, Competency and Behaviours;
- Control of Work;
- Risk Management;
- Working with Machinery;
- Management of Change;
- Occupational Health and Hygiene;
- Industrial Hygiene;
- Security management;
- Incident Notification, Investigation and Reporting;
- Emergency Response and Crisis Management;
- HSSE reporting; and
- Assurance and Audit.

Both the contractor and BP will be responsible for waste management, with the BP's focus related to disposal and overall management. Figure 12.1 sets the roles and responsibilities of the contractor and BP. Section 12.4 provides further details on the waste management responsibilities of BP.

Figure 12.1 Roles and Responsibilities of the Contractor and BP

Contractor	BP
Waste Management • Implement waste management contract clause requirements; • Segregate waste as per BP requirements detailed within the contract clauses; • Deliver skips to CWAA; • Ensure Waste Transfer Notes (WTNs) accompany all waste transfers; • Minimise waste; and • Develop and maintain waste management and minimisation.	**Waste Management** • Ensure Contractor adopt contract clause requirements and ESIA commitments implemented and deviations managed; • Lead interface between AGT Region waste operations team and Contractor; • Responsible for the provision of waste handling, storage, collection and disposal; and • Providing separate containers for different waste types.
Environmental and Social Management • Implementation of environmental and social contract clause requirements.	**Environmental and Social Management** • Ensure Contractors adopt contract clause requirements and ESIA commitments implemented and deviations managed via the management of change process; • Implement assurance program to influence Contractors environmental and social performance; • Lead interface with Contractor; • Management and implementation of IEMP.

The Contractor will be required to ensure that all subcontractors comply with the HSSE Plan.

12.3.2 HSSE Management System Requirements

An overview of the key environmental and social requirements to be implemented in the Contractor's HSSE Management System is provided in Table 12.1.

Table 12.1 Key Requirements of the Contractors HSSE Management System

Topic	Key Requirements
Environmental	

Environmental Management	• Contractors will prepare and implement an environmental management plan which is consistent with the requirements of ISO 14001 and includes the following support procedures and plans:
	  • Environmental Aspects and Impacts Identification, Targets and Objectives Plan;
	  • Development and maintenance of a Legislation Register;
	  • Waste Management Plan;
	  • Waste Minimisation and Green Procurement Plan;
	  • Pollution Prevention and Spill Response Plan;
	  • Nuisance Management Plan;
	  • Wildlife Management Plan;
	  • Archaeology and Cultural Heritage Management Plan; and
	  • Spoil, Surface Water and Landscape Management Plan.

Waste Management	• Contractors will identify and manage waste in accordance with the following core principles:
	  • Waste management planning;
	  • Waste minimisation;
	  • Waste register and classification;
	  • Waste segregation and storage; and
	  • Waste awareness and training.
	Contractors will submit a Waste Management and Minimisation Plan for BP approval prior to contract commencement.

Nuisance Management	• A Nuisance Management Plan will be prepared and implemented that details the processes used to prevent nuisance associated with construction noise, light from construction work areas, odours, pests and vermin. The plan will include details of the site controls used to manage and monitor nuisance issues.

Topic	Key Requirements

Pollution Prevention	• A Pollution Prevention and Control Plan will be prepared and will include the following:
	  ◦ A register of the nature, location and quantities of all ozone depleting chemicals on site.
	  ◦ A management strategy focused on minimising the environmental impact as a result of using chemicals, through the correct selection, transportation, storage, deployment and disposal.
	  ◦ A Hazardous Materials Inventory that will record all use of hazardous substances and materials.
	  ◦ Identification of potential planned discharges prior to mobilisation.

Wildlife Management	• A Wildlife Management Plan will be prepared and implemented which defines the activities and actions to be taken to minimise the impact to local wildlife and habitats during the works. • The plan shall include procedures for inspecting vegetation for wildlife prior to removal, actions to be taken should wildlife be encountered and reporting requirements.

Archaeology and Cultural Heritage Management	• An Archaeology and Cultural Heritage Management Plan will be developed and implemented, detailing how the works will be managed in relation to potential archaeological cultural heritage impacts to include:
	  ◦ Known archaeological resources within the site, including location, significance, and protective buffers;
	  ◦ Watching brief procedure to be followed during ground breaking activities;
	  ◦ Archaeological chance finds procedure including reporting requirements and procedure for notifying BP; and
	  ◦ Contractors training requirements.
	• The Archaeology and Cultural Heritage Management Plan will be updated to include details of finds and any corrective actions.

Spoil, Surface Water and Landscape Management	• A Spoil and Landscape Management Plan will be prepared and implemented, detailing the following:
	  ◦ The estimated amount of spoil to be generated on site;
	  ◦ The estimated amount of spoil suitable for re-use on site;
	  ◦ Amount and destination of unused spoil (including locations of any spoil heaps);
	  ◦ The contaminative potential of the spoil generated onsite and control actions to prevent pollution;
	  ◦ Dust management;
	  ◦ Schedule of spoil activities; and
	  ◦ Biorestoration Plan.

Spill Response, Notification and Close Out Actions	• Contractors will prepare and implement a Spill Response Plan and Notification Plan.

Traffic and Transportation	• Contractors will develop a Traffic Management Plan to effectively manage vehicles and pedestrians on site.
	• Contractors will implement a Transportation Plan which will cover all forms of transport both onsite and offsite in Azerbaijan. The Transportation Plan shall will cover, as a minimum, the following:
	  ◦ Scope of work to be performed by Transport department;
	  ◦ Overview of Transport Organisation;
	  ◦ Roles and Responsibilities;
	  ◦ How vehicle will be sourced and minimum standard;
	  ◦ Inspection and Maintenance Systems;
	  ◦ Vehicle Operations; and
	  ◦ Drivers.

Social	

Community Interaction and Social Impact Management	• Contractors will prepare and implement a Community Interaction and Social Impact Management Plan, detailing how construction workers will be managed in relation to potential social impacts and how interactions with the adjacent communities will be managed. This Plan should include:
	  ◦ Roles and responsibilities associated with liaising and interacting with the community; and
	  ◦ Grievance mechanisms for dealing with community complaints.
	• A Community Health Plan will be developed and implemented to address and monitor community health risks associated with the infrastructure construction work.

Workforce Welfare and Local Employment	• Contractors will prepare and implement a Workforce Welfare and Local Employment Plan for the works, detailing the following:
	  ◦ Azerbaijani content development strategy to include well-planned nationalisation agenda and local content inclusion through continuous search of local market, engagement of local suppliers and priority given by the organisation to local content;
	  ◦ Detailed description of the proposed approach to developing Azerbaijani capabilities in the tendered services;
	  ◦ Estimation of the percentage of compensation associated with the proposed services that ultimately stay in Azerbaijan;
	  ◦ Detailed description of Azerbaijani content factor within organisation;
	  ◦ Proportion of men and women staff proposed;
	  ◦ Process for de-manning of the workforce at the end of the construction phase;
	  ◦ Potential market distortion due to temporary inputs to local economy;
	  ◦ Recruitment procedures; and
	  ◦ Grievance mechanisms for dealing with worker complaints.

12.4 Waste Management

Waste generated during the SD2 Infrastructure Project will be managed in accordance with the existing BP AGT Region management plans and procedures. All wastes generated as part of the SD2 Infrastructure Project will be identified and managed in accordance with the following requirements:

- Site specific Waste Management Plans will be prepared;
- Waste minimisation;
- All waste streams identified and classified;
- Waste segregation at source;
- Workforce awareness and training;
- AGT Region Approved Waste Contractors List;
- AGT Region Waste Streams Register; and
- AGT Region Waste Management Strategy.

In accordance with internationally recognised best practice, the waste hierarchy, coupled with the AGT Region Best Practicable Environmental Option (BPEO) assessment of available waste disposal / treatment technologies that has been conducted, the AGT Region Waste Management Strategy and supporting documentation will be adopted as the basis for guiding waste management decisions. This approach is intended to ensure that wastes are managed in the most sustainable way and in compliance with all applicable AGT Region standards and national legislation whilst ensuring they are recovered or disposed of efficiently without endangering human health and minimising environmental and social impacts.

12.4.1 Waste Management Processes and Procedures

Waste Management and Minimisation Plans will be developed and maintained to cover the duration of the SD2 Infrastructure Project's activities to match the anticipated waste streams, likely quantities and any special handling requirements.

A schedule of internal audits will be developed to objectively monitor the performance of the waste management systems during the SD2 Infrastructure Project's activities and to ensure that all corrective actions and improvements are identified and implemented.

To support the Waste Management Plan, contractors will receive waste management training covering:

- Identification of waste types and potential associated hazards;
- Waste segregation; and
- Waste transfer documentation (if involved in waste movement).

All new waste disposal routes are routinely assessed prior to use and must be compliant with applicable local laws and regulations. Waste will only be routed to those waste disposal facilities that have been approved for use by the AGT Region.

12.4.2 Waste Segregation and Transfer

Waste streams will be segregated at source to permit reuse/recycling and to avoid contact between incompatible materials. The segregation requirements will be clearly indicated by the use of containers with clear signage denoting the waste types that are suitable for the containers provided.

All waste transfers will be accompanied by individual Waste Transfer Notes (WTNs), confirming the waste type, quantity, waste generator, consignee, consignor (if different from the generator) and, in the case of hazardous wastes, both Waste Passports and, where required, MSDS documentation. A final visual inspection of all waste consignments will be made prior to transfer note sign-off and uplift. Coloured copies of the waste transfer documentation together with other relevant information e.g. MSDS, Waste Passports, will be retained by the waste generator. All parties involved in transporting wastes will retain a copy of the waste transfer note.

Depending upon the nature of the waste and the approved method of recycling/disposal, wastes may be routed via the Central Waste Accumulation Area (CWAA), waste transfer station or similar facility, or alternatively may be routed directly to their final approved destination.

12.5 Environmental Monitoring

BP's AGT Region has implemented an Integrated Environmental Monitoring Programme (IEMP) designed to provide a consistent, long-term set of data, with the objective of ensuring an accurate picture of potential impacts of AGT Region activities on the surrounding environment so that they can be managed and mitigated as effectively as possible. The SD2 Infrastructure Project will be integrated into this programme.

Onshore monitoring undertaken as part of the IEMP includes:

- Baseline surveys – provide a general understanding of the physical, chemical and ecological parameters at a particular location before development commences. Any unusual or sensitive ecological features, which might affect the design of a development, can also be identified; and
- Routine environmental monitoring surveys – provide an assessment of the impact of AGT Region operations, aiding responsible environmental management.

The existing IEMP will be supplemented by construction focused monitoring that will include:

- Noise;
- Dust;
- Wetland water quality; and
- Air quality.

This monitoring will be integrated into the construction phase Environmental and Social Mitigation and Monitoring Plan (ESMMP).

13 Residual Impacts and Conclusion

Contents

List of Tables

13.1 Introduction

This section summarises the residual environmental and socio-economic impacts and conclusions of the Shah Deniz 2 (SD2) Infrastructure Project ESIA.

13.2 Environmental Impacts

Environmental impacts have been assessed for SD2 Infrastructure Project and Table 13.1 provides a summary of the residual impacts.

Table 13.1 Summary of Residual Environmental Impacts

	Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from onsite and offsite construction plant and vehicles.	Medium	(Humans) Medium	**Moderate Negative**
	Emissions from surface soil layer removal and spoil movement.			
Noise	Noise emissions associated with construction activities.	Medium	(Humans) Medium	**Moderate Negative**
			(Biological/ Ecological) Medium	
Impact to the Terrestrial and Coastal Environment (Ecology)	Surface soil layer removal and spoil movement, drainage management works and Pipeline Landfall Area preparation.	Medium	(Biological/ Ecological) Medium	**Moderate Negative**
Impact to the Terrestrial Environment (Soil, Groundwater and Surface Water)	Excavation works and ground disturbance	Medium	(Soil) Medium	**Moderate Negative**
			(Surface Water) Medium	**Moderate Negative**
Impacts to the Terrestrial and Coastal Environment (Cultural Heritage)	Impacts to cultural heritage due to earthworks and piling.	Medium	(Physical Receptors) Medium	**Moderate Negative**

Air Quality and Dust

Emissions from onsite plant and vehicles and offsite vehicles will be generated within the vicinity of the Terminal and disperse into the atmosphere. The combined impact to air quality (specifically the contribution to NO_2 concentrations) from these sources at sensitive receptors (i.e. Sangachal Town, Umid, Azim Kend and Masiv 3) is considered to be of no more than a moderate negative impact.

The generation of dust and PM_{10} from surface soil layer removal and spoil movement activities has been modelled. Modelling of long term (annual average) and short term (24 hour) PM_{10} concentrations at ground level concluded that the expected increase at sensitive receptors would be no more than 12% (under worst case conditions) of the relevant short term PM_{10} limit value of 50 µg/m^3, and this increase would be imperceptible when compared to existing PM_{10} concentrations at Sangachal Town (109 µg/m^3). The maximum daily dust deposition rate was calculated as 132 mg/m^2/day at Sangachal Town. This is comparable to the guidance value of 133 mg/m^2/day[1]. Existing measures to control dust include limiting vehicle speeds on unsurfaced roads, use of water to control dust from exposed surfaces and suspension of work should excessive dust levels arise. It is expected that, in general, the dust generated by the construction works will be imperceptible in the context of the existing, background levels of dust deposition that generally occur in semi-arid areas (estimated to be between 495-896 mg/m^2/s)[2].

Noise

Noise modelling has been undertaken to estimate the increase in noise levels at sensitive receptors in the Terminal vicinity from onsite plant and vehicles. Modelling was based on a realistic scenario which reflects the expected typical construction activities (i.e. 50% of the plant and vehicles are operating at the works boundary and 50% within the centre of the SD2 Infrastructure area).

The results of the noise modelling showed that no exceedances are predicted at Azim Kend, Masiv 3, Umid or Sangachal Town. Highest noise levels were predicted at Sangachal Town, where the noise limit value of 65dB is predicted to be just met. The noise level predicted, however, was lower than the existing average ambient noise level of 67dB(A). This implies that construction noise would not be significantly noticeable in the context of existing noise levels.

An assessment was also undertaken to determine the likely worst case impacts should all project activities that contribute to construction noise (including concrete breaking and the piling activities) coincide with the period of highest onsite construction plant and vehicle activity. It was concluded that under this worst case scenario, the limit value of 65 dB(A) would be met at Azim Kend and Umid, but exceeded at Sangachal Town. At this receptor, however, it is predicted that the worst case noise level would be comparable to the existing ambient noise level of 67 dB(A), implying that construction noise would not be significantly noticeable in the context of the existing noise levels in this location.

Existing control measures to mitigate noise impacts include switching off construction plant and vehicles whilst not in use, and the requirement for all onsite construction plant and vehicles to be fitted with effective exhaust silencers. In addition, the following mitigation measures will be implemented:

- Where practicable, portable acoustic screens will be used around pneumatic hammers when undertaking concrete breaking; and
- The local communities will be informed of the proposed schedule and works prior to commencement of the trial piling activities with driven piles.

Overall, it was concluded that the noise impact to both humans and biological/ecological receptors would be a moderate negative impact.

Terrestrial and Coastal Ecology

It is estimated that the SD2 Infrastructure works associated with removal of the surface soil layer removal, spoil movement, drainage management works and preparation works at the Pipeline Landfall Area will result in the removal of approximately 85 hectares of existing habitat. The loss will be permanent within approximately 50% of the affected area. The remaining areas will be in temporary use and subsequently reinstated.

Local vegetation in the vicinity of the SD2 Infrastructure area is characterised by floral species which are typical for the area surrounding the Terminal and are neither rare nor threatened. Surveys have shown no significant change in the distribution or status of desert/semi-desert vegetation over time.

[1] Most stringent guidance levels of 133 µg/m^2/day were used sourced from Australian guidance. No single international value exists.
[2] Wanquan Ta and Tao Wang (2004); 'Measurements of dust deposition in arid and semi-arid regions, China', American Society of Civil Engineers (ASCE) pp. 1-10.

The wetland area to the south of the Terminal, where wadi clearance works are planned, is dependant primarily on seasonal water flow through the wadi system. However, surveys have shown no significant change in species present or the overall extent of the wetland, other than as a result of 3rd party construction activities. The wetland habitat is not considered to be unique and the area affected by the works is not critical to the function of the habitat as a whole.

Approximately 12% of the bird species recorded in Terminal vicinity are ground nesting birds. However, there is no evidence within the surveys completed to date to indicate that the habitat within the SD2 Infrastructure area is of unique value to breeding birds. It is considered likely that birds within the Terminal vicinity are already habituated to noise from industrial and road traffic noise.

Six faunal species (including four with conservation status[3]) have been recorded in low numbers in the Terminal vicinity. Only the spur thighed tortoise (*Testudo graeca*) has been recorded consistently. The area affected by the works is not optimal habitat and not considered critical to the existing population. The works would contribute to no more than a minor temporary change and ecological functionality of the faunal species populations will be maintained.

Impacts will be minimised as far as practicable and necessary through the implementation of the existing control measures, which include a requirement to:

- Inspect vegetation prior to removal to detect presence of wildlife and cease activities until appropriate action is taken to ensure any wildlife encountered is not harmed;
- Minimise surface soil layer removal and vegetation clearance near to wetlands, rivers or stream banks; and
- Undertake daily checks of excavations for wildlife prior to work commencing.

A Wildlife Management Plan will be prepared and implemented, which defines the activities and actions to be taken to minimise the impact to local wildlife and habitats during the works including planned relocation of any mammals, reptiles or any IUCN or Azerbaijan Red Data Book listed species encountered within the areas affected by the SD2 Infrastructure works.

The assessment concluded that the SD2 Infrastructure works will result in a no more than moderate adverse impact to ecological receptors.

Soil, Groundwater and Surface Water

The surface soil layer removal and spoil movement and drainage management works may result in mobilisation of existing soil, groundwater and surface water contamination through physical disturbance. Monitoring to date has not indicated any significant or widespread contamination in the areas where infrastructure works are planned, but it is possible that localised areas of contamination exist.

Within the wetland area, including the areas where wadi clearance works are planned, surveys have indicated high levels of Total Hydrocarbon Content (THC), Polyaromatic Hydrocarbons (PAH) and cadmium (within groundwater samples) and phenols (in soil). In addition, localised hydrocarbon spills were observed during a walkover in June 2011.

Where oily contaminated soil, ground water, surface water or other materials outside of the existing Sangachal Terminal property boundary are encountered and require handling, these materials will be relocated to areas of comparable environmental quality and function and the characteristics of the materials recorded. If contaminated materials are encountered within the existing Sangachal Terminal property boundary, these will be classified and managed as waste in accordance with existing BP waste management procedures. Other control measures to minimise potential mobilisation of contamination include locating spoil piles away from watercourses, and maintaining site drainage and pollution hazards maps that show

[3] Including IUCN Lower Risk/Near Threatened, IUCN Vulnerable and Azerbaijan Red Data Book Species.

potential sources of pollution (e.g. storage areas), pathways (e.g. drains) and receptors (e.g. the Caspian Sea).

The assessment concluded that there was a moderate negative impact on soil and surface water. It is considered that impacts to soil and surface water are minimised as far as practicable and necessary through the implementation of the existing control measures.

Cultural Heritage

Surface soil layer removal and spoil movement and drainage management works has the potential to impact cultural heritage. No state protected monuments or other type of cultural heritage sites are known to occur within the upper 0.15m of topsoil, or under existing stockpiles. Areas beneath existing spoil heaps are likely to have been substantially impacted as a result of previous construction works, and the Pipeline Landfall Area has also been previously disturbed by aggregate and/or limestone quarrying. Existing controls include a watching brief to identify any artefacts or sites of archaeological importance and a chance-finds procedure. An archaeological baseline survey, undertaken in 4Q 2011 (results pending), will inform the Archaeology and Cultural Heritage Management Plan, further reducing the potential for damage to cultural heritage sites.

Piling activities are planned to include driven pile trials in the SD2 Expansion Area and bored piles at the pipeline crossings. Piling activities, especially driven piles, can generate vibrations within soil and rock matrices that have the potential to impact cultural heritage structures, such as the Caravanserai. The driven piles trials are planned to be located west of the SD2 Expansion Area more than 1km from the Caravanserai. The areas where the bored pipeline crossings are planned are located a minimum of 250m from the Caravanserai. As vibrations from piling activities are not expected to travel more than 50m from the source it is considered unlikely that the Caravanserai would be affected by piling activities.

Overall, the impact to cultural heritage from the earthworks and piling is considered to have a moderate negative impact.

13.3 Socio-Economic Impacts

Socio-economic impacts have been assessed for SD2 Infrastructure Project and Table 13.2 provides a summary of the residual impacts.

Table 13.2 Summary of Residual Socio-Economic Impacts

Event	Magnitude: Spatial Scope	Magnitude: Timing and Duration	Probability	Receptor Sensitivity	Significance
Direct Impacts					
Disruption and access restrictions (SD2 Infrastructure Area)	Local	All SD2 Infrastructure area will be temporarily fenced during works to prevent unauthorised access. Temporary impact Up to approximately 115 hectares will be permanently removed from use for herders. Permanent impact	Highly likely	Local herders – High	**Moderate – major negative**
Disruption and access restrictions (Pipeline Landfall Area)	Local	The majority of the SD2 Infrastructure Area will be temporarily fenced during works (between March 2012 and June 2013). Temporary impact	Highly likely	Recreational fishermen - Low	**Negligible**
			Highly likely	Commercial fishermen - Medium	**Negative**
			Highly likely	Recreational users - Low	**Negligible**
			Unlikely	Shoreline property values - Low	**Negligible**
Employment creation	Local	Employment will occur throughout the project, and is expected to peak between April 2012 and November 2012. Temporary impact	Highly likely	Local community - High	**Moderate-Major Positive**
	Regional		Likely	Regional community – Medium	**Positive**
Training and skills development	Local	Training will commence prior to the project activities and continue throughout the project. Permanent	Highly likely	Local community – High	**Moderate-Major positive**
	Regional		Highly likely	Local community – Medium	**Positive**
Procurement of goods and services	Local and Regional	Procurement will take place throughout the project and benefits will cease shortly after the project finishes. Temporary	Highly likely	Local and regional businesses - High	**Moderate-Major positive**
	National			National businesses - High	**Positive**
Disruption and impact to community safety associated with construction vehicle movements (offsite)	Local	Off site traffic movements will take place throughout the project. Temporary	Unlikely	Road users and local community – High	**Negative**
Deterioration in Road Conditions	Local	Changes to road condition from the transportation of construction materials will take place throughout the project and will cease after the project finishes. Temporary	Highly unlikely	Local Roads – High Main highway - Low	**Negligible**
Road and rail works	Local, and regional	Road and rail works are expected throughout the project but disruption is expected to be of short duration. Temporary	Highly likely	Local, regional and national businesses – High	**Negative**
De-manning	Local	De-manning will likely commence prior to end of the project as manning levels decrease however it is expected that the main SD2 Project will provide relevant employment opportunities for workers. Permanent	Unlikely	Local community – High	**Negligible**

Disruption and Access Restriction

Project activities associated with establishment of the initial site compound at the commencement of the works, to closure of the EOP Road and At-Grade Railway Crossing, during the final stages will all involve changes to land access within the footprint of the SD2 Infrastructure Area. While it is not intended to permanently fence the entire perimeter of the SD2 Infrastructure Area, it will be necessary to fence each area temporarily during construction works for safety and security reasons.

The sensitivity of recreational fishermen, recreational users and shoreline properties is considered to be low; impacts are considered to be minimised as far as practicable and necessary and no mitigation is required. Overall, the impact to herders is considered to be moderate to major negative and the impact to commercial fishermen negative.

Employment Creation

It is anticipated that the project will employ between 450 and 700 people over the duration of the works. A Workforce Welfare and Local Employment Plan will be prepared and implemented with the aim of maximising the employment opportunities for the four local communities. It is considered that local and regional impacts associated with employment are maximised as far as practicable through existing controls. A moderate-major positive impact on a local scale is anticipated as a result of the project, specifically within the local communities.

Training and Skills Development

A Training Plan will also be put in place which sets out training programmes similar to those that were implemented for the previous ACG and SD projects. The aim of the Training Plan will be to provide training and skill development opportunities with particular emphasis on the training of Azerbaijani citizens. A formal system of competency assurance will be implemented and records will maintained of competency testing and training undertaken. Based on this, it is considered that the SD2 Infrastructure Project will have moderate to major positive impact on a local scale on training and skills development, specifically within the four local communities.

Procurement of Goods and Services

The procurement of materials, equipment, goods and services will commence prior to the commencement of project activities and will continue throughout the project. The anticipated benefit to businesses cannot be quantified at present as the procurement strategy and award of construction contracts has been not been made. However, preference will be given to source equipment (such as plant and construction vehicles) and materials (such as gravel) which meet the required project specifications from Azerbaijan wherever possible. This is considered to have a moderate to major positive impact at a local and regional level and a positive impact at a national level.

Disruption Due to Construction Vehicle Movements

The contribution of project vehicle movements to the existing daily flows on the Baku-Salyan Highway is expected to peak at 162 (between May 2012 and October 2012). Existing controls to minimise traffic impacts include the implementation of a Transportation and Traffic Management Plan. The focus of the Plan will be to ensure that drivers and their vehicles are safe when on the road and adopt safe driving behaviours. To further minimise potential impacts to local communities associated with offsite traffic movements, it will be necessary to communicate the potential hazards associated with offsite traffic movements, as part of ongoing community liaison. It is considered that the SD2 Infrastructure Project will have a negative impact on existing traffic flows.

Road Conditions

It is expected that the Baku-Salyan Highway will be the primary route that is used for the transport of construction materials. However, the exact transport routes used will not be determined until the procurement strategy is in place and the construction contract has been awarded. Prior to and following the SD2 Infrastructure works, it is planned to complete a survey of local roads used to transport construction materials to assess their existing condition. Any changes to the condition of local roads associated with the project will be identified and repairs made to restore their condition. Construction traffic will have no effect on the future condition of the main highway and therefore the impact is considered be negligible to both local roads and the Highway.

Road and Rail Works

It is anticipated that disruption to road and railway users are likely to occur as a result of road and rail works including potential temporary closures and diversions. Procedures will be established to manage any road closures requirements and/or disruption to the rail services to include duration, timings and options considered to minimise disruption. The Azerbaijan Ministry of Transport and the emergency services will be notified in advance of road closures. Activities that may affect the railway and associated timings will be agreed with the Azerbaijan rail authority. It is considered that the disruption to road and railway users will be negative.

Demanning

As activity reduces towards the end of the project, workforce levels will reduce. However, it is understood that the works associated with the main SD2 Project will begin immediately following the completion of the SD2 Infrastructure Project. The SD2 Project will provide further opportunities for employment and therefore the probability of impacts associated with de-manning are considered to be negligible.

13.4 Cumulative, Transboundary and Accidental Events

Cumulative impacts, potential transboundary impacts and the impacts of accidental events associated with the SD2 Infrastructure Project have been assessed.

The potential for interaction between the different SD2 Infrastructure Project related residual impacts, resulting in a cumulative impact has been considered. The cumulative effect of all expected project activities will be managed through the implementation of a Nuisance Management Plan. The Plan will detail the processes used to prevent nuisance associated with construction noise, light from construction work areas, odours, pests and vermin. In addition a Community Interaction and Social Impact Management Plan will be implemented and maintained as a mechanism of communicating with the community and responding to community grievances.

Given the existing control measures in place, it is considered that the appropriate measures are in place to mitigate and manage potential cumulative effects between project related residual impacts.

Based on a review of available information, it is understood that the following projects (which have the potential to interact with the impacts of the SD2 Infrastructure Project based on their location and scale) are planned or under construction in the vicinity of the Terminal:

- **Qizildas Cement Plant** – To be located approximately 4km north of the Terminal;
- **Garadagh Dry Kiln Upgrade Project** – Upgrade to the existing Garadagh cement works (approximately 6km to the east) to install dry kiln technology and increase production; and
- **New Highway Junction** – Planned immediately to the south of the Terminal and planned to connect to the new Terminal access road, which forms part of the SD2 Infrastructure works.

The assessment of cumulative impacts demonstrated that negative cumulative impacts associated with the SD2 Infrastructure Project and other projects in the Terminal vicinity planned or under construction are expected to be limited.

The aspect with the greatest potential for negative impact is traffic disruption, assuming that the SD2 Infrastructure Project and the Qizildas Cement Plant construction schedules overlap. There is also potential for cumulative noise impacts at sensitive receptors associated with the SD2 Infrastructure Project and the Highway Junction. It will therefore, be necessary for the construction contractors and the Highways Authority to liaise to ensure these impacts are minimised through scheduling of works and use of appropriate mitigation measures.

There are also a number of significant positive cumulative impacts, primarily associated with employment and economic flows.

Accidental events are considered separately from routine and non-routine activities as they only arise as a result of a technical failure, human error or as a result of natural phenomena such as a seismic event.

Potential accidental events associated with the SD2 Infrastructure Project works include:

- Impact to a pipeline(s) within the existing pipeline corridor during construction activities;
- Loss of containment from fuel tanks within the construction camp/facilities area;
- Loss of containment from a fuel bowser, drum, Intermediate Bulk Container or fuel transfer container;
- Minor spills associated with leaks/small spills;
- Failure of the sewage treatment plant;
- Overflow of underground oil separators or septic tanks;
- Release of concrete into watercourses or the Caspian Sea; and
- Flood events causing silty water runoff from stockpiles and exposed ground.

Measures to mitigate accidental events have been incorporated at the project design stage and include:

- Pipeline mapping and condition assessment of existing pipelines;
- Construction of culverts/crossings over existing pipelines;
- Use of concrete barriers and buried pipeline protection on the EOP road;
- Bunding and containment; and
- Design of underground and septic tanks.

In addition, procedures and controls will be implemented during the construction to ensure that there is a minimum risk of spills. Key controls include:

- Production of site drainage and pollution hazard maps, showing the sources of potential pollution pathways and key receptors;
- Provision of adequate training in spill response for all personnel; and
- Maintenance of a spills register documenting key details of all spills including remediation works, if required.

Furthermore, a Spill Response Plan will be prepared prior to commencing work on the SD2 Infrastructure Project. This document will be aligned with BP's Oil Spill Response Plans (OSRP) and integrate with those plans maintained by the 3rd party pipeline owners that operate those pipelines over which crossings will be installed.

13.5 Environmental and Social Management

The SD2 Infrastructure works will be performed by key contractors, appointed by BP. A rigorous contractor selection process will be in place to ensure that key contractors used during the SD2 Infrastructure Project have effective HSSE Management Systems that align with BP expectations.

The appointed contractor(s) will be required to develop, implement and monitor environment and social requirements through the HSSE Management System (aligned with ISO 14001 and OHSAS 18001 Standard).

The environmental and social management process will benefit from accumulated experience and 'lessons learned' from executing previous projects and a well-established environmental monitoring programme. Other benefits of previous project experience include the development of:

- Effective and reliable procedures for onsite segregation and management of waste;
- A non-hazardous landfill site designed and constructed to EU standards; and
- An effective process for identifying and utilising opportunities for waste recovery and recycling.

13.6 Conclusions

Planning for the SD2 Infrastructure Project has benefited, to a considerable extent, from the experience gained from previous construction projects at the Terminal. Lessons learnt from previous projects have informed the SD2 Infrastructure Project.

In conclusion, the SD2 Infrastructure Project has considered all aspects of its impact on the environmental and socio-economic receptors and incorporated additional mitigation to existing controls to ensure any negative impacts are minimised as far as practicable.

APPENDIX 2A

Shah Deniz Production Sharing Agreement Extract

Appendix 2A

Shah Deniz Production Sharing Agreement Extract

ARTICLE XXVI - Environmental Protection and Safety

26.1 Environmental Standards

Contractor shall develop jointly with SOCAR and the State Committee of the Azerbaijan Republic on Ecology and Control over the Use of Natural Resources ("SCE") safety and environmental protection standards and practices appropriate for the regulation of Petroleum Operations. The safety and environmental protection standards shall take account of the specific environmental characteristics of the Caspian Sea and draw, as appropriate, on (i) international Petroleum industry standards and experience with their implementation in exploration and production operations in other parts of the world and (ii) existing Azerbaijan safety and environmental legislation. In compilation of such standards and practices account shall be taken of such matters as environmental quality objectives, technical feasibility and economic and commercial viability. Subject to the first sentence of Article 26.4 the standards, which shall apply to Petroleum Operations from Effective Date shall be the standards and practices set out in part II of Appendix IX until substituted by new safety and environmental protection standards devised and agreed between Contractor, SOCAR and SCE on a date between the Parties and SCE and from such date such agreed standards and practices shall have the force of law as if set out in full in the Agreement. In the event that the safety and environmental protections standards and practices are imposed otherwise than with the agreement of Contractor it is agreed that the provisions of Article 23.2 shall apply. The Parties and SCE shall agree a separate protocol for the detailed implementation of the joint development and definition of the new standards and practices for safety and environmental protection. The cost to Contractor of such development and definition shall be Cost Recoverable.

26.2 Conduct of Operations

Contractor shall conduct the Petroleum Operations in a diligent, safe and efficient manner in accordance with the Environmental Standards to minimise any potential disturbance to the general environment, including without limitation the surface, subsurface, sea, air, lakes, rivers, animal life, plant life, crops, other natural resources and property. Contractor shall implement an integrated management system covering all health, safety and environmental aspects of the activities carried out in relation to the Petroleum Operations as outlined in Part 1 of Appendix IX.

26.3 Emergencies

In the event of emergency and accidents, including but not limited to explosions, blow-outs, leaks and other incidents which damage or might damage the environment, Contractor shall promptly notify SCE (Goskomokhrana) and SOCAR of such circumstances and of its first steps to remedy this situation and the results of said efforts. Contractor shall use all reasonable endeavours to take immediate steps to bring the emergency situation under control and protect against loss of life and loss of or damage to property and prevent harm to natural resources and to the general environment. Contractor shall also report to SOCAR and appropriate Government Authorities on the measures taken.

26.4 Compliance

Contractor shall comply with present and future Azerbaijani laws or regulations of general applicability with respect to public health, safety and protection and restoration of the environment, to the extent that such laws and regulations are no more stringent than the Environmental Standards. In the event any regional or multi-governmental authority having jurisdiction enacts or promulgates environmental standards relating to the Contract Area, the Parties will discuss the possible impact thereof on the project. The provisions of Article 23.2 shall apply to any compliance or attempted compliance by Contractor with any such standards which adversely affect the rights or interests of Contractor hereunder.

26.5 Environmental Protection Strategy

An environmental protection strategy shall be developed which shall include:

(a) the establishment of an environmental management system as an integral part of Petroleum Operations and the formation of an environmental sub-committee as described in the Environmental Standards.

(b) an environmental work programme carried out in sequences appropriate to the normal phases of Petroleum Operations as described in the Environmental Standards (seismic survey, exploration drilling, field development and production).

26.6 Environmental Damage

(a) Contractor shall be liable for those direct losses or damages incurred by a Third Party (other than Government Authority) arising out of any environmental pollution determined by the appropriate court of the Azerbaijan Republic to have been caused by the fault of Contractor. In the event of any environmental pollution or environmental damage caused by the fault of Contractor, Contractor shall reasonably endeavour, in accordance with generally acceptable international Petroleum industry practices, to mitigate the effect of any such pollution or damage on the environment.

(b) Contractor shall not be responsible and shall bear no cost, expense or liability for claims, damages or losses arising out of or related to any environmental pollution or other environmental damage, condition or problems which it did not cause, including but not limited to those in existence prior to the Effective Date of this Agreement and SOCAR shall indemnify and hold harmless Contractor, its Sub-contractors and their consultants, agents, employees, officers and directors from any and all costs, expenses and liabilities relating thereto.

(c) Any damages, liability, losses, costs and expenses incurred by Contractor arising out of or related to any claim, demand, action or proceeding brought against Contractor, as well as the costs of any remediation and clean-up work undertaken by Contractor, on account of any environmental pollution or environmental damage (except for such pollution or damage resulting from the Contractor's Wilful Misconduct) caused by Contractor shall be included in Petroleum Costs.

ARTICLE XXVI – APPENDIX IX – Environmental Standards and Practices

I. Integrated Management System

A. Environmental Sub-Committee

1. The formation and organisation of an environmental sub-committee of the Steering Committee shall be set forth in a proposal of Contractor which will be submitted to SOCAR for approval. Once approved SOCAR, the environmental sub-committee shall be formed in accordance with the approved recommendation and shall be composed of environmental representatives of Contractor Parties and SOCAR, the State Committee of the Azerbaijan Republic on Ecology and Control over the Use of Natural Resources, Azerbaijan Academy of Sciences and other relevant research institutes.
2. Responsibilities of the environmental sub-committee shall be to:
    - Design monitoring programme for monitoring of selected environmental parameters
    - Coordinate monitoring programme
    - Review results and propose recommendations
    - Publish annual report

B. Environmental Work Programme

The environmental work programme to be pursued during Petroleum Operation pursuant to Article 26.2 shall be phased as follows:

1. For seismic surveys
    - Environmental impact assessment
    - Health, safety and environmental management plan for seismic operations, including emergency procedures, oil spill contingency plan, waste management plan and an audit programme

2. For exploration drilling
    - Drilling environment impact assessment
    - Baseline environmental study
    - Health, safety and environment management plan for exploration drilling, including emergency procedures, oil spill contingency plan, waste management plan (including drill cuttings disposal) and an audit programme
3. For development and production
    - The environmental work programme for the Development and Production Period shall be submitted together wit the Development Programme to SOCAR for approval

II Environmental Standards

The following are general and specific guidelines relating to discharges associated with oil and natural gas exploration and production activities.

A. General Guidelines

1. There shall be no discharge of waste oil, produced water and sand, drilling fluids, drill cuttings or other wastes from exploration and production sites except in accordance with the following guidelines.
2. There shall be no unauthorised discharges directly to the surface of the sea. All discharges authorised by these guidelines shall be controlled by discharging into a caisson whose open end is submerged, at all times, a minimum of two (2) feet below the surface of the sea.

B. Discharge Guidelines and Monitoring

1. Produced Water

(a) Contractor will endeavour to utilise produced water for reservoir pressure maintenance if, through standard compatibility testing with Caspian Sea water, no damage to the reservoir resulting in a reduction in overall hydrocarbon recovery would occur by mixing the two water streams. In the event that the two water streams are compatible, Contractor may only discharge a volume of produced water after treatment to the Caspian Sea that exceeds the total volume required for reservoir pressure maintenance or in the event of an emergency, accident or mechanical failure. In the event that the two water streams are not compatible, Contractor may discharge produced water to the Caspian Sea after treatment in accordance with generally accepted international Petroleum industry standards and practices.

2. Drill Cuttings and Drilling Fluids

(a) There shall be no discharge of oil based drilling fluids, other than low toxicity and biodegradable drilling fluids.
(b) There shall be no discharge of drill cuttings generated in association with the use oi oil based drilling fluids, invert emulsion drilling fluids, or drilling fluids that contain radiation, if any, waste engine oil, cooling oil, gear oil, or other oil based lubricants, other than cuttings generated in association with the use of low toxicity and biodegradable drilling fluids.
(c) There shall be no discharge of drill cuttings or drilling fluids if the maximum chloride concentration of the drilling fluid system is greater than four (4) times the ambient concentration of the receiving water.
(d) Prior to the start of the drilling programme, a drilling mud system will be designed and laboratory tested under the US EPA, 96-hour acute toxicity test using mycid shrimp or other indicator organisms of the Caspian Sea agreed between Contractor and SOCAR. Those muds biodegradable and of low toxicity will be authorised for discharge during the drilling programme.
(e) During drilling operations, mud samples will be collected periodically to determine toxicity using procedures established for the Caspian Sea.
(f) The composition of the mud system may be altered as necessary to meet changes in the drilling operations. The modified mud system may be discharged if it has been shown to meet the above limits on oil, salinity and toxicity.

3. Other Wastes

(a) Sanitary waste may be discharged from a U.S Coast Guard certified or equivalent Marine Sanitation Device (MSD) with total residual chlorine content greater than 0.5 mg/l but less than 2.0 mg/l as long as no floating solids are observable. The Hach method CN-66-DPD test shall be used to measure the residual chlorine.
(b) Domestic wastes and grey water may be discharged as long as no floating solids are observable.
(c) Desalinisation unit wastes shall be discharged.
(d) Deck drainage and wash water may be discharged as long as no visible sheen is observable. Oily and clean drainage or wash water shall be segregated: clean water shall be discharged to the sea and oily water shall be treated as provided in B.1 above.
(e) Trash shall not be discharged offshore. Trash shall be transported to an appropriate land-based disposal facility

4. Monitoring

(a) Produced Water

1. The volume of produced water discharged and concentration of oil and grease contained in the discharge will be monitored daily.
2. The daily maximum and monthly average oil and grease concentration will be reported to the appropriate environmental authority monthly.

(b) Drill Cuttings and Drilling Fluids

1. An inventory of drilling fluids additives and their volumes or mass added to the drilling fluid system will be maintained for each well.
2. Drilling fluid properties, including volume percent oil concentration of chlorides, will be monitored daily for each well.
3. The estimated volume of drill cuttings and drilling fluids discharged shall be recorded daily and reported monthly to the appropriate environmental authority.

(c) Other Wastes

1. The estimated volume of other wastes discharged shall be recorded daily and reported monthly to include:
   (i) Sanitary waste
   (ii) Domestic waste
   (iii)Deck drainage and wash water

C. Air Emission Guidelines and Monitoring

Contractor is authorised to discharge air emissions. Such discharges will be limited and monitored in accordance with generally accepted international Petroleum industry standards and practices.

D. Safety Guidelines

Contractor shall take into account subject to the provisions of Article 26.1 relevant Azerbaijani regulations and the following international safety and industrial hygiene standards in conducting its Petroleum Operations under the Agreement:

1. Oil Industry International Exploration and Production Forum (E&P Forum) Reports – HSE Management
2. International Association of Drilling Contractors (IADC) – Drilling Safety Manual
3. Association of Geophysical Contractors International (IAGC) – Operations Safety Manual
4. Threshold Limited Values for Chemical Substances in the Work Environment – American Conference of Governmental Industrial Hygienists.

APPENDIX 5A

Emissions Estimate Assumptions

Appendix 5A
Atmospheric Emissions Estimates

1. Introduction

This Appendix provides supplementary information to the emissions calculations presented in Chapter 5: Project Description and includes pollutant emission factors and the basis of emissions estimates for each Onsite Construction Plant.

Emissions were calculated using internationally accepted emission factors and calculating equations, that were calculated based on real time data collected over time. These were obtained from:

- European Environment Agency EMEP/CORINAIR Emission Inventory Guidebook – 2007; and
- United States Environmental Protection Agency AP42.

Table 1 presents the emissions factors for a range of potentially polluting Non-Greenhouse Gas emissions (Non-GHG) and Greenhouse Gas (GHG) emissions, which are considered to be emitted from the combustion of diesel used by the onsite plant. It is anticipated that all onsite plant will be diesel fuelled (use of low sulphur diesel is assumed). There are no standard emission factors for Carbon Dioxide (CO_2) from non-road vehicle emissions, The US EPA AP42 provides an emission factor calculation method based on brake specific fuel consumption (BSFC) of a diesel engine. The relevant parameters required to calculate the CO_2 emission factor are presented in Table 2.

Table 1 Emission Factors

	Species Emission Factors (g/kWhr)				
Engine size	[1]CO_2	[2]NO_x	[2]CH_4	[2]CO	[2]NMVOC
0-20	948	14.4	0.05	8.38	3.82
20-37	948	14.4	0.05	6.43	2.91
37-75	948	14.4	0.05	5.06	2.28
75-130	948	14.4	0.05	3.76	1.67
130-300	948	14.4	0.05	3	1.3
300-560	948	14.4	0.05	3	1.3
560-1000	948	14.4	0.05	3	1.3
>1000	948	14.4	0.05	3	1.3

[1]EMEP/CORINAIR Emission Inventory Guidebook - 2007. Group 8: Other mobile sources and machinery. SNAP Sector 0808 Industry.
[2]Carbon Dioxide Calculation from US EPA420-R-05-019 Exhaust Emission Factors for Nonroad Engine Modelling NR-010e

Table 2 Calculations of CO_2 Emission Factor

CO_2 emissions factors from BSFC[1]		
1,232	g/hp-hr	gCO_2/hp/hr
948	g/kWhr	gCO_2/kWhr
Brake Specific Fuel Consumption (BSFC) of Diesel Engine		
50.0	KW	Engine size
0.4	Efficiency	Efficiency of engine
125.0	kJ/s	Engine Fuel Input
44,800.0	KJ/kg	Calorific value of Diesel
0.003	kg/s	Mass Fuel Input
26.0	hp	Power Fuel Input
0.1	g/hp/s	BSFC

[1]Using the equation CO2 = (BSFC * 453.6 - HC) * 0.87 * (44/12), where;
• CO2 is in g/hp-hr
• Brake Specific fuel Consumption (BSFC) is the diesel fuel consumption in lb/hp-hr
• 453.6 is the conversion factor from pounds to grams
• HC is the in-use adjusted hydrocarbon emissions in g/hp-hr
• 0.87 is the carbon mass fraction of gasoline and diesel fuel
• 44/12 is the ratio of CO2 mass to carbon mass

2. Methodology

The estimated number of typical key construction plant and vehicles expected to be used onsite during each phase of the SD2 Infrastructure works is presented in Chapter 5 Table 5.4 of the SD2 Infrastructure ESIA. The indicative schedule is presented in Figure 5.4.

Using the schedule (which shows the expected duration and overlapping of phases) and expected number of onsite plant and vehicles per phase. The total number of plant across the construction period has been calculated as presented in Table 3. Operating hours have been calculated assuming plant is operational for 50% of the working day.

Table 3 Estimated Number of Onsite Construction Plant Operating Hours

Plant	Total Number of Onsite Project Plant	Operating Hours per Month	Total Plant Hours	Engine Capacity Size (kW)
Air Compressor	185	198	36,630	7.5
Asphalt Paver	160	198	31,680	130.0
Backhoe loader	155	198	30,690	10.0
Bull Dozer	1152	198	228,096	530.0
Compactor Plate	96	198	19,008	6.0
Concrete Mixer	84	198	16,632	1.5
Concrete Pump	37	198	7,326	75.0
Diesel Generator	48	198	9,504	100.0
Dump Truck	974	198	192,852	25.0
Earthworks Compactor	311	198	61,578	10.0
Fork Lift Trucks	324	198	64,152	5.0
Fuel Bowser	103	198	20,394	20.0
JCB Tractor	85	198	16,830	200.0
Mechanical Water Bowser	210	198	41,580	25.0
Mobile Telescopic Crane	90	198	17,820	25.0
Motor Grader	113	198	22,374	25.0
Road Lorry	179	198	35,442	25.0
Road Roller	91	198	18,018	13.0
Sheep foot roller / Vibro roller	81	198	16,038	10.0
Tilting Drum Mixer	73	198	14,454	5.0
Tracked Excavator	87	198	17,226	27.0
Tracked Mobile Crane	124	198	24,552	115.0
Water Pump	107	198	21,186	20.0
Welding Set	76	198	15,048	50.0
Wheeled Loader	47	198	9,306	25.0

Emissions of each onsite plant were calculated by multiplying total plant operating hours and the relevant emission factor from Table 1 (taking into account engine size). The results of this calculation are presented in Table 4.

Table 4 Estimated Total Project Emissions of Individual Plant

Plant	Plant Emissions (Tonnes)						
	CO_2	NO_x	N_2O	CH_4	CO	NMVOC	PM
Air Compressor	260.4	3.96	0.10	0.01	2.30	1.05	0.61
Asphalt Paver	3,904.2	59.30	1.44	0.21	15.49	6.88	5.07
Backhoe loader	290.9	4.42	0.11	0.02	2.57	1.17	0.68
Bull Dozer	114,604	1,740.8	42.3	6.04	362.7	157.2	133.0
Compactor Plate	108.12	1.64	0.04	0.01	0.96	0.44	0.25
Concrete Mixer	23.65	0.36	0.01	0.00	0.21	0.10	0.06
Concrete Pump	520.88	7.91	0.19	0.03	2.07	0.92	0.68
Diesel Generator	900.98	13.69	0.33	0.05	3.57	1.59	1.17
Dump Truck	4,570.6	69.43	1.69	0.24	31.00	14.03	8.73
Earthworks Compactor	583.76	8.87	0.22	0.03	5.16	2.35	1.37
Fork Lift Trucks	304.08	4.62	0.11	0.02	2.69	1.23	0.71
Fuel Bowser	386.67	5.87	0.14	0.02	3.42	1.56	0.91

Plant	Plant Emissions (Tonnes)						
	CO_2	NO_x	N_2O	CH_4	CO	NMVOC	PM
JCB Tractor	3,191.0	48.47	1.18	0.17	10.10	4.38	3.70
Mechanical Water Bowser	985.45	14.97	0.36	0.05	6.68	3.02	1.88
Mobile Telescopic Crane	422.33	6.42	0.16	0.02	2.86	1.30	0.81
Motor Grader	530.26	8.05	0.20	0.03	3.60	1.63	1.01
Road Lorry	839.98	12.76	0.31	0.04	5.70	2.58	1.60
Road Roller	222.05	3.37	0.08	0.01	1.96	0.89	0.52
Sheep foot roller / Vibro roller	152.04	2.31	0.06	0.01	1.34	0.61	0.36
Tilting Drum Mixer	68.51	1.04	0.03	0.00	0.61	0.28	0.16
Tracked Excavator	440.92	6.70	0.16	0.02	2.99	1.35	0.84
Tracked Mobile Crane	2,676.7	40.66	0.99	0.14	10.62	4.72	3.47
Water Pump	401.69	6.10	0.15	0.02	3.55	1.62	0.94
Welding Set	713.28	10.83	0.26	0.04	3.81	1.72	1.14
Wheeled Loader	220.55	157.46	3.83	0.55	70.31	31.82	19.79

Table 5 summarises the GHG (i.e. CO_2 and CH_4) and Non-GHG emissions predicted to be generated during the SD2 Infrastructure Project from onsite construction plant, vehicles and generators.

Table 5 Estimated GHG and Non GHG Emissions Associated with SD2 Infrastructure Activities

	CO_2 (tonne)	NO_X (tonne)	CH_4 (tonne)	CO (tonne)	NMVOC (tonne)	GHG[1] (tonne)
TOTAL	137,324	2,120	8	502	244	137,487
1. CH_4 Greenhouse Gas Equivalent = 21 X CO_2						

APPENDIX 8A

Public Meeting Presentation and Meeting Minutes

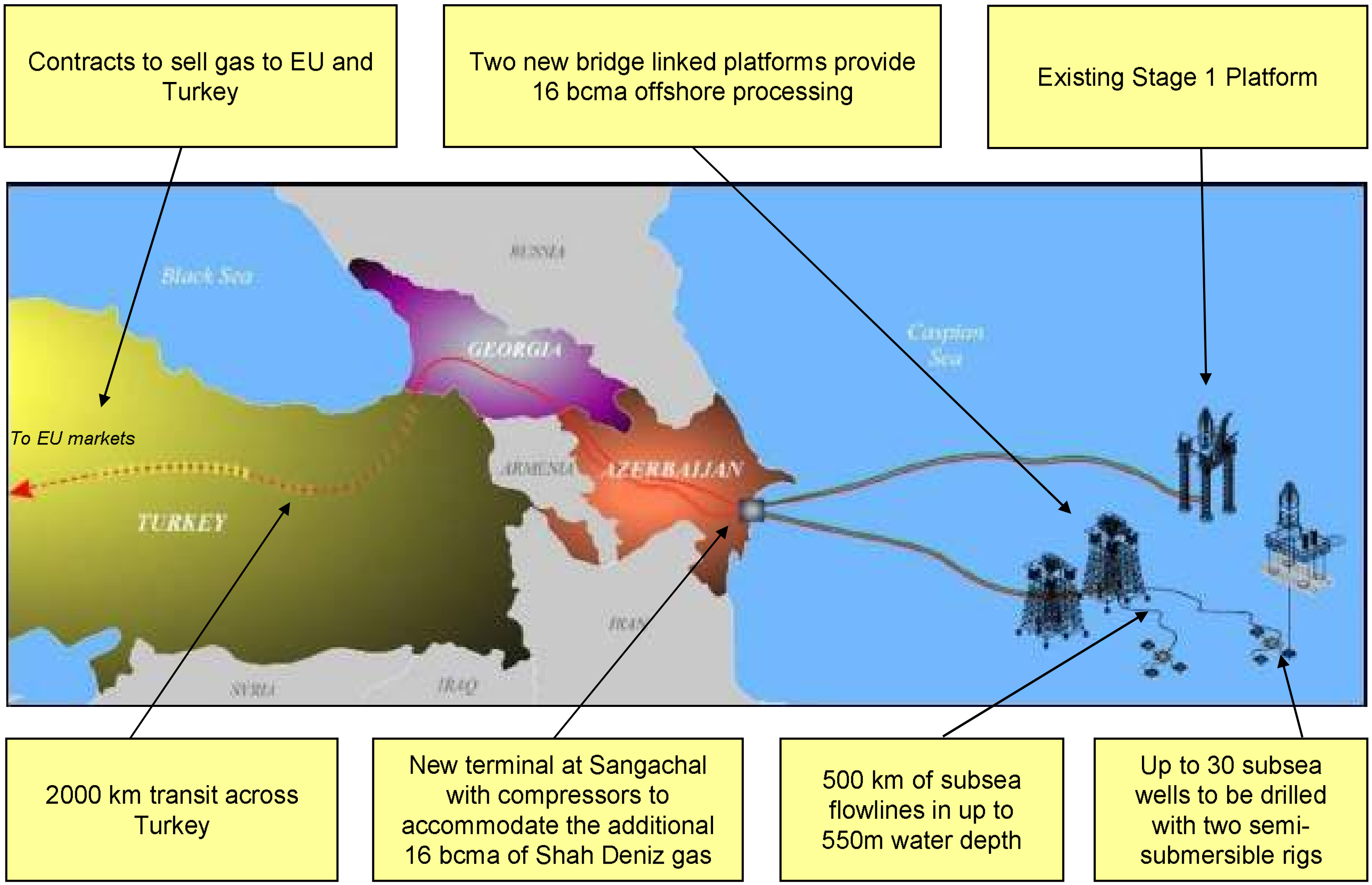
SD 2

Infrastructure ESIA Disclosure

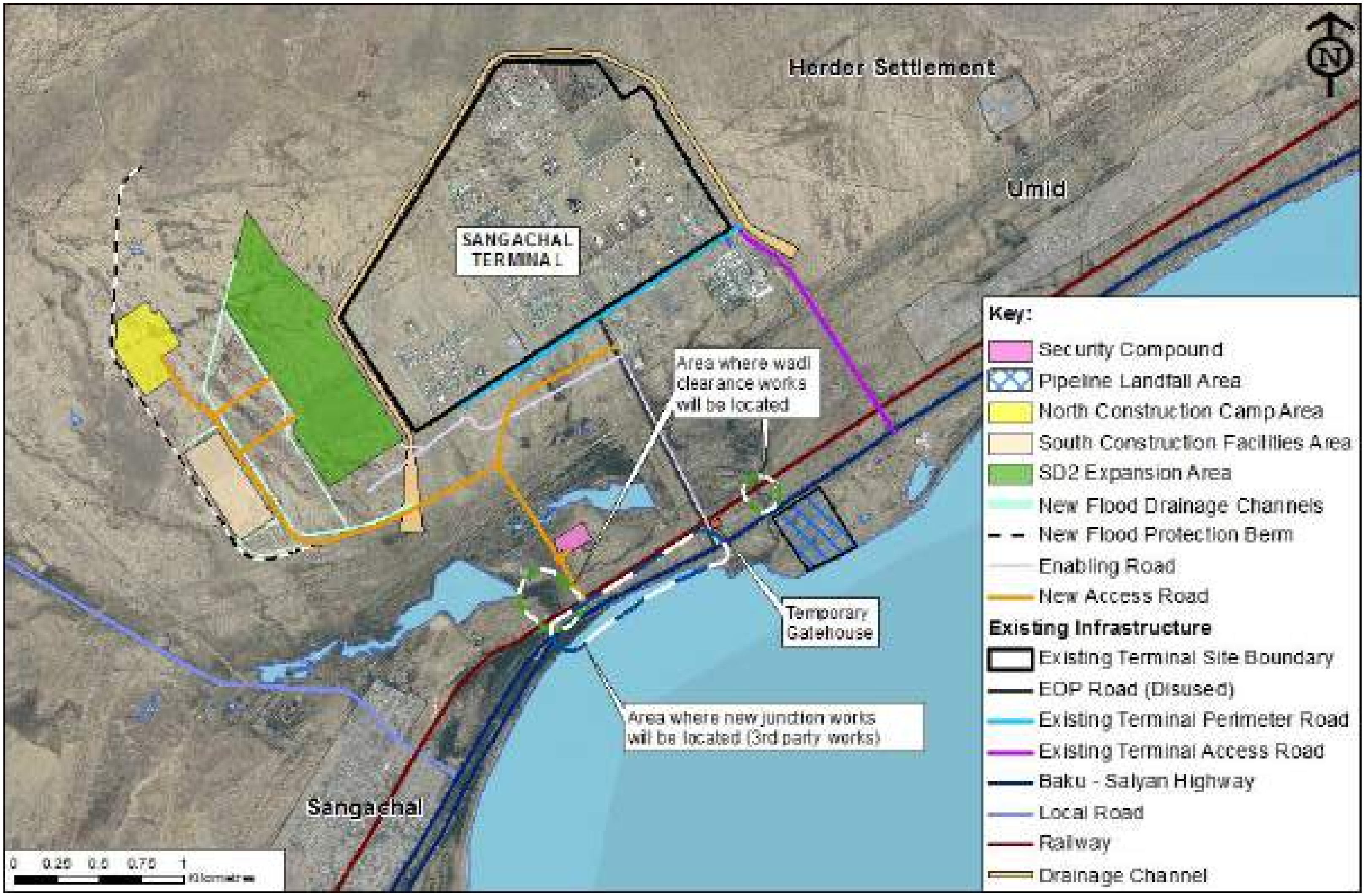
Community meeting

Baku

Shah Deniz full field development – concept and planned activities

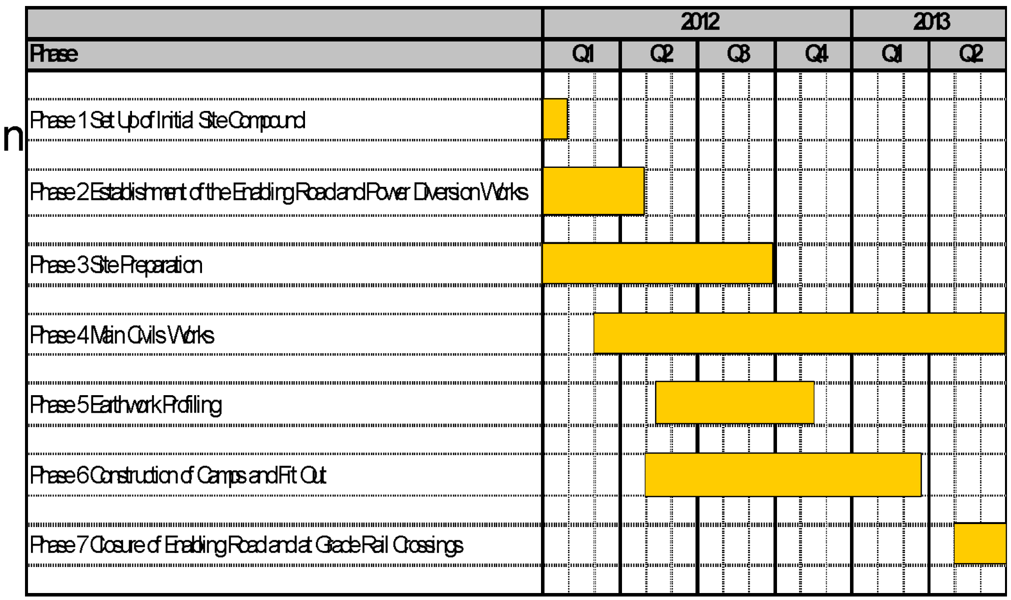


SD2 Infrastructure Project Scope



SD2 Infrastructure Project Overview

- **SD2 Infrastructure Project** comprises works **prior to** main construction, installation, commissioning and operation of SD2 onshore, offshore and subsea facilities.
- SD2 Infrastructure Project scope includes:
  - New Terminal access road
  - Site clearance and preparation
  - Piling
  - Construction & fit out of SD2 construction camps
  - Planned start of construction Q1 2012



SD2 Infrastructure ESIA – Key Issues

- **Noise**
  - Monitoring and Modelling undertaken, monitoring will continue
  - Good plant maintenance and selection will be promoted to reduce site noise
- **Dust**
  - Modelling undertaken and monitoring started this week to improve data
  - Mitigation to focus on mechanical/site controls and use of water to supress dust
- **Drainage**
  - Assessment of flood risk completed
  - Design promotes good drainage and does not increase flooding potential
  - Working with authorities to improve drainage under rail way line
- **Cultural Heritage**
  - Engagement with Ministry of Culture initiated
  - Detailed survey of Infrastructure areas and survey of Caravanserai and cave with IoAE completed
  - No significant finds during survey
- **Employment expectations:**
  - Potential positive local impact identified
  - BP to work with contractor and C&EA to ensure local recruitment promoted

SD2 Infrastructure ESIA
public meetings

Meeting Minutes

Facilitator:	Guivami Rahimli,	**Location:**	ST Communities Azimkend -26 October, 2011 Sangachal- 26 October, 2011 Umid - 28 October, 2011
Organizer:	C&EA		
Minutes by:	Bill Boulton , Ali Aliyev	**Date of Meeting:**	26, 28 October 2011

Participants BP reps:

1. Guivami Rahimli, SDI
2. Bill Boulton, SD2 E&S Manager
3. Habiba Bagirova, ST Sr.Environmental Advisor
4. Rustam Hajiyev, ST Health Advisor
5. Ali Gambarchayev, ST Security Manger
6. Ali Aliyev, EA Advisor
7. Shahla Seyidova, Health Advisor

NGO: Rasim Jafarguliyev, "Umid" NGO

Contractors:

1. Ilgar Yarmamedov (Azfen)
2. Fakhraddin Alimardanov, HR director at Rovshan-Oguz
3. Javidan Askerov, HSE Advisor at Rovshan-Oguz
4. Yusif Hajiyev, General Manager of the Barama Construction Services

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Azimkend community meeting (AzFen representative attended**)**

Number of participants : 15

Introduction by Guivami Rahimli

BP representative opened the meeting and gave information about BP Sangachal Terminal (ST) project, its benefits and environmental impact. He also explained the strategic importance of ST as for Azerbaijan Republic as for BP in Azerbaijan. Then BP representative briefed community members about SD FFD project and future expansion activities around Sangachal Terminal. He informed participants about SD2 Infrastructure ESIA project and planned infrastructure activities throughout 18 months starting from January 2012. Then he demonstrated the copies of SD2 Infrastructure ESIA document and forms for community members' feedback. He stressed that executive summary of ESIA document and feedback forms will be placed in public information centre until November 30, 2011. Facilitator has also mentioned that representatives of contractor companies *AzFen, Rovshan-Oguz and Barama* are present in the room.

Then community members started to ask questions about their environmental concerns and possible support they expect from the company.

Questions (community members):
The flame of the gas burning in the adjacent location disturbs us and the flame has grown since last month. What is the reason for that?
Answer (BP representative):
At present we carry out sub sea maintenance work on the gas pipe line at CA. It is planned maintenance to keep all facilities in normal working condition. A lot of gas has remained in the pipes after we blocked the delivery which we have to burn via the flare. Therefore the increased flaring is inevitable, otherwise it can cause safety issues and potentially explosion. We carried out noise monitoring at day and night time at community areas to define potential impact on people health. Results show slightly exceeded night level of noise only at Umid village due to constant noise from highway (Baku-Iran) traffic, overhead power (electrical) lines and horn from the train at the moment of testing.

Question (community member):
I think that local people should be compensated for the flame impact. We breathe that air. If you compare our nutrition and environmental condition you'll understand the health risks we undergo.
Answer (BP representative):
We try to decrease volume of flared gas. Approximately 10000000 m3 of gas is usually delivered to SOCAR which is distributed to gas network to provide Garadaq and other districts with gas supply. We carry out air quality and noise monitoring around ST on systematic basis. The results show that the content of contaminants in the air and noise level don't exceed permissible international and national standards. Also, Ministry of Ecology and Natural Resources controls our activities if we were outside standards they would certainly warn us about it.

Question (community member):
Although BP promised to provide our locals with jobs in previous meetings, most of us couldn't get a job in the Terminal?
Answer (BP representative):
In the 1st Sangachal project we employed about 5000 workers to work in the Terminal. During the infrastructure project the total Azfen workforce will be between 800 to 1000 workers, which includes skilled and unskilled labor. If locals have appropriate qualifications and competency they'll certainly be considered for work and there place of residence will be confirmed. If we don't find adequate skills in communities around the terminal then we will need to recruit from areas outside of the terminal. We'll make sure that majority of contractors are local companies and that community members are employed. Your relatives, friends and neighbors used to and still work in the Terminal and you know that we do our best to involve locals to the business.

Question (community members):
During construction works noise and dust is unbearable. Sometimes dust forms clouds.
Answer (BP representative):
We understand the magnitude of impact and we do our best to minimize it. Our mitigation measures include watering the site, and other controls to minimise dust and we monitor levels of dust during the work.

Question (community member):
Can you help us to improve our school conditions?
Answer (BP representative):
The school is in the balance of Ministry of Education and it is their responsibility to do something. As you remember we offered to provide gravel pavement around the school and to fence it. You said you don't need this initiative because Executive Power promised to build a new school. However we still can do it. Anyway, the best way to solve this issue is to go to Executive Power and raise your problems there. All we do as a BP company is only a voluntary support, and it is not our responsibility to do it.

Community member opinion: I don't think there is some place like this anywhere in Azerbaijan. We have no tap water system for our washrooms. Children don't come to school during rainfalls due to mud. The roof of the school is leaking. However, a truck of gravel is also something for us. Please do whatever you can and thank you for you initiatives.

BP representative thanks the participants for attending and closes the meeting. At the end reminded one more time about the Executive Summary of ESIA document and Feedback forms that will be placed in public information Centre.

Sangachal community meeting (AzFen representative, as well as local ST contractors Rovshan Oghuz and Barama attended)

Number of participants : 35

Introductory section - ***As above***

Questions (community members):
The flame of the gas burning in the adjacent location has grown since last month. We have noticed that and would like to know the reason?

Answer (BP representative):
There is gas pipeline coming from two platforms. At present we carry out repair works in the gas station. It is not an emergency repair but a planned maintenance to keep all facilities in normal working condition. A lot of gas has remained in the pipes after we blocked the delivery which we have to burn. The flame/flaring is inevitable, otherwise it can cause explosion. We understand that extra flame/flaring means extra noise. We have carried out noise measurement and it doesn't exceed permissible limits.

Question (community member):
We used to have a contact person to inform us of any changes and news. His name is Shafa Rahimov. We don't have him anymore. The increase of flame and other changes in the environment should be informed.

Answer (BP representative):
We provided necessary information on flaring to the community leaders, representatives of local authorities and municipalities in Sangachal and Umid, as well as to Azimkend school. So far Sangachal community leader here confirms that he informed all those who were curious about increase of flaring. At the same time we are here to updater on current situation and our future plans and we do this on regular basis. Gas burning/flaring is a safety measure that is necessary to control pressure and avoid explosions. In fact we only burn insignificant part of gas which separates from oil. More than 10 mln m3 of gas we deliver to State Oil Company annually.

Question (community member):
You say 1/3 of Rovshan Oghuz employees are local residents but it is not true. They bring workers from outside, register them here and employ them as local residents. In fact, local residents who lived here their whole lives are not able to get jobs in the Terminal. Despite, most of work force we can offer is unskilled labor but we still have skilled labor as well. You bring welders, drivers and other staff from outside when we have all these potentials?

Answer (BP representative):
When we employ local residents we can only look at their ID cards or passports. We see that the applicant has local registration and adequate skills we take him. Please give us a list of your workforce divide them into skilled and unskilled and describe the skills. Submit this list to us and that will make sure that we interview the local person and not somebody from outside.

Question (community member):
We have problems with fishing. BP doesn't allow us to fish in our original fishing points. Your people came and took our fishing nets 700 meters away. Of course we thank BP for all initiatives but we need our previous fishing locations back.
Answer (BP representative):
We'll consider your concern during the planning of future work and previously we corporated with you and assisted in fishing permit issues.

Question (community member):
I think that the reality is you don't need any skilled labor. BP is tricking us by bringing labor from outside, registering them here and giving them jobs.
Answer (BP representative):
In the 1st Sangachal project we employed about 5000 workers to work in the Terminal. During the infrastructure project the total Azfen workforce will be between 800 to 1000 workers, which includes skilled and unskilled labor. If locals have appropriate qualifications and competency they'll certainly be considered for work if their place of residence can be confirmed. If we don't find adequate skills in communities around the terminal then we will need to recruit from areas outside of the terminal. We'll make sure that majority of contractors are local companies and that community members are employed. Your relatives, friends and neighbors used to and still work in the Terminal and you know that we do our best to involve locals to the business.

Question (community members):
During construction works noise and dust is unbearable. Sometimes dust forms clouds.
Answer (BP representative):
We understand the magnitude of impact and we do our best to minimize it. Our mitigation measures include watering the site, and other controls to minimize dust.

Question (community member):
Earlier we had training centers where our young representatives could acquire skills and learn some crafts. Why not open such centers before works start and employ skilled labor from the participants of these trainings?
Question (community members):
You have mentioned construction of waste collection areas as BP infrastructure initiative in our settlement. We don't need collection points we need to solve the transportation of solid waste to the landfill site otherwise the waste collection areas will be demolished and all the facilities stolen as previous.
Answer (BP representative):
Transportation of solid waste is not our business. There should be a department of Executive Power to deal with it. As to the training centers: Yes we had them before, participants of which could find jobs in different fields.

BP representative thanks the participants for attending and closes the meeting. At the end reminded one more time about the Executive Summary of ESIA document and Feedback forms that will be placed in public information Centre.

Umid community meeting 28 October, 2011

(AzFen representative and local ST contractors Barama attended)

Number of participants : 30

Introductory section – ***As above***

Questions (community members):
The flame of the gas burning in the adjacent location disturbs us and the flame has grown since last month. We also feel strong smell which disturbs us a lot. What is the reason for that?
Answer (BP representative):
At present we carry out repair works in the gas station. It is not an emergency repair but a planned maintenance to keep all facilities in normal working condition. A lot of gas has remained in the pipes after we blocked the delivery which we had to flare. Therefore increased flaring was inevitable, otherwise it can cause explosion. Part of gas is usually delivered to gas network which is distributed to Garadagh and other districts to provide them with gas supply.

Question (community member):
We cannot open windows due to strong gas smell.
Answer (BP representative):
We measure dust, noise and other forms of impacts regularly. Also we do our best to minimize the impact. And all the measurements show relevance to international standards. Moreover, the smell is caused by produced water.

Question (community member):
Do you really think that your initiatives minimize impact?
Answer (BP representative):
We try to minimise all impacts. The produced water smell, and other causes are inevitable due to activities carried out in the Terminal. You talk about negative impacts but don't forget that the operation of the Terminal has a lot of positive ones. The Shahdeniz 2 Project envisages start of infrastructure project approximately the first quarter of 2012. We'll need a peak of 800-1000 workforce for that project which will continue 18 months.

Question (community members):
How will you organize selection process?
Answer (BP representative):
For unskilled labor recruitment from settlements close to Terminal will be prioritised, skilled labor will be selected by means of interviews and check of adequate qualification and capacity. As far as I know our contractor "Rovshan Oghuz" has already employed some labor from Umid. As to filling application forms and writing CVs BP will assist in this process via the NGO working on-behalf of BP in the area. The larger-scale works to start in 2013 will demand more labor.

Question (community member):
Our houses are in very poor condition how could you help us to improve our living condition?
Answer (BP representative):
The improvement of living condition, especially repair of houses is not our responsibility. We have prepared a program to repair community center and talked with Excom to find out if they can help with funds. 50 percent of contribution should come from your side which is pending. However, knowing your budget hardships we reduced community contribution to 45% and will see what we can do to make it even less or get it provided in the form of workforce and other.

Question (community member):
We need improvement of our houses rather than the community center. We though that new projects and initiatives will include repair of our living places.
Answer (BP representative):
Most of your residents are IDP families. The government develops special programs to improve living standards of IDP families. The program is being carried out in certain steps location by location. I hope one day it'll cover your settlement. However, that the repair of houses is not our business.

Question (community member):
In fact our priority is the employment of our residents. If one member of each family works this means an income for the family.
Answer (BP representative):
We'll do our best to make sure that all the unskilled labor be employed from the closest settlements to the Terminal which are Umid, Azimkend and Sangachal. We have trained 9 young residents from your settlement of which 4 found jobs to apply new skills.

BP representative thanks the participants for attending and closes the meeting. At the end reminded one more time about the Executive Summary of ESIA document and Feedback forms that are placed in public information Centre.

APPENDIX 9A

SD2 Infrastructure Project Activities, Events and Interactions (Environment)

ACTIVITIES/INTERACTIONS

ID (R=Routine, NR= Non-Routine)	Activity	Scoped In/Out	Project Phase	Reference	Event	Event Category	Receptor
A1-R	Operation of construction plant and vehicles including diesel generators (onsite)	✓	All Phases	-	Emissions to atmosphere (non GHG)	On-site construction plant and vehicles	Atmosphere
					Noise		Terrestrial Environment (Noise)
					Disturbance/indirect effect to wildlife		Terrestrial Environment (Ecology)
A2-R	Construction vehicle movements (offsite)	✓	All Phases	-	Emissions to atmosphere (non GHG)	Offsite construction vehicles	Atmosphere
					Disturbance/indirect effect to wildlife		Terrestrial Environment (Ecology)
		×			Noise		Terrestrial Environment (Noise)
A3-R	Removal and storage of surface soil layer and vegetation - including pipeline landfall area preparation	✓	Phases 1 & 3	5.5.1, 5.5.3	Disturbance/indirect effect to wildlife	Surface soil layer removal and spoil movement	Terrestrial Environment (Ecology)
					Loss of habitat		
					Potential disturbance/damage to cultural heritage		Coastal Environment (Ecology & Cultural Heritage)
					Dust generation		Atmosphere
A4-R	Movement and temporary storage of spoil	✓	Phase 3	5.5.3	Disturbance/indirect effect to wildlife		Terrestrial Environment (Ecology)
					Dust generation		Atmosphere
					Potential mobilisation of contamination		Terrestrial Environment (Soil, Groundwater & Surface Water)
A5-R	Subsurface groundworks associated with wadi clearance and new drainage channels	✓	Phase 3	5.5.3	Disturbance/damage to cultural heritage	Subsurface groundworks	Terrestrial & Coastal Environment (Cultural Heritage)
					Potential mobilisation of contamination		Terrestrial Environment (Soil, Groundwater & Surface Water)
					Disturbance/indirect effect to wildlife		Terrestrial Environment (Ecology)
					Loss of habitat		
		×			Alteration to surface water flow		Terrestrial Environment (Hydrology & Flooding)
A6-R	Above ground structural groundworks works including construction of road embankments, flood protection berm and culverts	×	Phase 3 &4	5.5.4	Alteration to surface water flow	Above ground structural groundworks	Terrestrial Environment (Hydrology & Flooding)
					Visual impact		Visual context
A7-R	Piling associated with installation of pipeline crossings	✓	Phase 4	5.5.4	Noise	Piling works	Terrestrial Environment (Noise)
					Potential disturbance/damage to cultural heritage		Terrestrial & Coastal Environment (Cultural Heritage)
A8-R	Test piling	✓	Phase 5	5.5.5	Noise		Terrestrial Environment (Noise)
					Potential disturbance/damage to cultural heritage		Terrestrial & Coastal Environment (Cultural Heritage)

ID (R=Routine, NR= Non-Routine)	Activity	Scoped In/Out	Project Phase	Reference	Event	Event Category	Receptor
A9-NR	Sewage Treatment Discharges (following commissioning of SD2 STP)	×	Phase 4	5.5.4	Treated sewage	Discharge of treated sewage	Terrestrial Environment (Soil, Groundwater & Surface Water)
							Terrestrial Environment (Ecology)
A10-R	Construction plant/vehicle refuelling	×	All Phases	-	Leaks and Spills	Leaks and Spills	Terrestrial Environment (Soil, Groundwater & Surface Water)
A11-R	Erection of temporary structures (e.g. temporary rail crossing gatehouse, security facilities, initial site compound offices)	×	Phases 1,2 & 6	5.5.1, 5.5.2 & 5.5.6	Visual impact	Erection of buildings and structures	Visual context
A12-R	Erection of permanent structures (e.g. construction camp/facility structures)	×	Phase 6	5.5.6			
A13-R	Grit blasting and painting of construction camp/facility structures	×	Phase 6	5.5.6	Dust generation	Completion of buildings and structures	Atmosphere
A14-R	Use of temporary lighting	×	All Phases	-	Indirect effect/disturbance to wildlife (terrestrial)	Temporary lighting	Terrestrial Environment (Ecology)
					Indirect effect/disturbance to wildlife (coastal)		Coastal Environment (Ecology)
					Light impacts (spill/glare) to the community		Light
A15-R	Waste Generation	×	All Phases	-	Generation of hazardous and non hazardous waste	Non-Hazardous Waste	Waste
						Hazardous Waste	
A16-R	Discharge from oil water separators to wadi system	×	All Phases	-	Discharge of treated water	Discharge of treated water	Terrestrial Environment (Soil, Groundwater & Surface Water)
A17-R	Leak test of construction camp drainage pipework	×	Phase 6	5.5.6	Discharge of uncontaminated water	Discharge of uncontaminated water	Terrestrial Environment (Soil, Groundwater & Surface Water)
A18-R	Installation and use of permanent lighting (access road, construction camp and construction facilities)	×	Phase 6	5.5.6	Indirect effect/disturbance to wildlife (terrestrial)	Permanent lighting	Terrestrial Environment (Ecology)
					Light impacts (spill/glare) to the community		Light

	Event Magnitude				Receptor Sensitivity														
	Event Category	Magnitude Parameters	Ranking	Event Magnitude	Sensitivity Parameters	Human		General Biological/ Ecological		Specific Biological/Ecological: Breeding Birds	Fauna	Desert/ Semi Desert Vegetation	Wetland Vegetation	Coastal Zone Vegetation	Soil	Surface Water	Cultural Heritage	Impact Significance
impacts to the Atmosphere	Emissions from onsite and offsite construction plant and vehicles	Scale	1	8	Presence	3	3	-										Moderate Negative
		Frequency	3															
		Duration	3		Resilience	1												
		Intensity	1															
	Emissions and dust from surface soil layer removal and spoil movement	Scale	1	8	Presence	2	3	-										Moderate Negative
		Frequency	3															
		Duration	3		Resilience	1												
		Intensity	1															
Impacts to the Terrestrial Environment (Noise)	Noise associated with construction activities	Scale	1	8	Presence	2	3	1	3	-								Moderate Negative
		Frequency	3															
		Duration	3		Resilience	1		2										
		Intensity	1															

<table>
<tr><th></th><th></th><th colspan="3">Event Magnitude</th><th colspan="18">Receptor Sensitivity</th></tr>
<tr><th rowspan="2"></th><th rowspan="2">Event Category</th><th rowspan="2">Magnitude Parameters</th><th rowspan="2">Ranking</th><th rowspan="2">Event Magnitude</th><th rowspan="2">Sensitivity Parameters</th><th rowspan="2">Human</th><th rowspan="2">General Biological/ Ecological</th><th colspan="12">Specific Biological/Ecological</th><th rowspan="2">Cultural Heritage</th><th rowspan="2">Impact Significance</th></tr>
<tr><th colspan="2">Breeding Birds</th><th colspan="2">Fauna</th><th colspan="2">Desert/ Semi Desert Vegetation</th><th colspan="2">Wetland Vegetation</th><th colspan="2">Coastal Zone Vegetation</th><th>Soil</th><th>Surface Water</th></tr>
<tr><td rowspan="4">Impacts to the Terrestrial Environment (Ecology)</td><td rowspan="4">Surface soil layer removal and spoil movement

Drainage management works) -Wadi Clearance Works

Drainage management works) - New Drainage Channel Works

Pipeline Landfall Area Preparation</td><td>Scale</td><td>2</td><td rowspan="4">8</td><td rowspan="2">Presence</td><td rowspan="4"></td><td rowspan="4"></td><td rowspan="2">2</td><td rowspan="4">4</td><td rowspan="2">2</td><td rowspan="4">4</td><td rowspan="2">2</td><td rowspan="4">4</td><td rowspan="2">2</td><td rowspan="4">4</td><td rowspan="2">2</td><td rowspan="4">4</td><td rowspan="4" colspan="3">-</td><td rowspan="4">Moderate Negative</td></tr>
<tr><td>Frequency</td><td>1</td></tr>
<tr><td>Duration</td><td>3</td><td rowspan="2">Resilience</td><td rowspan="2">2</td><td rowspan="2">2</td><td rowspan="2">2</td><td rowspan="2">2</td><td rowspan="2">2</td></tr>
<tr><td>Intensity</td><td>2</td></tr>
</table>

	Event Category	Magnitude Parameters (Event Magnitude)	Ranking (Event Magnitude)	Event Magnitude	Sensitivity Parameters (Receptor Sensitivity)	Human	General Biological/ Ecological	Breeding Birds (Specific Biological/Ecological)	Fauna	Desert/ Semi Desert Vegetation	Wetland Vegetation	Coastal Zone Vegetation	Soil		Surface Water		Cultural Heritage		Impact Significance
Environment (Soil, Groundwater and Surface Water)	Mobilisation of contamination during earthworks	Scale	1	6	Presence	-							2	3	2	4	-		Moderate Negative
		Frequency	1																
		Duration	3		Resilience								1		2				
		Intensity	1																
Terrestrial & Coastal Environment (cultural heritage)	Impacts to Cultural Heritage due to earthworks and piling	Scale	2	6	Presence	-											3	4	Moderate Negative
		Frequency	2																
		Duration	1		Resilience												1		
		Intensity	1																

APPENDIX 9B

Visual and Lighting Screening Assessments

1. Visual Screening Assessment

1.1 Introduction

A screening assessment has been undertaken to understand the potential visual impact of the SD2 Infrastructure Project on the local communities in the vicinity of the Sangachal Terminal, namely Sangachal Town, Azim Kend, Masiv 3 and Umid (refer to Annex A for photographs taken within these communities).

Specifically the assessment has considered the potential visibility of:

- Construction plant and vehicles operating within the SD2 Infrastructure area; and
- Structures (e.g. workshops) to be built within the construction camp and construction facilities areas.

The assessment has made use of viewshed analysis, site visits and photography taken within the local communities and the project information as presented in Chapter 5 of the SD2 Infrastructure ESIA.

1.2 Viewshed Analysis Input Data

The purpose of viewshed analysis to identify whether an assessment point or area is visible or not from a selected receptor. Viewshed analysis is undertaken using specialist tools within a geographic information system (GIS). Input data required includes:

- A digital terrain model (DTM) which provides the topography of the relevant assessment area; and
- Location, height and extent of the feature(s) for assessment.

Viewshed analysis does not take into account any existing buildings or structures and the extent to which they may obstruct a view. As such it provides a conservative indication of visibility based on topography only.

1.3 Methodology

The methodology used to undertake the visual assessment was as follows:

- Define the assessment area and obtain the relevant DTM;
- Determine the sensitive receptors where visibility of project elements are to be considered;
- Determine the assessment scenarios;
- Model visibility using the viewshed analysis tool;
- Estimate the likely visibility from each receptor for each assessment scenario taking into consideration the presence of existing buildings, infrastructure and vegetation based on photography and knowledge of the area obtained through site visits undertaken in 2010 and 2011 as part of various baseline surveys (e.g. noise); and
- Compile and present results and key findings.

Defining the Project Area and Sensitive Receptors

A DTM was obtained for an area approximately 5km in radius around the existing Sangachal Terminal. This includes the local communities of Sangachal Town, Azim Kend, Masiv 3 and Umid (refer to Figure 1.1 below). The residents of these communities are considered to be sensitive receptors. The impact to views from public areas associated with these communities is therefore assessed.

Assessment Scenarios

A review was undertaken of the SD2 Infrastructure Project activities as presented in Chapter 5 of the ESIA. The following was determined:

- The main activities would occur within the SD2 Infrastructure area (refer to Figure 1.1);
- Works would occur on site throughout the whole construction period with the greatest activity expected within the SD2 Infrastructure area and specifically within the SD2 Expansion Area where levelling and grading works are planned;
- Onsite activities would mainly involve the use of plant such as excavators, dump trucks and bulldozers (refer to Chapter 5 Table 5.4);
- The majority of the onsite activity will involve earthworks and therefore, while it is planned that cranes will be used on site, their use (e.g. to erect the construction camp structures) will be limited to short periods. Cranes are therefore excluded from the visual assessment;
- Construction camp and construction facilities structures (e.g. warehouses, workshops, accommodation blocks) will be no more than 10m in height (refer to Chapter 5 Section 5.5.6);
- The new flood protection berm (to the west of the SD2 Infrastructure area) will be constructed during Phase 3; and
- The height of the flood protection berm will vary between from 1 to 3m (refer to Section 5.5.3 Chapter 5 Project Description). An average height of 2m is assumed.

The following assumptions were made:

- Height of on site plant (excluding cranes) approximately 3m (based on a review of plant specifications for the types of plant proposed); and
- Average eye level assumed to be 1.6m above ground level.

On the basis of the review above, it is expected that the flood protection berm, which extends along the western boundary of the SD2 Infrastructure area, may provide some visual screening of the plant and vehicles operating at onsite. Given its height, the berm is not expected to provide visual screening of the construction camp and construction facilities structures or plant operating immediately adjacent to the berm.

Three assessment scenarios were considered:

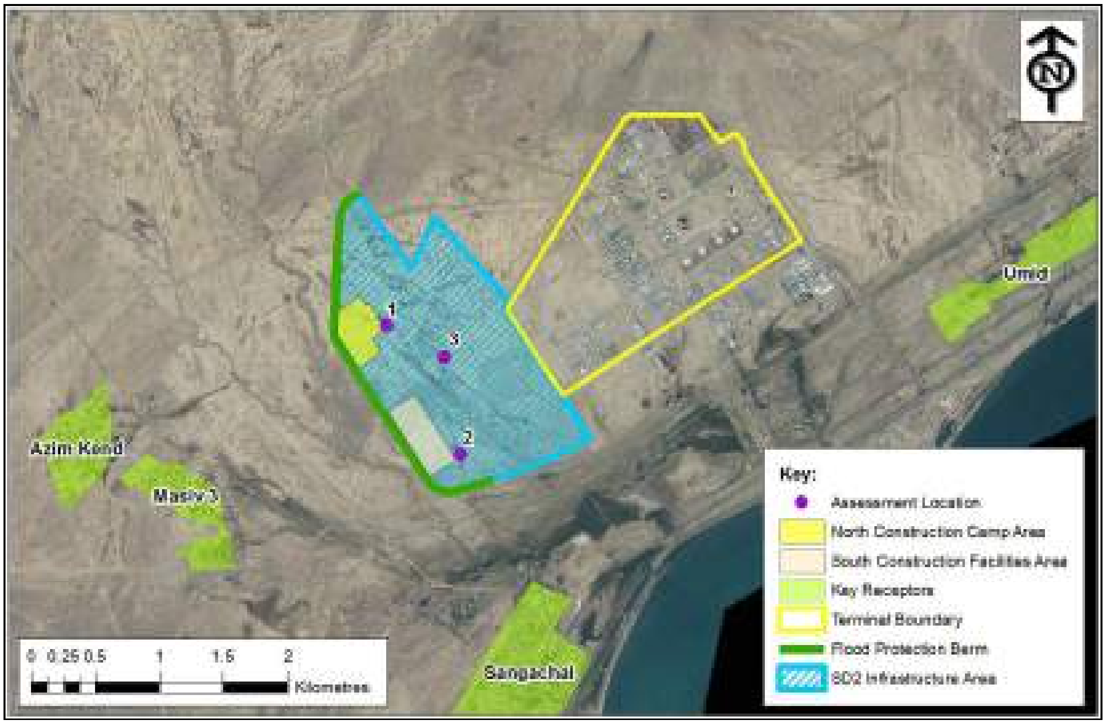
- **Scenario 1 (Construction Plant):** Assess visibility of two points approximately 200m set back from the western boundary of the SD2 Infrastructure area, 3m above ground level (denoted Assessment Location 1 and Assessment Location 2) with and without the berm.
- **Scenario 2 (Construction Plant):** Assess visibility of one point located within the SD2 Expansion Area, 3m above ground level (denoted Assessment Location 3) with and without the berm.
- **Scenario 3 (Structures):** Assess visibility of blocks to a height of 10m across the footprint of the construction camp and construction facilities areas. Blocks were assumed as the location of specific structures is not fixed and therefore this scenario represents a worst case.

Table 1.1 presents a summary of the assessment scenarios. Figure 1.1 shows the assessment locations and the construction camp and construction facilities areas.

Table 1.1 Assessment Scenarios

Scenario	Plant/ Structures Assessed	Without Berm	With Berm	Plant Assessment			Structures Assessment
				Assessment Locations	Height of Assessment Locations	Distance set back from berm	Height of structures
1	Plant	✓	✓	1 & 2	3m	200m	-
2	Plant	✓	✓	3	3m	600m	-
3	Structures	✓	×	-	-	-	10m

Figure 1.1 Assessment Locations, Construction Camp and Construction Facilities Areas and Location of Sensitive Receptors



1.4 Viewshed Analysis Results and Key Findings

Scenario 1

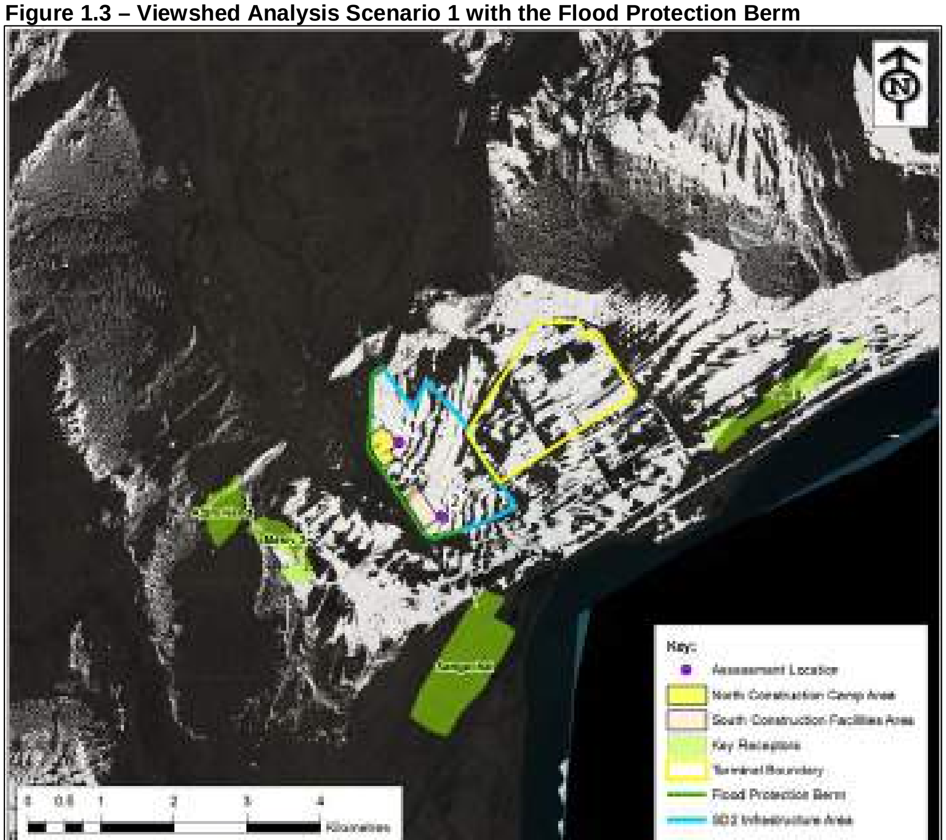
Results of the viewshed analysis for Scenario 1 with and without the flood protection berm in position are shown in Figures 1.2 and 1.3.

The results indicate that the presence of the flood protection berm does not significantly alter the extent of visibility of the two Assessment Locations at the key receptors (i.e. within Sangachal Town, Umid, Azim Kend and Masiv 3).

Figure 1.2 – Viewshed Analysis Scenario 1 without the Flood Protection Berm

Notes: Black = not visible White = visible

Figure 1.3 – Viewshed Analysis Scenario 1 with the Flood Protection Berm



Notes: Black = not visible White = visible

Umid – Figures 1.2 and 1.3 indicate that Assessment Locations 1 and 2 may be visible from within the south west and north east of Umid (approximately 25% of Umid by area). However the assessment does not include the structures associated with Sangachal Terminal. Photo A2 (refer to Annex A) suggests that visibility of the Assessment Locations from the south-western corner will be obscured by the existing presence of Sangachal Terminal. Visibility from the north-east part of Umid is likely to be very limited due to the long distance (approximately 6.5km) to the Assessment Locations 1 & 2. The view will continue to be dominated by the existing Sangachal Terminal.

Sangachal Town - Figures 1.2 and 1.3 indicate that Assessment Locations 1 and 2 will not be visible from Sangachal Town, with the exception of a very small area (approximately $180m^2$) located at the north western edge (approximately 0.5% of Sangachal Town by area). This is because the line of sight from Sangachal Town to the SD2 Infrastructure area is predominantly obscured by a ridge. Photo A1 (refer to Annex A) within Sangachal Town indicates that views towards the SD2 Infrastructure area from the north west corner of the town is likely to be obscured due to the presence of existing buildings.

Azim Kend - Figures 1.2 and 1.3 indicate that the Assessment Locations will only be visible from locations along the northern part of the community (approximately 5% of Azim Kend by area). However, due to the presence of buildings in this area (refer to Photo A4) unobscured views would only be likely from the north eastern edge of Azim Kend. From this location the works would be over 2km away and plant would be barely visible in the views towards the Terminal.

Masiv 3 – Figures 1.2 and 1.3 indicate that the Assessment Locations will only be visible from locations within the southern area of the community (approximately 35% of Azim Kend by area). The presence of buildings and structures within Masiv 3 indicates that unobscured views are likely only from the south east of the community. However given the relatively long distance between the eastern edge of Masiv 3 and the Assessment Locations (approximately 1.4km) plant is only likely to be barely visible and the structures associated with the existing Terminal (up to approximately 10m in height) would continue to dominate the view (refer to Photo A3).

Scenario 2

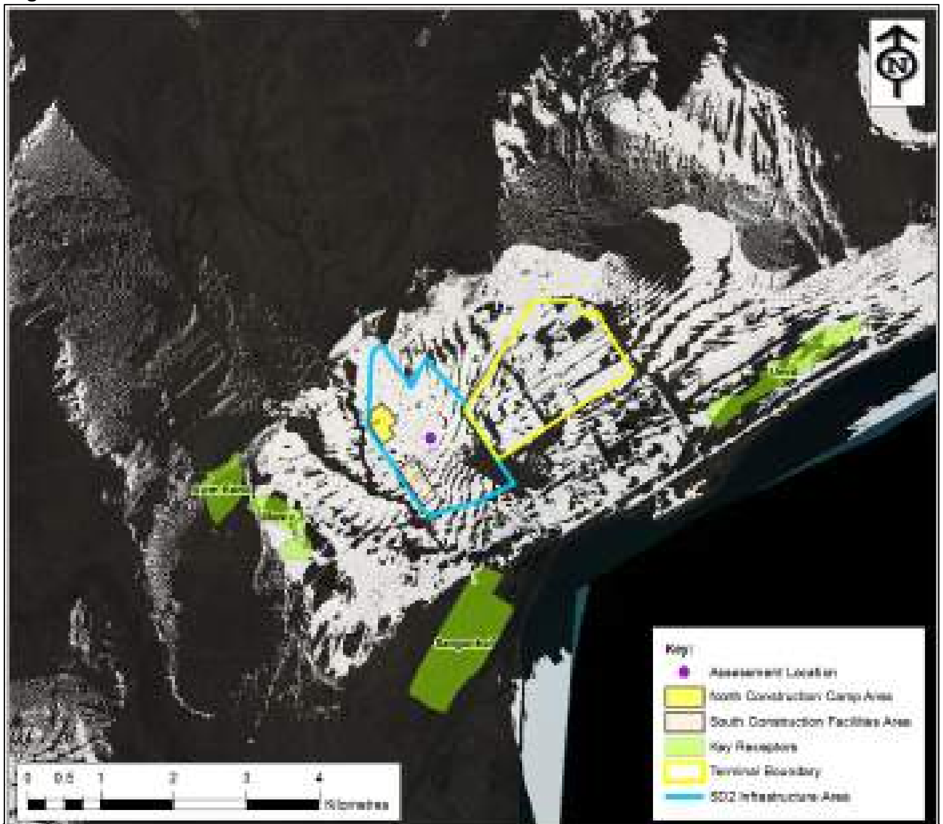
The results of the viewshed analysis for Assessment Location 3 with and without the flood protection berm are shown in Figures 1.4 and 1.5.

The figures show:

- The presence of the flood protection berm does not significantly alter the extent of visibility of Assessment Location 3 at the key receptors (i.e. within Sangachal Town, Umid, Azim Kend and Masiv 3); and
- Results obtained for Scenario 2 show no difference to those obtained for Scenario 1.

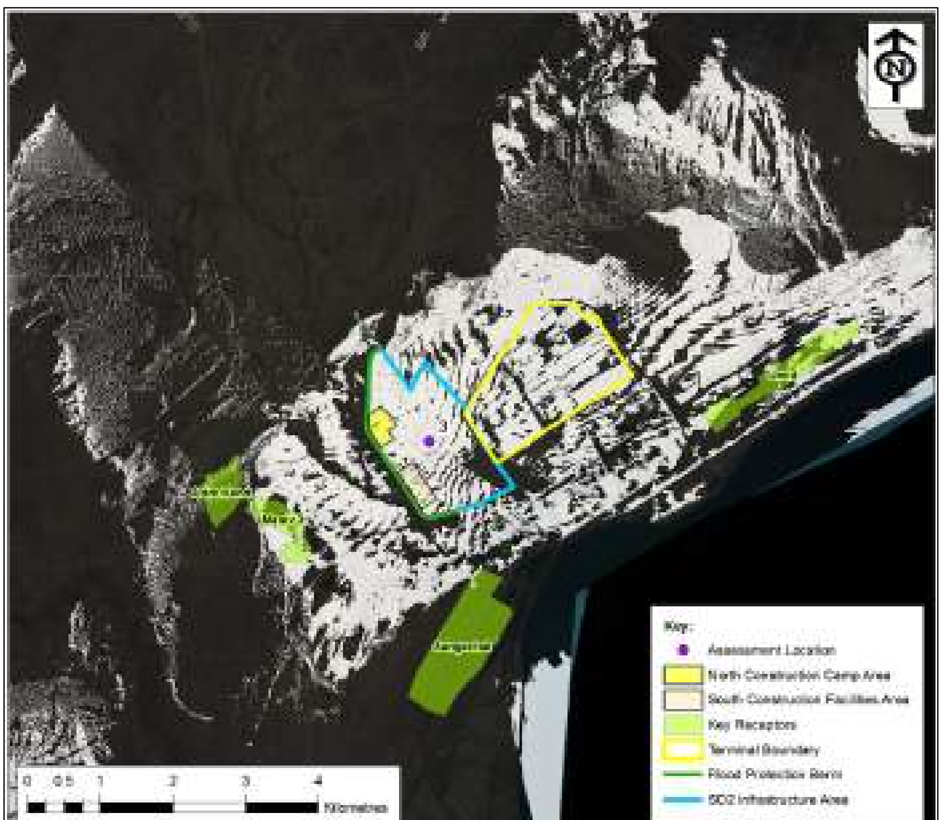
The Scenario 1 and 2 results indicate that the flood protection berm therefore does not provide complete screening of the plant and vehicles operating within the SD2 Infrastructure Area or within the SD2 expansion Area. The greatest screening is provided by the existing topography in the vicinity of the Sangachal Terminal e.g. the ridge located behind Sangachal Town.

Figure 1.4 – Results from Scenario 2 without the Flood Protection Berm



Notes: Black = not visible White = visible

Figure 1.5 – Results from Scenario 2 with the Flood Protection Berm



Notes: Black = not visible White = visible

Scenario 3

The results of the viewshed analysis for Scenario 3 are shown in Figure 1.6. This Scenario assumes blocks of 10m in height located across the Construction Camp and Construction Facilities Areas.

Figure 1.6 – Viewshed Analysis Scenario 3

Notes: Black = not visible White = visible

Umid - Results of the viewshed analysis indicate that the 10m blocks may be visible from approximately 80% of Umid. However, as for Scenarios 1 and 2, the presence of existing buildings and the Sangachal Terminal will obscure the view towards the SD2 Infrastructure area. The structures within the construction camp and construction facilities areas are therefore unlikely to be significantly visible from Umid. The view will continue to be dominated by the exiting Terminal structures.

Sangachal Town - The viewshed analysis suggests that the 10m blocks would be visible only from the north and western part of Sangachal Town (approximately 7% of Sangachal Town by area). However as for Scenarios 1 and 2, existing buildings in Sangachal Town will largely restrict views from the west and north. The structures within the construction camp and construction facilities areas are therefore likely to be visible from very limited locations to the north of Sangachal Town.

Azim Kend and Masiv 3 – The viewshed analysis indicates that the 10m blocks would be visible from the majority of Azim Kend and Masiv 3. In the majority of locations however, the view would be wholly or partially obscured by existing buildings. Locations along western edges of these communities would have a direct and unobscured view towards the construction camp and construction facilities areas. However, the visual impact will be limited as these views are already dominated by the existing structures associated with the

Sangachal Terminal, which are of a height to the proposed construction camp and construction facilities structures

Summary of Key Findings

Table 1.2 provides a summary of the area of each community where the assessment locations or structures were shown to be visible based on the viewshed analysis. This analysis considers local topography only and does not take into account existing structures that may obscure views.

Table 1.2 Areas Within Each Community Where Assessment Locations or Structures May be Visible (Based on Viewshed Analysis)

Key Receptor	Approximate Area of Community where Assessment Locations/Structures May be Visible				
	Scenario 1		Scenario 2		Scenario 3
	Without Flood Protection Berm	Change with Flood Protection Berm?	Without Flood Protection Berm	Change with Flood Protection Berm?	
Azim Kend	5%	None	5%	None	75%
Masiv 3	35%	None	35%	None	99%
Umid	25%	None	25%	None	80%
Sangachal Town	0.5%	None	0.5%	None	7%

From all receptors the presence of the **flood protection berm** was shown to have **no effect** on the visibility of the assessment locations and structures associated with the SD2 Infrastructure Project.

From **Sangachal Town** the assessment showed that views towards the SD2 Infrastructure area are largely obscured by a ridge located behind the town. It is therefore concluded that views would only be possible from very limited locations.

From **Umid** while the assessment showed that there may be limited views of the construction plant and vehicles (Scenarios 1 & 2) and greater potential for views of the construction camp and construction facilities structures (Scenario 3), the presence of the existing Terminal structures and the distance between the community and the works suggests that views would largely be obscured and very distant.

Similarly from **Azim Kend and Masiv 3** the assessment indicated potential for limited views of the construction plant and vehicles (Scenarios 1 & 2) and greater potential for views of the construction camp and construction facilities structures (Scenario 3). The presence of existing structures within these communities limits the likely visibility of the works within the SD2 Infrastructure area to a small number of locations. In these locations however views are currently dominated by the existing Terminal structures.

In summary at each key receptor it is expected that there will be very limited visibility of the construction plant and vehicles (Scenarios 1 & 2) and structures associated with the construction camp and construction facilities (Scenario 3) since views will be largely obscured by existing structures. Where views are possible, the works would not dominate or significantly alter the existing view and no significant visual impacts are anticipated.

2. Lighting Screening Assessment

2.1 Introduction

A lighting assessment was carried out at and in the vicinity of the Sangachal Terminal in May 2010 to understand the existing light levels within the local communities (Sangachal Town, Umid, Azim Kend and Masiv 3) and the existing contribution to light levels from the Terminal.

2.2 Methodology

Light can be defined as a type of radiation and it forms part of the electromagnetic spectrum visible to the eye. Light is measured in lumen (lm). The amount of light which falls onto a surface is known as illuminance and this is measured in lumens per square metre or lux[1].

There is currently no national guidance on lighting assessments and as such this assessment has considered best practice guidance produced by the International Commission on Illumination (CIE) and the Institution of Lighting Engineers (ILE). The guidance is set out in the CIE's "Guide on the limitations of the effect of obtrusive light from outdoor lighting installations"[2] and the ILE's "Guidance notes for the reduction of obtrusive light".

In order that light in environmentally sensitive areas is controlled the ILE has recommended the following environmental zones for development areas:

- E1 - Intrinsically dark areas. National Parks, Areas of Outstanding Natural Beauty;
- E2 - Low district brightness areas. Rural or small village locations;
- E3 - Medium district brightness areas. Small town centres or urban locations; and
- E4 - High district brightness areas. Town centres with high levels of night time activity.

Given the rural setting of the four communities the zone applicable to them is E1. The recommended lighting conditions for the E1 zones is 2 lux for Pre-curfew (23.00 hours) and 1 lux post-curfew (from public roads lighting installations only).

2.3 Monitoring Locations

A survey of the existing Terminal boundary lighting was undertaken to establish the sources and extent of the boundary lighting. Where possible, boundary lighting was recorded noting the type and direction of the lighting.

Monitoring locations were selected in each of the four communities surrounding the Terminal at a point where the Sangachal Terminal lighting at night was most visible. These locations were selected to provide a "worst case" assessment. The monitoring locations at the surrounding communities were selected away from local light sources in order to focus the assessment on the impact of light from the Terminal.

Table 2.1 sets out the position of the monitoring locations and relative distances to the Terminal boundary (see Figure 2.1).

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[1] Department for Environment, Food and Rural Affairs (DEFRA), 2006. Statutory Nuisance from Insects and Artificial Light: Guidance on Sections 101 to 103 of the Clean Neighbourhoods and Environment Act 2005

[2] Commission International Éclairage (CIE), 2003. Guide on the limitations of the effect of obtrusive light from outdoor lighting installations. Publication No 150 2003.

Table 2.1 Distances of the Communities from the Sangachal Terminal Boundary

ID	Monitoring Location	GPS Reference		Approximate Distance from the Terminal Boundary (km)	Direction from Terminal Boundary
		Northing	Easting		
C1	Azim Kend	40 11.491	49 25.621	3	South east
C2	Masiv 3	40 11.142	49 26.101	2.6	South east
C3	Sangachal	40 10.627	49 27.827	1.6	South east
C4	Umid	40 11.850	49 30.065	1.1	South west

Figure 2.1 Light Assessment Monitoring Locations

2.4 Results

In addition to the boundary lighting of the existing Terminal and due to the fact that the site is in operation for 24 hours, all plant and machinery within the existing Terminal is lit at night for safely and security reasons. A large proportion of the plant extends above the height of the boundary lighting such as the tanks and flares (see Figure 2.2). The Terminal boundary road is also illuminated with high pressure sodium luminaries. The view of the Terminal from all four communities includes boundary lighting, plant lighting and light from the flares[3].

[3] During the lighting baseline survey the flares where operating under routine conditions. Light increases when additional gas is flared in non routine conditions (e.g. emergency depressurisation).

Figure 2.2 Photo from Sangachal Showing Boundary and Plant Lighting of the Terminal

Table 2.2 presents the findings of the lighting monitoring undertaken on 18 and 19/20 May 2010.

Table 2.2 Lux Measurements in the Communities

ID	Monitoring Location	Approximate Distance (km) and Direction from the Terminal Boundary	Lux Value		ILE Lux Limit		Comment
			18 May	19 May	Pre-curfew	Post-Curfew	
C1	Azim Kend	3km south west	0.14	0.06			Limited lighting approximately 50m south of the monitoring location
C2	Masiv 3	2.6m south west	0.08	0.06			-
C3	Sangachal	1.6km south west	0.1	0.05	2	1	Low level lighting interference from the power station to the south west of the monitoring location.
C4	Umid	1.1km south east	0.21	0.2			-

The lighting impact of the Terminal on the surrounding communities was most evident at the Umid monitoring location (C4), located approximately 1.1km to the south east of the Terminal. The average illuminance value recorded at the C4 location was 0.2 lux. The recommended level as set out by the ILE (refer to Table 2.2 above) is 1 lux post-curfew and as such the impact of the Terminal on Umid is well within the requirements of the ILE Guidelines. The measurements from monitoring locations C1 – C3 ranged between 0.05 – 0.14 lux, well below the maximum light intensity levels set out in the guidance document. Annex B includes photographs taken from the communities of the Terminal at night.

1.4 Conclusion

The Terminal has been identified as the dominant source of light from all communities. The lighting survey has determined that light levels within the communities do not result in obtrusive light levels according to ILE guidance.

Annex A –Photographs of the Communities

Photo A1 - View of Sangachal Town in a westerly direction (away from Sangachal Terminal)

Photo A2 - View from western edge of Umid looking Eastwards towards Sangachal Terminal

Photo A3 - View from the Eastern Edge of Masiv 3 looking Eastward towards Sangachal Terminal

Photo A4 - View from Azim Kend looking towards the South-East

Annex B – Lighting Photographs

Photo B1 - View of Sangachal Terminal from Azim Kend

Photo B2- View of Sangachal Terminal from Masiv 3

Photo B3 - View of Sangachal Terminal from Sangachal Town

Photo B4- View of Sangachal Terminal from Umid

APPENDIX 9C

Air Quality Assessment for Construction

URS

SD2 Infrastructure Project

Air Quality Assessment for Construction

13 July 2011

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CONTENTS

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EXECUTIVE SUMMARY

This report presents the findings of a screening assessment of predicted atmospheric emissions associated with the construction of the Shah Deniz 2 (SD2) Infrastructure Project.

The SD2 Infrastructure Project includes the works that are required prior to the construction, installation, commissioning and operation of the onshore SD2 facilities within the SD2 Expansion Area at the Sangachal Terminal.

This report considers the effect of the following activities associated with the SD2 Infrastructure Project:

- *Dust generation attributed to earth moving and construction activities;*
- *Exhaust emissions from onsite construction plant; and*
- *Exhaust emissions arising from offsite road traffic movements associated with the SD2 Infrastructure Project.*

Methodology

Dust generation and onsite plant emissions have been assessed using the ADMS4 dispersion model (version 4.2). Emissions associated with offsite road vehicle movements have been considered using the Design Manual for Roads and Bridges (DMRB) screening tool (1.03c).

*For the assessment of **dust emissions and construction plant emissions**, a two dimensional Cartesian grid system has been used based on the 'Pulkovo 1942' coordinate system, using the 'Krasovsky 1940 spheroid'. The 4km x 4km grid is centred on the SD2 Expansion Area, with 80 receptor points (resulting in a modelled concentration every 50m). Four sensitive receptor locations were also included in the ADMS4 model at which the effect of the atmospheric emissions has also been calculated. These include Azim Kend/Masiv 3, Sangachal Town, Umid, and a nearby Herder Settlement.*

*For the assessment of **offsite road traffic emissions** the closest residential location to the Baku-Alyat Highway, (approximately 20m from the southbound carriageway within Sangachal Town) was selected and the contribution to NO_2 concentrations at this location associated with project traffic estimated DMRB screening .*

Assessment Criteria

*Dust emissions (which comprise both suspended and deposited particulate matter up to 75 microns (µm) in diameter) associated with **earth moving and construction activities** have been evaluated. In the absence of international limits for dust deposition the potential for nuisance has been assessed against guidance limits used in Western Australia and Argentina (which represents the most stringent limit based on a literature review of available limits). PM_{10} concentrations associated with these activities have also been modelled and the contribution at receptors assessed against relevant limit values.*

Construction plant and offsite road traffic emissions *arise from combustion of fuels. The key species of concern in this study is NO_2. This species and relevant averaging periods have been modelled to assess the contribution of emissions from the project at the selected receptors against the applicable air quality limit values, set for the protection of human health. PM_{10} concentrations associated with road traffic have also been modelled and compared to the relevant limit value*[1].

The predicted NO_2 and PM_{10} concentrations at receptors have been assessed against the project limits provided in the SD2 Environmental Basis of Design. The following table presents a summary of modelling undertaken.

	Parameter Modelled			Model
	NO_2	PM_{10}	Dust	
Earth moving and construction activities		✓	✓	ADMS4.2
Construction plant	✓			ADMS4.2
Road traffic	✓	✓		DMRB

Project limit values also exist for SO_2, however this pollutant species has not been assessed for site plant or offsite road traffic because of the relatively low sulphur content of vehicle fuels in Azerbaijan. For example, NO_X emissions are expected to be 9.5 times higher than SO_2 from offsite road vehicles and site plant (see Section 2.1.1 for more detail).

Historically in Azerbaijan ambient concentrations of NO_2 and PM_{10} have also been assessed against specific 24 hour and 1 hour standards. These standards were not derived using the same health based criteria as the IFC, WHO and EU guideline values and the standards derived are not widely recognised. For completeness the estimated NO_2 and PM_{10} emissions associated with the SD2 Infrastructure Project activities have been compared to the historic Azeri standards

Model Input Parameters

The potential generation of airborne particles during ***earth moving and construction activities*** *has been estimated using the United States Environmental Protection Agency (US EPA) document 'Fugitive Dust Sources' where appropriate emission factors are provided.*

The number and type of ***site plant and offsite road vehicles*** *and the expected project activities are based on the data (as estimated by the project engineers) presented in Chapter 5: Project Description of the SD2 Infrastructure Project ESIA. Emission rates have been estimated from the EMEP/CORINAIR Emission Inventory Guidebook.*

The meteorological data used in the dispersion modelling (including sunlight, temperature and wind data) was based on the available measurements made at Sangachal Terminal and supplemented by data from Baku Airport for the year (2007). No meteorological data is required for the DMRB road traffic assessment.

[1] *PM_{10} emissions from onsite plant have not been included within the ADMS4 model. These are estimated to be a factor of 10 times less than NO_X emissions (and therefore the significance of the impact can be extrapolated from the NO_X output), and indiscernible in comparison with the dust generated during earth moving and construction activities. Refer to Section 2.3.2 for more details.*

Conclusions

The results of the modelling undertaken are presented in the following table.

	Modelled Increase at Receptors[1]			***Increase as % of Relevant Limit/Guidance Value***[2]		
	NO_2 Concentration ($\mu g/m^3$)	***PM_{10} Concentration ($\mu g/m^3$)***	***Dust Deposition ($mg/m^2/day$)***	***NO_2***	***PM_{10}***	***Dust Deposition***
Earth moving and construction activities	*N/A*	*0.1 - 0.3*	*1.7 - 9.8*	*N/A*	*0.5 - 1.5%*	*1.3 – 7.4%*
Construction plant	*<0.1*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Offsite road traffic	*0.9*	*0.2*	*N/A*	*2.2%*	*1%*	*N/A*
All activities	***0.9***	***0.3 - 0.5***	***2-10***	***2.2%***	***1.5 - 2.5%***	***1.3 – 7.4%***

Notes:
1. NO_2 and PM_{10} background concentrations are 6 $\mu g/m^3$ and 109$\mu g/m^3$ respectively as determined from 2010 air quality monitoring report.
2. NO_2 annual average limit value = 40$\mu g/m^3$ PM_{10} annual average limit value = 20$\mu g/m^3$, dust nuisance guideline = 133 mg/m^2/day.

The findings of the screening assessment are:

- ***PM_{10} emissions (associated with construction dust)*** *– The modelling predicts a contribution of between 0.1 and 0.3 $\mu g/m^3$ to PM_{10} concentrations at the receptors modelled from earth moving and construction activities. This constitutes 0.5 - 1.5% of the annual average PM_{10} limit value (20 $\mu g/m^3$) and represents less than 0,1% of the traditional Azeri 24 hour limit value (100 $\mu g/m^3$);*

- ***Dust deposition -****. The results obtained at sensitive receptors shows that the maximum daily rate of deposition offsite due to earth moving and construction activities is predicted to be between 1.7 and 9.8 mg/m^2/day (on an annual basis). This represents 1.3 – 7.4% of the guidance levels and would be imperceptible in comparison with background levels. The maximum worst case daily dust deposition rate was also modelled with the highest rate of 132mg/m^2/day estimated at Sangachal. This is comparable to the most stringent guidance value for dust deposition found in literature;*

- ***Onsite plant and equipment emissions (NO_2 emissions) -*** *The modelling predicts that exhaust emissions from onsite plant and equipment are anticipated to lead an increase of less than 0.1 $\mu g/m^3$ in NO_2 and PM_{10} concentrations at modelled receptors;*

- ***Offsite road vehicle emissions (NO_2 and PM_{10} emissions)*** *- A contribution of up to 0.9 $\mu g/m^3$ to NO_2 concentrations and less than 0.2 $\mu g/m^3$ to PM_{10} concentrations is predicted at the selected receptor 20m from the Highway. This represents 2.2% of the annual average air quality project and traditional Azeri limit values for NO_2 and 0.5% of the annual average air quality project for PM_{10}.*

- ***Overall contribution from SD2 Infrastructure Project activities (NO_2 and PM_{10} emissions)*** *–The cumulative impact of construction site and plant and the road traffic activities on PM_{10} concentration at nearby sensitive receptors is expected to be 0.1-0.3 µg/m^3. The cumulative impact on NO_2 concentrations will vary across receptors. Nearer to the Highway the contribution to NO_2 concentrations is predicted to be a maximum of 0.9 µg/m^3, within the communities both onsite plant and offsite vehicle emissions are predicted to lead to increase of less than 0.1 µg/m^3.*

- ***Compliance with applicable limit values*** *- When taking account of the existing background concentrations the predicted NO_2 concentrations easily comply with the applicable air quality limit values[2]. This is not the case for PM_{10}, because PM_{10} background concentrations already exceed the applicable limit values - this is considered to be predominantly a consequence of the dusty nature of the region.*

In summary, it is not expected that the project will cause any air quality limit values to be exceeded where concentrations currently comply with the limit values. Where limits are currently exceeded (i.e. PM_{10}) the contribution from the project (from plant, earth moving activities, onsite and offsite vehicles) is predicted to be a maximum of 0.3 µg/m^3. This represents an increase of 0.4% when compared to current background concentrations.

Dust deposition rates are expected to vary between an annual average of less than 10 mg/m^2/day to a maximum of approximately 132 mg/m^2/day. It is therefore recommended that measures are incorporated to minimise dust generation including:

- *Limiting of vehicle speeds on unsurfaced roads;*
- *Minimise use of unsurfaced roads where possible;*
- *Where unsurfaced, the main access routes will be created using compacted well graded granular fill, appropriately designed to ensure good drainage to minimise the potential for erosion;*
- *Construction activities shall be suspended if excessive dust arises and measures shall be taken to control ground prior to resuming activities; and*
- *Consider using an additive (used in preference to untreated water) to be applied to non sealed roads, disturbed land and spoil piles to reduce dust generation.*

These measures are considered appropriate to minimise dust to acceptable levels. However, a Community Interaction and Social Impact Management Plan should be implemented and maintained as a mechanism of communicating with the community (particularly to communicate when particularly dusty activities are planned) and responding to community grievances

[2] The traditional Azeri limit for NO_2 is the same as the annual average project limit value of 40µg/m^3

Units and Abbreviations

Unit	Description
°C	Degrees Celsius
µm	Micron
g/s	Grams per second
$\mu g/m^2/s$	Micrograms per square metre per second
$g/m^2/s$	Grams per square metre per second
$\mu g/m^3$	Micrograms per cubic metre
g/KW-hour	Grams per Kilowatt hour
m	Metre
km	Kilometre
kW	Kilowatts
M	Meters
m/s	Meters per second
M^3	Cubic metres
%	Percent
%ile	Percentile
Abbreviation/ Acronym	**Description**
ADMS	Atmospheric Dispersal Modelling System
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
CERC	Cambridge Environmental Research Consultants
DMRB	Design Manual for Roads and Bridges
EHS	Environmental Health and Safety
EMEP	Environmental Monitoring, Evaluation, and Protection (programme)
EU	European Union
ISCST	Industrial Source Complex Short Term
IFC	International Finance Corporation
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_X	Oxides of nitrogen
OH	Hydroxyl
O_3	Ozone

PM	Particulate matter
SD	Shah Deniz
SO_2	Sulphur dioxide
UK	United Kingdom
US	United States
US EPA	United States Environmental Protection Agency
UV	Ultra violet
WHO	World Health Organisation

1. INTRODUCTION

This report presents the findings of a screening assessment of predicted atmospheric emissions associated with the construction of the Shah Deniz 2 (SD2) Infrastructure Project.

The SD2 Infrastructure Project includes the works required prior to the construction, installation, commissioning and operation of the onshore SD2 facilities within the SD2 Expansion Area at the Sangachal Terminal.

The key components of the SD2 Infrastructure Project (refer to Figure 1) are:

- Temporary reinstatement of the Early Oil Project Terminal access road;
- New access road from the Baku-Alyat Highway to the Terminal (and associated facilities);
- Clearance of the SD2 Project expansion area, located immediately to the west of the existing Terminal site;
- Site terracing;
- Construction and fit out of the construction camp and construction facilities;
- Installation and operation of a sewage treatment plant;
- Installation of storm water drainage and surface water/flood protection berms; and
- Beach pull / landfall area levelling.

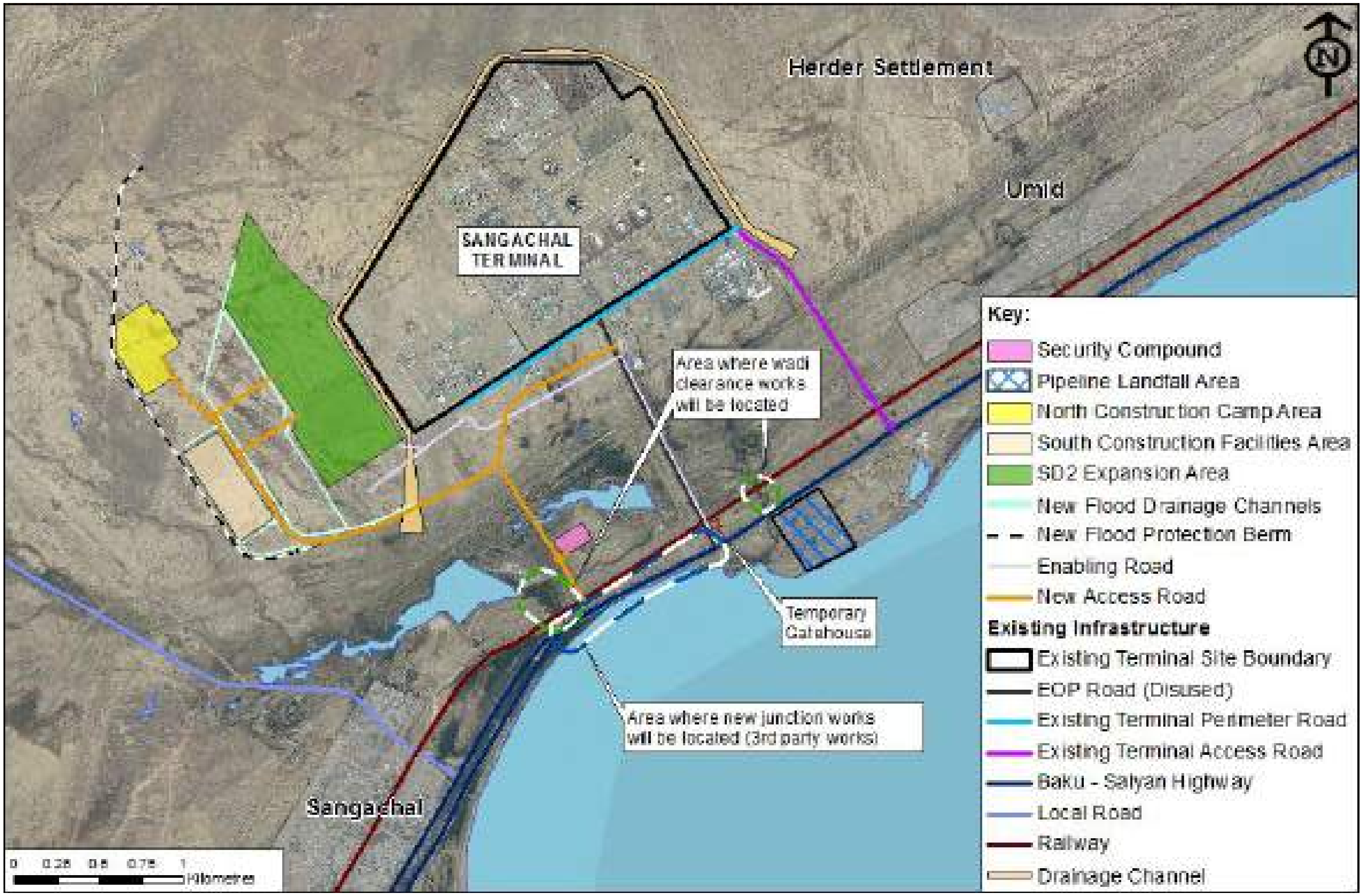
1.1 Scope

This report comprises an assessment of the contribution from the following to key pollutant concentrations at sensitive receptors:

- Dust due to earth moving and construction activities;
- Exhaust emissions from onsite construction plant; and
- Exhaust emissions arising from offsite road traffic movements associated with the SD2 Infrastructure Project.

The pollutant species and averaging periods modelled have been based on the applicable air quality limit values set for the protection of human health, as presented in Section 2.1 of this report, and dust nuisance guidance.

Figure 1: Location of SD2 Infrastructure Project



2. METHODOLOGY

The following steps have been followed to undertake the assessment:

1. Define applicable air quality limit values, dust nuisance guideline values and associated averaging periods;
2. Select a suitable atmospheric dispersion model or screening tool;
3. Determine the model input parameters, which for area sources includes:
    - Release height of the source,
    - Exit gas velocity,
    - Exit gas temperature,
    - Emission rate; and
    - Meteorological conditions.

    And for road sources includes:
    - Daily average traffic flows (SD2 Infrastructure Project traffic only);
    - Road type; and
    - Average vehicle speed.
4. Define dimensions of modelling grid and/or location of sensitive receptors;
5. Define background pollutant concentrations receptors;
6. Undertake the modelling/screening exercise; and
7. Compare the modelled pollutant concentrations (including background concentrations) against the applicable air quality limit values to identify potential air quality impacts.

2.1 Air Quality Limits and Other Study Pollutants

2.1.1. Air Quality Limit Values

Ambient air quality limit values are defined by the World Health Organisation (WHO) and European Union (EU) based on scientific knowledge with the aim of avoiding, preventing or reducing harmful effects to human health and/or the environment as a whole.

Each limit value is presented for a given averaging period, based on scientific knowledge of known toxicity to human health. Certain limit values are allowed a certain number of exceedances per calendar year, which corresponds to a particular ‘percentile’.

The key pollutants that have been assessed in this study (associated with dust and combustion plant source emissions) are described as follows[3]:

- **Fine Particulate matter (PM_{10})** – PM_{10} is defined as particulate matter with an aerodynamic diameter of less than 10 microns and is the result of a combination of man-made and natural processes, such as fossil fuel combustion, construction works or earth moving activities, and the natural entrainment of particles by the wind during periods of extended dry weather for example. In semi-arid and arid locations ambient PM_{10} concentrations can exceed the international air quality standards regardless of the presence of local man-made activities (due to the un-vegetated and exposed soils). Exposure to increased levels of PM_{10} are consistently associated with respiratory and cardiovascular illness and mortality; and`

- **Nitrogen dioxide (NO_2):** Oxides of nitrogen (NO_X) are formed as a by-product of the high temperature combustion of fossil fuels (such as natural gas) by the oxidation of nitrogen in the air. NO_X primarily comprises of nitrogen oxide (NO), but also contains NO_2; once emitted the former can be oxidised in the atmosphere to produce further NO_2. It is the NO_2 that is associated with the health impacts, and at high concentrations it can affect lung function and airway responsiveness, and increase the risk of asthma and mortality. The rate of conversion of NO_X to NO_2 in the atmosphere is discussed further in Section 2.4 of this report.

Project limit values exist for sulphur dioxide (SO_2) however this pollutant species has not been assessed for site plant or offsite road traffic, because of the relatively low sulphur content of vehicle fuel in Azerbaijan. Diesel fuel in Azerbaijan currently has to comply with the 'GOST 305-82' regulations, which requires a maximum sulphur content of 0.2% (reducing to 0.1% by 2015) (Ref. 1). Based on this level of sulphur, and according to emission factors provided by the International Association of Oil and Gas Producers (OGP) (Ref. 2), NO_X emissions are expected to be 9.5 times higher from construction and offsite road vehicles than SO_2. Given that the project air quality limit values for SO_2 and NO_2 (which forms part of NO_X) are similar [4], it was not considered necessary to assess SO_2 emissions.

Table 1 summarises the ambient air quality limit values and averaging periods which have been adopted for the SD2 Infrastructure Project and provided in the SD2 Environmental Basis of Design (Ref. 3).

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[3] While air quality limit values exist for CO, this species has been omitted from the assessment as the air quality limit value is more than 50 times that of NO_X, but yet the emissions of these two pollutants from construction activities are of a similar magnitude.

[4] The mean annual limit values for NO_2 and SO_2 are 40 µg/m^3 and 50 µg/m^3 respectively. The 1 hour limit values for NO_2 and SO_2 are 200 µg/m^3 and 350 µg/m^3 respectively. SO_2 also has a daily and 10 minute limit value.

Table 1: Ambient Air Quality Limit Values – NO_2 and PM_{10}

Pollutant Species	Air Quality Limit ($\mu g/m^3$)	Averaging Period
NO_2	40	Annual
	200	1 hour
PM_{10}	50	24 hours (99th percentile)
	20	Annual

These limit values apply to locations where members of the public are generally expected to be normally present (e.g. residential areas, schools, hospitals). They do not apply to work premises such as within the Sangachal Terminal, which is subject to less stringent workplace limits. Occupational and workplace exposure is not assessed within this report.

Historically in Azerbaijan ambient concentrations of NO_2 and PM_{10} have also been assessed against specific 24 hour and 1 hour standards. These standards were not derived using the same health based criteria as the IFC, WHO and EU guideline values and the standards derived are not widely recognised. For completeness the estimated NO_2 and PM_{10} emissions associated with the SD2 Infrastructure Project activities have been compared to the historic Azeri standards. These are:

- NO_2 24 hour average of 40 $\mu g/m^3$; and
- PM_{10} 1 hour average of 300 $\mu g/m^3$ and 24 hour average of 100 $\mu g/m^3$.

2.1.2. Dust Nuisance Criteria

The term 'dust' refers to both suspended and deposited particulate matter up to 75 microns (µm) in diameter. Dust emissions have the potential to create a public nuisance, through deposition of dust e.g. on vehicles, window sills etc.

There are no international criteria for nuisance dust deposition or safe levels of airborne dust in the ambient air, with health criteria instead focusing on the PM_{10} dust fraction as discussed above.

There are no statutory limits for nuisance dust provided by the EU, World Bank, or WHO, though guidance levels do exist in some countries. A report by Airshed Planning Professional Ltd in 2010 (Ref. 4) provides a literature review of guidance limits in various countries. The most stringent limit value provided is 133 milligrams per metre squared per day (mg/m^2/day) (as an annual average), which is considered the onset of loss of amenity by the Government of Western Australia State and the Argentine Government.

2.2 Model Selection

2.2.1. Earth Moving and Construction Activities and Onsite Plant

A range of models are available for atmospheric dispersion modelling, including Industrial Source Complex Short Term (ISCST), American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD), and Atmospheric Dispersion Modelling System (ADMS).

This assessment has been undertaken using the UK Atmospheric Dispersion Modelling System, ADMS4 (version 4.2). This is a detailed dispersion model developed by Cambridge Environmental Research Consultants (CERC), which can also be applied to screening assessments.

Further details on model validity are provided in Annex A of this report and an extensive library of ADMS validation reports is available at: http://www.cerc.co.uk/software/publications.html.

Reasons for selection of ADMS4 are given as follows:

- ADMS-4.2 incorporates a superior basis for dispersion modelling, based on the Monin-Obhukov length parameter, rather than the Pasquill stability classes/Gaussian profiles used in earlier models. The systems in practice give similar results for stable and neutral atmospheric stability conditions, but, under unstable conditions, the predictions of models incorporating the Monin-Obhukov length are regarded as superior;

- The ADMS-4.2 model incorporates an integrated plume rise module, rather than the simple empirical formula used in ISCST and the basic AERMOD model. The empirical approach is known to give poor predictions of emissions from low release heights (such as dust release from construction works) as the equations were established primarily from the observations of large power station plumes;

- Many regulatory authorities explicitly endorse or accept the use of ADMS4. In the UK the Environment Agency does not formally “approve” any model (the UK Government's open policy). However, ADMS is routinely used and approved by the Environment Agency of England and Wales, Scottish Environmental Protection Agency, and the Department of the Environment in Northern Ireland. ADMS is also used routinely on behalf of Department for Environment, Food and Rural Affairs (Defra), the UK Government department for the environment;

- ADMS is included in the United States Environmental Protection Agency’s Appendix W List of Alternative Models, and is approved for all types of environmental impact assessment in China. ADMS is an approved model in France, Italy, the Netherlands, Ireland, the Baltic States, South Africa, Hungary and Thailand and was used by the California Department of Health. The models are also used in Spain, Portugal, Sweden, Cyprus, Austria, United Arab Emirates, Sudan, Saudi Arabia, Tunisia, Slovenia, Poland, New Zealand, Korea, Japan, India, Canada and Australia;

- The model uses hourly sequential meteorological data to enable a realistic assessment of dispersion from point sources to be conducted; and

- ADMS has been rigorously validated by its manufacturers (CERC) against existing monitoring data and alternative models that are available. For the validation studies that were tested in simple terrain (which is considered to be the most similar to the study area), ADMS out performed these other models and demonstrated a model accuracy to be within ±10% of the actual monitoring findings.

2.2.2. Offsite Road Vehicles

A range of detailed and screening models exist for assessing the impacts of road vehicle emissions. Examples of screening tools include the Design Manual for Roads and Bridges (DMRB) screening tool, CAR-International, and CALINE 4. It was not considered necessary to use a detailed dispersion model such as ADMS-Roads to assess road traffic emissions given the relatively small increase in traffic flows expected on the local road network and absence of existing traffic data.

The Design Manual for Roads and Bridges (DMRB) Screening Method, version 1.03c (Ref. 5) was chosen for the assessment. This screening tool, published by the Highways Agency in England and Wales, and subsequently in Scotland and Northern Ireland, provides a method for estimating the impact of additional road traffic movements on local air quality.

The DMRB screening tool is based on UK emission limits and fleet composition. Since new vehicles in Azerbaijan are currently only required to meet 'EURO 2' emission limits, which was introduced to the UK in 1996 (Ref. 6), the year of assessment was set to 1996 in the screening tool.

2.3 Model Input Parameters

2.3.1. Earth Moving and Construction Activities

Significant atmospheric dust can arise from the mechanical disturbance of the ground. Dust generated from open sources is termed "fugitive" because it is not discharged to the atmosphere in a confined flow stream (such as emissions from a boiler flue).

The potential drift distance of airborne particles is governed by the initial injection height of the particle, the terminal settling velocity, and the degree of atmospheric turbulence. According to the United States Environmental Protection Agency (US EPA) document 'Fugitive Dust Sources' (Ref. 7), particles larger than about 100 microns (µm) are likely to settle within 6 to 9 metres (m) from the emission source, with particles 30-100 µm in diameter settling within 50-100m. Smaller particles, such as PM_{10}, can travel several hundreds of metres from the source, sometimes up to 1 kilometre (km).

It is difficult to provide an accurate prediction of dust and PM_{10} emissions associated with earth moving and construction activities, due largely to the uncertainty associated with estimating a reliable emission factor. Dust emissions can vary substantially from day to day depending on the level of activity, the specific operations and the prevailing meteorological conditions.

Despite this limitation, a screening exercise has been undertaken using the dispersion model ADMS4 (version 4.2), applying the parameters outlined in the US EPA document 'Fugitive Dust Sources' (Ref. 7).

The US EPA presents an emission rate for total suspended particles arising from heavy construction work of 2.69 tonnes per hectare per month of construction work (within a semi-arid climate with medium silt content). This corresponds to approximately 100 micrograms dust per square metre per second ($\mu g/m^2/s$).

Furthermore, the US EPA report that, although dependent upon a variety of factors, such as soil type and soil moisture content, particles are unlikely to become entrained from undisturbed ground through the action of turbulent winds at speeds below 19km per hour (5.3 m/s). Wind speeds at the site are likely to exceed the aforementioned threshold for approximately 38% of the year, according to the 2007 meteorological data presented in Section 2.5 of this report. The emission factor is therefore likely to overestimate the actual impacts of dust emissions from the construction works.

An emission rate of $20\mu g/m^2/s$ (or $0.00002 g/m^2/s$) was utilised to determine the effect on PM_{10} concentrations at specified receptor points. This is based on the U.K. approach which draws on research by the Quality of Urban Air Review Group (Ref. 8), which states that 20% of the airborne particles from construction activities tend to be of the size fraction PM_{10} and below.

Table 2 presents the parameters inputted into the ADMS4 model. It is considered that mobilisation of dust will be greatest during site preparation and earthworks, and therefore windblown dust from soil stockpiles and exposed areas of soil has not been modelled. Based on Chapter 5 of the SD2 Infrastructure Project ESIA, the most significant site preparation and earthworks will take place within the central part of the SD2 Infrastructure Area. This is estimated to be approximately 140 hectares and has been entered into ADMS4 as an area source.

Table 2: Construction Dust Model Input Parameters

Parameter	Value
Source type	Area source
Height of release above ground level	1m
Velocity of release	5m/s
Temperature of release	Ambient
Vertices	368589, 4451280 367928, 4452278 369023, 4452884 369573, 4451900
Emission rate for PM_{10}	$0.00002 g/m^2/s$ during working hours
Emission rate for Dust	$0.0001 g/m^2/s$ during working hours

It has been assumed that project activities will be limited to working hours, which will be 7am – 7pm Monday - Saturday.

2.3.2. Onsite Construction Plant

Table 3 presents the estimated number of plant operating onsite each day during the peak month of activity, which is anticipated to occur between January and September

2012 (based on Figure 5.4 and Table 5.4 Chapter 5: Project Description, which present the anticipated phasing and number and type of site plant for each phase respectively).

Table 3 also includes the estimated power rating of each plant (based on a review of manufacturer data) and expected NO_X emissions, which is derived from an emission factor of 14.4 grams per kilowatt-hour (g/KW-hour) from the EMEP/CORINAIR Emission Inventory Guidebook (Ref. 9) for uncontrolled diesel powered site plant.

Table 3: Estimated Number of Site Plant and NO_X Emissions during Peak Construction

Unit	Estimated Rating (kW)	NO_X Emissions per unit (g/s)	No. plant in peak activity	NO_X Emissions (g/s)
Bull Dozer	530	2.12	18	38.2
Wheeled Loader	25	0.10	15	1.5
Tracked Excavator	27	0.11	15	1.6
Dump Truck	25	0.10	114	11.4
Motor Grader	25	0.10	10	1.0
Sheep foot roller	10	0.04	9	0.4
Road Roller	13	0.05	3	0.2
Asphalt Paver	130	0.52	3	1.6
Road Lorry	25	0.10	95	9.5
Diesel Generator	100	0.40	30	12.0
Mechanical Water Bowser	25	0.10	30	3.0
Tracked Mobile Crane	115	0.46	9	4.1
Mobile Telescopic Crane	25	0.10	7	0.7
Earthworks Compactor	10	0.04	21	0.8
Concrete Mixer	1.5	0.01	8	0.0
Fork Lift Trucks	5	0.02	10	0.2
Water Pump	20	0.08	15	1.2
Concrete Pump	75	0.30	8	2.4
Air Compressor	7.5	0.03	7	0.2
Backhoe loader	10	0.04	7	0.3
Welding Set	50	0.20	8	1.6
Compactor Plate	6	0.02	12	0.3
JCB Tractor	200	0.80	10	8.0
Tilting Drum Mixer	5	0.02	7	0.1
Fuel Bowser	20	0.08	4	0.3
TOTAL	**-**	**-**	**475**	**100.6**

The total estimated release rate for NO_X from the construction site plant is 100.6 g/s.

The working hours will be 7am – 7pm Monday to Saturday.

Table 4 presents the parameters inputted into the ADMS4 model, based on a working area of 140 hectares (representative of the central section of the SD2 Infrastructure Area) which has been entered into ADMS4 as an area source.

Table 4: Site Plant Model Input Parameters

Parameter	Value
Source type	Area source
Height of release above ground level	2m
Velocity of release	5m/s
Temperature of release	100˚C
Vertices	368589, 4451280 367928, 4452278 369023, 4452884 369573, 4451900
Emission rate for NO_X	0.00007g/m^2/s during working hours

PM_{10} emissions from onsite plant have not been included within the ADMS4 model. These are estimated to be a factor of 10 times less than NO_X emissions and are expected to be indiscernible in comparison with the PM_{10} emissions generated during earth moving and construction activities (Ref. 9).

2.3.3. Offsite Road Vehicles

In order to assess the predicted impact attributed to additional road traffic flows associated with the SD2 Infrastructure Project, a screening exercise has been undertaken using the DMRB Screening Method, version 1.03c.

In the absence of existing traffic flow data for the Highway, the screening assessment has focused on the predicted change due to the additional traffic due to the project, rather than absolute concentrations.

Table 5 presents the estimated number of daily 2-way offsite road vehicle movements (i.e. 1 arrival and departure equates to 2 movements) associated with the SD2 Infrastructure Project[5].

The greatest increase in traffic flows is expected to occur between May and October 2013, with an estimated 162 vehicle movements per day. The low loader, road lorry and 7.5 tonne flat bed vehicle represent approximately 20% of the vehicle movements, and have been classed as Heavy Duty Vehicles in the DMRB screening tool. The remaining vehicles (minibus, 4x4 truck and private car) have been classed as Light Duty Vehicles, which are less than 3.5 tonne in weight.

It has been assumed that 100% of all vehicles will be travelling on the Baku Salyan Highway either to the west or east[6].

[5] Derived from Table 5.5, Chapter 5: Project Description

Table 5: Offsite Road Vehicle Movements

Vehicle Type	2-way Daily Movements				
	Jan-Feb 2012	Mar-Apr 2012	May-Oct 2012	Nov 2012 - May 2013	Jun 2013
Low loader	2	6	2	2	0
Road lorry 25 tonnes	2	4	40	4	0
Minibus (18-20 seater)	6	30	60	60	6
7.5 tonne flat bed	2	4	4	4	0
4x4 pickup truck	8	16	16	16	8
Private car	10	40	40	40	20
Total	**30**	**100**	**162**	**126**	**34**

2.4 Conversion of NO_X to NO_2

At the point of release (from a combustion activity) NO_X emissions predominantly comprise nitrous oxide (NO). However, NO converts to NO_2 in the free troposphere under influences of other gases such as ozone (O_3) and hydroxyl (OH) compounds in the presence of UV radiation (in sunlight).

Since the focus of human health criteria is on NO_2 rather than NO_X, it is important to determine a rate of conversion in the atmosphere, in order to calculate the ground level impact of NO_2.

The Environment Agency for England and Wales's Horizontal Guidance Note (H1) on Assessment and Appraisal Best Available Technology (Ref. 10) presents the preferred conversion rates for NO_X to NO_2. It conservatively assumes that 100% of NO_X converts to NO_2 in the long term (i.e. annual average), and 50% conversion for short term averaging periods (such as 1 hour and 24 hour).

Similarly, the United States Environmental Protection Agency (US EPA) recommends (in the absence of accurate monitoring data) a tiered approach for modelling NO_2 impacts (Ref. 11). The second tier uses the 'Ambient Ratio Method', which assumes that 75% of NO_X is converted to NO_2 for the long term averaging period.

While ADMS4 includes a Chemistry Function which calculates NO_2 and NO_X it was not considered appropriate to use for this study, as it requires accurate background ozone concentrations in order to calculate the convert NO_X to NO_2 conversion. Ozone concentrations in the Terminal vicinity are not recorded. The DMRB screening tool also includes the ability to calculate NO_2 from NO_X; however this is based on UK vehicle emissions data and has recently been dismissed by the U.K. Defra as underestimating actual NO_2 concentrations (Ref. 12).

The approach advocated in the Environment Agency for England and Wales's Horizontal Guidance Note (H1) has been chosen for this assessment. This is likely to provide an

[6] The direction of travel is not relevant within the model

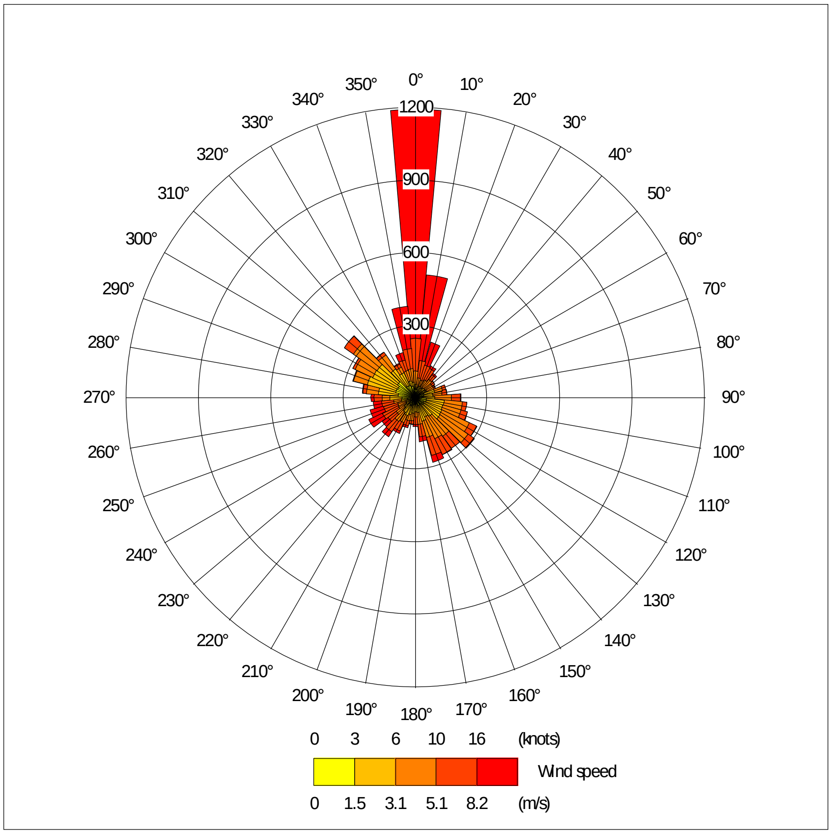
overestimate for road traffic and site plant NO_2 emissions and hence provides a conservative assessment.

2.5 Meteorology

The dispersion of emissions from an area source is largely dependent on atmospheric stability and turbulent mixing in the atmosphere, which in turn are dependent on wind speed and direction, ambient temperature, cloud cover and the friction created by local terrain.

The meteorological data used in the dispersion modelling (including sunlight, temperature and wind data) was based on the available measurements made at Sangachal Terminal and supplemented by data from Baku Airport for the year (2007) (Ref. 13) and is shown in Figure 2.

Figure 2: Wind-Rose (Sangachal Terminal) 2007



The DMRB Screening tool does not require meteorological data to be inputted. This is not considered a limitation to the assessment since road traffic emissions are affected less by changes in meteorological conditions than stationary combustion plant such as boilers due to their lower height of release and therefore more localised impact.

2.6 Model Domain and Specified Receptors

2.6.1. Earth Moving and Construction Activities and Onsite Plant

For the assessment of dust emissions and site plant emissions, a two dimensional Cartesian grid system has been used based on the 'Pulkovo 1942' coordinate system, using the 'Krasovsky 1940 spheroid'. The 4km x 4km grid is centred on the SD2 Expansion Area, with 80 receptor points (resulting in a modelled concentration every 50m).

The effect of atmospheric emissions has been assessed at the following modelled sensitive receptor locations:

- **Receptor 1:** Azim Kend/Masiv 3 - Two small communities 2.5km from the northwest corner of the Terminal, and approximately 1.9km from the western edge of the SD2 Expansion Area and associated works. Receptor located at 366485, 4451525;
- **Receptor 2:** Sangachal Town - Nearest main town, 1.5km from the southwest corner of the Terminal perimeter, and 1.2km from the closest edge of SD2 Expansion Area and associated works. Receptor located at 369409, 4450500;
- **Receptor 3:** Umid - Located 1km from the southeast perimeter of the Terminal, and approximately 2.9km from the SD2 Expansion Area and associated works. Receptor located at 372433, 4452634; and
- **Receptor 4:** Herder Settlement – A herder settlement located 1.3km east of the Terminal and approximately 3.8km from the expansion area. Receptor located at 372954, 4453793.

The locations of these sensitive receptors are illustrated in Figure 3, along with the area source chosen to represent the construction works (i.e. a working area of 140 hectares in the central section of the SD2 Infrastructure Area).

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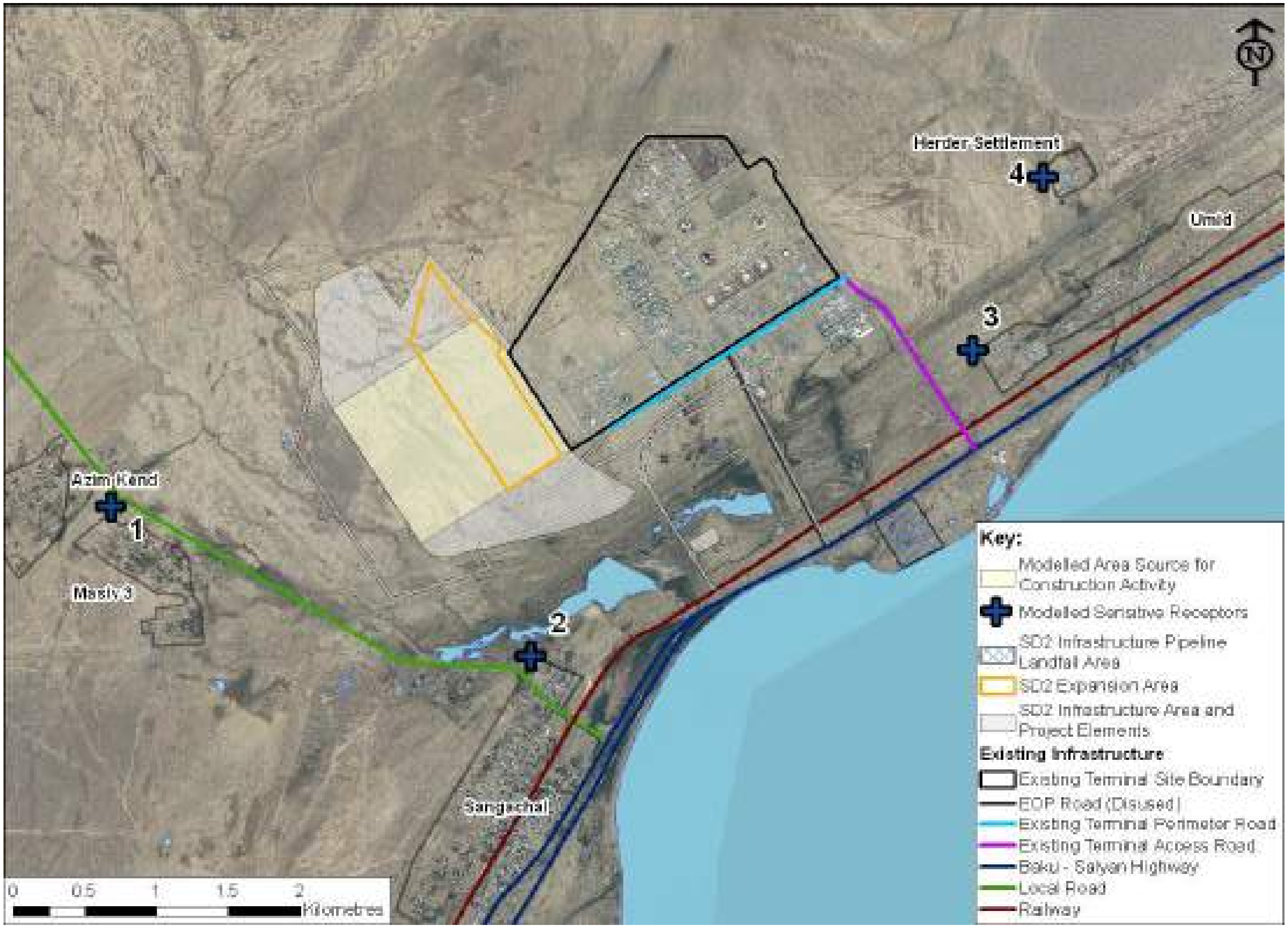
Figure 3: Location of Sensitive Receptors and Source Area



2.6.2. Offsite Road Traffic

For the assessment of road traffic emissions and impacts from construction traffic, associated with the project, a sensitive receptor location adjacent to the Baku-Salyan Highway in the south of the Sangachal Town, has been considered. It is understood this is the nearest receptor to the Highway, located approximately 20m north of the kerbside of the southbound Baku-Salyan Highway and 65m north of the northbound Baku-Alyat Highway, located at 369712, 4449629.

3. BASELINE CONCENTRATIONS

3.1 NO_2 and PM_{10}

The background pollutant concentrations used in the assessment are presented in Table 6. These have been derived from the Sangachal Ambient Air Quality Monitoring Programme for 2010 (Ref. 14).

Table 6: Background Pollutant Concentrations Used in the Assessment

Pollutant	Mean Annual Concentrations
NO_2	6 µg/m^3
PM_{10}	109 µg/m^3

Concentrations of SO_2, benzene, VOC and NO_2 were monitored at 17 locations using passive diffusion tubes. Hourly real-time monitoring data (for NO, NO_2, NO_X, SO_2 and PM_{10}) was also collected at an automatic monitoring station (station AAQ23) between February - May 2009 and May – December 2010[7].

Mean NO_2 concentrations ranged between approximately 2-6 µg/m^3 at background locations, increasing to 10-20 µg/m^3 at monitoring locations near the Terminal and within the communities, therefore easily complying with the mean annual limit value of 40µg/m^3.

Ambient NO_2 concentrations recorded at the real-time monitoring station complied with the one hour average limit (200 µg/m^3).

The average monthly PM_{10} concentration in 2010 ranged between 33 µg/m^3 and 180 µg/m^3, with considerable variance between the 9 months of monitoring. The average PM_{10} concentration for the monitoring period was 109 µg/m^3, which exceeds the annual average limit of 20 g/m^3. In addition, PM_{10} results exceeded the daily standard of 50 µg/m^3 during all but one month. This is likely to be predominantly due to natural processes such the exposed soils in the area leading to the natural entrainment of particles in the atmosphere.

[7] Interruptions to the monitoring station power supply prevented further data from being obtained.

3.2 Dust Deposition

Dust deposition rates are not currently monitored in the vicinity of the Terminal. However, data exists from other monitoring programmes that have been carried out in similar types of environments.

For example, a 15 year programme in China showed that the annual average rate of dust deposition in semi-arid areas ranges between 495 mg/m^2/day and 896 mg/m^2/day (Ref. 15).

Existing deposition rates from natural dust deposition are therefore likely to exceed the guidance limit value of 133 mg/m^2/day.

4. SCREENING ASSESSMENT RESULTS

4.1 Earth Moving and Construction Activities

Table 7 presents a summary of the predicted increase in PM_{10} concentrations from earth moving and construction activities at the modelled sensitive receptor locations.

Table 7: Modelled Increase in PM_{10} Concentrations due to Construction Activities (µg/m^3)

Pollutant	Receptor				Objective
	Azim Kend/ Masiv 3 R1	Sangachal R2	Umid (east) R3	Umid (west) R4	
Increase in mean annual PM_{10}	0.1	0.3	0.1	0.1	20
Maximum Increase in daily PM_{10} (99th Percentile)	1.1	3.0	1.4	1.9	50

The predicted increase in mean annual PM_{10} concentrations at the nearest sensitive receptors is expected to range between 0.1 and 0.3 µg/m^3. This represents between 0.5% and 1.5% of the project limit value.

The increase in daily PM_{10} concentrations (modelled as the 99th percentile) is higher, due to the shorter averaging period associated with this limit value. There is predicted to be an increase in the daily PM_{10} concentration of 1.1 - 3.0 µg/m^3 at the modelled nearby sensitive receptor locations. This represents between 2.2 and 6% of the project limit value and between 1.1 – 3% of the traditional Azeri 24 hour standard.

The impact on PM_{10} concentrations associated with earth moving and construction activities is considered insignificant, and would be imperceptible in comparison with the background PM_{10} concentration of 109 µg/m^3.

The increase in daily PM_{10} concentrations (modelled as the 100th percentile) is again even higher, due to the shorter averaging period associated with this limit value. There is predicted to be an increase in the daily PM_{10} concentration of 1.6 - 6.7 µg/m^3 at the modelled nearby sensitive receptor locations. This represents between 3.2 and 13.4% of the limit value and between 1.6 - 6.7% of the traditional Azeri 24 hour standard.

It should be noted the 100th percentile demonstrates worst-case deposition and should not be confused with the highest wind speed. While PM_{10} and dust 'lifting' is generally increased by high wind speeds, dust deposition does not necessary correlate directly with lifting as deposition is influenced by rate of dispersion and dilution in the atmosphere. A sensitivity study was undertaken using the model for the short term (24 hour) case and it demonstrated that PM_{10} concentrations at ground level were similar for winds speeds of 5 and 15m/s but higher (by a factor of approximately 5) for wind speeds between 7-8 m/s.

Figure 4 present isopleths showing the contribution of mean annual PM_{10}. Figures 5 and 6 present isopleths showing the contribution of 24 hour PM_{10}, modelled as the 99th and 100th percentile respectively, due to earth moving and construction activities.

Figure 4: Mean Annual PM_{10} Emissions due to Earth Moving and Construction

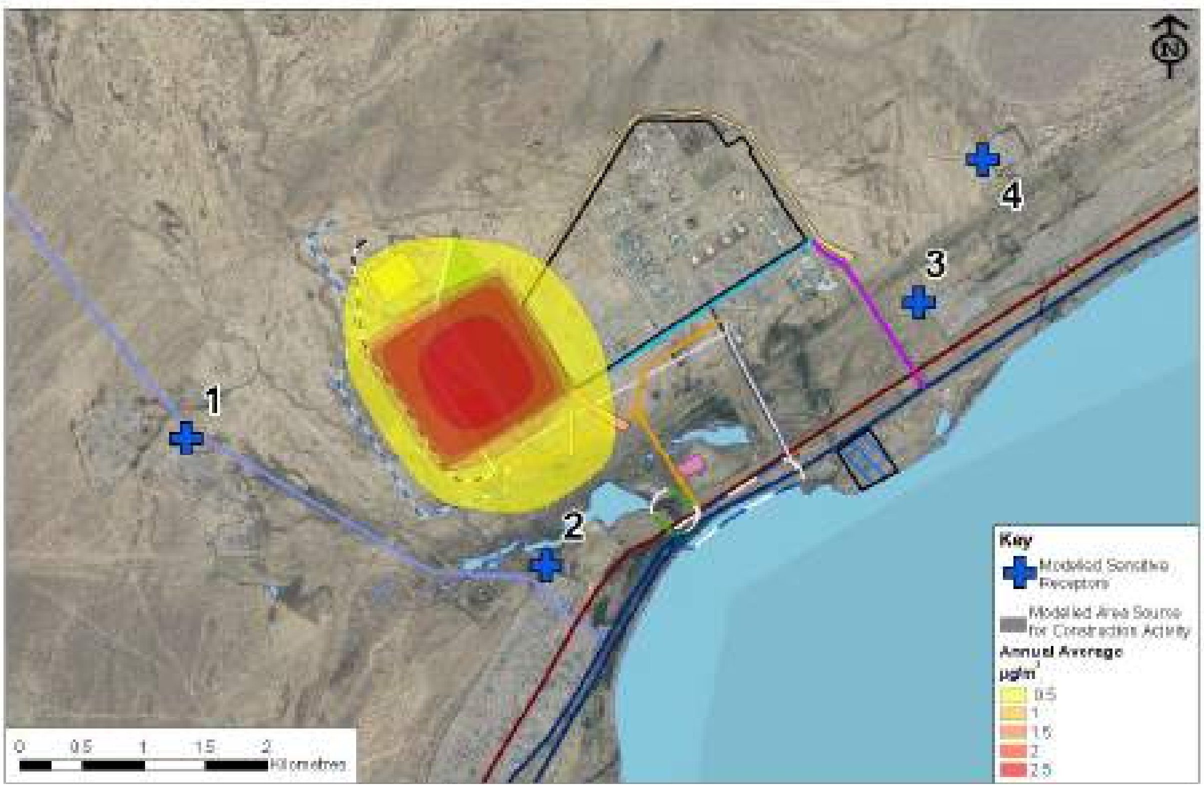


Figure 5: Modelled 99th Percentile 24-hour PM_{10} Emissions due to Earth Moving and Construction

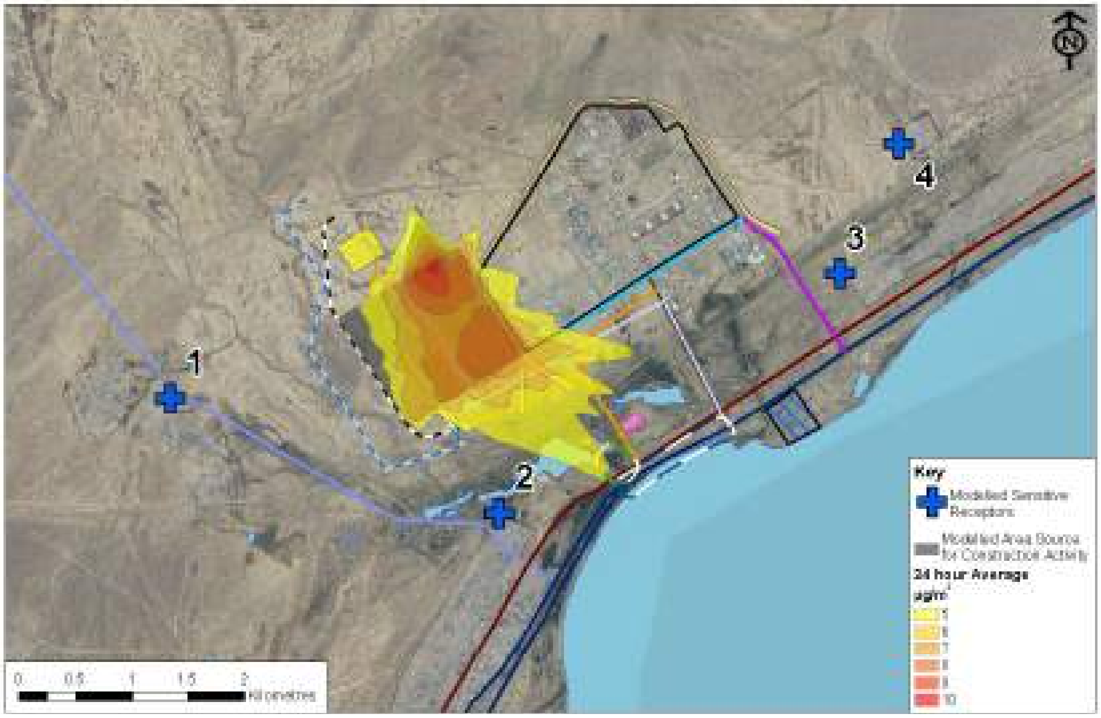
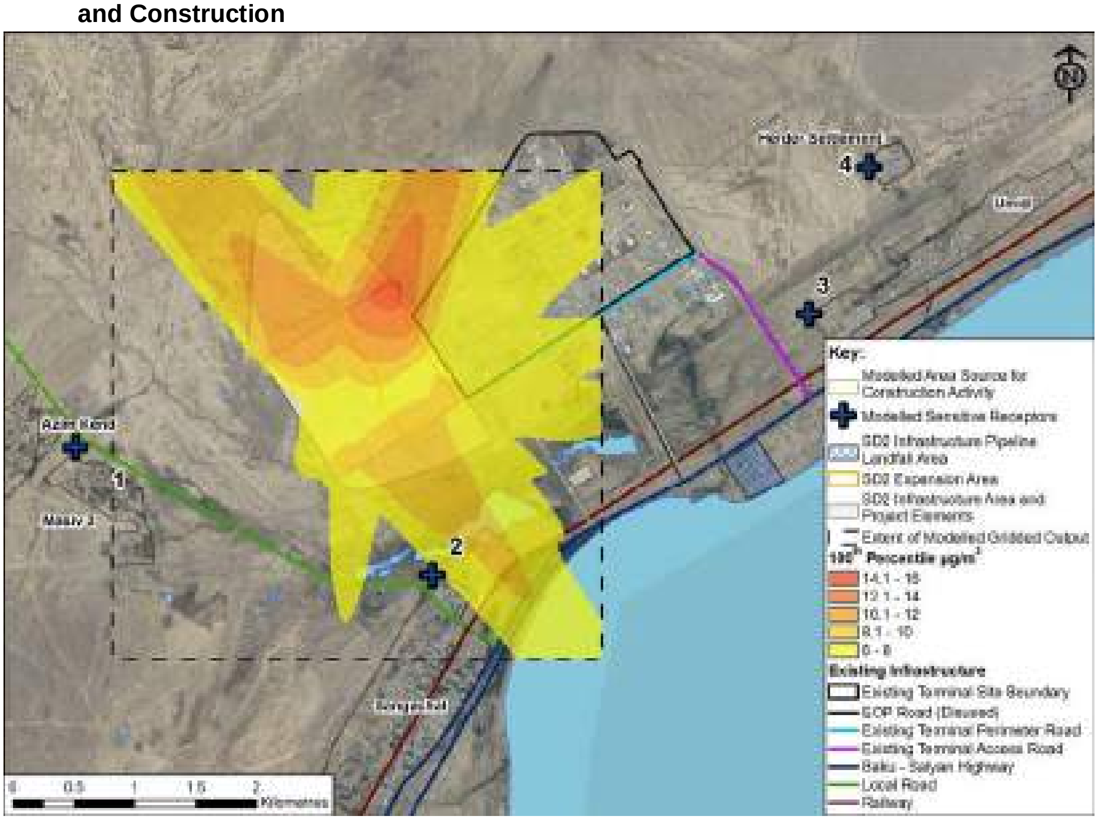


Figure 6: Modelled 100th Percentile 24-hour PM_{10} Emissions due to Earth Moving and Construction



There are no internally agreed criteria against which to assess the potential for dust emissions arising from construction activities to cause a nuisance to nearby residents. There are. However, a number of guidance levels, the most stringent of which is known to be 133 mg/m^2/day (refer to Section 2.1.2).

Table 8 presents the modelled rate of dust deposition that is predicted to occur at the nearest sensitive receptors due to earthmoving and construction activities as part of the SD2 Infrastructure Project.

Table 8: Modelled Dust Deposition due to Construction Activities (mg/m^2/day)

Pollutant	Receptor				Guidance Limit
	Azim Kend/ Masiv 3 R1	Sangachal R2	Umid (east) R3	Umid (west) R4	
Mean annual daily dust deposition rate	3.5	9.8	2	1.7	133
Maximum daily dust deposition rate[1]	31	132	115	51	133

1 Calculated from the product of the 100th PM_{10} percentile and the ratio of Mean Annual Dust to PM_{10} deposition.

The maximum predicted rate of dust deposition offsite due to earth moving and construction activities is approximately 40 mg/m^2/day, according to the ADMS4 model (based on annual mean). This occurs at the site boundary and represents approximately 30% of the guidance level.

The impact at the sensitive receptors is much less, ranging between 1.7 and 9.8 mg/m^2/day. This represents 1.3 – 7.4% of the guidance level and is therefore considered imperceptible in comparison to the existing, background levels of dust deposition that generally occur in semi-arid areas.

The maximum (100th percentile) daily dust deposition rate, (i.e. the maximum daily rate during the entire metrological year) is estimated to range from 31-132 mg/m^2/day. This represents 23 – 99% of the guidance levels, with worst case impacts identified at R2 (Sangachal). This does not take into account any mitigation applied to minimise dust generated on site.

4.2 Onsite Construction Plant

Table 9 presents a summary of the predicted impacts associated with onsite plant NO_2 emissions.

Table 9: Modelled Change in NO_2 Concentrations due to Onsite Plant ($\mu g/m^3$)

Pollutant	Receptor				Objective
	Azim Kend/ Masiv 3 R1	Sangachal R2	Umid (east) R3	Umid (west) R4	
Increase in Mean Annual NO_2	<0.1	<0.1	<0.1	<0.1	40
Increase in 1–hour NO_2	<0.1	<0.1	<0.1	<0.1	200

There is predicted to be an increase in mean annual and 1 hour NO_2 concentrations at nearby receptor locations of less than 0.1 $\mu g/m^3$. This represents less than 0.25% of the annual average NO_2 limit value and the traditional Azeri limit value and less 2% of the background NO_2 concentration.

PM_{10} emissions were not modelled, but given that they are expected to be approximately ten times less than NO_X (see Section 2.3.2), they would also be imperceptible.

4.3 Offsite Road Vehicles

Table 10 presents the modelled change in mean annual NO_2 and PM_{10} concentrations at the sensitive receptor location along the Baku Salyan Highway using the DMRB screening tool. The screening tool is not able to calculate the affect of emissions on the 1 hour NO_2 limit value; this is not considered a limitation, however, given that the mean annual limit value is generally considered to be the more stringent limit value (Ref. 16)[8].

Table 10: Modelled Change in Pollutant Concentrations due to the Offsite Road Vehicle Movements ($\mu g/m^3$)

Pollutant	Increase in Mean Annual Concentrations at Closest Sensitive Receptor	Air Quality Standard
NO_2	0.9	40 $\mu g/m^3$
PM_{10}	0.2	40 $\mu g/m^3$

The modelled impact of the additional vehicle movements due to the SD2 Infrastructure Project is predicted to lead to an increase in mean annual NO_X concentrations of 0.9$\mu g/m^3$ (at a receptor located 20m from Baku-Alyat Highway (Southbound) and 65m from Baku-Alyat Highway (Northbound)). This is despite the conservative assumption that this level of traffic will continue for an entire calendar year. At a distance of 150m from the Highway increases in NO_x concentrations were predicted to be less than 0.1 $\mu g/m^3$

[8] Research in the UK has shown that mean annual NO_2 concentrations have to be at least 150% of the limit value before an exceedance of the 1 hour limit value is expected (Ref. 18).

It has been conservatively assumed that 100% of NO_X converts to NO_2, and therefore the impact on mean annual NO_2 concentrations is estimated to be 0.9µg/m^3. **This represents 2.2% of the air quality project and traditional Azeri limit values for NO_2, which is considered a negligible impact on local air quality.**

The anticipated change to mean annual PM_{10} concentrations is expected to be 0.1µg/m^3. This equates to 0.5% of the air quality project limit value (and 0.1% of the traditional Azeri limit value). This is also considered a negligible impact on local air quality, despite the background concentrations exceeding the air quality limit value. At a distance of 35m from the Highway increases in PM_{10} concentrations were predicted to be less than 0.1 µg/m^3

5. CONCLUSIONS

The results of the modelling undertaken are presented in Table 11.

Table 11: Summary of the Modelled Impacts due to the SD2 Infrastructure Project

Activity	**Modelled Increase at Receptors**[1]			**Increase as % of relevant limit/guidance value**[2]		
	NO_2 concentration (µg/m^3)	**PM_{10} concentration (µg/m^3)**	**Dust deposition (mg/m^2/day)**	**NO_2**	**PM_{10}**	**Dust deposition**
Earth moving and construction activities	NA	0.1 - 0.3	1.7 – 9.8	NA	0.5 – 1.5%	1.3 – 7.4%
Construction site plant exhaust emissions	<0.1	<0.1	NA	NA	NA	NA
Road traffic emissions	0.9	0.2	NA	2.2%	1%	NA
Cumulative effect of all activities	**0.9**	**0.3 - 0.5**	**1.7-9.8**	**2.2%**	**1.5 – 2.5%**	**1.3 – 7.4%**

Notes:
1. NO_2 and PM_{10} background concentrations are 6 and 109µg/m^3, respectively as determined from 2010 air quality monitoring report.
2. NO_2 annual average limit value = 40µg/m^3 PM_{10} annual average limit value = 20µg/m^3, dust nuisance guideline = 133 mg/m^2/day.

The findings of the screening assessment are:

- **PM_{10} emissions (associated with construction dust)** – The modelling predicts a contribution of between 0.1 and 0.3 µg/m^3 to PM_{10} concentrations at the receptors modelled from earth moving and construction activities. This constitutes 0.5 - 1.5% of the annual average PM_{10} limit value (which is 20 µg/m^3) and represents less than 0,1% of the traditional Azeri 24 hour limit value (100 µg/m^3);
- **Dust deposition -** The results obtained at sensitive receptors shows that the maximum daily rate of deposition offsite due to earth moving and construction activities is predicted to be between 1.7 and 9.8 mg/m^2/day (on an annual basis). This represents 1.3 – 7.4% of the guidance levels and would be imperceptible in comparison with background levels. The maximum worst case daily dust deposition rate was also modelled with the highest rate of 132 mg/m^2/day estimated at Sangachal. This is comparable to the most stringent guidance value for dust deposition found in literature;

- **Onsite plant and equipment emissions (NO_2 emissions) -** The modelling predicts that exhaust emissions from onsite plant and equipment are anticipated to lead an increase of less than 0.1 µg/m^3 in NO_2 concentrations at modelled receptors;

- **Offsite road vehicle emissions (NO_2 and PM_{10} emissions)** - A contribution of up to 0.9 µg/m^3 to NO_2 concentrations and less than 0.2 µg/m^3 to PM_{10} concentrations is predicted at receptors 20m adjacent to the Highway when the anticipated SD2 Infrastructure Project traffic flows are modelled. This represents 2.2% of the air quality project limit value for NO_2 and 0.5% for PM_{10};

- **Overall contribution from SD2 Infrastructure Project activities (NO_2 and PM_{10} emissions)** –The cumulative impact of construction site and plant and the road traffic activities on PM_{10} concentration at nearby sensitive receptors is expected to be 0.1-0.3 µg/m^3. The cumulative impact on NO_2 concentrations will vary across receptors. Nearer to the Highway the contribution to NO_2 concentrations is predicted to be a maximum of 0.9 µg/m^3, within the communities both onsite plant and offsite vehicle emissions are predicted to lead to increase of less than 0.1 µg/m^3; and

- **Compliance with applicable limit values** - When taking account of the existing background concentrations the predicted NO_2 concentrations easily comply with the applicable air quality limit values. This is not the case for PM_{10}. This is because PM_{10} background concentrations already exceed the applicable limit values - this is considered to be predominantly a consequence of the dusty nature of the region.

In summary, it is not expected that the project will cause any air quality limit values to be exceeded where concentrations currently comply with the limit values. Where limits are currently exceeded (i.e. PM_{10}) the contribution from the project (from plant, earth moving activities, onsite and offsite vehicles) is predicted to be a maximum of 0.3 µg/m^3. This represents an increase of 0.4% when compared to current background concentrations.

Dust deposition rates are expected to vary between an annual average of less than 10 mg/m^2/day to a maximum of approximately 132 mg/m^2/day. It is therefore recommended that measures are incorporated to minimise dust generation including:

- Limiting of vehicle speeds on unsurfaced roads;

- Minimise use of unsurfaced roads where possible;

- Where unsurfaced, the main access routes will be created using compacted well graded granular fill, appropriately designed to ensure good drainage to minimise the potential for erosion;

- Construction activities shall be suspended if excessive dust arises and measures shall be taken to control ground prior to resuming activities; and

- Consider applying water to non sealed roads, disturbed land and spoil piles to reduce dust generation.

These measures are considered appropriate to minimise dust to acceptable levels. However, a Community Interaction and Social Impact Management Plan should be implemented and maintained as a mechanism of communicating with the community (particularly to communicate when particularly dusty activities are planned) and responding to community grievances.

6. REFERENCES

Ref. 1 Partnership for Clean Fuels and Vehicles and United Nations Environmental Programme (UNEP); Opening the Door to Cleaner Vehicles in Developing and Transition Countries: The Role of Low Sulphur Fuels. http://www.unep.org/transport/pcfv/PDF/SulphurReport.pdf

Ref. 2 International Association of Oil and Gas Producers (OGP) (1994); Methods for Estimating Atmospheric Emissions from E&P Operations.

Ref. 3 BP Exploration (Shah Deniz) Limited (2011); Shah Deniz Stage 2 Project. Environmental Basis of Design. BP-SM222-EV-BOD-001-02

Ref. 4 Airshed Planning professionals Ltd (2010); Qualitative Air Quality Impact Assessment for the proposed Extension of the Existing General Waste Disposal Site at the Tutuka Power Station (Report No. APP/10/ZIT-01 http://www.eskom.co.za/content/Appendix%20J%20-%20Air%20Quality%20Report.pdf

Ref. 5 The Highways Agency, (2003); 'Design Manual for Roads and Bridges: Environmental Assessment,' Volume 11, Section 3: Air Quality.

Ref. 6 Department for Environment, Food and Rural Affairs (Defra). Appendix 1 EU Emission Standards for Petrol Vehicles. http://uk-air.defra.gov.uk/reports/cat15/0408171318_SIPhase1reportAppendix1Issue3.pdf

Ref. 7 United States Environmental Protection Agency (US EPA). AP 42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources. Chapter 13.2 Fugitive Dust Sources.

Ref. 8 Quality of Urban Air Review Group (QUARG) (1996); Airborne Particulate Matter in the United Kingdom.

Ref. 9 EMEP/CORINAIR Emission Inventory Guidebook (2007); Group 8 Other Mobile Sources and Machinery. http://www.eea.europa.eu/publications/EMEPCORINAIR5

Ref. 10 Environment Agency (2010); Horizontal Guidance Note H1 – Environmental Risk Assessment for Permits. http://www.environment-agency.gov.uk/business/topics/permitting/36414.aspx

Ref. 11 United States Environmental Protection Agency (US EPA) Applicability of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard. http://www.epa.gov/ttn/scram/ClarificationMemo_AppendixW_Hourly-NO2-NAAQS_FINAL_06-28-2010.pdf

Ref. 12 Department for Environment, Food and Rural Affairs, (2010). Memo 'Background concentrations for future years'.

Ref. 13 BP (2009); 2009 Sangachal Terminal Air Quality Modelling and Monitoring Comparison.

Ref. 14 Akvamiljø Caspian (2011); Sangachal Ambient Air Quality Monitoring Programme 2010, Final report (AmC report 10709-R1)

Ref. 15 Wanquan Ta and Tao Wang (2004); 'Measurements of dust deposition in arid and semi-arid regions, China', American Society of Civil Engineers (ASCE) pp. 1-10.

Ref. 16 UK Department for Environment, Food and Rural Affairs, (2009), Local Air Quality Management Technical Guidance, LAQM.TG (09).

Annex A: ADMS Model Overview

ADMS 4 is a practical, short range dispersion model that simulates a wide range of buoyant and passive releases to the atmosphere either individually or in combination. It is a new generation air dispersion model developed by Cambridge Environmental Research Consultants (CERC) in the UK, which means that the atmospheric boundary layer properties are characterised by two parameters rather than in terms of the single parameter Pasquill-Gifford class:

- the boundary layer depth, and
- the Monin-Obukhov length.

Dispersion under convective meteorological conditions uses a skewed Gaussian concentration distribution (shown by validation studies to be a better representation than a symmetrical Gaussian expression).

The model is applicable up to 60km downwind of the source and provides useful information for distances up to 100km.

Table A1: The ADMS 4 model

Model options	ADMS 4 has a number of model options including: dry and wet deposition; NOX chemistry; impacts of hills, variable roughness, buildings and coastlines; puffs; fluctuations; odours; radioactivity decay (and γ-ray dose); condensed plume visibility; time varying sources and inclusion of background concentrations.
Meteorological pre-processor	ADMS 4 has an in-built meteorological pre-processor that allows flexible input meteorological data both standard and more specialist. Hourly sequential and statistical data can be processed, and all input and output meteorological variables are written to a file after processing.
User-defined outputs	The user defines the pollutant, averaging time (which may be an annual average or a shorter period), which percentiles and exceedence values to calculate, whether a rolling average is required or not and the output units. The output options are designed to be flexible to cater for the variety of air quality limits, which can vary from country to country, and are subject to revision.
Visualisation	ADMS 4 includes the ADMS Mapper: an integrated mapping tool for displaying and editing source data, buildings and receptor locations and viewing results. The model has links to the Surfer contour-plotting package, in addition to ArcGIS and MapInfo Professional Geographical Information System (GIS) software. The GIS links can be used to enter and display input data, and display output, usually as colour contour plots.

Table A2: Comparison of ADMS versus other models

	ADMS 4	AERMOD	ISC
Meteorology			
Meteorological pre-processor	✓	✓	✗
Dispersion			
Boundary-layer structure	h, L_{MO} scaling	h, L_{MO} scaling	Pasquill stability classes
Plume rise	Advanced integral model	Briggs empirical expressions	Briggs empirical expressions
Concentration distribution	Advanced Gaussian	Advanced Gaussian	Basic Gaussian
Complex effects			
Buildings	ADMS buildings module[1]	PRIME buildings module[1]	PRIME buildings module[1]
Complex terrain	Based on calculation of flow field and turbulence field by FLOWSTAR model	Interpolation between neutral flow approximate solution and stable flow impaction solution	Simple approach assuming plume trajectory unaffected by terrain
Deposition (wet and dry)	✓	✓	✓
Chemistry	Generic Reaction Set 8 reaction scheme	Ozone limiting model, assumes maximum conversion of NO to NO_2	Ozone limiting model, assumes maximum conversion of NO to NO_2
Other options			
Fluctuations	✓	✗	✗
Visible plumes	Condensed plume visibility	✗	✗
Radioactivity	Radioactive decay / γ-ray dose; decay chain database	Simple decay	Simple decay

	ADMS 4	AERMOD	ISC
Puff model	✓	✗	✗
Coastline module	✓	✗	✓
Input of vertical profiles of meteorological data	✓	✓	✗

[1] See A. Robins,2000:*A discussion of the building modules in ADMS 3 and PRIME*

APPENDIX 9D

Noise Screening Assessment

URS

Shah Deniz 2 Infrastructure Project

Construction Noise Assessment

13th July 2011

Issue No 1
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CONTENTS

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Units and Abbreviations

Unit	Description
dB	Decibel, unit of sound
dB(A)	A-weighted sound pressure level in decibels
Km	Kilometre
LAeq	The equivalent continuous A-weighted sound pressure level over a specific time period.
Lw	Sound power level in decibels
LA10	The noise level exceeded for 10% of the time, and normally attributable to a series of higher noise events such as road traffic
LA90	The noise level exceeded for 90% of time. Often referred to as the “background level” this value, particularly in the case of a steady continuous noise source (such as the terminal) can be used to indicate the steady noise level emitted by that source.
m	Metres
Abbreviation/ Acronym	**Description**
SD	Shah Deniz
UK	United Kingdom

1. INTRODUCTION

This report presents the findings of modelling assessments undertaken to estimate the expected noise levels due to the Shah Deniz Stage 2 (SD2) Infrastructure Project at sensitive receptors.

The SD2 Infrastructure Project includes the works required prior to the construction, installation, commissioning and operation of the onshore SD2 facilities within the SD2 Expansion Area at the Sangachal Terminal. The key components of the SD2 Infrastructure Project (refer to Figure 1) are:

- Temporary reinstatement of the Early Oil Project Terminal access road;
- New access road from the Baku-Alyat highway to the Sangachal terminal (and associated facilities);
- Clearance of the SD2 Project expansion area, located immediately to the west of the existing terminal site;
- Site terracing;
- Construction and fit out of the construction camp and construction facilities;
- Installation and operation of a sewage treatment plant;
- Installation of storm water drainage and surface water/flood protection berms; and
- Beach pull / landfall area levelling.

1.1 Scope

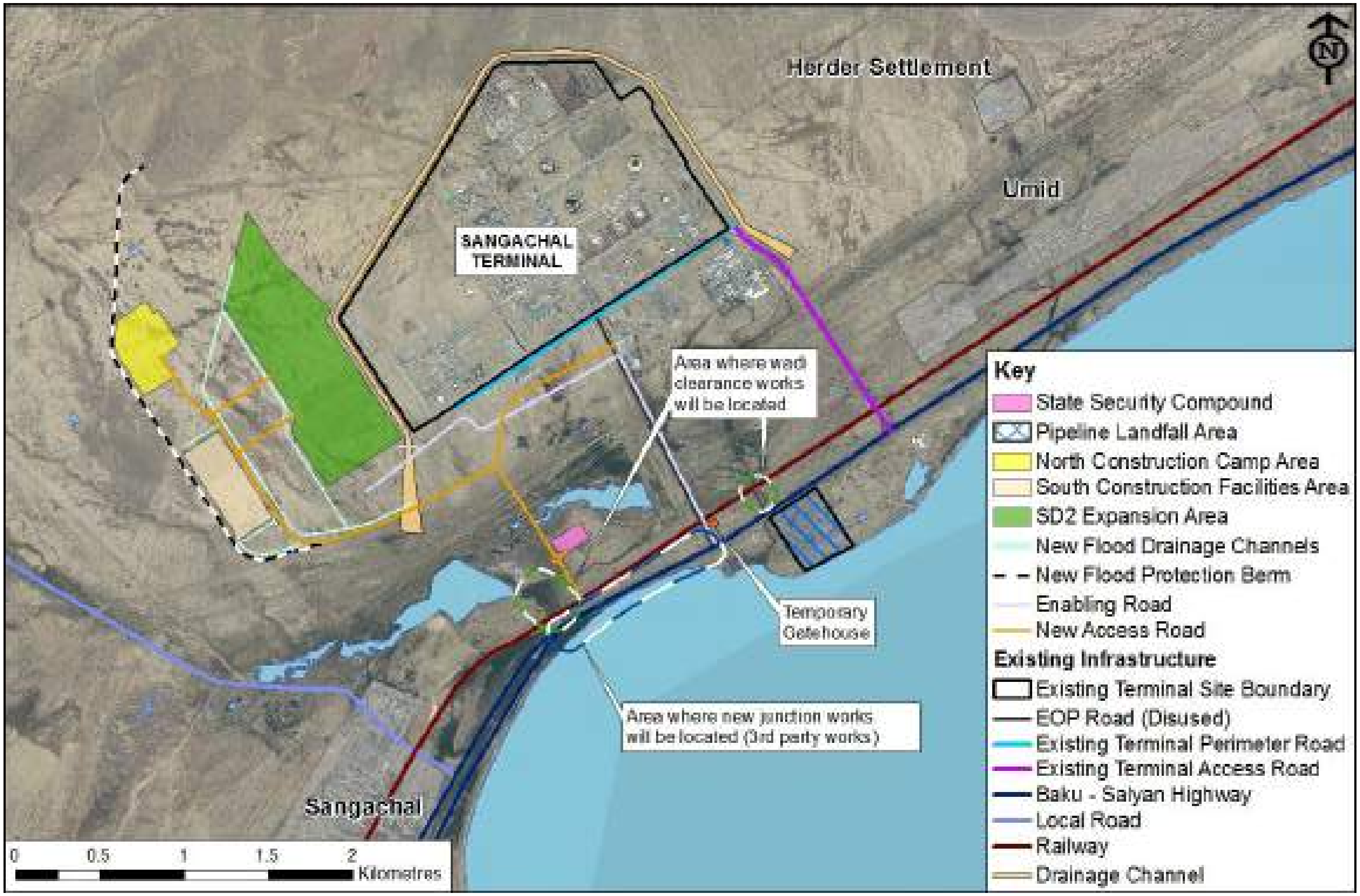
Assessments have been undertaken to evaluate the relative contribution levels of noise at sensitive receptors from the following sources:

- Construction plant (on-site);
- Concrete Batching Plant[1];
- Off-site Road Traffic;
- Piling; and
- Concrete Breaking

A cumulative assessment of all construction activity has also been carried out for the most active period of construction. The predicted noise levels at sensitive receptors have been compared to the limits defined in Section 2.1 of this report.

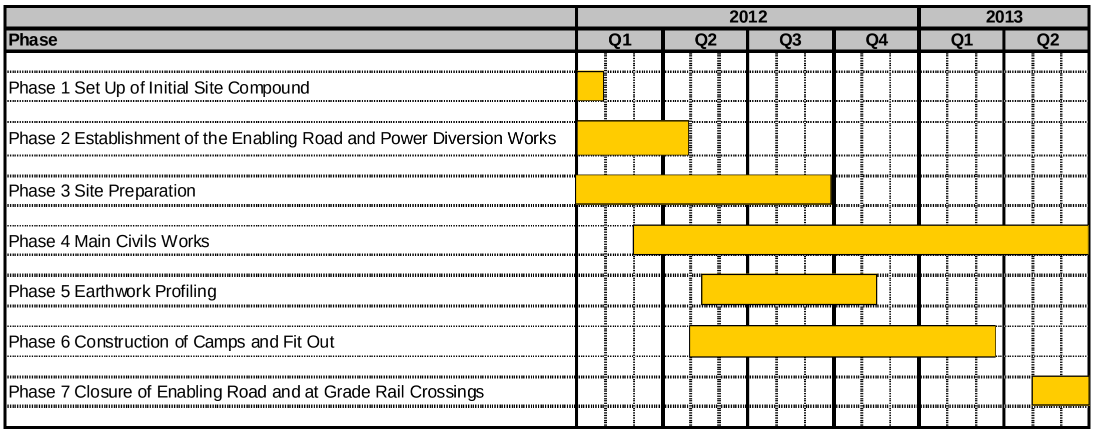
[1] Not included with the project base case. Space has been allocated should this option be selected.

Figure 1: Location of SD2 Infrastructure Project



The SD2 Infrastructure Project is expected to commence in January 2012 with an expected duration of 18 months. The works will be undertaken in seven distinct phases (refer to Figure 2) as described within the SD2 Infrastructure ESIA Project Description chapter (Ref. 2).

Figure 2: Indicative SD2 Infrastructure Project Schedule



2. METHODOLOGY

The following steps have been followed to undertake the construction noise assessment:

1. Review the SD2 Infrastructure Project ESIA Project Description (Chapter 5) (Ref. 2);
2. Review of applicable project standards and assessment criteria for construction noise and traffic noise;
3. Determine the requirement for traffic assessment in accordance with relevant guidance based on:
   - Current estimated traffic flows along the Baku-Salyan Highway; and
   - Predicted flows associated with the SD2 Infrastructure project.
4. Prepare a construction propagation modelling spreadsheet that predicts construction plant noise levels at noise sensitive receptors (refer to Annex B);
5. Determine the construction plant noise model input parameters which are;
   - The types and numbers of construction plant used and their associated noise generation levels from routine use;
   - Distances (in metres) between the sources of construction noise and locations of each noise sensitive receptor;

- The correction to be applied to reflect the presence of buildings (referred to as the façade correction factor);

6. Determine the construction noise model input parameters for the concrete batching plant including noise generation level, estimated usage and location relative to sensitive receptors;
7. Determine the construction noise model input parameters for concrete breaking activities and a number of different piling scenarios, including piling type, estimated usage and location relative to sensitive receptors;
8. Establish construction noise assessment scenarios based on:
    - The location of construction plant;
    - The estimated duration of use per day;
    - The level of attenuation by project elements (i.e. the proposed flood protection berm).
9. Use the construction noise model to identify the contribution of noise from the on-site construction plant at receptors;
10. Use the construction noise model to identify the contribution of noise from the Concrete Batching Plant at receptors;
11. Determine noise levels at receptors associated with concrete breaking and piling activities;
12. Determine overall construction noise at receptors assuming all activities occur simultaneously during the most active period on site; and
13. Evaluate the need for, and type of, construction noise mitigation measures.

2.1 Applicable Project Standards for Noise and Guidance

2.1.1 Construction Plant

The assessment of construction noise is based on the guidance provided within British Standard BS5228:2009 *Code of practice for noise and vibration control on construction and open sites* (Ref. 3).

BS5228:2009 provides a number of methods to assess significance of construction noise. For this assessment the method adopted determines the potential acceptability of predicted noise levels based on absolute limit values, which take into account existing ambient noise levels. This is achieved by establishing different categories as follows:

- Category A noise limits – relevant when ambient noise levels are **less than** the limit values;

- Category B – relevant when ambient noise levels are **the same** as the Category A noise limits; and
- Category C - relevant when ambient noise levels are **greater than** the Category A noise limits.

The relevant noise limits are provided in Table 1 below.

Table 1: BS5228:2009 Construction Noise Limits (dB LAeq)

Period	Category A	Category B	Category C
Night-time (23:00 to 07:00)	45	50	55
Evening and weekends	55	60	65
Daytime (07:00 to 19:00) and Saturday (07:00 to 13:00)	65	70	75
Category A –when ambient noise levels are less than these values			
Category B –when ambient noise levels are the same as category A			
Category C –when ambient noise levels are higher than category A values			

Construction working hours are assumed, from the Project Description (Chapter 5) (Ref. 2), to be:

- 07:00 to 19:00 Monday to Saturday.

Based upon the working hours above and current baseline noise levels at receptors (see Section 3 below) the construction noise guideline level of 65 dB(A) is considered a suitable limit for the assessment of on-site construction plant, piling and concrete breaking activities.

2.1.2 Concrete Batching Plant

The concrete batching plant will be stationary source and it is assumed it will operate throughout the project (once installed). It is classified as construction plant and the construction guideline level of 65 dB(A) applies to noise generated by the plant operation.

2.1.3 Off-site Road Traffic

The UK Institute of Environmental Management and Assessment (IEMA) Guidance Note No. 1 (Ref. 4) provides relevant guidance with regard to when a traffic noise assessment should be undertaken. The Guidance Note states that an assessment should be completed when:

a) Traffic flows will increase by more than 30%; or

b) Where traffic flows (including Heavy Goods Vehicles (HGVs) at receptors sensitive to road traffic noise will increase by more than 10%.

It is estimated that traffic levels along the Baku-Salyan Highway are between 10,000 and 20,000 per day. Assuming that 10% of vehicles are HGVs (which is supported by observations made by URS during the 2010 baseline surveys- see Section 3 below) then the estimated daily number of HGVs is currently 1,000.

Chapter 5 of SD2 Infrastructure ESIA (Ref. 2) indicates that the estimated number of vehicles to use the Baku-Salyan Highway during the SD2 Infrastructure Project will peak between May 2012 and October 2012 at 162 vehicles per day (1.62% of the total traffic flow). IEMA Guidance Note No. 1 indicates that an increase in traffic flows that is less than 10% for noise sensitive locations then there will be no significant impacts associated with off-site road traffic.

According to the Design Manual for Roads and Bridges (Ref. 5), a 25% increase in HGV traffic flow results in an increase in noise levels of 1 dB(A). The estimated number of additional HGVs during the construction period is 4.6%. Therefore it is expected that noise levels at receptors due to construction traffic along the Highway will increase by no more than 1 dB(A) and no significant impacts associated with traffic noise are expected.

2.2 Model Input Parameters

2.2.1 Construction Plant

The types of construction plant expected to be used during the SD2 Infrastructure Project are provided in Chapter 5 (Section 5.7.1) of the SD2 Infrastructure ESIA (Ref. 2). Table 2 presents the sound levels generated from each item of machinery. The noise levels generated from each type of machinery are derived from BS5228:2009 Part 1 and are presented in dB(A) at a distance of 10m from the source.

Table 2: Construction Plant Types and Sound Levels

Plant Item	dB(A) at 10m	Reference from BS5228:2009 Part 1
Bull Dozer D6/D8/D9/D10	79	Table C2 Ref. 11
Wheeled Loader – 25t	79	Table C2 Ref. 26
Tracked Excavator – 27t	75	Table C4 Ref. 64
Dump Truck – 25t	85*	Table C6 Ref. 17
Motor Grader – 25t	86	Table C6 Ref. 31
Sheet Foot Roller/Vibro Roller – 10t	80*	Table C5 Ref. 19
Road Roller – 13t	80*	Table C5 Ref. 21
Asphalt Paver	77	Table C5 Ref. 31
Road Lorry – 25t	80	Table C6 Ref. 21
Diesel generator (50/100 kVA)	65	Table C6 Ref. 39
Mechanical Water Bowser	83*	Table C6 Ref. 38
Tracked Mobile Crane – 115t	75	Table C4 Ref. 52

Plant Item	dB(A) at 10m	Reference from BS5228:2009 Part 1
Mobile Telescopic Crane – 25t	82	Table C4 Ref. 45
Earthworks Compactor – 10t	73*	Table C2 Ref. 38
Concrete Mixer 200 litres	77	Table C4 Ref. 21
Fork Lift Trucks – 5t	79	Table C4 Ref. 54
Water Pump - 20kW	65	Table C2 Ref. 45
Concrete Pumps	78	Table C3 Ref. 25
Air Compressor – 8/20 m3/min	65	Table C5 Ref. 5
Backhoe Loader – 10t	67	Table C4 Ref.14
Welding Set	73	Table C3 Ref. 31
Compactor Plate	82	Table C5 Ref. 29
JCB Tractor	67	Table C4 Ref.14
Tilting Drum Mixer	61	Table C4 Ref. 23
Fuel Bowser	89*	Table C6 Ref. 36
* Maximum "pass-by" sound pressure level		

Using the project schedule (Figure 2) and the quantity of each type of construction plant in use during each of the seven phases, (refer to Chapter 5 (Table 5.4) of the SD2 Infrastructure ESIA (Ref. 2)) the quantity of each type of plant in use per month has been calculated.

2.2.2 Concrete Batching Plant

Based on information derived from concrete batching plant operations recorded from surveys completed in the UK, a noise level of 111 dB(A) Lw has been assumed for this facility. It is assumed that the concrete batching plant will be operational during daytime hours (07:00 – 19:00) only and will be located on the SW boundary of the SD2 Expansion Area.

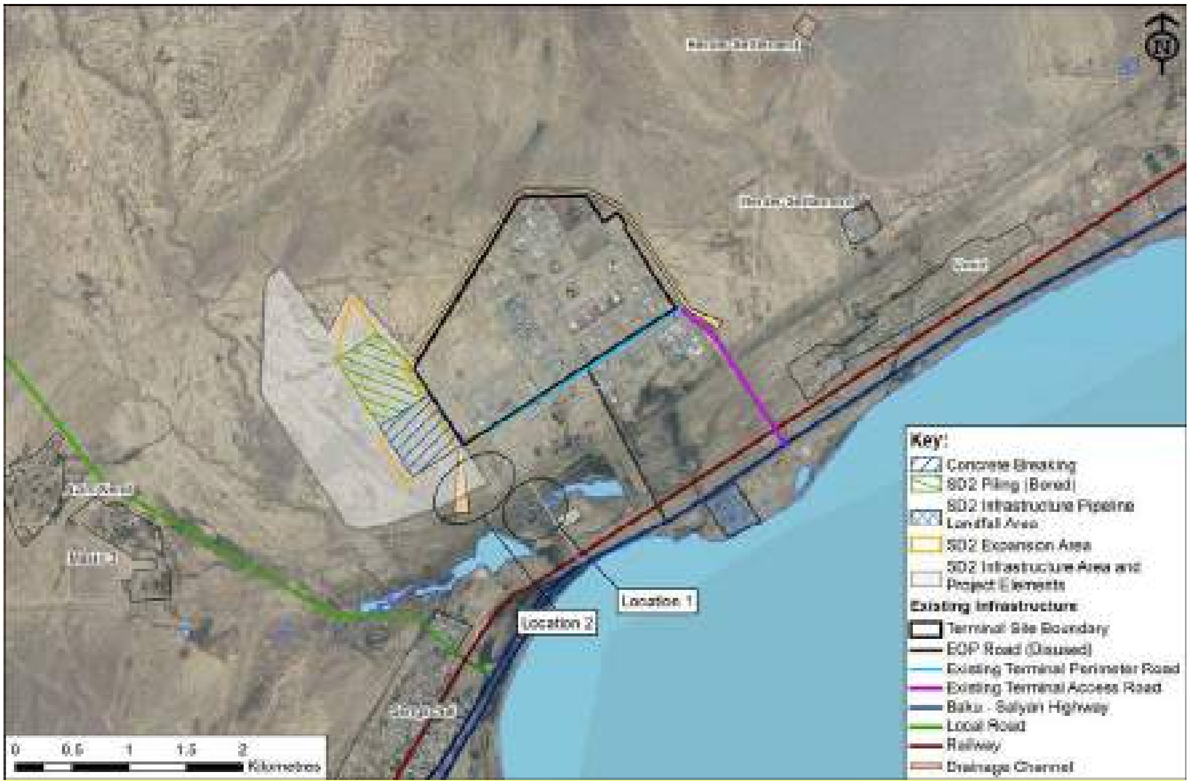
2.2.3 Piling

The following piling activities are planned:

- Bored piling associated with installation of crossings under the new access road within the state pipeline corridor immediately to the south of the Terminal (refer to Chapter 5 Figure 5.8); and
- Piling trials either within or 100m from the boundary of the SD2 Expansion Area (refer to Chapter 5 Section 5.5.5).

It is assumed that the piling associated with the installation of the access road crossing will require 3 bored piling rigs; pneumatic hammers and an air compressor in Location 1 and Location 2 (see Figure 3). It is assumed that the rigs would be operational 100% of the day.

Figure 3: Location of Piling Activities and Concrete Breaking



2.2.4 Concrete Breaking

Two noise levels have been assumed for the concrete breaking activities:

- 96 dB(A) for an excavator mounted breaker (based on actual measurements) at 10m from the activity; and
- 82 dB(A) for an associated concrete crusher (based on information contained within BS228) at 10m from the activity.

The location of the concrete breaking is assumed to be in the centre of the SD2 Expansion Area (Figure 3).

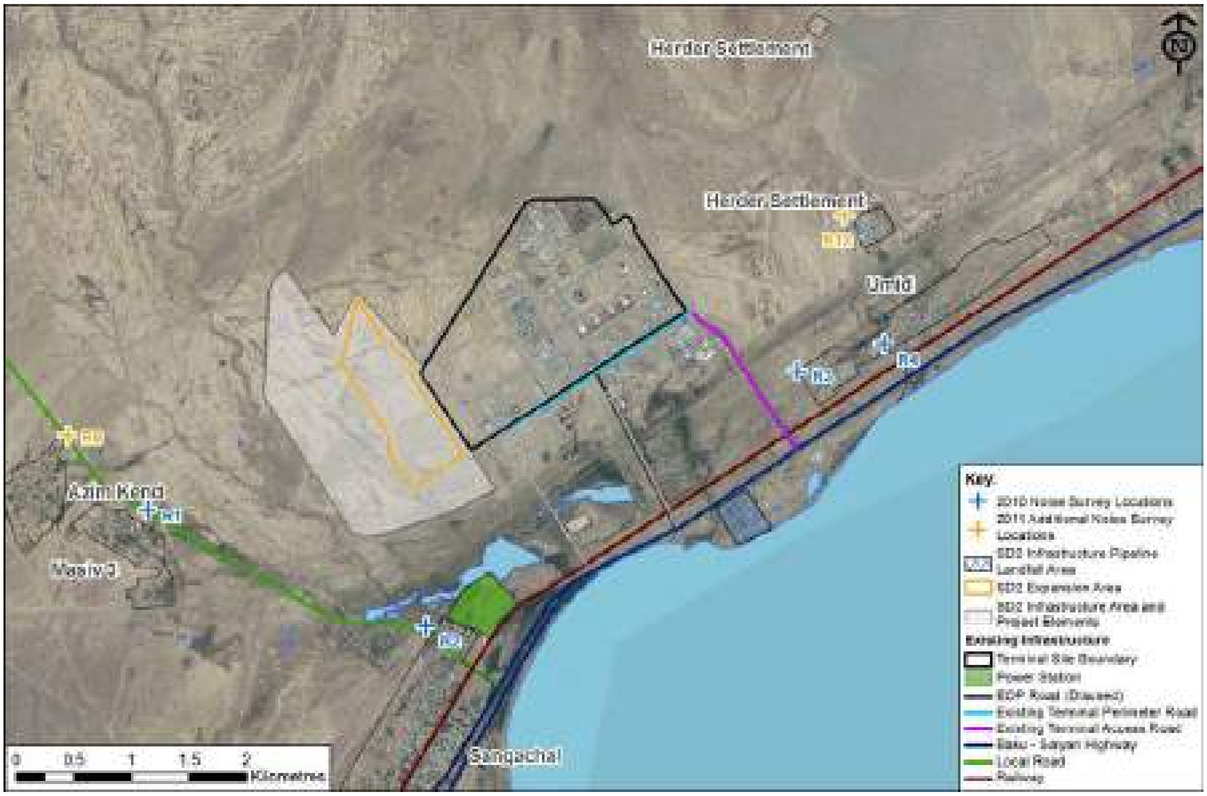
2.3 Receptors

The type and location of noise sensitive receptors included in the construction noise model are described in Table 3 and illustrated in Figure 4. Full details of the locations of receptors are provided in Annex A.

Table 3: Noise Sensitive Receptors

ID	Receptor & Assessment Position	Description and Location	Receptors
R1	**Azim Kend/Masiv 3** 40^{o} 11'24.83" N 49^{o} 26'11.11" E	Two small settlements 2.3km from the north west corner of the Terminal perimeter.	The closest residential receptors are single storey dwellings with a clear line of sight to the construction areas.
R2	**Sangachal** 40^{o} 10'40.98" N 49^{o} 27'52.68" E	Nearest main town 1.5km from the south west corner of the Terminal perimeter.	The closest residential receptors are multi-storeyed tower blocks with a clear line of sight to the construction areas.
R3	**Umid (west)** 40^{o} 11'51.60" N 49^{o} 30'03.96" E	Settlement located approximately 1km from the south east perimeter of the Terminal.	The closest receptors are single storey dwellings with a clear line of sight to the construction areas.
R4	**Umid (east)** 40.199815 N 49.511215 E	Settlement, on main entry road to camp, over 1km from Terminal boundary, and approximately 300m from the Baku-Salyan Highway (M3).	The closest residential receptors are single storey dwellings with a clear line of sight to both the construction areas and the Baku–Salyan Highway (M3).
R8	**Azim Kend** 40^{o} 11'29.06" N 49^{o} 25'57.02" E	Small settlement located north of Masiv 3. The measurement location was on a mound, with clear line of sight to the Terminal.	The closest residential receptors are single storey dwellings with a partial line of sight to the terminal. There are some two-storey buildings 100m further west.
R12	**Herder Settlement** 40^{o} 12'28.03" N 49^{o} 30'34.07" E	Measurement location on track just east of residences.	Single storey residences with clear line of sight to east boundary of terminal.

Figure 4: Noise Sensitive Receptors



3. BASELINE NOISE LEVELS

Previous baseline noise surveys have been completed at noise sensitive receptors within the vicinity of the Terminal. The most recent baseline noise measurements were taken during May 2010 and March 2011.

The results of the May 2010 and March 2011 baseline surveys are presented in Table 4 and 5, respectively.

Table 4: Baseline Daytime Noise Survey Results for May 2010

Location	Daytime LAeq	Daytime LA90	Daytime LA10	Main Noise Sources
Azim Kend/Masiv 3 R1	44 – 56	35 – 39	47 – 59	Road traffic noise from Baku-Salyan Highway, occasional car passing on road, distant aircraft and helicopter, birdsong.
Sangachal R2	50 – 62	48 – 52	51 – 67	Road traffic noise from Baku-Salyan Highway, vehicle horns, trains, distant aircraft and helicopter, birdsong.
Umid (west) R3	48 – 67	37 – 46	53 – 70	Road traffic noise from Baku-Salyan Highway, occasional car passing on road, distant aircraft and helicopter, birdsong.
Umid (east) R4	55 – 64	48 – 54	56 – 67	Road traffic noise from Baku-Salyan Highway, occasional passing car on track, distant aircraft and helicopter, local construction work, birdsong.

Table 5: Baseline Daytime Noise Survey Results for March 2011

Location	Daytime LAeq	Daytime LA90	Daytime LA10	Main Noise Sources
Azim Kend/Masiv 3 R1	50 – 53	42 - 43	53 – 56	Stone works, distant helicopter, cows, cock crow, local cars, helicopter, distant geese.
Sangachal R2	49 – 58	46 - 49	50 – 63	Distant traffic, HGVs, train horn, cars (7) distant helicopter, distant train, power station slightly audible, birds, tracked excavator, goats.
Umid (west) R3	62 - 70	45 - 46	64 - 75	Long goods train (1.5 minutes), distant traffic, passenger train, cock crow.
Umid (east) R4	51 – 54	46 – 47	52 – 55	Highway traffic, local cars and HGVs, dog barking.
Herder Settlement R12	45 – 47	39 – 40	48 – 50	Wind noise.

The March 2011 survey was completed just before an annual holiday period in Azerbaijan and therefore the road traffic noise levels recorded were lower when compared to the May 2010 survey.

The Baku-Salyan Highway is a dominant source of noise which results in noise levels of over 60 dB(A) at some receptor locations. Although no specific traffic data is available for the existing Baku-Salyan Highway, traffic levels have been estimated to be between 10,000 and 20,000 vehicles per day.

Noise from the use of local roads affected the noise levels recorded at Sangachal settlement (R2) only. Noise generated by the Terminal was not detected at any of the sensitive receptors during both the 2010 and 2011 daytime surveys.

4. ASSESSMENT SCENARIOS

4.1 Construction Plant Scenarios

Following a review of the project areas, activities and the location of the sensitive receptors, it was determined that the most intense and potential nosiest activities for the sensitive receptors would likely be those occurring within the SD2 Infrastructure Area.

The following scenarios were modelled to estimate the worst case and realistic[2] noise levels at receptors associated with the SD2 Infrastructure Project construction noise from this area:

1. **Worst case (no berm)** – 100% of plant at the boundary of the works (i.e. closest to the receptor being assessed), operating for 10 hours per day (85% of the working day) without the flood protection berm in place;

2. **Worst case (with berm)** – 100% of plant at boundary of the works (i.e. closest to the receptor being assessed), operating for 10 hours per day (85% of the working day) with the flood protection berm in place;

3. **Realistic scenario (no berm)** – 50% of plant at the boundary of the works (i.e. closest to the receptor being assessed), operating for 6 hours per day (50% of the working day) without the flood protection berm in place; and

4. **Realistic scenario (with berm)** – 50% of plant at the boundary of the works (i.e. closest to the receptor being assessed), operating for 6 hours per day (50% of the working day) with the flood protection berm in place.

Scenarios 2 and 4 take into account the attenuation provided by the flood protection berm. It is assumed that the berm will be in place from March 2012. The location and characteristics of the berm have been determined from Chapter 5 (Section 5.5.3) of the SD2 Infrastructure ESIA (Ref. 2). For the Umid (west and east) (R3 and R4) and the Herder Settlement (R12) receptor locations Scenarios 2 and 4 have not been modelled as the berm will provide no attenuation in relation to these locations.

4.2 Concrete Batching Plant

For the purpose of the assessment it has been assumed that the concrete batching plant is located at the south west boundary of the SD2 Infrastructure area. A worst case scenario has been assessed assuming the flood protection berm is not in place.

[2] Estimated based on types of plant and activities proposed for each construction phase and taking into account typical operating periods from similar projects.

4.3 Piling Scenarios

Noise associated with piling trials was assessed based on the following 4 scenarios:

- Tubular piling at a location 100m from the north west corner of the SD2 Expansion Area;
- Pre cast concrete piling at a location 100m from the north west corner of the SD2 Expansion Area;
- Tubular piling at a location 100m from the south west corner of the SD2 Expansion Area; and
- Pre cast concrete piling at a location 100m from the south west corner of the SD2 Expansion Area.

4.4 Concrete Breaking Scenarios

Concrete breaking has been modelled with and without a local acoustic screen.

4.5 Cumulative Scenarios

An assessment of the cumulative impacts has included the following activities taking place at the same time:

- Construction activities – realistic case – no flood protection berm in place;
- Pipeline crossing piling;
- Concrete breaking in SD2 Expansion Area; and
- Piling within the SD2 Expansion Area.

The assessment considers the most active period of construction between April and June 2012.

5. SCREENING ASSESSMENT RESULTS

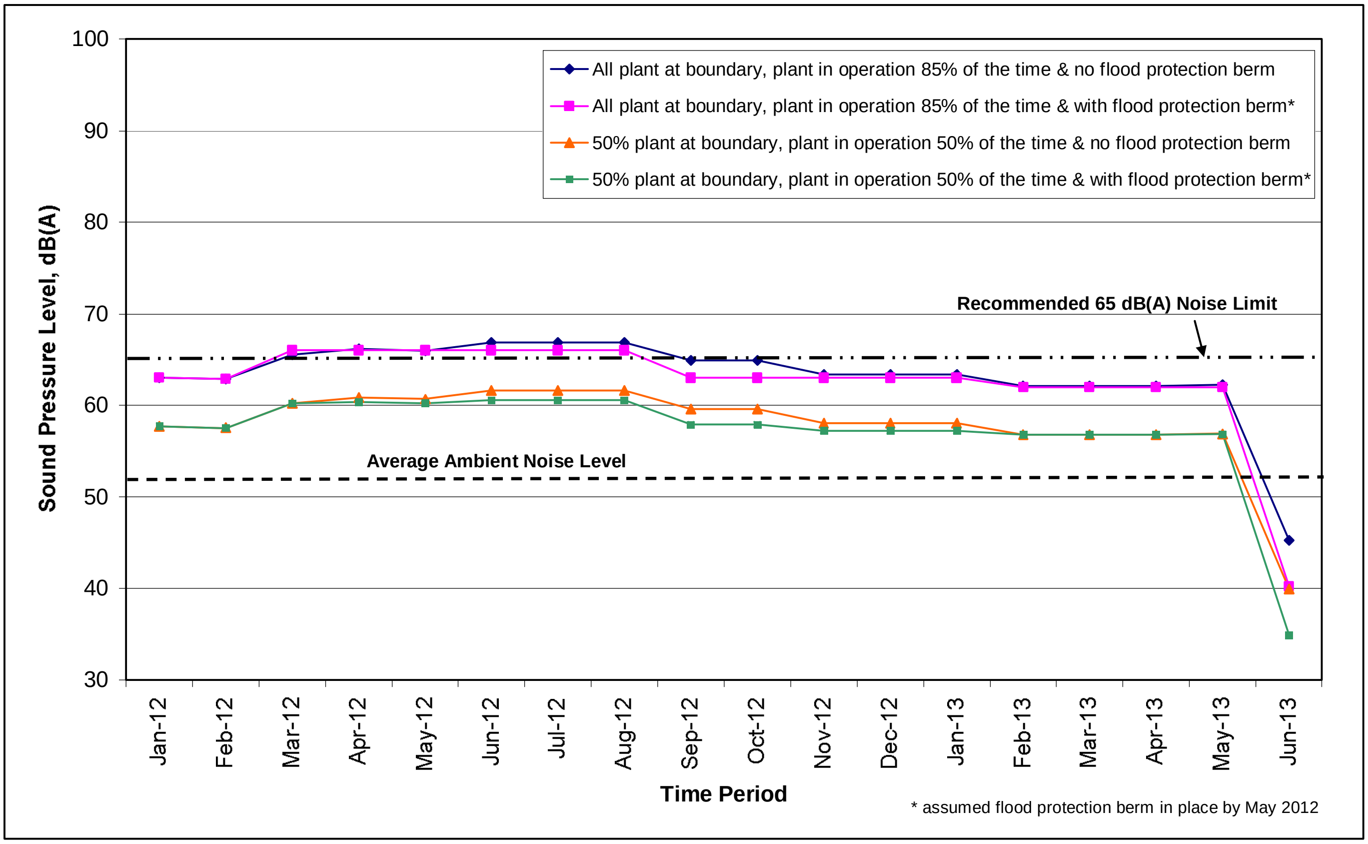
5.1 Construction Plant (on-site)

The assessment of construction noise (on-site) has been undertaken for the 4 scenarios listed in Section 4.1 above. The results are presented below. The detailed calculation results are presented in Annex B.

Receptor R1 – Azim Kend/Masiv 3

The predicted construction noise levels for each assessment scenario at Azim Kend/Masiv 3 are presented in Figure 5.

Figure 5: Predicted Construction Noise Levels at Receptor R1



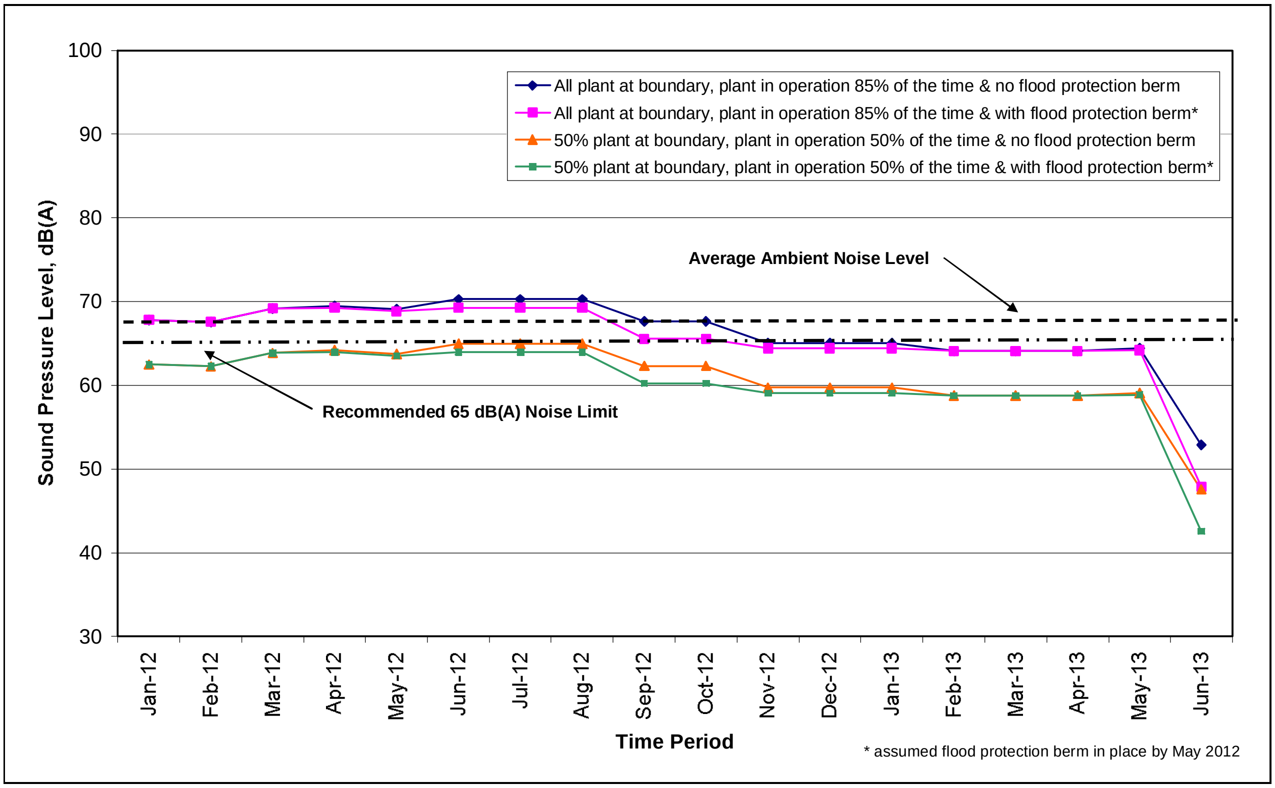
The results show that the highest noise levels are predicted to fall within the period March to September 2012, where construction activity will be at its most active. Under the worst case scenario, both with and without the flood protection berm (Scenarios 1 & 2), the construction noise limit of 65 dB(A) is exceeded during this period. After September 2012 with the flood protection berm in place (which lowers noise levels by approximately 1-2 dB at Azim Kend/Masiv 3 (R1)), even under worst case assumptions, construction noise levels at Azim Kend/Masiv 3 (R1) are expected to meet or be lower than the 65 dB(A) limit.

For the realistic case modelled (Scenarios 3 & 4), construction noise levels at R1 are predicted to be lower than the noise limit throughout the construction programme both with and without the flood protection berm.

Receptor R2 – Sangachal

The predicted construction noise levels at Sangachal are presented in Figure 6.

Figure 6: Predicted Construction Noise Levels at Receptor R2



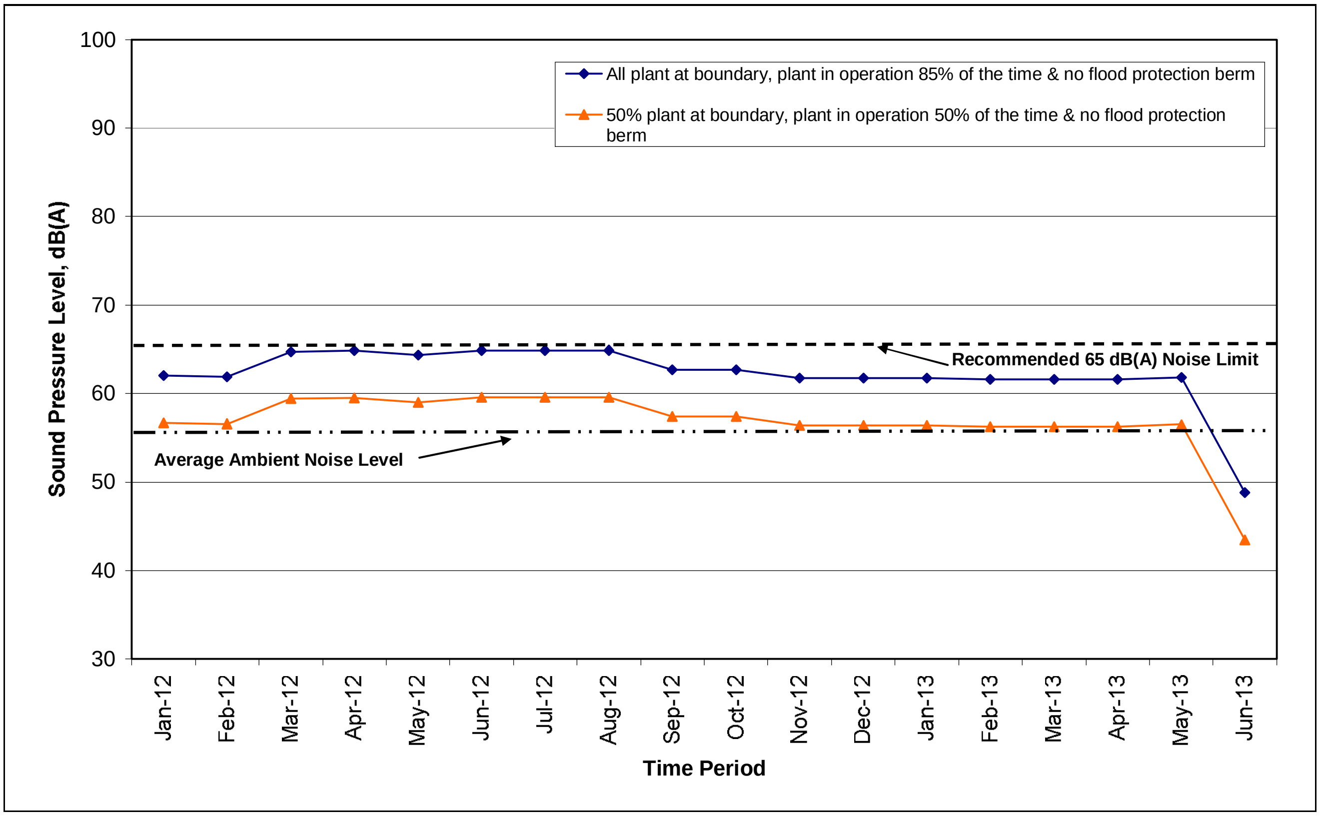
At Sangachal (R2), under the worst case scenario, both with and without the flood protection berm (Scenarios 1 & 2), the construction noise limit of 65 dB(A) is predicted to be exceeded between January 2012 - August 2012. After September 2012 with the flood protection berm in place, even under worst case assumptions, construction noise levels at R2 are expected to meet or be lower than the 65 dB(A) limit.

For the realistic cases modelled (Scenarios 3 & 4) construction noise levels at Sangachal (R2) are predicted to meet or be lower than the noise limit throughout the construction programme both with and without the flood protection berm.

Receptor R3 – Umid (west)

The predicted construction noise levels at Umid (west) are presented in Figure 7.

Figure 7: Predicted Construction Noise Levels at Receptor R3



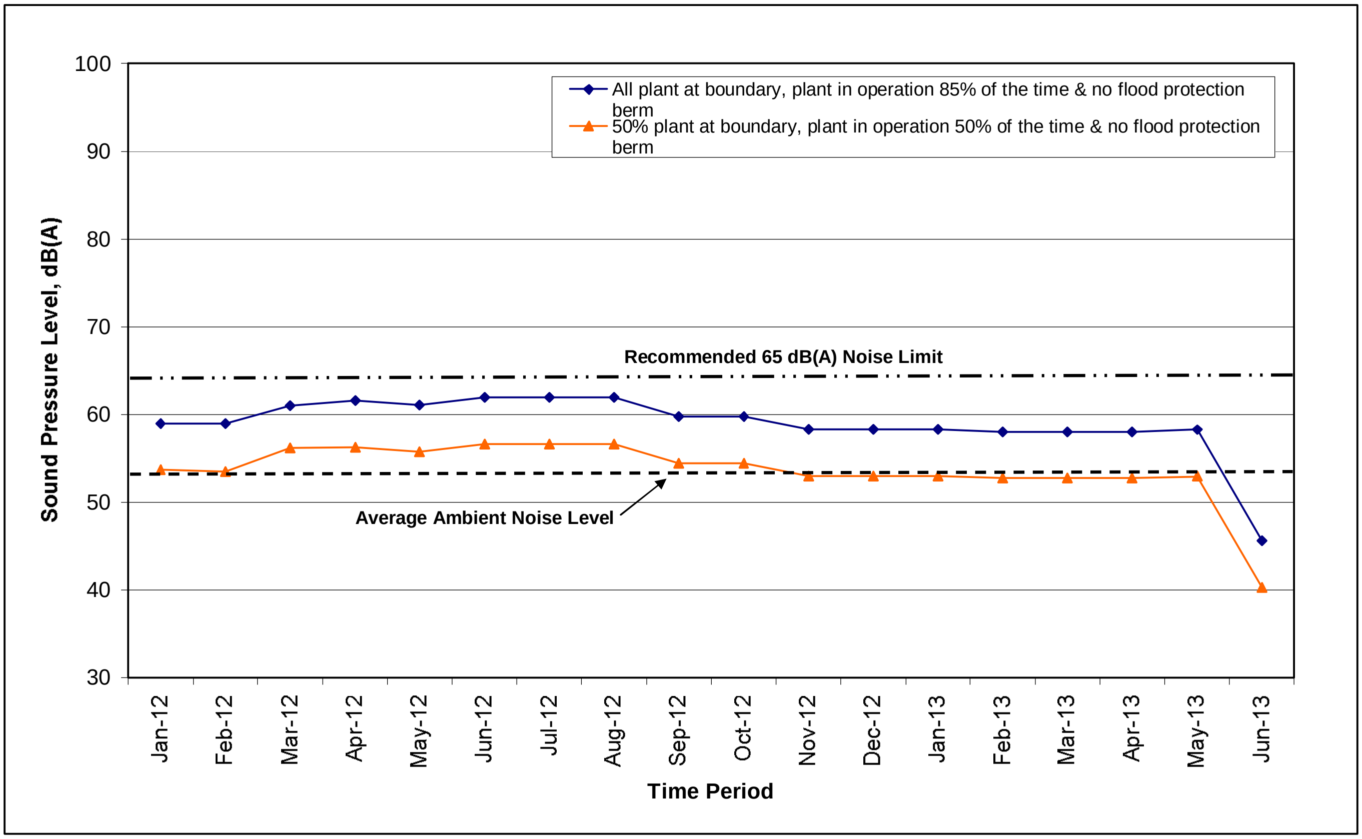
The construction noise levels at Umid (west) (R3) indicate that the predicted noise levels from construction will be no more than 65 dB(A) for both the worst case and realistic scenarios.

Given the location of the receptor (to the south east of the Terminal) the flood protection berm (which is located to the west of SD2 Infrastructure Area) was not included in the assessment at Umid (west).

Receptor R4 – Umid (east)

The predicted construction noise levels at Umid (east) are presented in Figure 8.

Figure 8: Predicted Construction Noise Levels at Receptor R4



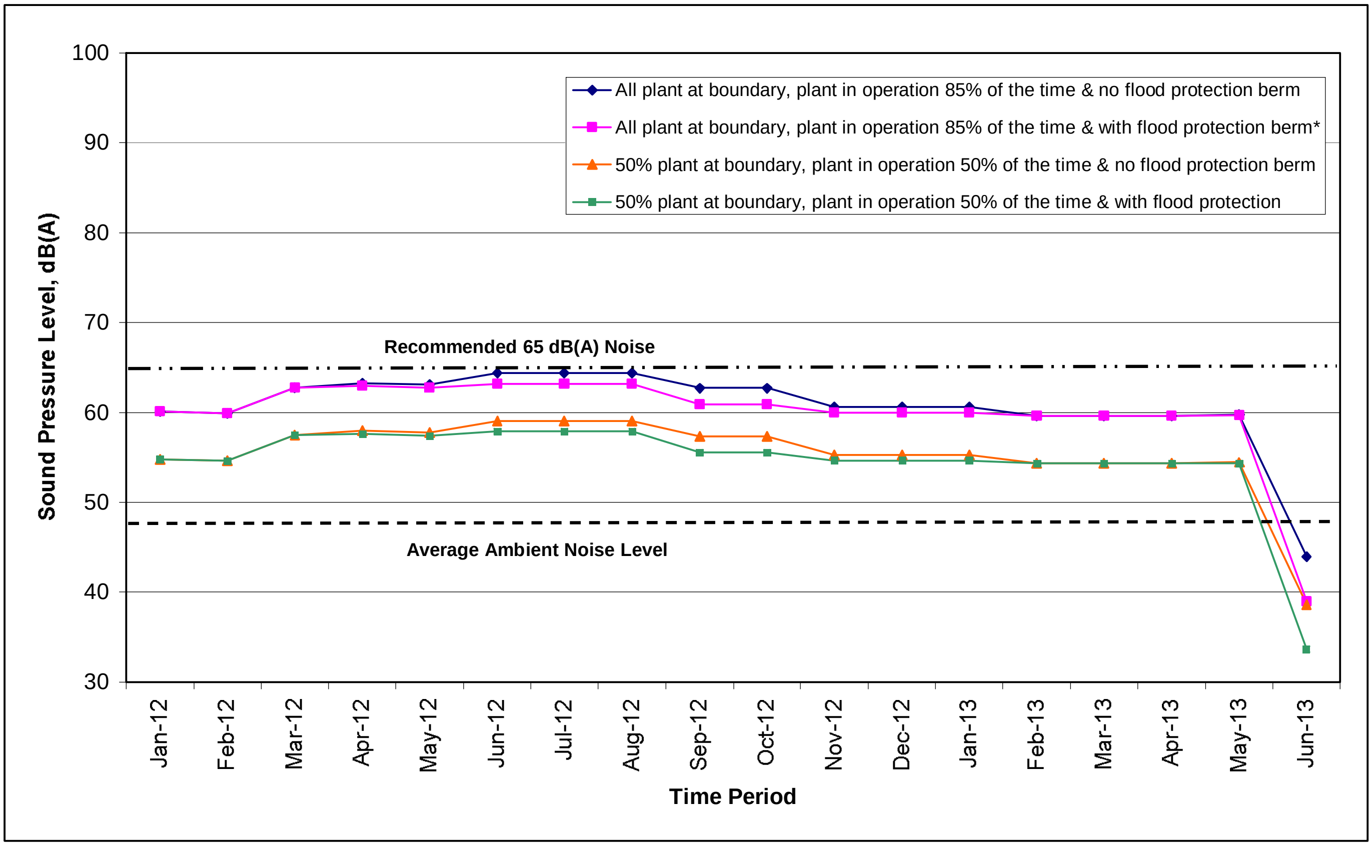
The calculated construction noise levels at Umid East (R4) indicate that the predicted noise levels from construction will be less than 65 dB(A) over the whole construction period for both worst case and realistic scenarios.

As for Umid (west) R3, given the location of the receptor, the flood protection berm was not included in the assessment at Umid (east).

Receptor R8 – Azim Kend (North of Masiv 3)

The predicted construction noise levels at this location are presented in Figure 9.

Figure 9: Predicted Construction Noise Levels at Receptor R8

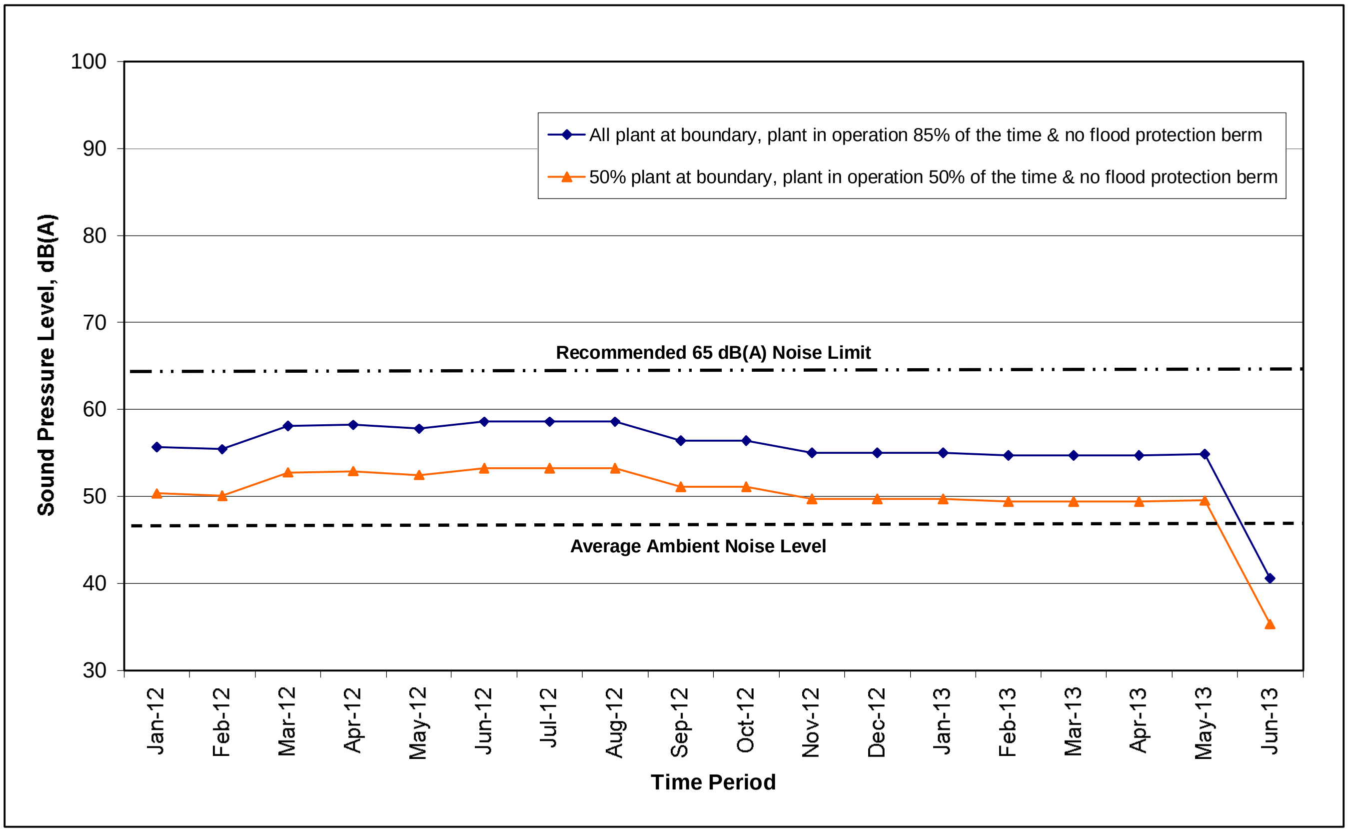


The calculated construction noise levels at Azim Kend (R8) indicate that the predicted noise levels from construction will be less than 65 dB(A) over the whole construction period for both worst case and realistic scenarios both with and without the flood protection berm.

Receptor R12 – Herder Settlement

The predicted construction noise levels at the Herder Settlement (R12) to the east of the Sangachal Terminal are presented in Figure 10.

Figure 10: Predicted Construction Noise Levels at Receptor R12



At the Herder Settlement location to the east of the Terminal (R12), construction noise levels are predicted to be less than 65 dB(A) over the whole construction period under both the worst case and realistic scenarios.

5.2 Concrete Batching Plant

The predicted noise levels associated with the operation of the concrete batching plant are presented in Table 5.

Table 5: Predicted Noise Levels from Concrete Batching Plant

Receptor	Receptor ID	Distance From Batching Plant (km)	Average ambient noise level, dB LAeq	Batching Plant Predicted Noise Level, dB LAeq
Azim Kend/Masiv 3	R1	2.2	52	39
Sangachal	R2	1	67	46
Umid (west)	R3	3.7	56	35
Umid (east)	R4	4.4	53	33
Azim Kend	R8	2.7	48	37
Herder Settlement	R12	4.7	47	33

The results of the construction noise model for the concrete batching plant indicate that the noise generated will be both below the 65 dB(A) limit value and below the average ambient noise levels measured at all receptors.

5.3 Piling

The results of the piling noise assessment are presented Table 6.

Table 6: Noise Levels at Sensitive Receptors Associated with Piling Activities

<table>
<tr><th rowspan="2">Scenario</th><th rowspan="2">Type of Piling</th><th rowspan="2">Location</th><th colspan="3">Predicted Noise Level (dB(A))</th><th rowspan="2">Limit Value (dB(A))</th></tr>
<tr><th>Azim Kend (R1)</th><th>Sangachal (R2)</th><th>Umid (west) (R3)</th></tr>
<tr><td colspan="7">Bored Piling Associated with Pipeline Crossings</td></tr>
<tr><td>1</td><td rowspan="2">Rotary bored</td><td>Location 1</td><td>54</td><td>60</td><td>52</td><td rowspan="2">65</td></tr>
<tr><td>2</td><td>Location 2</td><td>52</td><td>58</td><td>54</td></tr>
<tr><td colspan="7">Trial Piling</td></tr>
<tr><td>1</td><td>Tubular</td><td rowspan="2">100m from north west corner of SD2 Expansion Area</td><td>45</td><td>45</td><td>39</td><td rowspan="4">65</td></tr>
<tr><td>2</td><td>Pre cast concrete</td><td>46</td><td>46</td><td>40</td></tr>
<tr><td>3</td><td>Tubular</td><td rowspan="2">100m from south west corner of SD2 Expansion Area</td><td>44</td><td>49</td><td>40</td></tr>
<tr><td>4</td><td>Pre cast concrete</td><td>45</td><td>50</td><td>41</td></tr>
</table>

The modelling results indicate that no exceedances of the construction noise limit (65dB(A)) are predicted at any of the modelled receptors.

5.4 Concrete Breaking

The results of the concrete breaking are presented in Table 7.

Table 7: Noise Levels at Sensitive Receptors Associated with Concrete Breaking

Concrete Breaking Scenario	Concrete Breaking Type	Location	Duration	Predicted Noise Level, dB(A) Azim Kend (R1)	Sangachal (R2)	Umid (west) (R3)
1	Breaking/Crushing	Centre of SD2 Expansion Area	100%	51	55	49
2	Breaking/Crushing with Screen	Centre of SD2 Expansion Area	100%	46	50	44

The modelling results indicate that no exceedances of the construction noise limit (65dB(A)) are predicted at any of the modelled receptors due to concrete breaking activities without a screen. The use of the screen further reduced the noise levels.

5.5 Cumulative Assessment

A cumulative assessment has been undertaken which considers all the construction activities discussed in this report operating concurrently. The assessment covers the most active period of construction (April–June 2012), and therefore is considered a worst case scenario. Table 8 presents the results of the cumulative assessment.

Table 8: Cumulative Assessment of Noise Levels at Sensitive Receptors

Activity	Predicted Noise Level, dB(A) Azim Kend (R1)	Sangachal (R2)	Umid (west) (R3)
Construction – realistic – no berm	62	65	60
Pipeline crossing piling	54	60	52
Concrete breaking within the SD2 Expansion Area	51	55	49
Piling within the SD2 Expansion Area	54	60	52
TOTAL NOISE dB(A)	**63**	**67**	**61**

Noise levels are predicted to exceed 65 dB(A) at one modelled receptor, Sangachal, if all construction activities were to occur simultaneously. The predicted noise levels at Azim Kend and Umid West are predicted to be less than 65 dB(A).

6. CONCLUSIONS AND RECOMMENDATIONS

Tables 9 and 10 present a summary of the results of the construction plant noise modelling undertaken for the worst case and realistic scenarios across the construction period.

Table 9: Worst Case Scenario Predicted Noise Levels (Construction Plant Only)

Receptor	Receptor ID	Sound Pressure Levels, dB LAeq						Average Ambient Noise Level dB LAeq
		Jan – Mar 12	Apr – Jun 12	July – Sept 12	Oct – Dec 12	Jan – Mar 13	Apr – Jun 13	
Azim Kend/ Masiv 3	R1 (no berm)	63 - 66	66 - 67	65 - 67	63 - 65	62 - 63	45 - 62	52
	R1 (with berm)	-	66	66-63	63	62 - 63	40 - 62	
Sangachal	R2 (no berm)	68 - 69	69 - 70	68 - 70	65 - 68	64 - 65	53 - 64	67
	R2 (with berm)	-	69	66 - 69	64 - 66	64	48-64	
Umid (west)	R3	62 - 65	64 - 65	63 - 65	62 - 63	62	49 - 62	56
Umid (east)	R4	59 - 61	61 - 62	60 - 62	58 - 60	58	46 - 58	53
Azim Kend	R8 (no berm)	60 - 63	63 - 64	63 - 64	61 - 63	60 - 61	44 - 60	48
	R8 (with berm)	-	63	61-63	60-61	60	39 - 60	
Herder Settlement	R12	55 - 58	58 - 59	56 - 59	55 - 56	55	41 - 55	47

Note:
Shading indicates results above the construction noise limit value of 65 dB(A)

Table 10: Realistic Scenario Predicted Noise Levels (Construction Plant Only)

Receptor	Receptor ID	Sound Pressure Levels, dB LAeq						Average Ambient Noise Level dB LAeq
		Jan – Mar 12	Apr – Jun 12	July – Sept 12	Oct – Dec 12	Jan – Mar 13	Apr – Jun 13	
Azim Kend/ Masiv 3	R1 (no berm)	58 - 60	61 - 62	60 - 62	58 - 60	57 - 58	40 - 57	52
	R1 (with berm)	-	60 - 61	58 - 61	57 - 58	57	35 - 57	
Sangachal	R2 (no berm)	62 - 64	64 - 65	62 - 65	60 - 62	59 - 60	48 - 59	67
	R2 (with berm)	-	64	60 - 64	59 - 60	59	43 - 59	
Umid (west)	R3	57 -59	59 - 60	57- 60	56 - 57	56	43 - 56	56
Umid (east)	R4	54 - 56	56 - 57	54 - 57	53-54	53	40 - 53	53
Azim Kend	R8 (no berm)	55 - 57	57 - 58	56 - 58	55 - 57	54 - 55	39 - 54	48
	R8 (with berm)	-	57- 58	56 - 58	55 - 56	54 - 55	34 - 54	
Herder Settlement	R12	50 - 53	52 - 53	51 - 53	50 - 51	49 - 50	35 - 50	47

Notes:
Shading indicates results above the construction noise limit value of 65 dB(A).
Bold indicates where results are above the construction noise limit value of 65 dB(A) but below or equivalent to existing average ambient noise level.

Table 9 shows that:

- **Under worst case assumptions** - 100% of plant at the boundary of the works (i.e. closest to the receptor being assessed), operating for 10 hours per day (85% of the working day):

    - Noise levels are predicted to range between 39 dB(A) (at R8 – Azim Kend - during June 2013) and 70 dB(A) (at R2 – Sangachal – July 2012);

    - No exceedances of the noise limit are predicted at receptors R3 (Umid West), R4 (Umid East), R8 (Azim Kend/Masiv 3) and R12 (Herder Settlement);

    - Exceedances are predicted at R1 (Azim Kend) and R2 (Sangachal) up to September and December 2012 respectively; and

    - The results show that while, the flood protection berm provides some noise attenuation, the number of exceedances is unchanged when it is included within the noise model.

Table 10 shows that:

- **Under realistic assumptions** - 50% of plant at the boundary of the works (i.e. closest to the receptor being assessed), operating for 6 hours per day (50% of the working day):

    - Noise levels are predicted to range between 34 dB(A) (at R8 – Azim Kend - during June 2013) and 65 dB(A) (at R2 – Sangachal – July 2012); and

    - No exceedances of the noise limit are predicted at receptors R1 (Azim Kend), R3 (Umid West), R4 (Umid East), R8 (Azim Kend/Masiv 3) and R12 (Herder Settlement).

Noise levels associated with the operation of the concrete batching plant at receptors are predicted to vary between 33-46 dB(A). This is both below the 65 dB(A) limit value and below the average ambient noise levels measured at all receptors.

Noise levels associated with piling activities indicate that no exceedances of the construction noise limit (65dB(A)) are predicted at any of the modelled receptors.

- For rotary bored piling associated with crossing works, noise levels are predicted to range between 52 and 60 dB(A), depending upon the location of piling activities;

- For tubular piling associated with trial piling, noise levels are predicted to range between 39 and 45 dB(A) if piling is located 100m from the north-west corner of the SD2 Expansion Area, and between 40 and 49 dB(A) if piling is located 100m from the south-west corner of the SD2 Expansion Area; and

- For pre-cast concrete piling associated with trial piling, noise levels are predicted to range between 40 and 46 dB(A), if piling is located 100m from the north-west corner of the SD2 Expansion Area and between 41 and 50 dB(A) if piling is located 100m from the south-west corner of the SD2 Expansion Area.

Noise emissions generated by concrete breaking activities are predicted to range between 49 and 55 dB(A), and therefore, will be within the construction noise limit of 65 dB(A) for the modelled receptors.

The cumulative impact of all construction activities if they were to occur during the most active period of construction (April-June 2012) would be an exceedance of the guideline 65 dB(A) limit at Sangachal.

In summary it is considered, based on the realistic construction plant noise scenarios assessed, that **no significant noise impacts are expected during the construction programme.** In general, however, noise levels are predicted to be close to the noise limit, particular during March – August 2012, and under particularly active periods when plant may be operating for longer hours close to the site boundary, the limit may be exceeded.

Recommendations

It is recommended therefore that the following measures should be adopted:

- Construction plant and vehicles shall be modern and well maintained in accordance with written procedures based on the manufacturer's guidelines, applicable industry code, or engineering standard to ensure efficient and reliable operation;
- Noisy plant equipment should be situated as far as possible from noise-sensitive buildings. Where practicable, barriers (e.g. site huts, acoustic partitions etc.) should be used to provide shielding in order to reduce noise levels at sensitive receptors;
- Vehicles and mechanical plant used for the purpose of the works should be fitted with effective exhaust silencers and maintained in good and efficient working order and operated in such a manner as to minimise noise emissions. The contractor must ensure that all plant complies with the relevant statutory requirements;
- Compressors should be fitted with properly lined and sealed acoustic covers that should be kept closed whenever in use. Pneumatic percussive tools should be fitted with mufflers or silencers of the type recommended by the manufacturers;
- Noise emitting machinery that is required to run continuously should be housed, if necessary, in a suitable acoustic enclosure;
- All construction plant and vehicles shall be switched off whilst not in use and not left to idle;

- Where practicable, rotary drills and bursters actuated by hydraulic, chemical or electrical power should be used for excavating hard or extrusive material;

- Care should be taken when loading or unloading vehicles, dismantling scaffolding or moving materials etc. to reduce impact noise;

- Where practicable, mains electricity shall be used instead of mobile generators as a power source; and

- Where possible communities shall be warned in advance of any particularly noise activities to be undertaken; when unavoidable, noisy operations shall be undertaken during normal daylight working hours.

7. REFERENCES

Ref. 1 Document BP-SFZZZZ-EV-REP-0005-A1, Shah Deniz Stage 2 Project, Sangachal Terminal Baseline Noise Survey, 30th June 2010.

Ref. 2 Document BP-SFZZZZ-EV-REP-0023, Shah Deniz 2 Infrastructure Project, Environmental and Socio Economic Impact Assessment, Chapter 5 'Project Description', May 2011.

Ref. 3 British Standards Institute (BSi), (2009): 'BS5228 - Noise and Vibration Control on Construction and Open Sites', BSi, London.

Ref. 4 UK Institute of Environment Management and Assessment's (IEMA). 'Guidance Notes No. 1 Guidelines for the Environmental Assessment of Road Traffic'.

Ref. 5 UK Highways Agency, (August 1994); 'Design Manual for Road and Bridges Volume 11 Section 3 Part 7-Traffic Noise and Vibration'.

Annex A: Receptor Distances from Construction Areas

Receptor	Description	Phase 1 m	Phase 2 m	Phase 3 m	Phase 4 m	Phase 5 m	Phase 6 m	Phase 7 m
R1	Azim Kend/Masiv 3	2600	2400	1400	1500	2000	1300	2400
R2	Sangachal	1400	1000	850	1200	1200	1200	1000
R3	Umid West	3200	1600	1700	1600	3200	4000	1600
R4	Umid East	3900	2300	2400	2400	3700	4700	2300
R8	Azim Kend North of Masiv 3	3200	3000	2000	2000	2300	2000	2800
R12	Herders Settlement	3600	2500	2500	2500	3900	4600	2900

Annex B: Construction Noise Calculations (worst-case scenario – no flood protection berm)

Plant	Noise dB(A) at 10m	Stage													
		Phase 1		Phase 2		Phase 3		Phase 4		Phase 5		Phase 6		Phase 7	
		Qty	dB(A)	Qty	dB(A)	Qty	dB(A)	Qty	dB(A)	Qty	dB(A)	Qty	dB(A)	Qty	dB(A)
Bulldozer - D6/D8/D9/D10	79	1	79	1	79	6	87	6	87	6	87	0	0	0	0
Wheeled Loader - 25t	79	2	82	2	82	5	86	5	86	5	86	0	0	0	0
Tracked Excavator - 27t	75	1	75	1	75	5	82	5	82	5	82	0	0	0	0
Dump Truck - 25t	85	2	88	2	88	38	101	38	101	38	101	0	0	1	85
Motor Grader - 25t	86	1	86	1	86	2	89	3	91	5	93	0	0	0	0
Sheep Foot Roller/Vibro Roller - 10t	80	1	80	1	80	2	83	1	80	3	85	3	85	0	0
Road Roller - 13t	80	0	0	0	0	0	0	2	83	1	80	0	0	0	0
Asphalt Paver (and tipper lorry)	77	0	0	0	0	0	0	3	82	0	0	0	0	0	0
Road Lorry - 25t	80	8	89	4	86	28	94	28	94	28	94	11	90	0	0
Diesel Generator (50/100 kVA)	65	1	65	2	68	7	73	7	73	7	73	9	75	1	65
Mechanical Water Bowser	83	1	83	7	91	7	91	7	91	8	92	8	92	0	0
Tracked Mobile Crane - 115t	75	0	0	2	78	2	78	2	78	1	75	4	81	0	0
Mobile Telescopic Crane - 25t	82	0	0	1	82	2	85	3	87	2	85	1	82	0	0
Earthworks Compactor - 10t	73	0	0	0	0	7	81	7	81	7	81	0	0	0	0
Concrete Mixer - 200 litres	80	0	0	1	80	2	83	3	85	2	83	1	80	0	0
Fork Lift Trucks - 5t	77	1	77	3	82	3	82	3	82	3	82	1	77	0	0
Water Pump 20 kW	79	1	79	2	82	6	87	6	87	2	82	1	79	0	0
Concrete Pumps	65	0	0	0	0	2	68	3	70	1	65	2	68	0	0
Air Compressor - 8/20 m3/min	65	1	65	2	68	2	68	2	68	2	68	1	65	1	65
Backhoe Loader - 10t	67	0	0	4	73	3	72	0	0	2	70	2	70	0	0
Welding Set	73	1	73	1	73	2	76	2	76	2	76	2	76	1	73
Compactor Plate	82	0	0	1	82	2	85	2	85	2	85	6	90	0	0
JCB Tractor	67	1	67	1	67	2	70	2	70	2	70	4	73	1	67
Tilting Drum Mixer	61	0	0	1	61	1	61	1	61	1	61	4	67	1	61
Fuel Bowser	89	1	89	1	89	1	89	1	89	1	89	1	89	1	89
Total Noise at 10m		**95**		**97**		**103**		**103**		**103**		**97**		**91**	

			Stage							
			Phase 1 dB(A)	Phase 2 dB(A)	Phase 3 dB(A)	Phase 4 dB(A)	Phase 5 dB(A)	Phase 6 dB(A)	Phase 7 dB(A)	
Receptor	Azim Kend	R1	95	97	103	103	103	97	91	
Distance (m)			2600	2400	1400	1500	2000	1300	2400	
Screening			0	0	0	0	0	0	0	
Plant at Boundary			100%	100%	100%	100%	100%	100%	100%	
Façade			3	3	3	3	3	3	3	
On Time %			85%	85%	85%	85%	85%	85%	85%	
Noise level dB(A)			**49**	**52**	**63**	**62**	**60**	**57**	**45**	
										Total All Phases
R1	Jan-12		49	52	63	0	0	0	0	**63**
	Feb-12		0	52	63	0	0	0	0	**63**
	Mar-12		0	52	63	62	0	0	0	**66**
	Apr-12		0	52	63	62	0	57	0	**66**
	May-12		0	0	63	62	0	57	0	**66**
	Jun-12		0	0	63	62	60	57	0	**67**
	Jul-12		0	0	63	62	60	57	0	**67**
	Aug-12		0	0	63	62	60	57	0	**67**
	Sep-12		0	0	0	62	60	57	0	**65**
	Oct-12		0	0	0	62	60	57	0	**65**
	Nov-12		0	0	0	62	0	57	0	**63**
	Dec-12		0	0	0	62	0	57	0	**63**
	Jan-13		0	0	0	62	0	57	0	**63**
	Feb-13		0	0	0	62	0	0	0	**62**
	Mar-13		0	0	0	62	0	0	0	**62**
	Apr-13		0	0	0	62	0	0	0	**62**
	May-13		0	0	0	62	0	0	45	**62**
	Jun-13		0	0	0	0	0	0	45	**45**

			Stage							
			Phase 1 dB(A)	Phase 2 dB(A)	Phase 3 dB(A)	Phase 4 dB(A)	Phase 5 dB(A)	Phase 6 dB(A)	Phase 7 dB(A)	
Receptor	Sangachal	R2	95	97	103	103	103	97	91	
Distance (m)			1400	1000	850	1200	1200	1200	1000	
Screening			0	0	0	0	0	0	0	
Plant at Boundary			100%	100%	100%	100%	100%	100%	100%	
Façade			3	3	3	3	3	3	3	
On Time %			85%	85%	85%	85%	85%	85%	85%	
Noise level dB(A)			**55**	**59**	**67**	**64**	**64**	**58**	**53**	Total All Phases
R2	Jan-12		55	59	67	0	0	0	0	**68**
	Feb-12		0	59	67	0	0	0	0	**68**
	Mar-12		0	59	67	64	0	0	0	**69**
	Apr-12		0	59	67	64	0	58	0	**69**
	May-12		0	0	67	64	0	58	0	**69**
	Jun-12		0	0	67	64	64	58	0	**70**
	Jul-12		0	0	67	64	64	58	0	**70**
	Aug-12		0	0	67	64	64	58	0	**70**
	Sep-12		0	0	0	64	64	58	0	**68**
	Oct-12		0	0	0	64	64	58	0	**68**
	Nov-12		0	0	0	64	0	58	0	**65**
	Dec-12		0	0	0	64	0	58	0	**65**
	Jan-13		0	0	0	64	0	58	0	**65**
	Feb-13		0	0	0	64	0	0	0	**64**
	Mar-13		0	0	0	64	0	0	0	**64**
	Apr-13		0	0	0	64	0	0	0	**64**
	May-13		0	0	0	64	0	0	53	**64**
	Jun-13		0	0	0	0	0	0	53	**53**

			Stage							
			Phase 1 dB(A)	Phase 2 dB(A)	Phase 3 dB(A)	Phase 4 dB(A)	Phase 5 dB(A)	Phase 6 dB(A)	Phase 7 dB(A)	
Receptor	Umid West	R3	95	97	103	103	103	97	91	
Distance (m)			3200	1600	1700	1600	3200	4000	1600	
Screening			0	0	0	0	0	0	0	
Plant at Boundary			100%	100%	100%	100%	100%	100%	100%	
Façade			3	3	3	3	3	3	3	
On Time %			85%	85%	85%	85%	85%	85%	85%	
Noise level dB(A)			**47**	**55**	**61**	**62**	**56**	**48**	**49**	Total All Phases
R3	Jan-12		47	55	61	0	0	0	0	**62**
	Feb-12		0	55	61	0	0	0	0	**62**
	Mar-12		0	55	61	62	0	0	0	**65**
	Apr-12		0	55	61	62	0	48	0	**65**
	May-12		0	0	61	62	0	48	0	**64**
	Jun-12		0	0	61	62	56	48	0	**65**
	Jul-12		0	0	61	62	56	48	0	**65**
	Aug-12		0	0	61	62	56	48	0	**65**
	Sep-12		0	0	0	62	56	48	0	**63**
	Oct-12		0	0	0	62	56	48	0	**63**
	Nov-12		0	0	0	62	0	48	0	**62**
	Dec-12		0	0	0	62	0	48	0	**62**
	Jan-13		0	0	0	62	0	48	0	**62**
	Feb-13		0	0	0	62	0	0	0	**62**
	Mar-13		0	0	0	62	0	0	0	**62**
	Apr-13		0	0	0	62	0	0	0	**62**
	May-13		0	0	0	62	0	0	49	**62**
	Jun-13		0	0	0	0	0	0	49	**49**

			Stage							
			Phase 1 dB(A)	Phase 2 dB(A)	Phase 3 dB(A)	Phase 4 dB(A)	Phase 5 dB(A)	Phase 6 dB(A)	Phase 7 dB(A)	
Receptor	Umid East	R4	95	97	103	103	103	97	91	
Distance (m)			3900	2300	2400	2400	3700	4700	2300	
Screening			0	0	0	0	0	0	0	
Plant at Boundary			100%	100%	100%	100%	100%	100%	100%	
Façade			3	3	3	3	3	3	3	
On Time %			85%	85%	85%	85%	85%	85%	85%	
Noise level dB(A)			**46**	**52**	**58**	**58**	**54**	**46**	**46**	Total All Phases
R4	Jan-12		46	52	58	0	0	0	0	**59**
	Feb-12		0	52	58	0	0	0	0	**59**
	Mar-12		0	52	58	58	0	0	0	**61**
	Apr-12		0	52	58	58	0	46	0	**62**
	May-12		0	0	58	58	0	46	0	**61**
	Jun-12		0	0	58	58	54	46	0	**62**
	Jul-12		0	0	58	58	54	46	0	**62**
	Aug-12		0	0	58	58	54	46	0	**62**
	Sep-12		0	0	0	58	54	46	0	**60**
	Oct-12		0	0	0	58	54	46	0	**60**
	Nov-12		0	0	0	58	0	46	0	**58**
	Dec-12		0	0	0	58	0	46	0	**58**
	Jan-13		0	0	0	58	0	46	0	**58**
	Feb-13		0	0	0	58	0	0	0	**58**
	Mar-13		0	0	0	58	0	0	0	**58**
	Apr-13		0	0	0	58	0	0	0	**58**
	May-13		0	0	0	58	0	0	46	**58**
	Jun-13		0	0	0	0	0	0	46	**46**

			Stage							
			Phase 1 dB(A)	**Phase 2 dB(A)**	**Phase 3 dB(A)**	**Phase 4 dB(A)**	**Phase 5 dB(A)**	**Phase 6 dB(A)**	**Phase 7 dB(A)**	
Receptor	North of Azim Kend/Masiv 3	R8	95	97	103	103	103	97	91	
Distance (m)			3200	3000	2000	2000	2300	2000	2800	
Screening			0	0	0	0	0	0	0	
Plant at Boundary			100%	100%	100%	100%	100%	100%	100%	
Façade			3	3	3	3	3	3	3	
On Time %			85%	85%	85%	85%	85%	85%	85%	
Noise level dB(A)			**47**	**50**	**59**	**60**	**58**	**54**	**44**	Total All Phases
R8	Jan-12		47	50	59	0	0	0	0	**60**
	Feb-12		0	50	59	0	0	0	0	**60**
	Mar-12		0	50	59	60	0	0	0	**63**
	Apr-12		0	50	59	60	0	54	0	**63**
	May-12		0	0	59	60	0	54	0	**63**
	Jun-12		0	0	59	60	58	54	0	**64**
	Jul-12		0	0	59	60	58	54	0	**64**
	Aug-12		0	0	59	60	58	54	0	**64**
	Sep-12		0	0	0	60	58	54	0	**63**
	Oct-12		0	0	0	60	58	54	0	**63**
	Nov-12		0	0	0	60	0	54	0	**61**
	Dec-12		0	0	0	60	0	54	0	**61**
	Jan-13		0	0	0	60	0	54	0	**61**
	Feb-13		0	0	0	60	0	0	0	**60**
	Mar-13		0	0	0	60	0	0	0	**60**
	Apr-13		0	0	0	60	0	0	0	**60**
	May-13		0	0	0	60	0	0	44	**60**
	Jun-13		0	0	0	0	0	0	44	**44**

			Stage							
			Phase 1 dB(A)	**Phase 2 dB(A)**	**Phase 3 dB(A)**	**Phase 4 dB(A)**	**Phase 5 dB(A)**	**Phase 6 dB(A)**	**Phase 7 dB(A)**	
Receptor	Herder Settlement	R12	95	97	103	103	103	97	91	
Distance (m)			3600	2500	2500	2500	3900	4600	2900	
Screening			0	0	0	0	0	0	0	
Plant at Boundary			100%	100%	100%	100%	100%	100%	100%	
Façade			0	0	0	0	0	0	0	
On Time %			85%	85%	85%	85%	85%	85%	85%	
Noise level dB(A)			**43**	**48**	**55**	**55**	**51**	**43**	**41**	Total All Phases
R12	Jan-12		43	48	55	0	0	0	0	**56**
	Feb-12		0	48	55	0	0	0	0	**55**
	Mar-12		0	48	55	55	0	0	0	**58**
	Apr-12		0	48	55	55	0	43	0	**58**
	May-12		0	0	55	55	0	43	0	**58**
	Jun-12		0	0	55	55	51	43	0	**59**
	Jul-12		0	0	55	55	51	43	0	**59**
	Aug-12		0	0	55	55	51	43	0	**59**
	Sep-12		0	0	0	55	51	43	0	**56**
	Oct-12		0	0	0	55	51	43	0	**56**
	Nov-12		0	0	0	55	0	43	0	**55**
	Dec-12		0	0	0	55	0	43	0	**55**
	Jan-13		0	0	0	55	0	43	0	**55**
	Feb-13		0	0	0	55	0	0	0	**55**
	Mar-13		0	0	0	55	0	0	0	**55**
	Apr-13		0	0	0	55	0	0	0	**55**
	May-13		0	0	0	55	0	0	41	**55**
	Jun-13		0	0	0	0	0	0	41	**41**

Annex C: Construction Noise Calculations (realistic scenario – no flood protection berm)

Plant	Noise dB(A) at 10m	Stage													
		Phase 1		Phase 2		Phase 3		Phase 4		Phase 5		Phase 6		Phase 7	
		Qty	dB(A)	Qty	dB(A)	Qty	dB(A)	Qty	dB(A)	Qty	dB(A)	Qty	dB(A)	Qty	dB(A)
Bulldozer - D6/D8/D9/D10	79	1	79	1	79	6	87	6	87	6	87	0	0	0	0
Wheeled Loader - 25t	79	2	82	2	82	5	86	5	86	5	86	0	0	0	0
Tracked Excavator - 27t	75	1	75	1	75	5	82	5	82	5	82	0	0	0	0
Dump Truck - 25t	85	2	88	2	88	38	101	38	101	38	101	0	0	1	85
Motor Grader - 25t	86	1	86	1	86	2	89	3	91	5	93	0	0	0	0
Sheep Foot Roller/Vibro Roller - 10t	80	1	80	1	80	2	83	1	80	3	85	3	85	0	0
Road Roller - 13t	80	0	0	0	0	0	0	2	83	1	80	0	0	0	0
Asphalt Paver (and tipper lorry)	77	0	0	0	0	0	0	3	82	0	0	0	0	0	0
Road Lorry - 25t	80	8	89	4	86	28	94	28	94	28	94	11	90	0	0
Diesel Generator (50/100 kVA)	65	1	65	2	68	7	73	7	73	7	73	9	75	1	65
Mechanical Water Bowser	83	1	83	7	91	7	91	7	91	8	92	8	92	0	0
Tracked Mobile Crane - 115t	75	0	0	2	78	2	78	2	78	1	75	4	81	0	0
Mobile Telescopic Crane - 25t	82	0	0	1	82	2	85	3	87	2	85	1	82	0	0
Earthworks Compactor - 10t	73	0	0	0	0	7	81	7	81	7	81	0	0	0	0
Concrete Mixer - 200 litres	80	0	0	1	80	2	83	3	85	2	83	1	80	0	0
Fork Lift Trucks - 5t	77	1	77	3	82	3	82	3	82	3	82	1	77	0	0
Water Pump 20 kW	79	1	79	2	82	6	87	6	87	2	82	1	79	0	0
Concrete Pumps	65	0	0	0	0	2	68	3	70	1	65	2	68	0	0
Air Compressor - 8/20 m3/min	65	1	65	2	68	2	68	2	68	2	68	1	65	1	65
Backhoe Loader - 10t	67	0	0	4	73	3	72	0	0	2	70	2	70	0	0
Welding Set	73	1	73	1	73	2	76	2	76	2	76	2	76	1	73
Compactor Plate	82	0	0	1	82	2	85	2	85	2	85	6	90	0	0
JCB Tractor	67	1	67	1	67	2	70	2	70	2	70	4	73	1	67
Tilting Drum Mixer	61	0	0	1	61	1	61	1	61	1	61	4	67	1	61
Fuel Bowser	89	1	89	1	89	1	89	1	89	1	89	1	89	1	89

			Stage Phase 1 dB(A)	Phase 2 dB(A)	Phase 3 dB(A)	Phase 4 dB(A)	Phase 5 dB(A)	Phase 6 dB(A)	Phase 7 dB(A)	Total All Phases
Receptor	Azim Kend	R1	95	97	103	103	103	97	91	
Distance (m)			2600	2400	1400	1500	2000	1300	2400	
Screening			0	0	0	0	0	0	0	
Plant at Boundary			50%	50%	50%	50%	50%	50%	50%	
Façade			3	3	3	3	3	3	3	
On Time %			50%	50%	50%	50%	50%	50%	50%	
Noise level dB(A)			**44**	**46**	**57**	**57**	**54**	**52**	**40**	
R1	Jan-12		44	46	57	0	0	0	0	**58**
	Feb-12		0	46	57	0	0	0	0	**58**
	Mar-12		0	46	57	57	0	0	0	**60**
	Apr-12		0	46	57	57	0	52	0	**61**
	May-12		0	0	57	57	0	52	0	**61**
	Jun-12		0	0	57	57	54	52	0	**62**
	Jul-12		0	0	57	57	54	52	0	**62**
	Aug-12		0	0	57	57	54	52	0	**62**
	Sep-12		0	0	0	57	54	52	0	**60**
	Oct-12		0	0	0	57	54	52	0	**60**
	Nov-12		0	0	0	57	0	52	0	**58**
	Dec-12		0	0	0	57	0	52	0	**58**
	Jan-13		0	0	0	57	0	52	0	**58**
	Feb-13		0	0	0	57	0	0	0	**57**
	Mar-13		0	0	0	57	0	0	0	**57**
	Apr-13		0	0	0	57	0	0	0	**57**
	May-13		0	0	0	57	0	0	40	**57**
	Jun-13		0	0	0	0	0	0	40	**40**

			Stage Phase 1 dB(A)	Phase 2 dB(A)	Phase 3 dB(A)	Phase 4 dB(A)	Phase 5 dB(A)	Phase 6 dB(A)	Phase 7 dB(A)	Total All Phases
Receptor	Sangachal	R2	95	97	103	103	103	97	91	
Distance (m)			1400	1000	850	1200	1200	1200	1000	
Screening			0	0	0	0	0	0	0	
Plant at Boundary			50%	50%	50%	50%	50%	50%	50%	
Façade			3	3	3	3	3	3	3	
On Time %			50%	50%	50%	50%	50%	50%	50%	
Noise level dB(A)			**49**	**54**	**62**	**59**	**59**	**53**	**48**	
R2	Jan-12		49	54	62	0	0	0	0	**62**
	Feb-12		0	54	62	0	0	0	0	**62**
	Mar-12		0	54	62	59	0	0	0	**64**
	Apr-12		0	54	62	59	0	53	0	**64**
	May-12		0	0	62	59	0	53	0	**64**
	Jun-12		0	0	62	59	59	53	0	**65**
	Jul-12		0	0	62	59	59	53	0	**65**
	Aug-12		0	0	62	59	59	53	0	**65**
	Sep-12		0	0	0	59	59	53	0	**62**
	Oct-12		0	0	0	59	59	53	0	**62**
	Nov-12		0	0	0	59	0	53	0	**60**
	Dec-12		0	0	0	59	0	53	0	**60**
	Jan-13		0	0	0	59	0	53	0	**60**
	Feb-13		0	0	0	59	0	0	0	**59**
	Mar-13		0	0	0	59	0	0	0	**59**
	Apr-13		0	0	0	59	0	0	0	**59**
	May-13		0	0	0	59	0	0	48	**59**
	Jun-13		0	0	0	0	0	0	48	**48**

			Stage							
			Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	
			dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	
Receptor	Umid West	R3	95	97	103	103	103	97	91	
Distance (m)			3200	1600	1700	1600	3200	4000	1600	
Screening			0	0	0	0	0	0	0	
Plant at Boundary			50%	50%	50%	50%	50%	50%	50%	
Façade			3	3	3	3	3	3	3	
On Time %			50%	50%	50%	50%	50%	50%	50%	
Noise level dB(A)			**42**	**50**	**56**	**56**	**50**	**42**	**43**	Total
										All Phases
R3	Jan-12		42	50	56	0	0	0	0	**57**
	Feb-12		0	50	56	0	0	0	0	**57**
	Mar-12		0	50	56	56	0	0	0	**59**
	Apr-12		0	50	56	56	0	42	0	**60**
	May-12		0	0	56	56	0	42	0	**59**
	Jun-12		0	0	56	56	50	42	0	**60**
	Jul-12		0	0	56	56	50	42	0	**60**
	Aug-12		0	0	56	56	50	42	0	**60**
	Sep-12		0	0	0	56	50	42	0	**57**
	Oct-12		0	0	0	56	50	42	0	**57**
	Nov-12		0	0	0	56	0	42	0	**56**
	Dec-12		0	0	0	56	0	42	0	**56**
	Jan-13		0	0	0	56	0	42	0	**56**
	Feb-13		0	0	0	56	0	0	0	**56**
	Mar-13		0	0	0	56	0	0	0	**56**
	Apr-13		0	0	0	56	0	0	0	**56**
	May-13		0	0	0	56	0	0	43	**56**
	Jun-13		0	0	0	0	0	0	43	**43**

			Stage							
			Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	
			dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	
Receptor	Umid East	R4	95	97	103	103	103	97	91	
Distance (m)			3900	2300	2400	2400	3700	4700	2300	
Screening			0	0	0	0	0	0	0	
Plant at Boundary			50%	50%	50%	50%	50%	50%	50%	
Façade			3	3	3	3	3	3	3	
On Time %			50%	50%	50%	50%	50%	50%	50%	
Noise level dB(A)			**40**	**47**	**53**	**53**	**49**	**41**	**40**	Total
										All Phases
R4	Jan-12		40	47	53	0	0	0	0	**54**
	Feb-12		0	47	53	0	0	0	0	**54**
	Mar-12		0	47	53	53	0	0	0	**56**
	Apr-12		0	47	53	53	0	41	0	**56**
	May-12		0	0	53	53	0	41	0	**56**
	Jun-12		0	0	53	53	49	41	0	**57**
	Jul-12		0	0	53	53	49	41	0	**57**
	Aug-12		0	0	53	53	49	41	0	**57**
	Sep-12		0	0	0	53	49	41	0	**54**
	Oct-12		0	0	0	53	49	41	0	**54**
	Nov-12		0	0	0	53	0	41	0	**53**
	Dec-12		0	0	0	53	0	41	0	**53**
	Jan-13		0	0	0	53	0	41	0	**53**
	Feb-13		0	0	0	53	0	0	0	**53**
	Mar-13		0	0	0	53	0	0	0	**53**
	Apr-13		0	0	0	53	0	0	0	**53**
	May-13		0	0	0	53	0	0	40	**53**
	Jun-13		0	0	0	0	0	0	40	**40**

			Stage Phase 1 dB(A)	Phase 2 dB(A)	Phase 3 dB(A)	Phase 4 dB(A)	Phase 5 dB(A)	Phase 6 dB(A)	Phase 7 dB(A)	Total All Phases
Receptor	North of Azim Kend/Masiv	R8	95	97	103	103	103	97	91	
Distance (m)			3200	3000	2000	2000	2300	2000	2800	
Screening			0	0	0	0	0	0	0	
Plant at Boundary			50%	50%	50%	50%	50%	50%	50%	
Façade			3	3	3	3	3	3	3	
On Time %			50%	50%	50%	50%	50%	50%	50%	
Noise level dB(A)			**42**	**44**	**54**	**54**	**53**	**48**	**39**	
R8	Jan-12		42	44	54	0	0	0	0	**55**
	Feb-12		0	44	54	0	0	0	0	**55**
	Mar-12		0	44	54	54	0	0	0	**57**
	Apr-12		0	44	54	54	0	48	0	**58**
	May-12		0	0	54	54	0	48	0	**58**
	Jun-12		0	0	54	54	53	48	0	**59**
	Jul-12		0	0	54	54	53	48	0	**59**
	Aug-12		0	0	54	54	53	48	0	**59**
	Sep-12		0	0	0	54	53	48	0	**57**
	Oct-12		0	0	0	54	53	48	0	**57**
	Nov-12		0	0	0	54	0	48	0	**55**
	Dec-12		0	0	0	54	0	48	0	**55**
	Jan-13		0	0	0	54	0	48	0	**55**
	Feb-13		0	0	0	54	0	0	0	**54**
	Mar-13		0	0	0	54	0	0	0	**54**
	Apr-13		0	0	0	54	0	0	0	**54**
	May-13		0	0	0	54	0	0	39	**54**
	Jun-13		0	0	0	0	0	0	39	**39**

			Stage Phase 1 dB(A)	Phase 2 dB(A)	Phase 3 dB(A)	Phase 4 dB(A)	Phase 5 dB(A)	Phase 6 dB(A)	Phase 7 dB(A)	Total All Phases
Receptor	Herder Settlement	R12	95	97	103	103	103	97	91	
Distance (m)			3600	2500	2500	2500	3900	4600	2900	
Screening			0	0	0	0	0	0	0	
Plant at Boundary			50%	50%	50%	50%	50%	50%	50%	
Façade			0	0	0	0	0	0	0	
On Time %			50%	50%	50%	50%	50%	50%	50%	
Noise level dB(A)			**38**	**43**	**49**	**49**	**46**	**38**	**35**	
R12	Jan-12		38	43	49	0	0	0	0	**50**
	Feb-12		0	43	49	0	0	0	0	**50**
	Mar-12		0	43	49	49	0	0	0	**53**
	Apr-12		0	43	49	49	0	38	0	**53**
	May-12		0	0	49	49	0	38	0	**52**
	Jun-12		0	0	49	49	46	38	0	**53**
	Jul-12		0	0	49	49	46	38	0	**53**
	Aug-12		0	0	49	49	46	38	0	**53**
	Sep-12		0	0	0	49	46	38	0	**51**
	Oct-12		0	0	0	49	46	38	0	**51**
	Nov-12		0	0	0	49	0	38	0	**50**
	Dec-12		0	0	0	49	0	38	0	**50**
	Jan-13		0	0	0	49	0	38	0	**50**
	Feb-13		0	0	0	49	0	0	0	**49**
	Mar-13		0	0	0	49	0	0	0	**49**
	Apr-13		0	0	0	49	0	0	0	**49**
	May-13		0	0	0	49	0	0	35	**50**
	Jun-13		0	0	0	0	0	0	35	**35**

Annex D: Piling and Concrete Breaking Noise Calculations

BS5228 Reference	Plant	Noise dB(A) at 10m	Trial Piling - 100m from North West Corner of SD2 EA			
			Scenario 1		Scenario 2	
			Qty	dB(A)	Qty	dB(A)
Table C3 Item 3	Tubular Piling Rig	88	1	88	0	0
Table C3 Item 1	Pre-Cast Concrete Piling Rig	89	0	0	1	89
Table C3 Item 29	55 tonne Crane	70	1	70	1	70
	Total Noise at 10m		**88**		**89**	
			Stage			
			Scenario 1		Scenario 2	
			dB(A)		dB(A)	
Receptor	Azim Kend	R1	88		89	
Distance (m)			2000		2000	
Screening			0		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**45**		**46**	
	Sangachal	R2	88		89	
			2100		2100	
			0		0	
			3		3	
			100%		100%	
			45		**46**	
Receptor	Umid West	R3	88		89	
Distance (m)			3950		3950	
Screening			0		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**39**		**40**	

BS5228 Reference	Plant	Noise dB(A) at 10m	Trial Piling - 100m from South-West Corner of SD2 EA			
			Scenario 3		Scenario 4	
			Qty	dB(A)	Qty	dB(A)
Table C3 Item 3	Tubular Piling Rig	88	1	88	0	0
Table C3 Item 1	Pre-Cast Concrete Piling Rig	89	0	0	1	89
Table C3 Item 29	55 tonne Crane	70	1	70	1	70
	Total Noise at 10m		**88**		**89**	
			Stage			
			Scenario 3		Scenario 4	
			dB(A)		dB(A)	
Receptor	Azim Kend	R1	88		89	
Distance (m)			2300		2300	
Screening			0		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**44**		**45**	
	Sangachal	R2	88		89	
			1200		1200	
			0		0	
			3		3	
			100%		100%	
			49		**50**	
Receptor	Umid West	R3	88		89	
Distance (m)			3500		3500	
Screening			0		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**40**		**41**	

BS5228 Reference	Plant	Noise dB(A) at 10m	Bored Piling, Pipe Crossing - Location South			
			Scenario 1			
			Qty	dB(A)	Qty	dB(A)
Table C3 Item 14	Large Rotary Bored Piling Rig	88	3	93	0	0
Table D2 Item 7	Pneumatic Hammer	92	3	97	0	0
Table D3 Item 101	Air Compressor	85	1	85	0	0
	Total Noise at 10m		**98**		**0**	
			Stage			
			Scenario 1		**0**	
			dB(A)		dB(A)	
Receptor	Azim Kend	R1	98		0	
Distance (m)			2400		1	
Screening			0		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**54**		**0**	
	Sangachal	R2	98		0	
			1200		1	
			0		0	
			3		3	
			100%		100%	
			60		**0**	
Receptor	Umid West	R3	98		0	
Distance (m)			2900		1	
Screening			0		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**52**		**0**	

BS5228 Reference	Plant	Noise dB(A) at 10m	Bored Piling, Pipe Crossing - Location South-East			
			Scenario 2			
			Qty	dB(A)	Qty	dB(A)
Table C3 Item 14	Large Rotary Bored Piling Rig	88	3	93	0	0
Table D2 Item 7	Pneumatic Hammer	92	3	97	0	0
Table D3 Item 101	Air Compressor	85	1	85	0	0
	Total Noise at 10m		**98**		**0**	
			Stage			
			Scenario 2		**0**	
			dB(A)		dB(A)	
Receptor	Azim Kend	R1	98		0	
Distance (m)			3000		1	
Screening			0		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**52**		**0**	
	Sangachal	R2	98		0	
			1500		1	
			0		0	
			3		3	
			100%		100%	
			58		**0**	
Receptor	Umid West	R3	98		0	
Distance (m)			2300		1	
Screening			0		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**54**		**0**	

	Plant	Noise dB(A) at 10m	Concrete Breaking - no screening			
			Scenario 1			
BS5228 Reference			Qty	dB(A)	Qty	dB(A)
Table D2 Item 6	Breaker	96	1	96	0	0
Table C1 Item 14	Crusher	82	1	82	0	0
			0	0	0	0
	Total Noise at 10m		**96**		**0**	
			Stage			
			Scenario 1		**0**	
			dB(A)		**dB(A)**	
Receptor	Azim Kend	R1	96		0	
Distance (m)			2500		1	
Screening			0		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**51**		**0**	
	Sangachal	R2	96		0	
			1540		1	
			0		0	
			3		3	
			100%		100%	
			55		**0**	
Receptor	Umid West	R3	96		0	
Distance (m)			3270		1	
Screening			0		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**49**		**0**	

	Plant	Noise dB(A) at 10m	Breaking with Local Screen			
			Scenario 2			
BS5228 Reference			Qty	dB(A)	Qty	dB(A)
Table D2 Item 6	Breaker	96	1	96	0	0
Table C1 Item 14	Crusher	82	1	82	0	0
			0	0	0	0
	Total Noise at 10m		**96**		**0**	
			Stage			
			Scenario 2		**0**	
			dB(A)		**dB(A)**	
Receptor	Azim Kend	R1	96		0	
Distance (m)			2500		1	
Screening			-5		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**46**		**0**	
Receptor	Sangachal	R2	96		0	
Distance (m)			1540		1	
Screening			-5		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**50**		**0**	
Receptor	Umid West	R3	96		0	
Distance (m)			3270		1	
Screening			-5		0	
Façade			3		3	
On Time %			100%		100%	
Noise level dB(A)			**44**		**0**	

APPENDIX 9E

Summary of Surface Water Modelling

1 Introduction

This Appendix presents a summary of the results obtained from the hydrological water modelling studies completed in the vicinity of the Terminal by Water Resource Associates (WRA) during 2008, 2010 and 2011.

The summary presented describes the current hydrological regime in the vicinity of the Terminal, the methods used for hydrological modelling (for current conditions and with the SD2 Infrastructure Project) and the results of the modelling studies. Findings associated with the future flood risk at key receptors, and the potential for cumulative impacts associated with upstream development of the proposed Qizildas Cement Plant are also presented. Where relevant, the uncertainty associated with model input and output data is discussed.

1.1 Hydrology in the Vicinity of the Sangachal Terminal

Sangachal Terminal is located approximately 30 km south of Baku, north east of Sangachal Town and lies within a dry area of Azerbaijan where annual average rainfall is about 220-250 mm. The amount of rainfall received varies significantly from year to year.

Hydrology in the vicinity of the Terminal is complex due to its position within a number of drainage catchment areas (refer to Figure 1.1) which are:

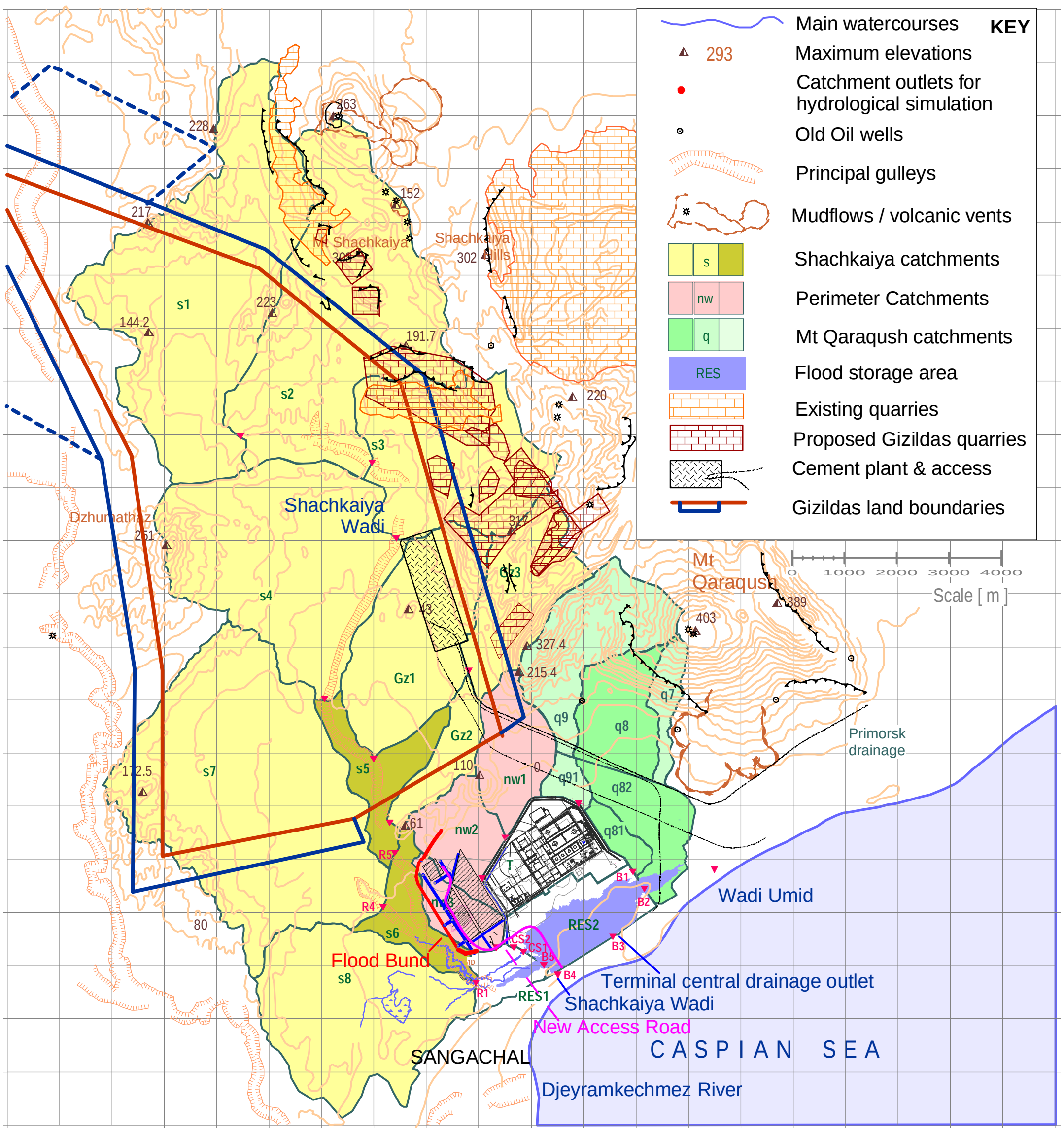
- Shachkaiya catchment areas (the Shachkaiya Wadi and its western tributaries);
- Northern and western perimeter catchment areas;
- Mt Qaraqush catchment areas which comprise:
  - Western Qaraqush slopes and north east perimeter channel;
  - Central Qaraqush slopes and Umid Wadi outlet; and
  - Flood storage areas between Sangachal Terminal and railway embankment.

During the 2010 modelling study catchment areas were divided into 23 sub-catchment areas to allow drainage of the Terminal to be characterised within a detailed hydrological model. The Terminal is directly affected by runoff from sub-catchments ‘nw1’, ‘nw2’ and ‘nw3’ to the west and northwest and ‘q81’, ‘q9’ and ‘q91’ which lie to the northeast and east of the Terminal (refer to Figure 1.1). Catchments ‘q7’, ‘q8’ and ‘q82’ drain the western slopes of Mt Qaraqush and enter flood storage area ‘RES2’ through culverts (denoted as B1 and B2 in Figure 1.1) beneath the existing Terminal access road.

Floodwaters around the existing Terminal are currently diverted into the perimeter flood protection channel. This situation will be modified by the SD2 Infrastructure Project which occupies a large part of what is shown as sub-catchment ‘nw3’ on Figure 1.1. The catchment area within the vicinity of the Terminal is 137 km^2 which includes low-lying areas to the south east along the third party pipeline corridor. The catchment area has two outlets which pass through the railway embankment and coastal highway:

- Bridge ‘B4’ under the railway and culvert B6 under the highway to the south close to Sangachal Town; and
- Bridge ’B3’ under the railway and culvert B9 beneath the highway midway between Sangachal Town and the current terminal access road (see Figure 1.2).

The third party pipeline corridor and railway embankment provide a barrier to outflow from the Shachkaiya Wadi and other surface water drainage channels.



© Water Resource Associates Ltd. Based on Soviet mapping at 1:50,000 scale and satellite imagery, with WRA data added.

Figure 1.1 Main Drainage Catchment Areas in the Vicinity of the Terminal

1.2 Proposed Qizildas Cement Plant

The proposed Qizildas Cement Plant is located in the upper catchment area of the Shachkaiya Wadi. It is understood that activities will include the quarrying of limestone within the catchment to be used in the cement production process. This upstream development, and potentially other industrial activities, have the potential to increase the level of flood risk at key receptors located downstream. At the time of writing, exact details and extent of these proposed developments were not known and a rough boundary of the proposed Qizildas Cement Plant is shown in Figure 1.1.

1.3 Scope of Hydrological Modelling Studies

The scope of hydrological modelling studies undertaken in the vicinity of the Terminal are summarised below:

1. Sangachal Terminal, Surface and Subsurface Water and Landscape Management, Scoping Study (WRA, 2008a). This study was carried out to ensure that the capacity of the perimeter drainage channels for the Terminal was sufficient to cope with a major flood event, and to investigate flood risk to Terminal facilities represented by the third party pipeline corridor. This Scoping Study comprised a desk study using existing data and did not involve the development of a new (or existing) hydrological model.

2. Sangachal Terminal Phase 2 Expansion, Surface Water Study, Stage 2 (WRA, 2008b). A hydrological modelling study of the disturbed drainage area within the third party pipeline corridor was undertaken. This Surface Water Study also supported the selection of access road options for construction of the SD2 Infrastructure Project (refer to Figure 1.2). The study findings were used to inform access road embankment heights and dimensions of culverts beneath various construction and access routes to the SD2 Infrastructure area. Hydrological modelling was undertaken using 'HEC-RAS' software and used rainfall data recorded at three meteorological stations within the region from 1992 to 2006.

3. Sangachal Terminal Phase 2 Expansion, Additional Surface Water Studies. (WRA, 2010). Further modelling of potential access road options was undertaken in 2010. The purpose of the report was to provide drainage advice and support to the SD2 Infrastructure design consultant. Additional study objectives included determining river flow data for annual maximum floods from three rivers within the region. Based on this information the SD2 Infrastructure design contractor selected a single route (refer to Figure 1.3).

4. Sangachal Terminal Phase 2 Expansion, Hydrological modelling in support of detailed design for the flood protection & drainage works (WRA, 2011). This study established the appropriate embankment height for the selected access road route and investigated culvert dimension options, where the road crosses the third party pipeline corridor (refer to point 'B8' on Figure 1.3). Further details of this work are given in Section 3.2 of this report. This study also provided guidance to the SD2 Infrastructure design contractor, on sizing of drainage channels and culverts within the new SD2 Infrastructure area (referred to as the 'subsidiary drainage system'). The study also provided design heights for a western flood protection berm for the SD2 Infrastructure area.

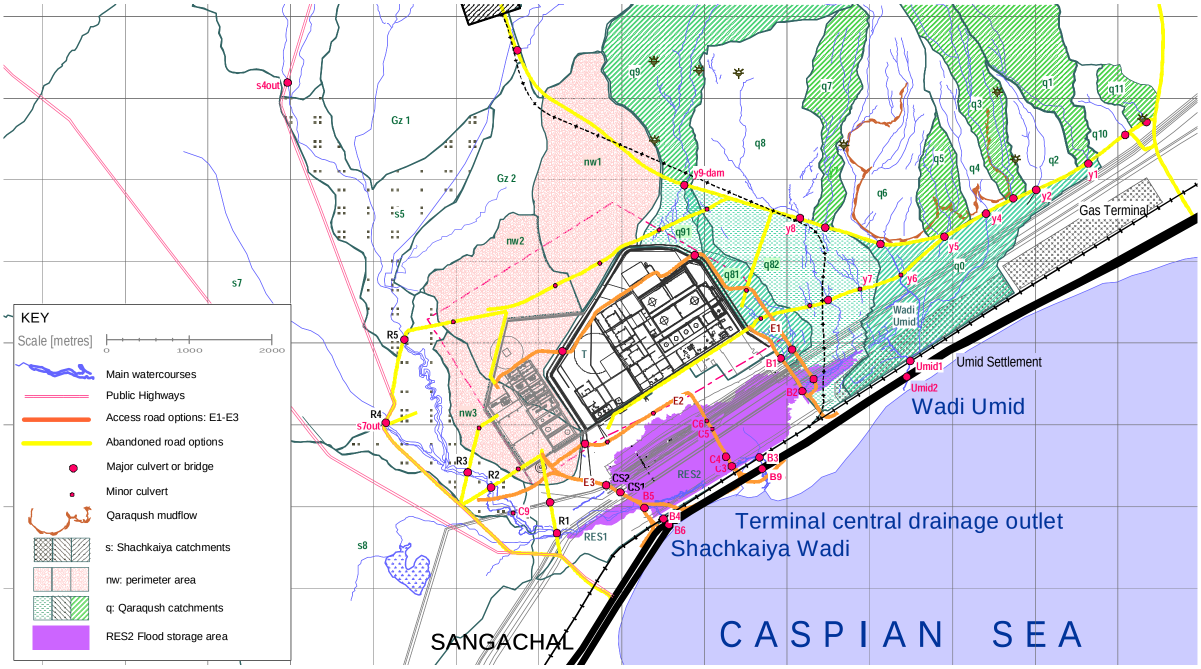


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Figure 1.2 Revised Access Road Options Studied (WRA, 2010)

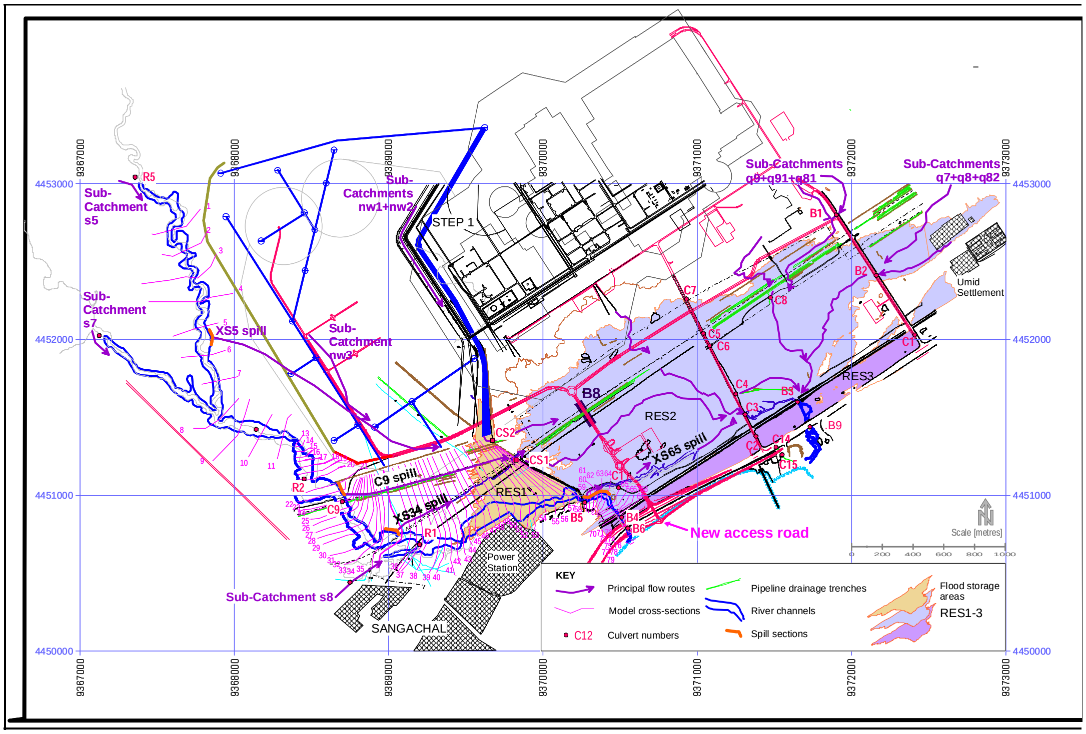


Figure 1.3 Principal Flow Routes Following SD2 Infrastructure Works and Final Access Road Layout

2 Modelling Methodology

2.1 Available Data

Hydrological modelling used a combination of statistical analysis of annual maximum flows from river gauging stations, local-rainfall data and a unit hydrograph approach to estimate flood hydrographs and runoff volumes.

2.1.1 Rainfall Data

Rainfall data was obtained from three meteorological stations located at Baku Airport, Alyat and at Mashtaga (refer to Figure 2.1). Daily rainfall data from 1977 to 2006 was obtained from for Baku and Alyat; rainfall data was obtained for Mashtaga between 1992 to 2006.

Figure 2.1 Rainfall Stations in the Absheron Region

Figure 2.2 shows the data at these stations for years 1992-2006 and although the three rainfall stations lie in Absheron region's coastal corridor, rainfall at Mashtaga is significantly higher than the rainfall at the other two sites. It is expected that the rainfall at Alyat and Baku will be more representative of the conditions at the Terminal (compared with Mashtaga), being in the rain shadow of the eastern end of the Caucasus Mountains. Consequently, the rainfall data from Mashtaga was not used. Some rainfall data is missing and marked as 'm' in Figure 2.2.

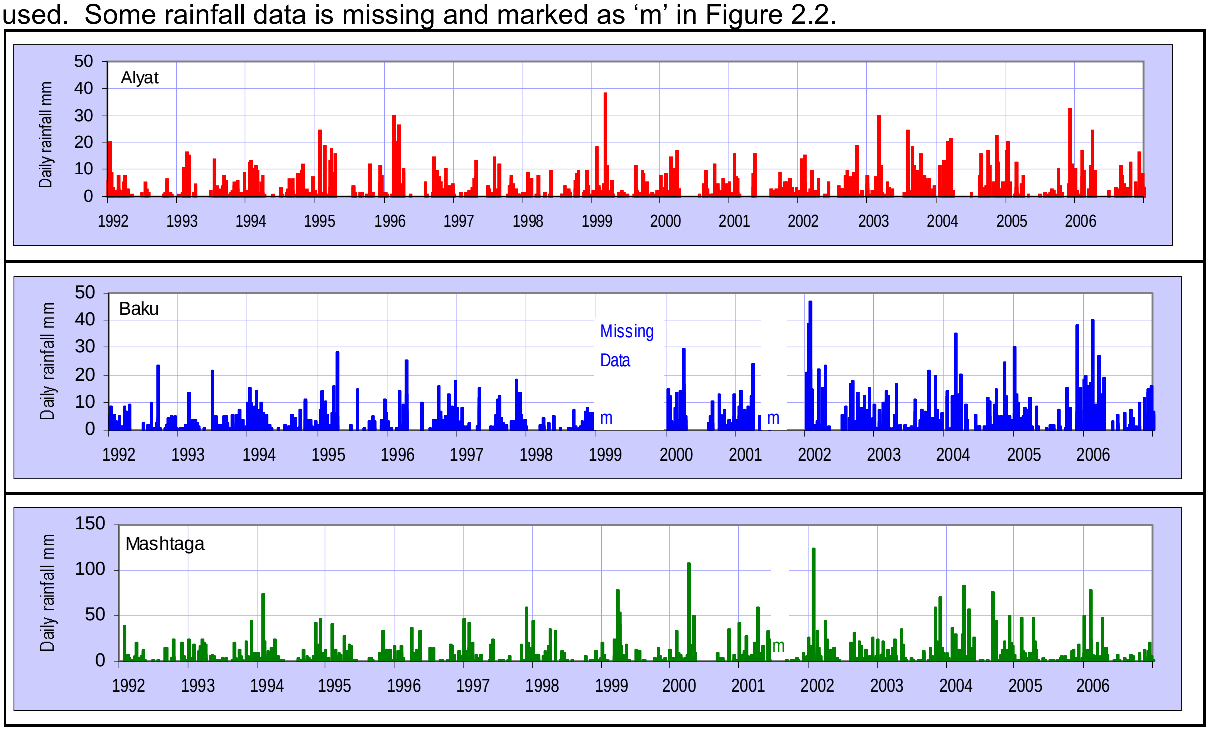


Figure 2.2 Daily Rainfalls in the Absheron Region

The National Meteorological Service provided daily rainfall data and flood return periods for 2008 which indicated that the 100-year, 24-hour rainfall value was 70 mm. A statistical analysis on 1977-2006 daily rainfall obtained from meteorological stations at Alyat and Baku was completed by WRA (2008b) using the statistical method of Gumbel and Log-Normal distribution. Results from Baku were subsequently incorporated into the hydrological model. The Log-Normal analysis produced a rainfall value of 72.4mm for the 100-year 24-hour rainfall; this is equivalent to an average rainfall intensity of 3.02 mm/hr. The Gumbel analysis produced a major flood event rainfall value of 66mm; this was lower than expected and not used in the hydrological model.

2.1.2 Surface Water Flow Data

A review of available data was undertaken and annual maximum flow data was obtained for the following surface water features: Djeyramkecmez (located immediately to the south of the Shachkaiya Wadi and shares a watershed with sub-catchments 's1' to 's8'), Sumqayit, and Pirsaat (refer to Table 2.1).

Table 2.1 Annual Maximum Flood Data Obtained

River	Flow Gauging Station	Area km^2	Number of Years Available	Years of Annual Maximum Flood Data Available	Mean Annual Flood (m^3/s)
Djeyramkecmez	Sangachal	1,170	14	1938-42, 1952-56, 1965-69	42.1
Djeyramkecmez	Umbaki	412	4	1957-58, 1960-61	12.4
Sumqayit	Perekeskül	1500	30	1937, 1939-40, 1942, 1958-75, 1976-85	77.8
Pirsaat	Poladli	995	21	1966, 1968-87	76.2
Pirsaat	Jassi	648	4	1937-38, 1940-41	26.8
Pirsaat	Zarat-Yeyberi	58	3	1961-63	2.88
Pirsaat	Sosseyniy Mocm	407	9	1953-56, 1958, 1860-63	41.2

2.2 Regional Flood Frequency Estimation

The problem associated with data gaps within the annual maximum flood data was addressed through the application of a statistical approach that estimates flood return periods. This approach (referred to as a Flood Frequency Analysis) essentially substitutes data gathered at gauging stations from other parts of the region or country which has similar climatic and catchment conditions. This can provide reliable estimates of major flood events.

There are limitations to the Flood Frequency Analysis approach. For example, where short periods of data exist (for 'N' number of years) the approach can only reliably estimate annual maximum flows for a return period of '2*N' years. Consequently, the 50 year return period for surface water features: Sumqayit at Perekeskül and Pirsaat at Poladli could be estimated. Estimation of the 100 year return period was not possible using the Flood Frequency Analysis approach due to the short periods of data available.

The Mean Annual Flood (MAF) value reflects the average of peak stream flows covering the timeseries data available. A variety of MAF values were taken from gauging stations located in western and central Azerbaijan as reported by Sutcliffe *et. al*., (2008). A total of 859 years of MAF data from 29 flow gauging stations was taken from Sutcliffe *et. al*., (2008) and combined with 85 years of data from the seven gauging stations collected by

WRA in 2010. The statistical relationship between LogMAF and LogAREA (catchment area) was subsequently investigated and the results are illustrated in Figure 2.3. Sangachal catchments are shown in red colour and data recorded from gauging stations elsewhere in Azerbaijan are shown in blue colour.

The correlation between flow gauging stations for Sangachal catchments and other stations in the region indicates that there is a broadly similar relationship between LogMAF and LogAREA. On this basis, MAF data was used to fill time periods in surface water flow, with model input data providing a reasonable level of confidence.

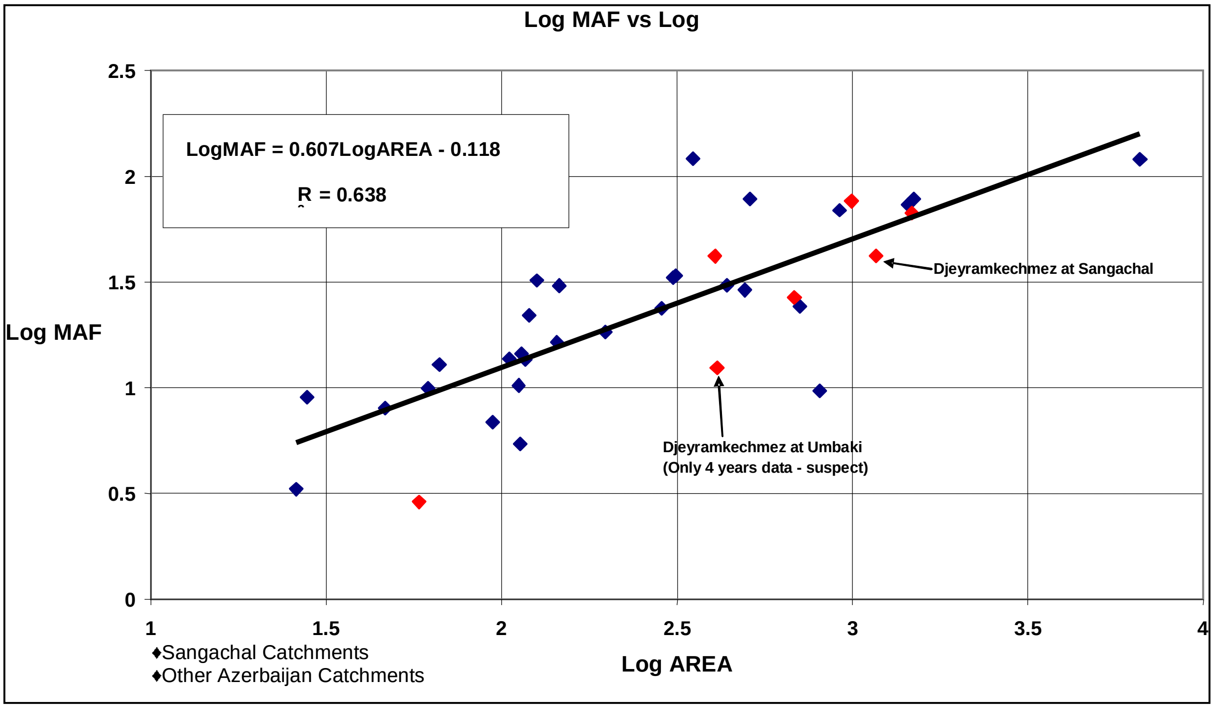


Figure 2.3 Relationship Between LogMAF and LogAREA for Sangachal Catchments (red) and regional data (blue)

Sutcliffe *et al*. (2008) also provides flood frequency curves for Azerbaijan where MAF data may be calculated to provide flood estimates 'Q(T)' for a range of return periods (T years). Using the flood frequency curves, flood peak discharge data can be calculated for each sub-catchment of interest (refer to Table 2.2). This approach combines uncertainty associated with Flood Frequency Analysis and in the use of flood frequency curves taken from Sutcliffe *et al.* (2008). Nevertheless, the preliminary flood estimates derived for a range of return periods provides useful flood values that reflects the maximum use of the data available. The flood peak discharge estimates in Table 2.2 can be used as a calibration in hydrological modelling and support subsequent flood estimation calculations.

Table 2.2 Flood Peak Discharge Based on Mean Annual Flood

Sub-catchment Reference	Area Name	Area (km^2)	Mean Annual Flood (m^3/s)	Peak Flood Discharge in m^3/s for given Return Period			
				Q(10)	Q(25)	Q(50)	Q(100)
s1-6	Shachkaiya Wadi	73.81	10.37	20.32	32.25	44.69	61.17
s7	Cexamud tributary	20.06	4.70	9.22	14.63	20.27	27.75
s8	Komplex CIR / Sangachal	9.99	3.08	6.04	9.58	13.27	18.17
nw1	Military Post - CPC North	3.56	1.65	3.23	5.12	7.10	9.72
nw2	Military Post - CPC Centre	2.12	1.20	2.36	3.74	5.18	7.09
nw3	WPC post phase 2	2.50	1.33	2.60	4.13	5.73	7.84
q9+q91	Qaraqush NPC	6.33	2.34	4.58	7.26	10.06	13.78
q8+q81+q82	Qaraqush B1+B2	6.89	2.46	4.82	7.65	10.60	14.51
T	Terminal area 1 (Ph1+2)	4.73	1.96	3.83	6.08	8.43	11.54
RES1	Shachkaiya Marshes	3.05	1.50	2.94	4.66	6.46	8.85
RES2	Central Drain floodplain	4.08	1.79	3.51	5.56	7.71	10.55
TOTAL		**137.12**					

2.3 Flood Hydrograph Estimation

Flood hydrographs were used to evaluate the extent of flood risk associated with temporary storage within the third-party pipeline corridor at 'RES1' and 'RES2' (see Figure 1.3). These locations allow surface water following high intensity rainfall events to be stored (or retained) behind drainage culverts during peak flow conditions.

A unit hydrograph method was used to derive streamflow hydrographs that reflect high-intensity rainfall events within catchments. The unit hydrograph of any catchment reflects runoff generated by a 'unit' of rainfall in a 'unit' period of time. For catchments which have limited data available, unit hydrograph parameters can be estimated using a range of calculation methods that link unit hydrograph time to peak 'Tp'; stream length 'L'; and slope 'S'. The most widely used formulae are those of Kirpich (1940), US Soil Conservation Service (SCS) (1986), and the UK Flood Studies Report (FSR) (1975). These formulae are shown below:

$Tp_{(Kirpich)} = 0.0195\ L^{0.77} S^{-0.385}$ where 'L' is stream length in m; and 'S' is slope in m/m.

$Tp_{(SCS)} = 0.00526\ L^{0.8}(1000/CN - 9)^{0.7}\ S^{-0.5}$ where 'L' is length in ft; 'S' is slope in ft/ft; and 'CN' the runoff curve number.

$Tp_{(FSR)} = 2.8(L/\sqrt{S})^{0.47}$ where 'L' is stream length in km; and 'S' is stream slope in m/km.

Each of the three equations above are suited to different types of catchment. For example, the FSR and Kirpich method are designed for catchments with an area greater than 20km^2, whilst the SCS equation was developed for smaller catchments. Consequently, TP estimates were used as a rough average of the FSR and Kirpich method where catchments area was greater than 20 km^2, and the FSR and SCS methods was used for smaller catchments.

The 2011 WRA study calculated flood hydrographs for different storm durations (6, 12, 18, 24, 36, 48 and 72 hours). Two 'indicator' catchments were also used to calculate flood hydrographs which were the largest sub-catchment (Shachkaiya Wadi) and a combination of two smaller sub-catchments ('nw1' and 'nw2').

The results of the analysis of peak flood and flood volume for each indicator catchment are shown in Table 2.3 and indicates the larger Shachkaiya Wadi catchment is more sensitive to longer duration storms (18 to 24 hours), compared with the smaller sub-catchments (12 to 18 hours). The minimum duration of a storm that could result in flood risk was calculated (often called the 'critical storm duration') at 18 hours and this was used in hydrological modelling to define the major flood event.

Table 2.3 Results of Storm Duration Trials

Duration (hrs)	Flood Peaks for Return period (years) (Flows in m^3/sec)				Flood Volumes for Return period (years) (Volumes in Million m^3)			
	10	20	50	100	10	20	50	100
(i) Shachkaiya Wadi								
6	26.2	31.6	39.3	45.5	1.18	1.4	1.72	1.98
12	29.9	36.4	45.4	52.6	1.48	1.74	2.12	2.42
18	33.5	40.8	51.8	60.9	1.84	2.14	2.59	2.97
24	32.4	40	50.9	60.1	2.05	2.36	2.81	3.19
36	29.9	37.7	49.6	60	2.59	2.89	3.38	3.82
48	26.9	34.6	46.5	56.7	3.14	3.45	3.92	4.35
72	21.6	28.2	38.8	51.3	4.24	4.48	4.89	5.4
(ii) Central Perimeter Channel								
6	10.8	13.3	16.9	19.8	0.087	0.106	0.133	0.154
12	10.2	13	16.9	20.1	0.103	0.125	0.156	0.181
18	9.5	12.3	16.4	19.9	0.117	0.14	0.176	0.206
24	8.8	11.6	15.7	18.9	0.13	0.156	0.194	0.225
36	7.1	9.6	13.3	16.5	0.156	0.181	0.222	0.258
48	5.7	7.9	11.1	13.9	0.182	0.207	0.246	0.282
72	3.5	5.1	7.3	9.9	0.235	0.256	0.288	0.33

For catchments where no river gauging data was available, the percentage of incoming storm rainfall that produces runoff was estimated using an approach outlined by the US Soil Conservation Service (1986). This approach uses a 'curve number' (CN) to reflect the relationship between rainfall and runoff which is a function of soil type and land cover. To identify a representative CN-value the 14 years annual maximum flood flow data for Djeyramkecmez at Sangachal, and the Azerbaijan flood frequency curves of Sutcliffe *et al*. (2008) were used.

Using the 100 year, a 24-hour design storm rainfall value of 72 mm and estimated unit hydrograph, various CN-values were varied empirically, until the resulting hydrograph peak matched the 100 year flood peak of 61.17 m^3/s predicted for the Shachkaiya Wadi (s1-6) (refer to Table 2.2). The optimum fit between hydrograph peaks was achieved using a CN value of 78. This uses a variable runoff percentage for different storm durations from 57% for a 6 hour storm, to 41% for a 72 hour storm. The percentage runoff for the recommended 18 hour storm was 48%, and for the 24 hour storm was 46%. The CN value of 78 was subsequently applied across all the sub-catchments as the computed runoff rate seemed reasonable for catchments visually inspected during site visits.

2.3.1 Climate Change Effects on Runoff Volumes

In order to reflect the way in which climate change could influence flood risk in the future through changes in the distribution and intensity of rainfall events, BP commissioned a report from Dr Ralph Toumi from Imperial College London. The report entitled: '*BP Climate Change Impact Project: Interim Report*' (January 2011) aimed to identify the flood-related consequences of climate change. The report concludes that the expected change in 100 year daily rainfall for Sangachal region from 2040 to 2060 was an increase of 10%. Whilst considerable uncertainty is associated with the 10% increase, the report recommended that historical storm data should be increased by 10% for hydrological flood modelling studies to reflect the consequences of climate change. The model input data was modified accordingly.

Rainfall distribution was identified through a combination of reviewing storm profiles from other arid regions and using the 90% summer rainfall profile from the FSR. The design storm rainfall was subsequently applied to each sub-catchment unit hydrograph using a CN value of 78, and the resulting peaks and runoff volumes are shown in Table 2.4.

Table 2.4 FSR-SCS Flood Peaks and Volumes for the 100 Year Event

Sub-catchment No	Catchment Area Name	Area km^2	Mean Annual Flood (m^3/s)	Q100 Hydrograph Peak (m^3/s)	Q100 Regional Equation peak(m^3/s)	Total Flood Volume (m^3)
s1-6 + Gz1 – Gz3	Shachkaiya Wadi	73.15	10.20	60.89	61.17	2,969,995
s7	Cexamud tributary	20.06	4.70	22.79	27.75	766,378
s8	Komplex CIR / Sangachal	9.99	3.08	14.28	18.17	371,852
nw1 + nw2	Drainage to CPC	5.96	2.25	20.93	13.96	210,274
q9 + q91	Qaraqush NPC	6.33	2.34	14.70	13.78	227,375
q8 + q81 + q82	Qaraqush B1+B2	6.89	2.46	12.12	14.51	251,965
T (Ph 1)	Terminal area 1 (Phase 1 only)	3.32	1.58	16.24	9.31	128,209
SD2	Phase 2 Terminal	1.94	1.14	8.83	6.72	70,421
RES1	Western flood storage area	3.05	0.84	15.63	8.85	123,246
RES2	Central Drain floodplain	4.08	1.79	34.21	10.55	239,350
Total inflow to Flood storage areas and flowing out through B3 and B4		**137.12**	**n/a**	**112.23***	**89.1****	**5,359,065**

**** Note: The peaks do not coincide so this figure is not the sum of individual sub-catchment peak flows***
***** Derived from Eqn-1 plus regional growth curves and not sum of peaks***

Generally, the 100 year flood estimates derived by the unit hydrograph method shown are consistent with those derived from use of the MAF approach and, also, flood frequency curves from Sutcliffe *et al*. (2008). Inconsistent results were obtained from the Terminal and flood storage areas 'RES1' and 'RES2' where the unit hydrograph approach produced significantly higher peak flows. This was expected as the runoff coefficient used on these largely impermeable areas was greater than the predominantly rural areas used in the MAF approach calculations.

The flood volume estimates given in Table 2.2 were calculated by converting rainfall to runoff and this data for each sub-catchment was used in the hydrological modelling study. Based on the results, the total 100 year flood volume channelled through the Shachkaiya Wadi and central drainage outlets will be 5.36 Mm^3, divided amongst the various sub-catchments.

The resulting sub-catchment hydrographs are shown in Figure 2.4 for a major flood event.

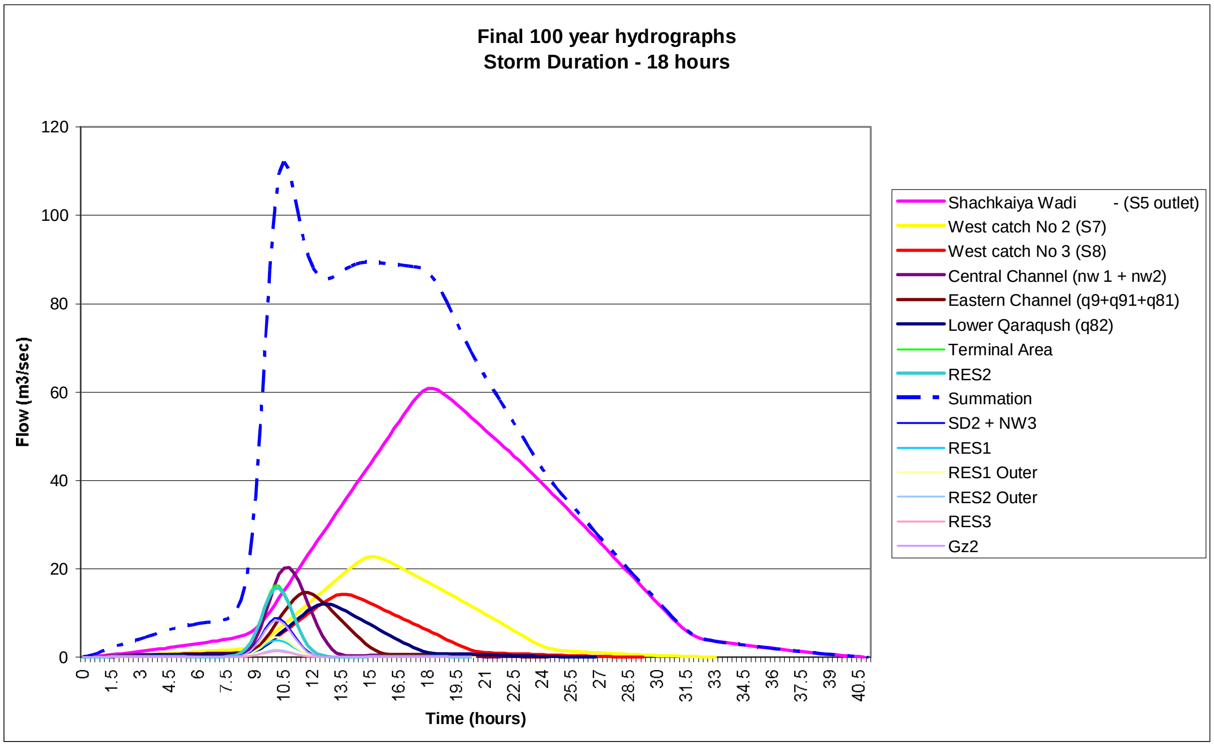


Figure 2.4 FSR-SCS Flood Hydrographs for Existing Conditions – 18 Hour Duration Storm

2.4 Hydrological Modelling

The WRA December 2008 (WRA, 2008b) report used 'HEC-RAS' hydrological model which was configured using results of a 2003 Shah Deniz topographic survey between the Terminal and Caspian Sea. The 2010 and 2011 WRA studies were undertaken using ISIS Pro v3.4 software. Annex 1 gives further details of the ISIS software and its applicability.

A field survey and visual inspection of surface water drainage flows in April 2010 assisted development of the hydrological model. As a result of the field survey, the Shachkaiya Wadi was represented as a linear flood corridor with channels and margins accurately derived from the field survey and supporting maps. The Shachkaiya corridor has a number of spill sections which permits water to move into areas defined by topographic depressions.

Upstream of the railway line there are two 'off-line' storage reservoirs that are separated by a prominent NW-SE trending earth embankment that continues from the end point of the CPC at 'CS2' outlet to 'B5' bridge (refer to Figure 1.3). The area upstream of the new access road embankment 'RES1' will maintain higher flood levels in front of the planned SD2 Infrastructure area. The outflow from 'RES1' is controlled by the dimensions of two openings: the 'B8' box culvert beneath the new access road and the railway bridge 'B4'. The volumetric storage in this area was estimated to be 0.751 Mm^3 at -15 m mean seal level (MSL).

The central flood storage area 'RES2' acts as a large, flood attenuation lake and the relationship between elevation and storage has been calculated from field survey data. Although the third party pipeline corridor and associated trenches act as partial obstacles to flow, they also cause dispersal flows to merge as they enter the storage area. These obstacles also divert outflow from the Terminal and perimeter channels along the northerly of the Shachkaiya overspill routes at 'C9' and 'S34'. The volumetric storage in this area was calculated to be 1.848 Mm^3 at -17 m MSL.

Finally, water passing under the railway enters a narrow strip of low-lying land which provides further floodwater storage 'RES3' controlled by the outlet capacity of the culverts under the coastal highway at 'B9' (previously called 'C16') and 'B6'. The volumetric storage capacity of this area was calculated to be 0.249 Mm^3 at -17 m MSL.

The ISIS model layout is reflected in Figure 2.6 which illustrates the following:

- Flow directions indicated by blue arrows;
- Hydrograph inputs are labelled 'H1-13' and shown in green colour;
- Bridges and culverts are labelled 'B1-9' and shown in pink colour;
- Spills, where water will overtop the banks of the main channel are labelled 'SP1-6' and shown in light blue; and
- Reservoirs where flood water will be temporarily stored are labelled 'RES1-3' and shown in dark blue.

A summary of the drainage structures are listed in Table 2.5.

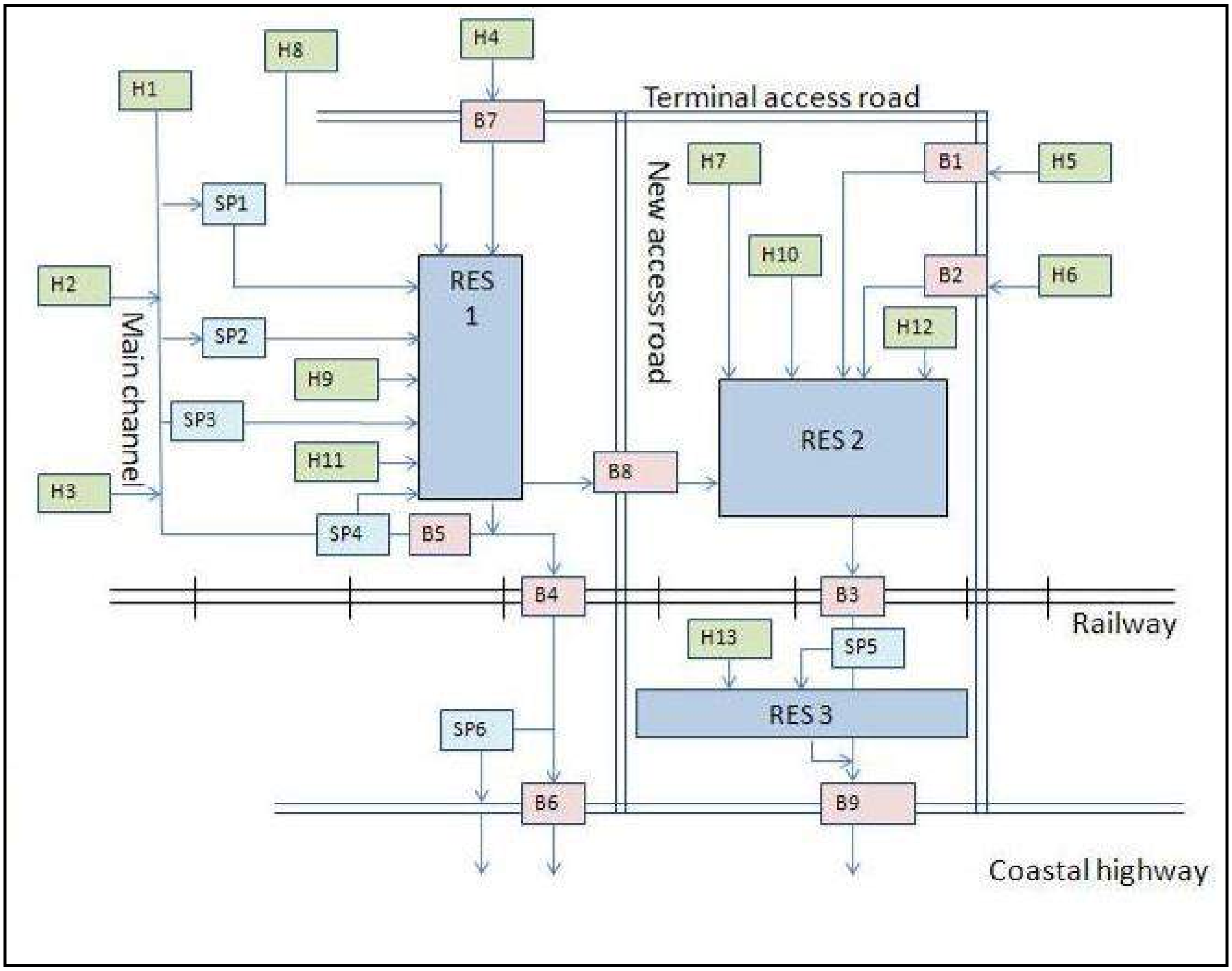


Figure 2.5 ISIS Model Schematic

Table 2.5 Definitions of Hydrographs, Bridges and Spills in the Model Schematic.

Text in brackets represents earlier or alternative labels for the same feature.

Hydrograph Number	Description	Bridge Number	Description
H1	Shachkaiya Wadi (S5 outlet)	B1	Terminal access road bridge
H2	West Catchment No 2 (S7)	B2	Terminal access road bridge
H3	West Catchment No 3 (S8)	B3	Railway bridge
H4	Central Perimeter Channel (nw 1 + nw2)	B4	Railway bridge near Sangachal Town
H5	Eastern Perimeter Channel (q9+q91+q81)	B5	Old access road bridge
H6	Lower Qaraqush (q82)	B6	Coastal highway bridge near Sangachal Town
H7	Terminal Area	B7	New access road bridge (BRC5 on option E3 in previous study)
H8	Subsidiary Drainage (essentially nw3 in previous study)	B8	New access road bridge (BRC3 on option E3 in previous study)
H9	Reservoir 1 direct rainfall	B9	Coastal highway bridge (C16)
H10	Reservoir 2 direct rainfall		
H11	Reservoir 1 outer area		
H12	Reservoir 2 outer area		
H13	Reservoir 3 direct rainfall		

Spill Number	Description
SP1	Main channel spill to reservoir 1 (XS5 spill)
SP2	Main channel spill to reservoir 1 (C9 spill)
SP3	Main channel spill to reservoir 1(XS34 spill)
SP4	Main channel spill at B5 to reservoir 1
SP5	Spill to and from reservoir 3
SP6	Reservoir 1 spill back into main channel downstream of B5

2.5 Scenarios Examined

The aims of the 2011 hydrological modelling study were to provide drainage advice and support to the SD2 Infrastructure design contractor with regard to the following:

- The height of a new flood protection berm along the eastern and north eastern margins of the SD2 Infrastructure area;
- The size of channels and culverts which comprise the subsidiary drainage system design;
- The design of the new access road and height and size of embankments and culverts, particularly proposed culvert ‘B8’ where the new access road crosses the third party pipeline corridor; and
- How to maximise flows through the western railway bridge ‘B4’ close to Sangachal Town in order to minimise outflows through the CPC bridge ‘B3’ with the aim of reducing the risk for the railway embankment to be flooded (which was noted in the WRA 2010 study).

3 Simulation Results

3.1 Existing Terminal Flood Risk

The first study (WRA, 2008a) was undertaken to check the capacity of the perimeter drainage channels for the existing Terminal, and determine the level of flood risk of the existing Terminal and associated facilities. The study concluded that the perimeter channels were adequate for a 100 year flood, even though they were designed for a 10 year event. The review confirmed that the Terminal was adequately protected from flooding through its existing configuration of perimeter drainage channels.

3.2 SD2 Infrastructure Project Hydrological Modelling

Hydrological modelling for the SD2 Infrastructure Project involved an evaluation of the optimum design of new drainage infrastructure and the location and design height of access roads and embankments. A hydrological model was used (WRA, 2008b) to investigate the behaviour of low-lying storage area 'RES2' where runoff from Qaraqush catchments, northern catchments 'nw1' and 'nw2' and stormwater runoff from the Terminal all gathers. The 'RES2' storage area also receives flood waters that spill from the Shachkaiya Wadi channel at a number of low points along its left bank. Some of these spills flow back into the lower Shachkaiya Wadi system and flow out through bridge 'B4'. However, a significant portion of flow is intercepted by the third-party pipeline corridor system and diverted north eastwards into the low-lying 'RES2' storage area.

The modelling identified that this diversion of flood waters spilling out of the Shachkaiya Wadi channel into the 'RES2' storage area from a major flood event would result in over-topping of the railway along a 250m length above bridge 'B3'. Modelling results suggest that the extent of over-topping could be up to 0.7m over the ballast and 0.1m above rails, potentially causing damage through scouring (erosion) and failure of the railway embankment. The hydrological model indicated that flood risk is linked to the large catchment area upstream of the railway embankment. It is important to note that the impact of additional runoff from the Terminal and SD2 Infrastructure Project did not add to flood risk, with the additional runoff being barely noticeable in model results.

The existing flood risk to the railway was studied in detail by WRA in 2010. Possible solutions include improvements to a number of drainage routes which diverts flow from the Shachkaiya Wadi to the railway bridge 'B4' near Sangachal Town, thereby reducing flows into 'RES2' which later flows into 'B3'. Although drainage route improvements were proposed in an earlier study by URS (URS, 2003) and expanded upon by WRA (WRA, 2010), detailed modelling to identify the optimum configuration of drainage improvements was not undertaken.

3.2.1 Modelling the New SD2 Access Road

During hydrological modelling work for the new SD2 Infrastructure access road, a drainage problem was detected where a tributary of the Shachkaiya Wadi had been diverted to the south, towards the SD2 Infrastructure Area connected to construction of a local access road from Sangachal Town. It is possible that construction works were related to a haul road to be used for regional quarrying activities, although the purpose of the access road is not known. The drainage problem is caused by an absence of a culvert constructed beneath the local access road which has resulted in the road embankment acting as a barrier to flow and subsequently diverts flood waters to the south. The drainage problem was identified from Google Earth images (refer to Figure 3.1) and later confirmed by the April 2010 field survey.

A proposed solution to this drainage problem involves extending the western flood protection berm (or embankment) to the north-east to meet the hillside base, to divert flood water south-west back into the natural channel (refer to Figure 3.1).

Figure 3.1 Diversion of Wadi by Haul Road North of SD2 Infrastructure area

Hydrological modelling indicated that culverts 'B7' and 'B8' (see Figure 1.3) can adequately convey flows beneath the SD2 access road resulting from a 1 in 100 year flood without causing localised flooding. A sensitivity analysis was undertaken on the total number of culverts used and their combined cross-sectional area, to determine how drainage flows are affected.

The sensitivity of the sizing of culvert 'B8' was assessed by varying the width of the five proposed box culverts to determine their optimal dimension. The peak flow levels at culvert 'B8' for different scenarios are listed in Table 3.1 where for each scenario, five box culverts 2.1m high with increasing width were tested along with different surface roughness values (referred to as Mannings 'n'). Results of the sensitivity analysis indicate that changes in culvert width have only a minor effect on peak flood levels.

Increases in surface roughness used to simulate the effects of greater numbers of smaller culverts which have the same, combined cross-sectional area, has no apparent effect once the total culvert cross sectional exceeds $63m^2$. The lack of effect is linked to the large storage volume provided by 'RES1' and the gentle slope between 'RES1' and 'RES2' at culvert B8 which generates a moderate flow over the duration of the event, leading to a relatively low peak of 2.12 m^3/sec for the major flood event.

Table 3.1 Peak Levels at Culvert B8 Inlet for Different Scenarios

Scenario	Peak Levels at Culvert B8 for100 year 18 hour flood (m MSL)
3m culvert width	-18.914
6m culvert width	-18.938
9m culvert width*	-18.942
12m culvert width	-18.943
0.015 Mannings n*	-18.942
0.03 Mannings n	-18.942
** Initial estimates.*	

Following a request from the SD2 Infrastructure design contractor an additional scenario was completed using the 10 year flood hydrographs which resulted in peak levels at culvert 'B8' being slightly lower at -18.952 m AOD for the five 9m culverts. Overall, the results indicate that there is no need to expand the current number and width of culverts included in the Base Case Design.

3.2.2 Flood Risk to the Railway at Central Drainage Bridge 'B3'

Hydrological modelling work that determined the optimum embankment height and size of culverts for the new SD2 access road indicated that new embankment will reduce existing high flood risk levels at the railway.

3.2.3 Flood Risk to the Coastal Highway at Culvert B6

The WRA reports of December 2008 (WRA, 2008b) and October 2010 (WRA, 2010) noted that the Coastal Highway culvert 'B6' located downstream of railway bridge 'B4' close to Sangachal Power Station, was at risk of flooding during the major flood event. Hydrological modelling undertaken in 2010 indicates that between 200m to 300m of the highway would be flooded in a major flood event, to a maximum depth of 0.05m to 0.10m. In this scenario, sediment-laden water would breach the road surface and cause physical damage to the highway. The exact location of the breach is difficult to predict due to the lack of detailed topographic survey data. The SD2 Infrastructure Project would not contribute in any significant way to the risk of nature of flooding at the highway.

The future risk of flooding to the Coastal Highway at culvert 'B6' from a major flood event will be slightly increased by the SD2 Infrastructure Project, as greater flows will be diverted from culvert 'B3' to 'B4' which ultimately flows into 'B6'. However, there will be a significantly reduced flood risk to the railway above bridge 'B3'. Following construction of the new SD2 access road, the access ramps to this route may provide a safe alternative route for traffic during such rare flood events. Consequently, the increased risk of culvert 'B6' overtopping and leading to flooding of the highway is offset by the alternative route provided by the new SD2 access road ramps during any major flood event.

3.2.4 Impact of Proposed Qizildas Cement Plant and Upstream Catchment Development

Construction of Qizildas Cement Plant which may include future quarrying activities for excavation of raw material upstream of the Shachkaiya Wadi catchment to the north of the Terminal, could be accompanied by similar industrial developments upstream. These activities have the potential to modify runoff volumes and reduce the response time of the catchment to rainfall events, reflected by lower 'Tp' values (i.e. the time to the peak of the unit hydrograph would shorten).

In order to investigate hydrological changes associated with development of Qizildas Cement Plant, the hydrological model was re-run with increased CN values (the relationship between rainfall and runoff) and reduced 'Tp' values to represent the potential changes linked to upstream developments of the main Shachkaiya Wadi catchment ('s1', 's2', 's3', 's4' and 's5' combined with runoff from 'Gz1', 'Gz2' and 'Gz3') and upper parts of the Cexamud tributary 's7'. The results indicate that peak runoff values from the major flood event increases from 60.9 m^3/sec to 80.0 m^3/sec for the Shachkaiya Wadi catchment, and from 22.8 m^3/sec to 29.9 m^3/sec. Total runoff values at 's7' (the Cexamud tributary) increases by 0.88 Mm^3. Revised 10 year hydrographs are illustrated in Figure 3.4

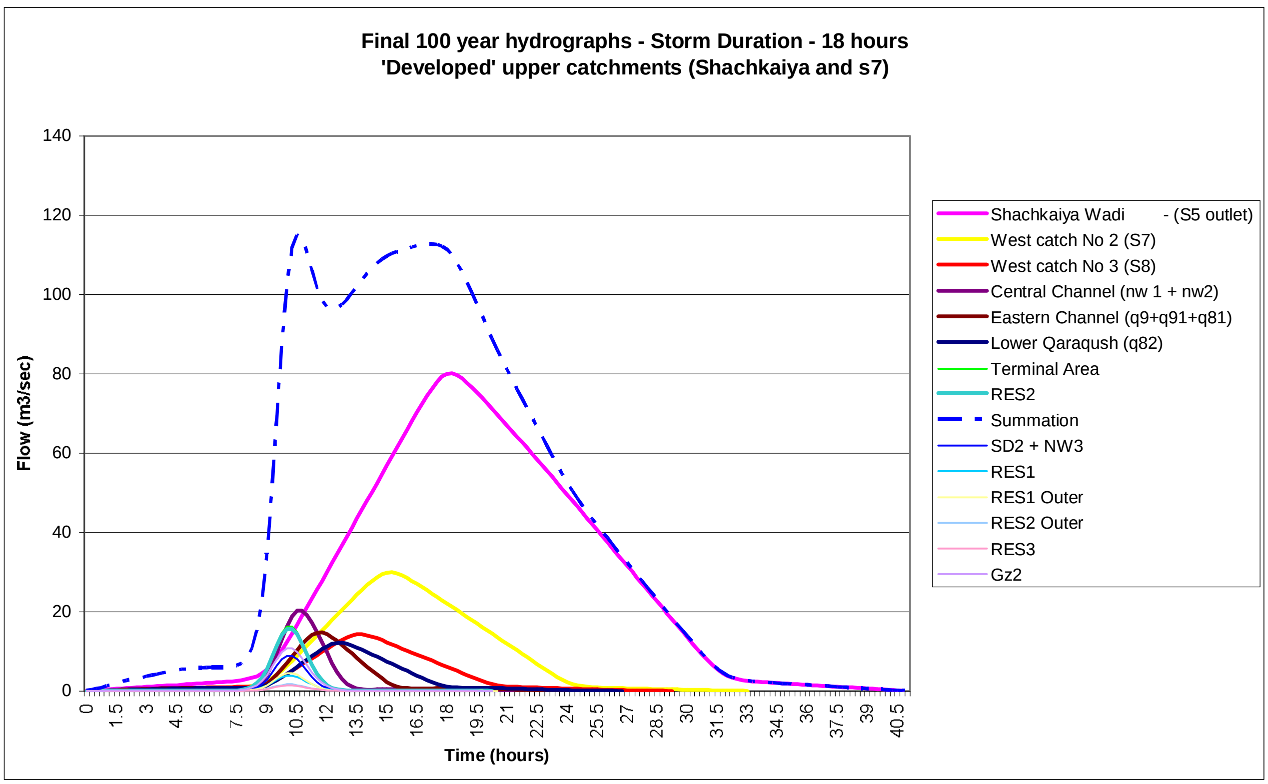


Figure 3.2 100 year Hydrographs for Upstream Catchment Developments

The impact from upstream developments upon critical locations are summarised in Table 3.2 and peak flood levels are stated with, and without, the upstream development.

Table 3.2 Impacts of Upstream 'Development' on 100 Year 18 Hour Levels at Critical Locations

Critical Location	100 Year Peak Flood Level (m) Without Development	100 Year Peak Flood Level (m) With Development
Culvert 'B5'	-18.98	-17.55
Railway bridge 'B4'	-20.95	-20.48
Coastal Highway culvert 'B6'	-23.70	-23.14
Culvert B8 under new access road	-18.94	-18.94
Central railway bridge 'B3'	-21.79	-21.79
Central Coastal Highway culvert 'B9'	-23.27	-23.27

The results of hydrological modelling indicates that water levels from a major flood event will increase at bridges/culverts 'B4', 'B5' and 'B6' due to the direct effect of greater runoff. Impacts to bridges/culverts 'B8', 'B3' and 'B9' are not impacted which confirms that there are relatively low interflows between the main Shachkaiya Wadi system into central storage area 'RES2'.

The predicted increase of 0.56m at Coastal Highway culvert 'B6' is likely to be an overestimate as limited survey data for the elevation of the highway elevations is available for this general area. The highway slopes away southwards at this location and water will be diverted out to the Caspian Sea along a significant stretch of road. Unfortunately, current survey data does not allow a reliable estimate of a change in flood level across the highway to be accurately determined.

4 Conclusions

Hydrological modelling undertaken by WRA during 2008 to 2011 focused on providing flood flows and flood elevation data to the SD2 Infrastructure design contractor. Such studies initially considered the capacity and effectiveness of the perimeter flood protection channels of the Terminal, then provided advice on road embankment heights and drainage culvert sizes for a number of alternative access road routes. The access route studies were undertaken in two stages, as route options were revised during design work for the SD2 Infrastructure Project.

Hydrological initial modelling demonstrated that the perimeter flood protection channels for the Terminal appeared to have been conservatively designed, and that they were capable of carrying flood waters up to, and including, the major flood event. Consequently, the Terminal can be considered to be safe in its current design, from water derived from catchments to the north and east.

The studies also demonstrate that the influence on local drainage patterns caused by presence of over-ground pipelines, unfilled trenches and spoil heaps along the third party pipeline corridor, which results in the diversion of over-bank spills from the Shachkaiya Wadi channel into 'RES2'. The diversion of flows results in increased flood risk to the railway embankment, as the central drainage bridge beneath the railway 'B3' will be unable to pass flows during a major flood event and result in overtopping of the embankment. This type of flood event could lead to significant damage as flood waters would pass over the embankment at a height of 0.7m resulting in scouring and physical damage. The contribution of flood risk to the railway embankment that is associated with the SD2 Infrastructure Project was barely detectable in hydrological modelling.

The 2011 hydrological modelling demonstrated that construction of the new SD2 access road embankment will significantly reduce flood risk to the railway embankment as it will prevent flood waters associated with the Shachkaiya Wadi from entering 'RES2' which drains to the Caspian Sea via 'B3'.

The 2011 hydrological modelling confirmed the overall need for a western flood protection berm and supported the design in terms of its height and lateral extent. The results indicated that an embankment is only required at specific sections along its proposed length, due to the presence of existing topographic depressions. These findings have been incorporated into the Base Case Design. In addition, the western extent of the flood protection berm required extension to prevent water from a small tributary of the Shachkaiya Wadi to cause flooding to the northern part of the SD2 Infrastructure area. Following incorporation of these design changes into the Base Case Design, the SD2 Infrastructure area is considered to be protected from a major flood event.

The 2001 hydrological modelling demonstrated that existing bridge 'B4' beneath the railway east of Sangachal Town and Sangachal Power Station has sufficient capacity to cope with flood waters from a major flood event. However, culvert 'B6' under the Coastal Highway immediately downstream of 'B4' is not able to channel these flood waters, resulting in overtopping the highway to reach the Caspian Sea. The three concrete box section culverts at 'B6' have a combined cross-sectional area of $17.6m^2$ which is significantly less than 'B4' which is $30.7m^2$.

The extent of flooding to the Coastal Highway cannot be predicted with a high level of certainty as there is not a complete set of topographical elevation data available for the road. Using available data, the hydrological model predicts that flood waters would impact a length of 300m up to 0.05 to 0.10m above the upper level of the road. Following construction of the new SD2 access road, the access ramps to this route would provide a safe alternative route for traffic during such flood events. The 2011 study also confirmed that Sangachal Town and Sangachal Power Station are sited on elevated ground and would be unaffected by a major flood event.

The 2011 Hydrological modelling results indicate that whilst the SD2 Infrastructure Project increases total runoff rates and volumes into the from the Shachkaiya Wadi, there are no increases in downstream flood or flood risk levels of more than 5mm at any of the key receptors included in the model. Key receptors were: Sangachal Town; Sangachal Power Station; the Caravanserai; the railway line; and the Coastal Highway.

Development of Qizildas Cement Plant (located approximately 4km north of the Terminal within the upper Shachkaiya Wadi catchment) and the associated access road and railway spur may have a significant impact on the flood risk and flood levels within lower reaches of the wadi. Details associated with the location, extent of quarrying activities and the exact position and width of the access roads are not available. Hydrological modelling using available data indicates that runoff could increase by up to 33 % from a major flood event. The development may increase existing flood levels at 'B4' by 0.47m and the Coastal Highway culvert 'B6' by up to 0.5m. Flood levels at 'RES2', 'B3' and 'B9' are not likely to be modified as the new SD2 access road embankment will protect this area from the effect of the increased flood runoff. There is however, some residual uncertainty associated with these predicted changes due to a combined lack of a ground elevation data, and absence of detailed information on the development.

Increased runoff flows from the Qizildas Cement Plant may have a significant effect on flooding of the Caravanserai located immediately to the west of railway bridge ‘B4’. Ground flood elevations at the State protected monument appear to be just above the major flood event level under existing conditions and after the SD2 Infrastructure Project. However, if the Qizildas Cement Plant were to be developed, then this key receptor could be flooded to a depth of over 0.45m. There are no significant changes to flood risk to Sangachal Town or Sangachal Power Station associated with this type of upstream development.

5 Bibliography

J V Sutcliffe, F A K Farquharson, E L Tate and S S Folwell, 2008. Flood regimes in the Southern Caucasus - the influence of precipitation on mean annual floods and frequency curves, Hydrology Research Vol 39 No 5–6 pp 385–401 © IWA Publishing 2008.

Kirpich Z. P., 940. Time of concentration in small agricultural watersheds. Civil Engineering, 10 (6): 362.

NERC, 1975. Flood Studies Report, Natural Environment Research Council, London.

URS, 2003. ‘AIOC Sangachal Terminal – Water management and landscape strategy’, Final Report to BP Ltd. by URS, November 2003.

U.S. Soil Conservation Service, 1986. Technical Release 55: Urban Hydrology for Small Watersheds. USDA (U.S. Department of Agriculture).

WRA, 2008a. ‘Sangachal Terminal – Surface and subsurface water and landscape management scoping study’, Report for BP Ltd. by Water Resource Associates, April 2008.

WRA, 2008b. ‘Sangachal Terminal Phase 2 Expansion – Surface Water Study’, Stage 2 Final Report for BP Ltd. by Water Resource Associates, December 2008.

WRA, 2010. ‘Sangachal Terminal Phase 2 Expansion – Additional Surface Water Studies’, Final Report for BP Ltd. by Water Resource Associates, October 2010.

WRA, 2011. ‘Sangachal Terminal Phase 2 Expansion – Hydrological and hydraulic modelling in support of detailed design for the flood protection & drainage works’, Final Report for BP Ltd., by Water Resource Associates, June 2011.

ANNEX 1
Details of ISIS Software

The ISIS hydrological modelling software used during the project is a commercial product developed in the UK jointly by one of the country's leading firms of consulting engineers, Halcrow Ltd. (see http://www.halcrow.com/isis/default.asp) and by the internationally renowned HR Wallingford Ltd., who were until the 1980s a UK Government funded hydrologic research laboratory but are now a private company. The software is now marketed and supported by Halcrow Ltd.

ISIS provides engineers, environmental scientists, planners and managers with a flexible and cost-effective range of tools for proactive decision making to help manage our environment. It is a suite of modular software solutions used for simulating water flow, hydrology, water quality changes and sediment transport in rivers, floodplains, canals, estuaries, catchments and urban areas. The version used for the study was the 1-D professional model, ISIS v3.4.

ISIS is suitable for a wide range of engineering and environmental applications, from calculating simple backwater profiles to modelling entire catchments. Applications include flood risk assessments, developing catchment management plans, flood alleviation scheme designs, river engineering and irrigation schemes, environmental impact assessments, water pollution management, flood risk mapping, integrated modelling, surface water management plans, catchment and floodplain development.

The ISIS suite of products is one of the leading software packages for river modelling and is used extensively throughout various countries around the world as an essential analysis tool for flood risk mapping, flood forecasting and many other aspects of flood risk management analysis. It has been used throughout the world by government bodies, environmental regulators, local authorities, water companies, drainage boards, insurance companies, universities and consultants.

ISIS users around the world

Clients include government bodies, environmental regulators, local authorities, drainage boards, universities and major river engineering consultants. Organisations that use the ISIS software include:

- AECOM
- AMEC
- ARDENT Consulting Engineers
- Atkins
- Black & Veatch
- British Waterways
- BRL Ingenierie
- Bureau Veritas UK Limited
- BURGEAP
- Buro Happold
- BWB Consulting Ltd
- Can Tho University
- Capita Symonds Ltd
- CARES Group
- CEDEX
- Civil Engineering Solutions
- Clarke Bond
- Cole Easdon Associates
- Cranfield University
- Create Consulting
- Dalgleish Associates Ltd
- Deltares
- Edenvale Young
- Egniol Environmental
- Entec UK Ltd
- Environ UK Ltd
- Environment Agency
- Evans Rivers and Coastal
- Forestry Commission
- Golder Associates
- H2oK
- Halcrow Group Ltd
- Hannah - Reed
- Haskoning UK Ltd
- Heriot-Watt University
- Hyder Consulting
- Hydro-Logic
- J B Barry
- Jacobs
- JBA Consulting
- Lindsey Marsh Drainage Board
- Martin Wright Associates
- Mason Clark Associates
- Mekong River Commission Secretariat
- Ministry of Water Resources and Irrigation
- Mott MacDonald
- Mouchel Group
- MWH
- O'Connor Sutton Cronin & Associates
- Office of Public Works
- Ove Arup & Partners International Ltd
- Parsons Brinckerhoff Ltd
- Perth and Kinross Council
- Peter Brett Associates
- Pick Everard
- Pinnacle Consulting
- Scott Wilson Ltd
- SEPA
- Stuart Michael Associates
- Thames Water Utilities
- The City of Edinburgh Council
- Thomas Mackay Ltd
- TransTech Ltd
- UNESCO
- University of Aberdeen
- University of Bristol
- University of Cardiff
- University of Coventry
- University of Cranfield
- University of Glasgow
- University of Leeds
- University of Middlesex
- University of Newcastle
- University of Nottingham
- University of Plymouth
- University of Sheffield
- URS Corporation Ltd
- W A Fairhurst & Partners
- Weetwood
- West Oxfordshire District Council
- WSP Group
- WYG Engineering

In the UK the Environment Agency does not formally “approve” any model (the UK Government's open policy). However ISIS is used routinely used in applications for the Environment Agencies in the UK and accepted by them as one of its limited range of hydrological modelling systems (the others being MIKE-11, InfoWorks and HEC-RAS). Its development was also supported by the Environment Agencies in UK. The three UK Environment Agencies: Environment Agency of England and Wales, Scottish Environmental Protection Agency and the Department of the Environment in Northern Ireland, are all users of ISIS.

Thus the software is one of the best available for the type of flood extent studied and use of the 1-D approach was deemed to be the most suitable option. A 1-D model treats the drainage system as a series of linked linear drainage channels whose properties are defined by a series of channel and flood plain cross sections. More complex 2-D models can make use of digital terrain models to understand better the flow routes that water will take during a flood. Unfortunately 2-D models are very input data intensive, requiring very high quality survey data for the entire study region, good quality hydrological inputs and more importantly, reliable historical data against which the model may be calibrated. Whilst the present study has good quality survey data for much of the area, the survey data does not extend far enough up the various wadi systems, local meteorological and hydrological data are limited, and there are no flow or level records available against which sophisticated 2-D models could be calibrated. Thus the choice of a 1-D ISIS model was believed to be the best option.

Any uncertainties in model results will stem from the limitations imposed upon the study by: the limited local historical rainfall and hydrological data available and; the absence of appropriate historical flood level or flood extent data against which model outputs could be validated.

APPENDIX 10A

SD2 Infrastructure Project Activities, Events and Interactions - Socio-Economic

ACTIVITY/INTERACTIONS

ID (R=Routine, NR= Non-Routine)	Activity	Scoped In/Out	Reference	Event	Event Category
S1-R	Land Acquisition	✗	-	Acquisition of land	Land Use and Access
S2-R	Disruption/access restrictions to natural resources and recreation	✓	5.5.2-5.5.6	Disruption/access restrictions to grazing land around terminal	Land Use and Access
				Disruption/access restrictions to wetland area	
				Disruption/access restrictions to fishing areas	
S3-R	Employment creation	✓	5.9	Job creation	Employment
S4-R	Training and skills development	✓	5.9	Workforce training and skills development	Training and Skills Development
S5-R	Procurement of goods and services	✓	5.3	Increased economic flows	Procurement
S6-R	Operation of construction plant and vehicles onsite and offsite, movement of spoil, subsurface and above ground structural works and erection of buildings/structures - Community Disturbance (e.g. noise, dust)	✗	-	Community disturbance (noise, vibration, dust, odour)	On-site and off-site construction plant and vehicles, topsoil and spoil movement, subsurface and above surface ground works and erection of buildings and structures
S7-R	Construction vehicle movements (offsite)	✓	-	Disruption to road users and community safety	Road and Rail
				Deterioration of public roads/highway	
S8-R	Road/railway closures and traffic works	✓	5.5.2-5.5.7	Disruption to road users	Road and Rail
				Disruption to railway users	
S9-R	Connections to mains water supply - Disruption to freshwater supply	✗	5.5.4	Disruption to fresh water supplies	Utilities
S10-R	Connections to mains power supply- Disruption to freshwater supply	✗	5.5.2	Disruption to mains power supply	Utilities
S11-R	In-migration of workers resulting in increased pressure on community infrastructure (utilities, waste & sewage)	✗	-	Disruption to freshwater supply	Utilities
				Disruption to mains power supply	
				Disruption to sewage network	
				Increased demand on municipal waste facilities	
S12-R	In-migration of workers resulting in increased pressure on community infrastructure (goods & services)	✗	-	Increased demand for goods and services	Goods and Services
				Inflation in local prices for goods/services	
S13-R	In-migration of workers resulting in increased pressure on community infrastructure (employment)	✗	-	Insufficient job creation	Employment
				Social tensions due to non-local employment & competition for jobs	
S14-R	In-migration of workers resulting in increased pressure on community infrastructure (health services)	✗	-	Increased demand on local health services	Health
S15-R	De-manning	✓	5.9	Loss of jobs	De-manning

	Event Category	Event Magnitude			Probability	Receptor Sensitivity	Impact Significance
		Spatial Scope	Timing	Duration			
Socio-Economic	Disruption and access restrictions (SD2 Infrastructure Area)	Local	All SD2 Infrastructure area will be temporarily fenced during works to prevent unauthorised access.	Temporary	Highly likely	Local herders – high	**Moderate – major negative**
			Up to approximately 115 hectares will be permanently removed from use for herders.	Permanent			
	Disruption and access restrictions (Pipeline Landfall Area)	Local	The majority of the SD2 Infrastructure Area will be temporarily fenced during works (between March 2012 and June 2013).	Temporary	Highly likely	Recreational fishermen - Low	**Negligible**
					Highly likely	Commercial fishermen - Medium	**Negative**
					Highly likely	Recreational users - Low	**Negligible**
					Unlikely	Shoreline property - Low	**Negligible**
	Employment creation	Local	Employment will occur throughout the project, and is expected to peak between April 2012 and November 2012.	Temporary	Highly likely	Local community - High	**Moderate- Major Positive**
		Regional			Likely	Regional community – Medium	**Positive**
	Training and skills development	Local	Training will commence prior to the project activities and continue throughout the project.	Permanent	Highly likely	Local community – High	**Moderate-Major positive**
		Regional			Highly likely	Local community – Medium	**Positive**
	Procurement of goods and services	Local, and Regional	Procurement will take place throughout the project and benefits will cease shortly after the project finishes.	Temporary	Highly likely	Local and regional businesses - High	**Moderate- Major positive**
		National				National businesses - High	**Positive**
	Disruption and impact to community safety associated with construction vehicle movements (offsite)	Local	Off-site traffic movements will take place throughout the project.	Temporary	Unlikely	Road users and local community – High	**Negative**
	Deterioration in Road Conditions	Local	Changes to road condition from the transportation of construction materials will take place throughout the project and will cease after the project finishes.	Temporary	Unlikely	Local Roads - High	**Negligible**
						Main highway – Low	**Negligible**
	Road and rail works	Local, and regional	Road and rail works are expected throughout the project but disruption is expected to be of short duration.	Temporary	Highly likely	Local, regional and national businesses – High	**Negative**
	De-manning	Local	De-manning will likely commence prior to end of the project as manning levels decrease however it is expected that the main SD2 Project will provide relevant employment opportunities for workers	Permanent	Unlikely	Local community – High	**Negligible**

5 Project Description

5.1 Introduction

5.1.1 Overview

The Shah Deniz gas-condensate field is located in the Azerbaijan sector of the South Caspian Sea in water depths ranging from 50 m to 500 m, approximately 100 km south of Baku. A Production Sharing Agreement (PSA) for Shah Deniz was ratified in October 1996 between the State Oil Company of Azerbaijan Republic (SOCAR) and a number of Foreign Oil Companies (FOC). The PSA grants rights to the FOC to invest in and develop the Shah Deniz field to produce and market the hydrocarbons.

BP has been appointed as a single operator on behalf of the other PSA partners and to date has drilled three wells in the Contract Area focussing on the northern and eastern flanks of the field in water depths up to 350 m; SDX1, SDX2 and SDX3 (Figure 5.1). The field was discovered in 1999 when SDX1confirmed gas in three reservoir zones on the structure. The southern and western flanks are yet to be appraised, although it is believed that the field may have an aerial extent of approximately 200 km^2 and approximately 2 km of vertical relief.

The potential size of Shah Deniz field requires a staged approach to development. With the successful appraisal wells drilled to date located on the Eastern Flank of the field, it is proposed that the Stage 1 development area encompass volumes of both the Eastern and Crestal region around these two wells, with drilling taking place at two new locations; E2 and E3. Early drilling activities will be initiated from the semi-submersible Mobile Offshore Drilling Unit (MODU) the Istiglal in approximately 100 m of water. Further development drilling and production from the MODU drilled wells will take place from a fixed platform[1] consisting of drilling and processing facilities with primary separation of gas and fluids. Gas and condensate (with produced water) will be delivered via two subsea pipelines to an onshore reception and gas-processing terminal to be constructed adjacent to the AIOC terminal at Sangachal and located some 38 km to the south of Baku (Figure 5.1). The onshore terminal will process fluids to meet the designed export specifications for onward transportation to market. The principal long-term components of the Stage 1 development are therefore:

?? an offshore drilling and production platform;
?? two export pipelines, one for gas and one for fluids; and
?? extension to the processing facilities at the Sangachal terminal.

Further stages of development may then address the remainder of the field in the future. To maintain future gas production rates from the Shah Deniz field, a subsea completion is proposed some 4km to the south of the fixed platform, five to 10 years after the first gas delivery. The subsea development will be installed in 350 m of water and produced fluids tied back to the Stage 1 platform via a pipeline for primary separation and onward transport to the onshore terminal. Figure 5.2 illustrates the proposed configuration of offshore developments (platform and subsea completions), subsea pipelines and the onshore processing terminal.

[1] The project's offshore platform base-case design is a fixed jack-up installation. The design is based on the proprietary Technip GeoProduction 500 (TPG500) design.

Figure 5.1 Location of Stage 1 developments (E2 and E3) in relation to the potential Shah Deniz field

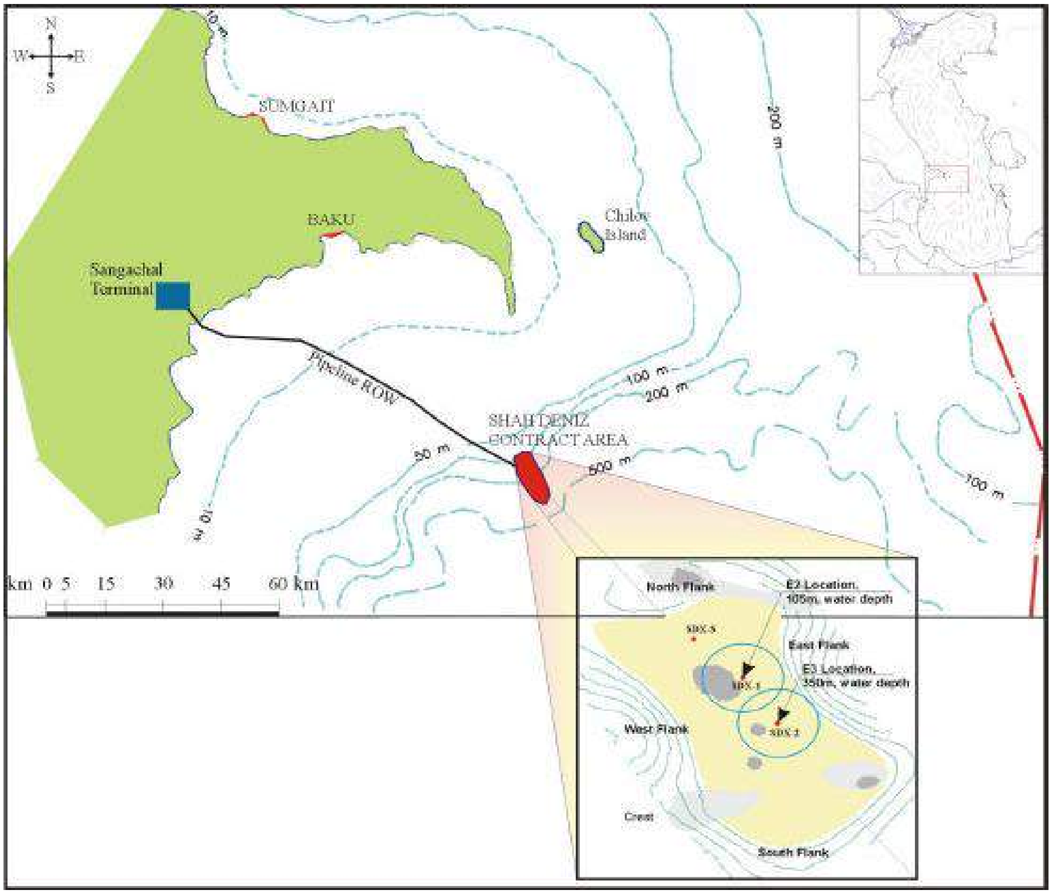
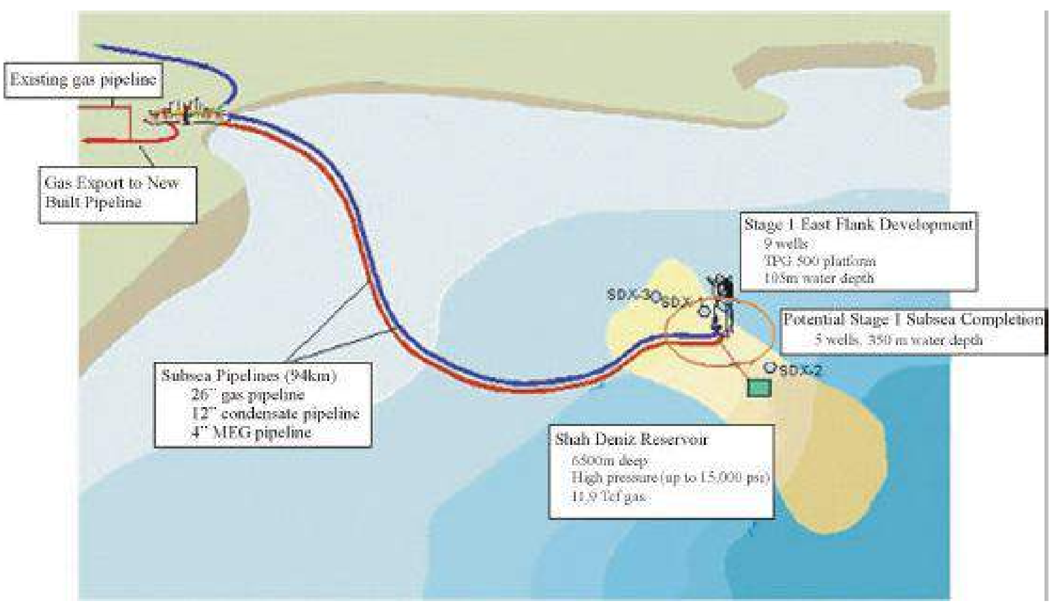


Figure 5.2 Configuration of Shah Deniz offshore installations, subsea pipelines and onshore terminal



This Chapter describes all of the proposed activities associated with the Stage 1 development including:

?? fabrication and construction of the facilities;
?? transportation of components to Azerbaijan;
?? installation and commissioning activities;
?? drilling operations;
?? production operations; and
?? decommissioning of the facilities.

The description provides detail on each stage of the development using available information provided by the project design engineers. In cases where the design is not fully defined this is clearly stated. The Chapter is separated into each distinct stage of the development and is set out in the following order:

?? MODU drilling (early drilling from the semi-submersible MODU drilling rig prior to installation of the TPG500);
?? platform drilling from the TPG500 jack-up rig;
?? TPG500 construction and installation;
?? offshore production;
?? pipelines (installation and operation);
?? terminal construction;
?? terminal operations;
?? transportation of components to Azerbaijan;
?? decommissioning; and
?? waste management.

The emissions and discharges associated with each stage of the Stage 1 development have been estimated as far as possible using standard techniques and included within each section.

5.1.2 Reservoir description

The Shah Deniz reservoir structure is classified as a High-Pressure (HP) gas field with pressures ranging between 9,000 to 15,000 psi. The target reservoirs are deeply buried with the uppermost reservoir located at a depth of approximately 4,700 m on the Crest of the structure (Figure 5.3). The gas-water contact for the deepest reservoir is interpreted to be approximately 6,500 m deep. Porosity and permeability in the reservoir are relatively low due to the depth of burial.

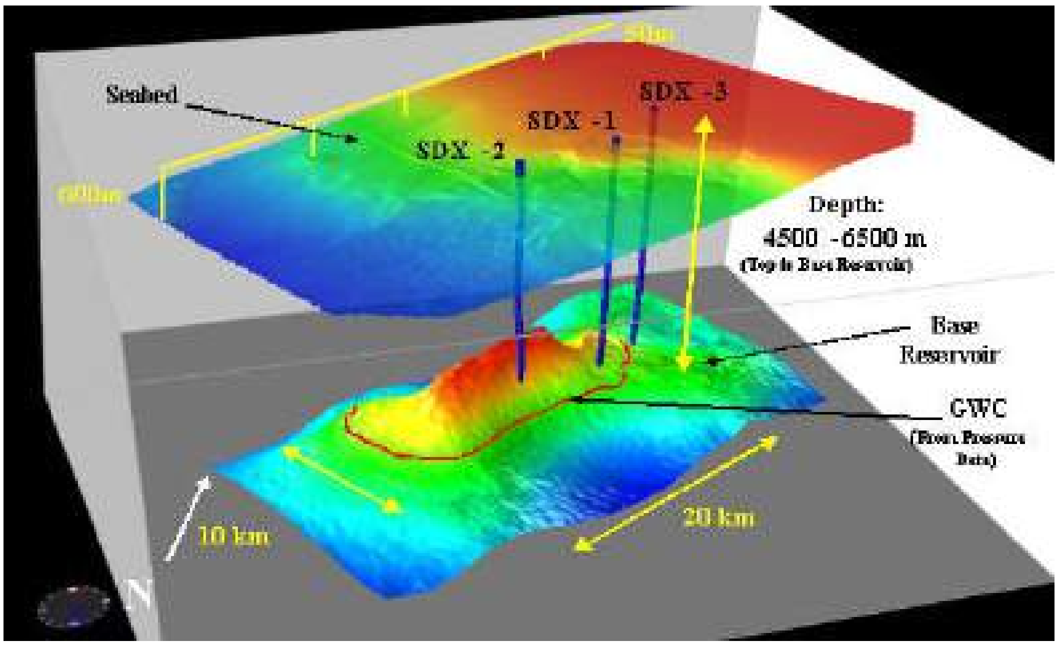
The reservoir is a large gas reserve with an estimated inventory of 31 trillion cubic feet (Tcf) of gas. Appraisal drilling of the field has confirmed gas in three reservoir zones within the structure. The gas bearing zones are found in the Lower Pliocene Fasila (Pereriv) and Balakhany Suites of the Productive Series that extend over the entire Shah Deniz structure. The four main sand units (shallowest to deepest) within the structure are:

?? Balakhany VIII (BVIII): gas bearing;
?? Sand Package 1 (SP1): water bearing and substantially over-pressured;
?? Sand Package 2 (SP2): gas bearing; and
?? Sand Package 3 (SP3): gas bearing.

The reservoirs are considered to be laterally extensive but vertically restricted. Each producing sandstone interval has been interpreted to have been deposited in low-sinuosity, braided fluvial systems. The reservoir zones are separated by thick mudstone intervals believed to have been deposited in an open lacustrine environment, which prevent any vertical connection between the reservoir zones.

The Stage 1 project targets approximately one third of the total potential resource in the Shah Deniz field. As shown in Figure 5.3, three appraisal wells have been drilled to further define the reservoir (SDX-1, SDX-2 and SDX-3). Data from these wells indicates that the structure is subject to significant tectonic stresses and associated well-bore breakout. The high pressure, depth, tectonic stresses, narrow pore/fracture pressure windows, well-bore stability and numerous shallow subsurface hazards all combine at Shah Deniz to provide a difficult drilling environment. The pressure regime on Shah Deniz is extremely complex with numerous pressure ramps and regressions. Depths and pressures vary greatly with depth across the structure. The water depth also varies significantly from approximately 50 m to 500 m with corresponding impact on fracture gradients.

Figure 5.3 Shah Deniz reservoir structure



5.1.3 Reservoir development plan

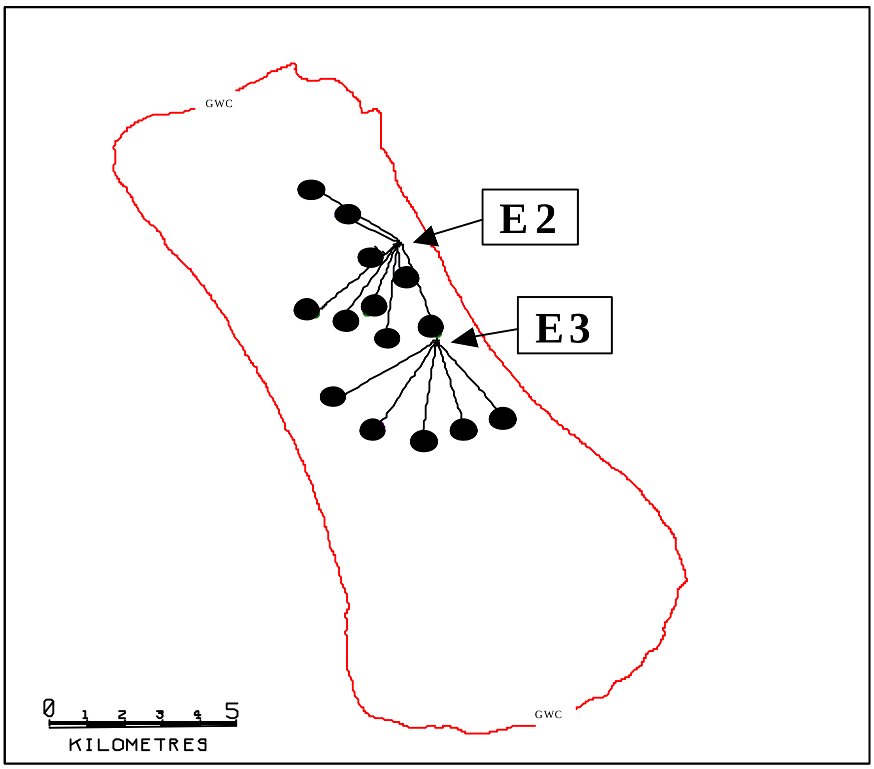
The Shah Deniz Stage 1 Development is proposed to commence on the Eastern Flank of the field where water depths range from 100 m to over 500 m. Key factors that influence the selection of suitable development drilling sites include:

?? the risk of shallow geo-hazards;
?? drillability and good reservoir access;
?? seabed geo-technical conditions; and
?? a site giving opportunity for optimum facilities cost.

Project development planning has identified a location towards the north of the field's Eastern Flank that is, in terms of the above criteria, a suitable location for the installation of a fixed drilling-production facility. This facility, the TPG500 or Shah Deniz Alpha platform, would be installed at this location in water depths of approximately 100 m. The location is referred to as "E2" (Figure 5.4).

The planning basis for development of the Stage 1 area of the gas-condensate field, is for a total of 14 wells developing some 11.9 Tcf (337 billion standard cubic metres (bscm)) gas in place in the three main reservoir zones referred to above. It is expected that nine development wells will be drilled from the E2 location with a further five wells drilled several years after first gas production, from a location approximately 4 km south of the E2 location. This latter location is referred to as "E3". Figure 5.4 shows the possible location of the proposed E2 and E3 wells.

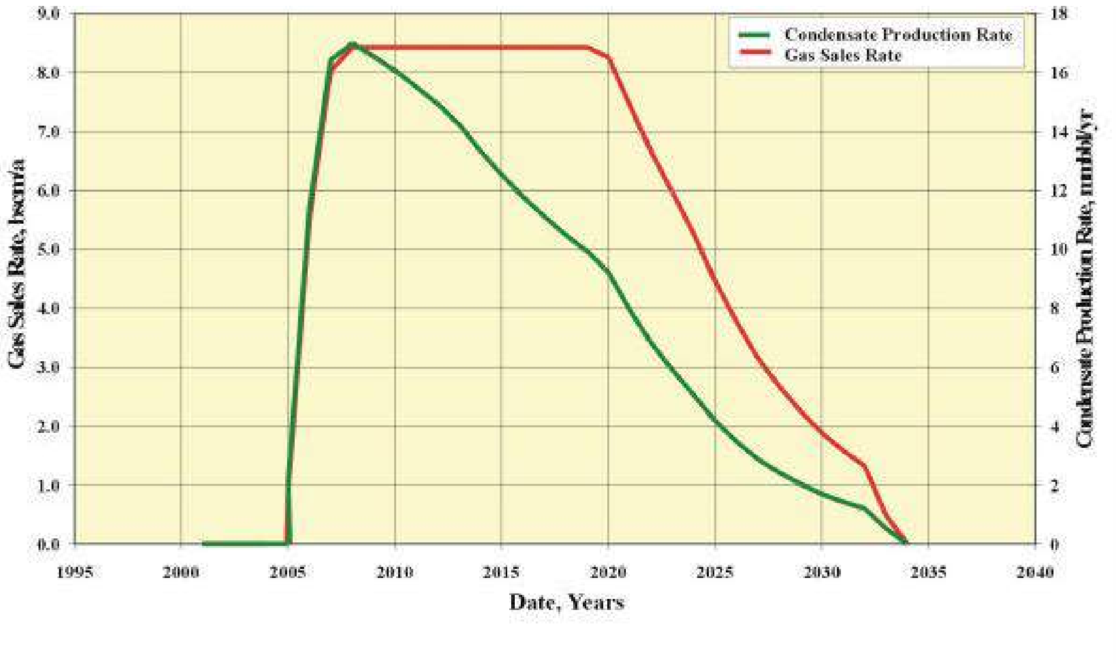
Figure 5.4 Location of proposed Shah Deniz Stage 1 E2 and E3 drill locations



5.1.4 Estimated Stage 1 development production rates

The estimated production profile for the Stage 1 Development is illustrated in Figure 5.5.

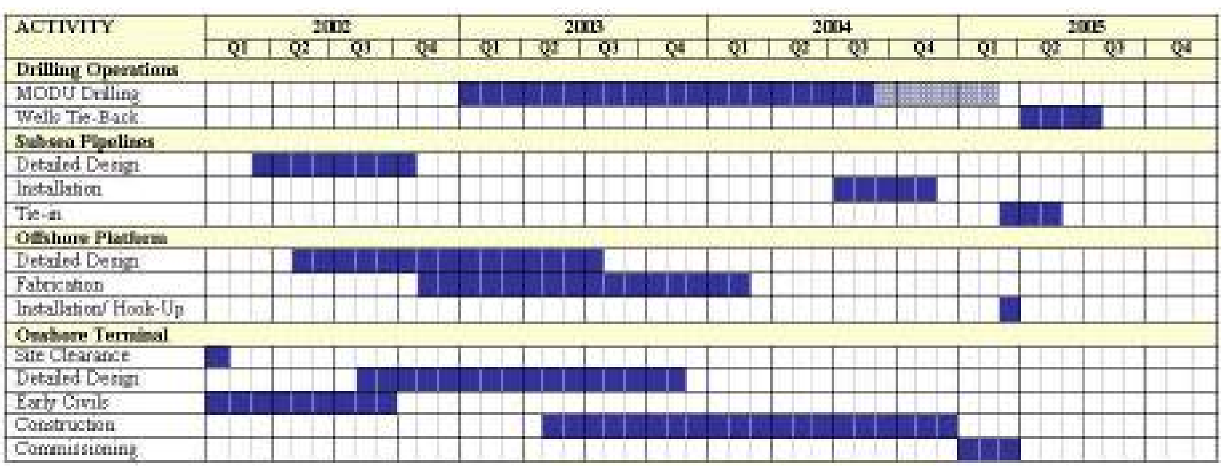
Figure 5.5 Estimated Stage 1 development production profile



5.1.5 Project schedule

The key milestone schedule for the main stages of the Shah Deniz Stage 1 Development is shown in Figure 5.6. The dates provided are estimated based on the planned schedule at the time of writing this ES and may be subject to change.

Figure 5.6 Key Stage 1 development milestone schedule



5.2 Drilling programme and schedule

As discussed above, initial production for Shah Deniz will be based on a single platform located at the E2 location in 101 m of water (Figure 5.1). The proposed base-case is to drill nine (9) producing wells at the E2 location. Three (3) wells will be drilled after the installation of a drilling template at the E2 location. These early wells will be drilled from a semi-submersible MODU prior to installation of the TPG500. After installation of the TPG500 platform, the early wells will be tied-back to the platform, enabling rapid gas production from the reservoir soon after installation of the fixed platform facilities whilst the remaining wells are drilled.

After several years, five (5) further wells will be drilled to maintain gas production from the field. These additional wells will either be developed as part of a subsea completion at the E3 location (in 350 m water depth) or may be targeted by directional drilling from the E2 location depending upon operational data and technological feasibility. The exact number of wells may also vary based on reservoir performance.

A summary of the proposed E2 and E3 well types and schedule are provided in more detail in Table 5.1.

Table 5.1 Well types and schedule for Shah Deniz Stage 1

Well No.	Description	Start date (year)									
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
E2 MODU Wells - Drilling											
1	SP2/SP3 producer - predrill										
2	SP2/SP3 producer - predrill										
3	SP2/SP3 producer - predrill										
E2 MODU Wells – Tieback to Platform											
1	SP2/SP3 producer - subsea										
2	SP2/SP3 producer - subsea										
3	SP2/SP3 producer - subsea										
E2 Platform (TPG500) Wells											
4	SP2/SP3 producer										
5	SP2/SP3 producer										
6	SP2/SP3 producer										
7	Balakhany VIII producer										
8	Balakhany VIII producer										
9	Balakhany VIII producer										
E3 Subsea Wells											
10	Producer										
11	Producer										
12	Producer										
13	Producer										
14	Producer										

5.2.1 MODU drilling

This stage of the development has been termed "MODU drilling" in order to distinguish it from the later "platform drilling" that will be undertaken from the TPG500 (Section 5.3.5).

5.2.1.1 Drilling rig selection

The semi-submersible drilling rig, the "Istiglal" (Figure 5.7) has been selected for the MODU drilling programme as the rig is:

?? designed to meet all relevant safety, health and environmental regulations;
?? capable of operating in the water depth of the licence (101 m); and
?? equipped with a high rating (15,000 psi) Blow Out Preventer (BOP) system required for drilling in the high-pressure reservoir.

Figure 5.7 The "Istiglal" MODU

The rig is currently owned by SOCAR and has been upgraded to meet the demanding Shah Deniz requirements.

5.2.1.2 Drilling template and MODU positioning and installation

The Istiglal will be towed to the E2 drilling location by one vessel; the Neftigas 62 or 64. A further vessel will be used during mobilisation to assist with rig positioning. It is anticipated that the Aura, Andoga or Liutoga vessels will be used. On arrival at the E2 drilling site, the Istiglal will be moored using a deep penetration anchor system. The first anchor will be dropped short of the planned well location and the anchor chain or cable paid-out to allow the rig to move to the desired position. The remaining anchors will then be deployed to secure the rig in position.

A 15-slot drilling template will be installed on the seabed by the Istiglal prior to commencement of the MODU drilling programme (three wells). It is proposed to install and secure the template to the seabed from the "Istiglal". The installation of the drilling template is predicted to take less than one day and will require not require any additional support vessels.

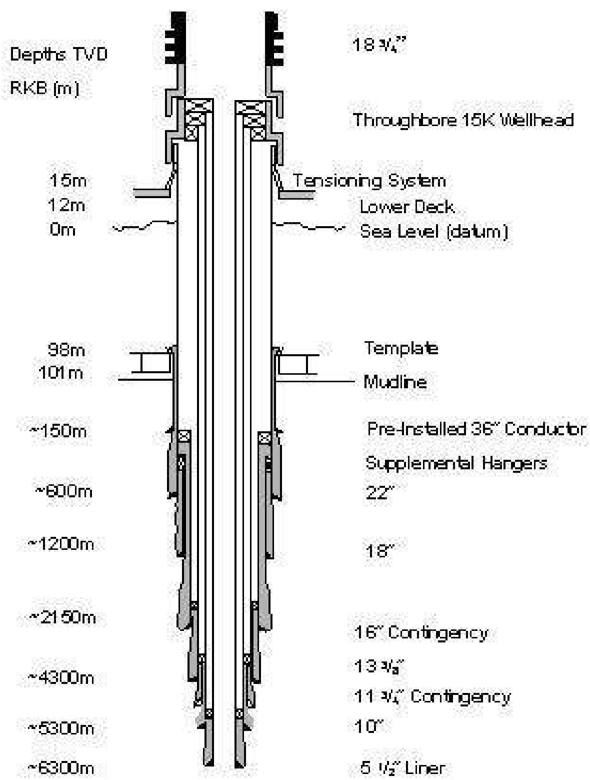
5.2.1.3 MODU drilling programme

The Shah Deniz drilling programme is based on deviated drilling with the angle of deviation increasing as each group of wells are drilled during the project. Wells will be drilled to the SP2/3 and Balakhany VIII reservoir zones and will be drilled with a step-out of up to 3.2 km from the E2 drilling centre. The combined step-out and vertical depth proposed for the development wells places the wells on the cutting edge of the industry-drilling development.

Well and casing plan

The proposed well and casing plans and mud programme for a typical Shah Deniz well is shown in Figure 5.8

Figure 5.8 Proposed Shah Deniz Stage 1 generic development well design



Hole Size (Drill Bit Size)	Proposed Drilling Mud Type
28"	Sea water with viscous sweeps
22"	SOBM (WBM contingency)
20"	SOBM
16"	SOBM
12 ¼"	SOBM
8 ½"	SOBM

SOBM = Synthetic Oil based Mud

The main functions of the drilling mud system are the removal of cuttings from the well and the control of formation pressures. The mud systems have a number of other important functions including:

?? sealing permeable formations;
?? maintaining well-bore stability;
?? cooling and lubricating the bit and drilling assembly; and
?? transmitting hydraulic energy to the drilling tools and drill bit.

Drilling of the MODU wells starts with the installation of a 36" diameter steel pipe (casing) approximately 50 m into the seabed. The top-hole section is then drilled through the conductor pipe by a 28"diameter drill bit using a seawater system which will be pumped down the drill string forcing the drill cuttings back up the pre-installed casing into the water column and onto the seabed. While drilling, the borehole will be cleaned out using high viscosity sweeps of pre-hydrated bentonite. The base case for cuttings and drilling fluid disposal from the surface-hole sections is by direct release to the seafloor.

Once the 28" hole section is drilled to depth, the 22" casing will be run and cemented into place. Losses may be encountered during cementing with the displaced cement released to the seabed. For the drilling of the 22" hole section, there are two options:

?? **base case:** use a Synthetic Oil Based Mud (SOBM) system. Where a SOBM system is used, all cuttings will be returned to the rig and passed through a solids control system, with the spent mud and cuttings stored in segregated skips for shipment to shore, where it will be treated before disposal.

?? **contingency case:** use of a WBM system (depending upon down-hole conditions). Should a water based mud system be used, the mud cuttings will be recovered to the rig, passed through the solids control system and disposed of via a cuttings chute.

Approximate chemical usage and WBM/cuttings generation rates for the surface-hole sections from a typical Shah Deniz well are presented in Tables 5.2 and 5.3 respectively. Cement discharges to seabed will be minimised by analysing well designs and anticipating the total volume required. Residual amounts will however, be discharged and this has now been modelled (Chapter 10; Section 10.4.2.3 and Technical Appendix 4).

Should the project require to utilise any drilling additives or other chemicals not identified below and that have not already been approved for use and discharge into the marine environment by the MENR, approval for their use will be subject to the substances passing the Caspian Specific Eco-toxicity test.

Table 5.2 Approximate chemical usage for the surface-hole sections of a typical Shah Deniz well

Chemical	Composition	Function	Approximate Use (t) [1]	HOCNS Category [2]
Barite	Barium Sulphate ore	Weighting agent	252	E
Bentonite	Clay ore	Viscosifier and removal of cutting's	49	E
Commercial chemicals	Soda Ash	Chemical balance	0.95	E
Polymers	Guar Gum	Viscosifier and removal of cutting's	1.95	E
Salts	Potassium chloride	Borehole stabiliser	63.4	E

1. The actual amount of each chemical used may vary depending on subsurface conditions encountered during drilling. The figures presented are estimates based on best available knowledge at the time of writing.
2. Harmonised Offshore Chemical Notification Scheme: HOCNS category E is the lowest category. Category E chemicals are of low aquatic toxicity, readily biodegradable and non-bio-accumulative.

Table 5.3 Estimated WBM/cuttings generated and discharged from each Shah Deniz well

Hole Section (in)	Section Length (m)	Drilling Fluids	Cuttings / WBM Discharged to Seabed		
			Volume (m^3/hr)	Total volume (m^3)	Total weight (tonnes)
28	437	WBM	28	268	536

From Table 5.3 it can be calculated that the total cuttings from three wells to be discharged to the seabed during the MODU drilling programme would be 804 m^3 or 1,608 t.

If the WBM contingency is used for the 22" hole instead of SOBM, an additional 632 t of WBM cuttings will be discharged.

As discussed above, for the base case, all lower-hole sections (i.e., 22", 20", 16", 12 ¼" and 8 ½") will be drilled with a SOBM and the spent mud and cuttings stored for transport to shore for subsequent treatment and disposal. It is proposed to use Linear Alpha Olefin (LAO) drilling fluid for these sections, although other options include an alternative Low Toxicity Base Oil based system, such as a more traditional mineral base oil type system. BP is currently running trials on different treatment options. Based on the results of these trials, the optimum method of disposal will be submitted to the MENR for approval. Recovered mud from the well returns will be re-circulated for reuse on the MODU.

The density of the drilling mud system will be monitored and adjusted by the addition of chemicals according to the down-hole conditions. The density of the recycled fluid depends on the efficiency of the solids control system, the well bore characteristics and the chemical composition of the drilling fluid. The typical ingredients of the proposed SOBM systems and approximate amounts that will be used are shown in Table 5.4.

Table 5.4 Approximate chemical usage for the lower hole sections of a typical Shah Deniz well

Chemical	Composition	Function	Estimated Use (t)[1]	HOCNS Category[2]
Barite	Barium sulphate ore	Weighting agent	3140	E
Bentonite	Clay ore	Viscosifier and removal of cutting's	15.1	E
Surfactants	Emulsifiers	Mud stability	49.5	E
Salts	Calcium Chloride	Borehole stabiliser	140.9	E
Commercial chemicals	Lime	Chemical balance	33.2	E
Synthetic Base Fluids	Linear Alpha Olefin	Base fluid	835.4	Z
Organics	Cellophanes	Fluid loss control	11.8	E

1. The actual amount of each chemical used may vary depending on subsurface conditions encountered during drilling. The figures presented are estimates based on best available knowledge at the time of writing.
2. Harmonised Offshore Chemical Notification Scheme: HOCNS category E is the lowest category. Category E chemicals are of low aquatic toxicity, readily biodegradable and non-bio-accumulative. Category Z refers to all Non Water Based Mud formulations (NWBM) and are considered zero discharge mud systems.

The drilled cuttings from these hole sections will be returned to the rig with the circulating mud and the mud separated from the cuttings in the solids control package for re-circulation down hole.

The solids control equipment available on-board the Istiglal consists of a series of four shale shakers and a vacuum degasser. The returned mud and fluids containing the entrained cuttings enters the vibrating screens of the cascading shale shakers. The shale shakers retain the larger cuttings particles whilst the mud passes through the screens and falls into the mud pit. The underflow comprising of smaller sand particles and silts are recovered in the sand trap underneath the shale shakers. The muds then go through the degasser tank and the collected mud is re-conditioned and re-circulated down-hole.

No cuttings generated from these sections will be discharged to the sea. All SOBM cuttings will be contained and transported to shore for further treatment and disposal. Once onshore, these wastes will be transported to a cuttings disposal facility. A final disposal site is yet to be selected. Options are currently being assessed as part of BP's development of a Waste Management Strategy for its Caspian projects (Section 5.7).

The density of recycled/reconditioned mud depends on the ability of the solids control system to remove sufficient cuttings from the mud returns, which in turn depends on the equipment and the well-bore characteristics. In many cases, a high proportion of solids remain in the mud and frequently mud dilution is used to reduce the proportion of solids present. Inevitably, mud dilution leaves excess mud, which will be contained for treatment and disposal onshore.

Estimated SOBM/cuttings generation rates for the lower-hole sections of a typical Shah Deniz well are presented in Table 5.5.

Table 5.5 Estimated SOBM/cuttings generated for a typical Shah Deniz well

Hole Section (in)	Section Length (m)	Drilling Fluids	Cuttings Generated		
			Volume (m^3/hr)	Total volume (m^3)	Total weight (tonnes)
22[1]	573	SOBM	25	316	632
20	929	SOBM	15	315	630
16	1,929	SOBM	4	418	836
$12^1/_4$	1,493	SOBM	2.1	211	422
$8^1/_2$	1,330	SOBM	0.3	92	184

1. As a contingency, the 22" hole section may be drilled with WBM. Quantities of cuttings will remain the same.

The maximum estimated total volume of SOBM cuttings that will be required to be shipped-to-shore from the three MODU wells will be 4,056 m^3 or 8,112 t.

Cementing

Cement is used to anchor the casing within the hole, to seal off any weak shallow formations and to prevent the hole from collapse. After drilling each section, cement is pumped down the casing or conductor and up the annulus formed between the casing and the well bore. As the cement is pumped down the well hole and up around the annulus some excess cement may be displaced into the water column and onto the seabed next to the well. Careful calculation of cement volumes should however, keep these losses to a minimum and cement slurry returns to seabed are only expected during the cementing of the upper casing string. In addition, during the drilling of the subsequent sections a small amount of solid cement will be drilled out from the top of each interval. This material will be commingled with the drill cuttings.

The cement contains a number of chemical constituents such as setting retarders and accelerators, surfactants, stabilisers and defoamers. The proposed cement constituents to be used during top hole cementing operations on a typical Shah Deniz well are provided in Table 5.6. It should be noted that the type and amount of chemicals used may vary depending on subsurface conditions encountered during the drilling programme, however all proposed chemicals are of a Category E under the HOCNS. These chemicals are deemed to have a low toxicity and persistence in the marine environment and the amounts that may be discharged would be very small. No significant adverse effect on the marine environment would be expected (Chapter 10; Section 10.4.2.3 and Technical Appendix 4).

Table 5.6 Probable cement chemicals discharged for a typical Shah Deniz well

Chemical Name	Estimated Amount Per Well (t)[1]	HOCNS Category[2]
Class G Cement	61.1	E
S001 Calcium Chloride	0.26	E
Silicate Additive D75	2.04	E
Antifoam Agent D175	0.11	E
RetarderD110	0.5	E

1. The actual type and amount of each chemical used may vary depending on conditions encountered during drilling. The figures presented are estimates based on best available knowledge at the time of writing.
2. Harmonised Offshore Chemical Notification Scheme: HOCNS category E is the lowest category. Category E chemicals are of low aquatic toxicity, readily biodegradable and non-bio-accumulative.

Well logging

All well hole sections will be logged. Logging of the wells will include:

?? mud logging;
?? monitoring of well bore parameters;
?? collection and geological description of drilling cuttings;
?? wireline logging: obtaining information on the physical properties of the rock formations, pressures and fluids within the formations by means of sensors deployed on logging tools attached to a multi-core electrically conductive cable; and
?? measurement while drilling: obtaining information on the physical properties of the rock formations and fluids within the formations by means of sensor gauges located within specially adapted drill-collars.

Drill stem testing

There is a possibility that a drill stem test (DST) would be completed on the last (third) well of the MODU drilling programme depending on the results of drilling. In the event the well is flowed and a DST completed the hydrocarbons will be disposed of by flaring. Initial estimates suggest that product will be flared at a rate of 100 MMscfd for a maximum period of 12 hours (i.e. a total of 50 MMscf flared). Emissions estimates for one DST have been calculated and are presented in Section 5.2.2.2.

Suspension of MODU Wells

After the wells have been drilled and all the casings have been run, they will be filled with water or mud and capped until the TPG500 has been installed and the wells are ready for tie-back and completion. Section 5.3.5.2 presents details of tie-back and completion.

5.2.1.4 Drilling hazards

The Shah Deniz reservoir is a complex, high-pressure formation and well control during well operations is a routine function, with all of the wells designed to maintain well integrity. Despite controls and planning there are however, a number of potential drilling hazards that may be encountered during drilling operations, including stuck pipe, loss of circulation and well kick. Previous down hole problems during test well drilling operations in the Shah Deniz field have been encountered and data from these programmes have been used in the design of the drilling programme. Possible drilling hazards during the drilling programme and the measures to mitigate these hazards are described below.

Shallow gas

Based on site surveys and on past experience in the Shah Deniz region, there is a slight risk of encountering shallow gas during the drilling of the wells. A 12 ¼" pilot hole will be drilled (scheduled for 2Q 2002) prior to commencing of MODU drilling and a stand alone technical note for this well has been prepared and submitted to the MENR for approval. This will help determine whether shallow gas is present and to prevent it creating a safety issue during MODU drilling.

Well control

A well control incident may occur if a formation pressure overcomes hydrostatic pressure applied by the column of well fluids.

Primary well control against an influx of formation fluid requires the maintenance of sufficient hydrostatic head of weighted drilling mud or completion fluid in the well bore to balance the pressures exerted by fluids in the formation being drilled. This is an inherently safe approach to maintaining well control.

Secondary well control is provided during drilling by a Blow Out Preventer (BOP) stack in place. BOPs consist of a series of hydraulically actuated steel and elastomer rams, which can be rapidly closed following an influx of formation fluids into the well bore. The BOP will be rated 15,000 psi and exceeds maximum predicted surface pressures.

The BOP is connected to the choke manifold and by maintaining closed-in pressure, the well can be circulated to safely remove the influx and increase the fluid density, if necessary.

The choke manifold is connected to both the mud system degassers and gas venting system. In an emergency situation this allows gas to be vented harmlessly at the surface and any oil to be contained for disposal.

Stuck pipe

Stuck pipe may occur if the lubricating function of the drilling mud loses its efficiency, if subsurface sediments become sticky or swell through the uptake of water or if pH differences occur leading to chemical reactions and precipitation. The use of SOBM will however, reduce the likelihood of stuck pipe in these hole sections. In the event of stuck pipe the pipe will either be freed by mechanical agitation or if possible fished out. If none of these methods are successful then the well will be side-tracked.

Loss of circulation

During loss of circulation, mud passes into the formation into adjacent fractures or rock formations and more mud is required to maintain the hydrostatic head by introducing more mud into the hole. In the event of loss of circulation, materials such as mica or walnut shells are added into the mud to help seal the formation.

Hydrogen sulphide H_2S (sour gas)

It should be noted that no H_2S has been encountered on Shah Deniz to date and the chances of this occurring are considered to be low. H_2S has been encountered in the nearby Azeri field and as the potential distribution of H_2S is uncertain H_2S safety plans will be in effect for all well operations.

5.2.1.5 Contingency chemicals

A number of chemicals will be stored on the drilling rig for use as contingency during the drilling programme. The probable inventory for all contingency chemicals for use in the MODU drilling programme are presented in Table 5.7. Under normal circumstances these chemicals will not be necessary and in the event that they are required, only some will be used, depending on the nature of the problem.

Table 5.7 Proposed contingency chemical inventory for a typical Shah Deniz well

Chemical	Function	Estimated Use (t)[1]	HOCNS Category[2]
Gluteraldehyde	Biocide to prevent bacteria growth	1.0	C
Sodium Bicarbonate	Ph control and calcium reducer	1.0	E
Citric Acid	pH control and to mitigate bit balling	1.0	E
Blended surfactant	Drilling Detergent	1.0	E
Lignites / Gilsonite	Organics / Asphalts for lost circulation	5.0	E
Cellophanes	Lost circulation material	7.5	E

1. The actual amount of each chemical used may vary depending on subsurface conditions encountered during drilling. The figures presented are estimates based on best available knowledge at the time of writing.
2. Harmonised Offshore Chemical Notification Scheme: HOCNS category E is the lowest category. Category E chemicals are of low aquatic toxicity, readily biodegradable and non-bioaccumulative.

5.2.2 Drilling rig utilities

5.2.2.1 Operations

Normal operations at the Istiglal in addition to drilling and completion facilities include loading and offloading of supply vessels and mud, chemical and cuttings transfers. Cuttings will be stored in enclosed containers on storage areas on the Istiglal prior to transfer to a supply vessel for back-load to shore. The majority of equipment, stores and chemicals will arrive by supply vessel and will be transferred from vessel to rig either by using a pressurised hose or by lifting containers onto the rig by crane. The supply vessels also play an important role in supporting emergency services. There will be around seven return supply vessel trips per week. A vessel will be kept on stand-by adjacent to the rig. Personnel transfer will normally be by helicopter, with four return helicopter trips anticipated per week.

Accommodation

There are air-conditioned quarters on board for up to 120 people. The accommodation includes galley, mess and recreation room.

Power generation

All MODU power requirements will be supplied on-board by means of diesel generators. The Istiglal is equipped with modern design diesel generators that meet the low emission Euromot standards. These consist of 4 x 2,400 kW diesel generators and 1 x 635 kW emergency generator. Diesel consumption is estimated to be 9 tonnes per day. Emission estimates from power generation have been calculated and are presented in Section 5.2.2.2. There will also be further minor emissions to the atmosphere from all of the support vessels in the area during the drilling activities.

Cooling water

The drilling process on board the Istiglal will require cooling for normal operation. Seawater will be drawn by pumps at a rate of 400 m^3/hr for cooling and once passed over the drilling equipment to be cooled, the heated seawater will be discharged back into the sea via a subsurface caisson. The cooling water system will include an electrical antifouling facility.

Sewage treatment

The sanitary wastes generated on the Istiglal will be treated to United States Coast Guard Standards, using Type II IMO (International Maritime Organisation) certified equipment (IMO MARPOL 73/78, Annex IV).

Sanitary wastes, including all black (sewage) and grey water (water from shower and washing facilities) will be combined and processed in a treatment system which utilises an extended aeration process to produce a final effluent treated to a BOD (Biological Oxygen Demand) of less than 40 mg/l, Suspended Solids 40 mg/l and Coliform 200 MPN[2] per 100 ml prior to discharge. The system works on a principle that sewage enters a treatment compartment and is retained for 24 hours where it is mixed and aerated. The aerobic bacteria and micro-organisms break down material into mainly carbon dioxide and water and inert organic material producing new bacteria and micro-organisms. In addition to BOD_5, suspended solids and coliforms, the Istiglal presently checks the chlorine levels from the treatment system on a weekly basis. Current chlorine levels from the system are maintained at 1.5 mg/l.

Degraded material is displaced by incoming sewage and is passed through a coarse screen to a settling compartment. In this compartment the sludge at the bottom, called the activated sludge, is pumped back into the aeration compartment where it is mixed with the incoming sewage. The clear supernatant is chlorinated. Floating debris is removed and the treated effluent is discharged.

Sewage sludge will be transported onshore where it will be treated at a municipal sewage treatment plant.

Desalination units

The desalination unit on board the Istiglal used to produce potable water for use by the rig personnel and as drill water is a Gefico SA, Type Aquamar AQ-25/30 that utilises main engine waste heat. The desalination system uses heat from the Istiglal engines to gather and

[2] MPN = Most Probable Number.

treat Caspian Water to make distilled water for rig's potable water needs. The heated water passes through a closed loop system, which is cooled by heat exchangers in the rig's pump rooms. Seawater is pumped in and back out through the rig's sea chests after cooling the fresh water closed loop system which is used to cool the engines.

Three chemicals are used in the operation of the unit as follows:

?? **Aquachem 1000**: water treatment chemical that is automatically infused as required into the feedwater to reduce scaling. This chemical is a blend of neutralised carboxylic polymers and organic phosphonates, which is added in very small quantities (i.e. ppb).
?? **Aquachem 2:** is a cleaning acid. Approximately 99% is used as a substitute sulphanic acid and it is an inorganic acid with a pH of 2. As it dissolves however, hydroxide and carbonates scales are formed, its pH changes and is neutral when discharged.
?? **Aquachem 8:** is a descaler for calcium sulphate. Components are polycarboxilic organics.

None of these chemical additives are discharged to the marine environment as only uncontaminated water is discharged by pipe below water level.

Drainage

Drainage water on the Istiglal will originate from various sources including:

?? rainfall deck run-off;
?? clean area floor drains;
?? machine area floor drains;
?? overflow drains;
?? bilge; and
?? bunded areas beneath fuel and chemical storage areas.

As some drainage water has the potential to contain some amounts of oily waste there are three dedicated routes for drainage on board the Istiglal. These are as follows:

?? Discharge to sea (clean water drainage).
?? Oily bilge water tank for transport onshore to Consolidated Supplies Management at Primorsk, or for treatment and disposal to sea with subsequent transport of 'sludge' onshore. This tank received drainage from the pontoons, the compressor room, the hydraulic power room and the generator room. Bunded areas and/or drip pans are located under engines and machinery spaces. The drip pans are connected to the oily water drains and are routed to the oily bilge water tank and will mostly contain lube oil, diesel, etc. Oily water collected will be treated by passing through a three-filter system. Treated effluent will be discharged to sea through an oil sensor that monitors the oil-in-water content. If the oil-in-water content exceeds 15 ppm the stream is diverted back through the oily bilge water tank for re-treatment in order to meet international standards. Residual oil is transported onshore for disposal.
?? The Hazardous Area Drainage Tank (HADT) for transport on shore for appropriate disposal. This tank is serviced by drains from the drill centre and rotary table, the shale shaker house, the cuttings room, the mud pump room, the moon-pool and pipe rack areas.

The only drainage discharge from the systems onboard the Istiglal will be of non-contaminated fluids from the clean water drainage and treated effluents from the oily water drainage system. This is quantified in Section 5.2.2.2 below.

5.2.2.2 MODU drilling programme emissions and discharges

Atmospheric emissions

There are a number of activities during the MODU well drilling programme that will result in emissions to the atmosphere:

?? exhaust emissions from helicopters and support vessel activities;
?? power generation emissions from the Istiglal; and
?? emissions from gas venting of storage vessels, bulk materials transfer operations, surface mud pits, mud recycling unit (mud degasser and mud gas separator) and water treatment facilities (including the desalination unit, sewage treatment unit, grey water tanks and oily bilge water tank).

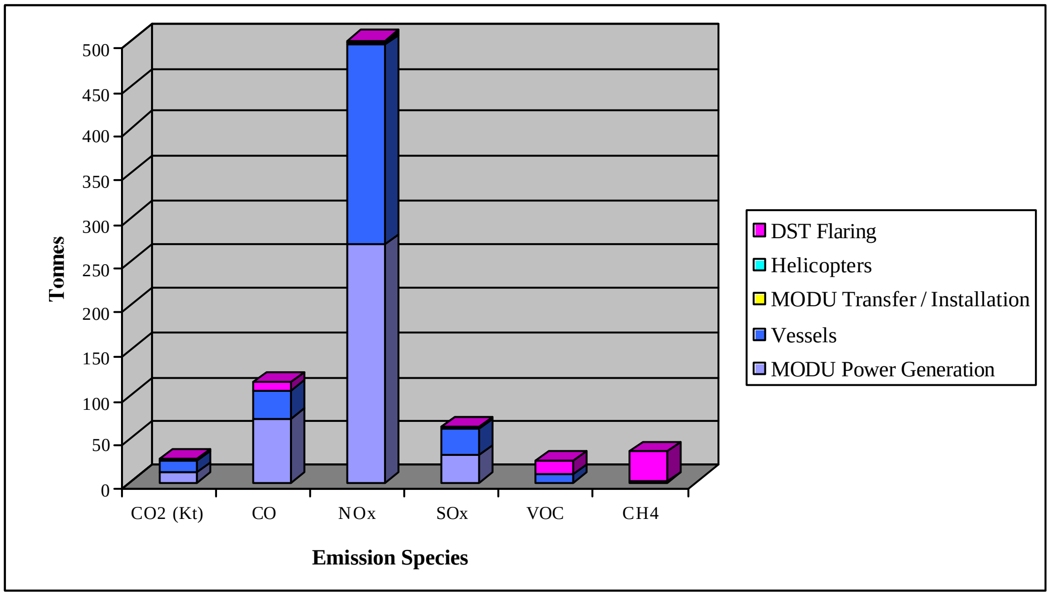
As stated in Section 5.2.1.3 above, although not a planned activity, a DST may be completed on third well during the MODU drilling programme. To cover this potential scenario, DST emissions have also been considered.

Estimated releases for the duration of the MODU drilling programme are presented in Figure 5.9 and are based on the following assumptions:

?? transfer and installation of the Istiglal will take four days and would require two vessels (6 tonnes per day fuel consumption);
?? MODU drilling programme duration of 426 days;
?? Istiglal average diesel fuel consumption of 9 tonnes per day;
?? standby vessel fuel consumption of 3 tonnes per day;
?? typical supply vessel daily fuel consumption of 6 tonnes per day;
?? vessel trips: seven return trips per week and a return trip duration of approximately 10 hours;
?? typical helicopter daily fuel consumption of 0.24 t/hr ;
?? helicopter trip duration: 1.5 hours (45 minutes each way) with four return trips per week; and
?? DST of the one MODU well with a maximum flow rate of 100 MMscfd over a total flaring period of 12 hours per well (i.e. total 50 MMscf).

The contribution of fugitive emissions will be small and is therefore, not included in the estimates.

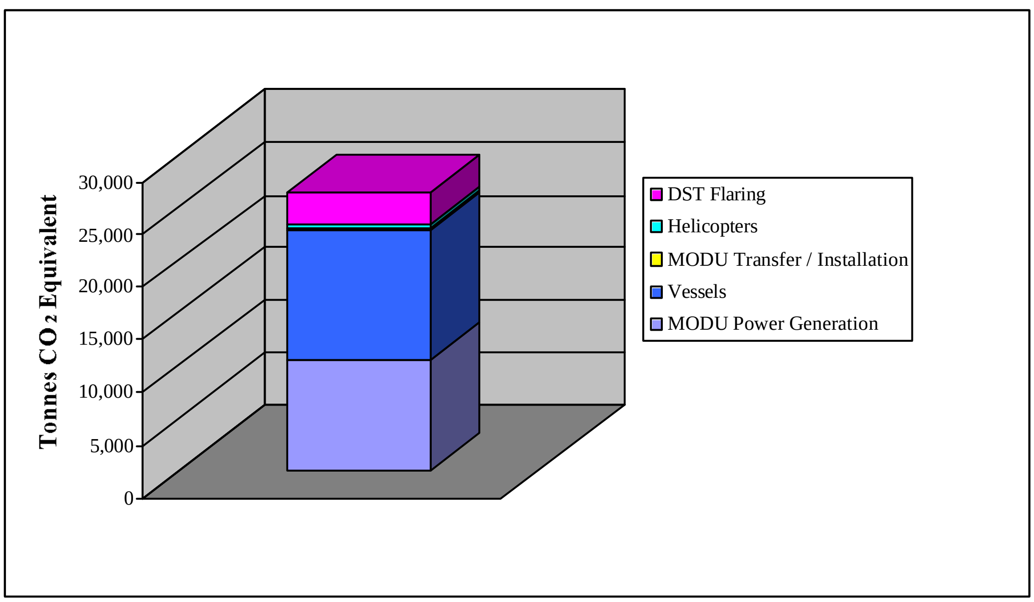
Figure 5.9 Estimated atmospheric emissions during the MODU drilling programme including one DST



Note: Units of CO_2 are kilotonnes.

Estimated GHG emissions for all gas species are presented in Figure 5.10.

Figure 5.10 Estimated GHG emissions during the MODU drilling programme including one DST



Aqueous discharges

Discharges to the sea, other than cuttings and WBM, during the MODU drilling programme include:

?? sewage;
?? desalination water discharges;

?? drainage water;
?? cooling water at 400 m^3/hr; and
?? food waste.

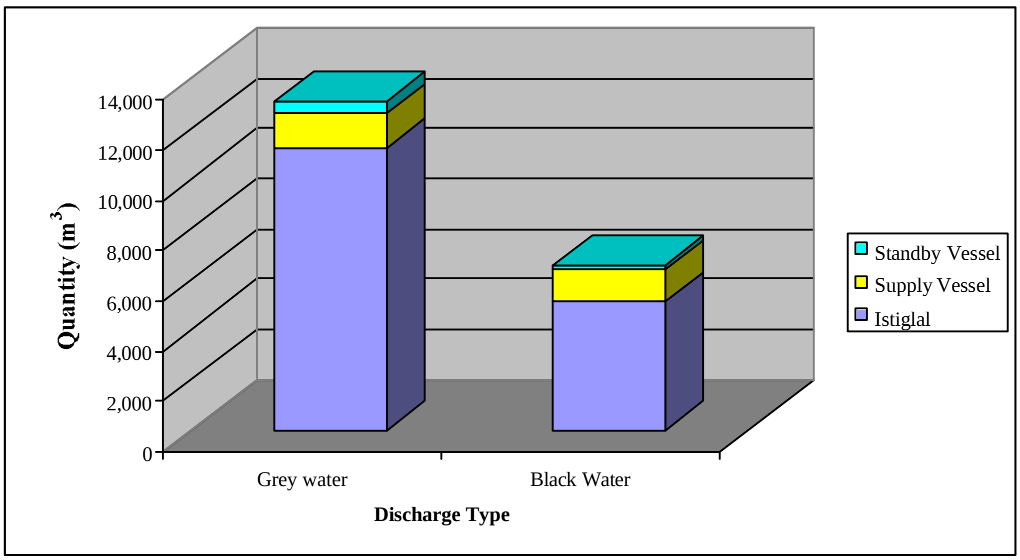
Sewage

The amount of sewage water generated and discharged from the facilities depends on the number of personnel present on board. In general it is assumed that one person generates 0.1 m^3 per day per of black water and 0.22 m^3 per day of grey water.

The estimated levels of sanitary waste generation during the MODU drilling programme are presented in Figure 5.11. The estimates are based on:

?? 120 POB the Isitglal MODU;
?? a well drilling period of 426 days (142 days per well for three wells); and
?? two support vessels (one supply and one stand-by) with 15 POB each.[3]

Figure 5.11 Estimated amounts of sanitary waste discharged to sea during the MODU well drilling programme



Desalination water discharges

The desalination unit runs with an intake of seawater of 3,640 l/hr that results in an output product of 1,820 l/hr and water discharges of 1,820 l/hr. The daily water discharges from the Istiglal desalination unit will therefore, be approximately 44 m^3, resulting in an expected total water discharge of 18,564 m^3 for the duration of the MODU drilling activities (426 days). There will no discharge of chemicals used in the desalination process (Section 5.2.2.1)

Drainage waters

The only drainage discharges from the systems onboard the Istiglal will be of non-contaminated fluids from the clean water drainage and treated effluents from the oily water drainage system. The volume of water going to the clean water drainage systems will be dependent on the level of rainfall during the MODU drilling programme. Based on 10,000 m^2

[3] Assumes supply vessels have USCG Type II treatment systems.

and 2,400 m^2 (x 2) rainfall capture areas for the Istiglal and the supply vessels respectively and for a mean annual rainfall of 413 mm (1999 and 2000 data; Chapter 6; Section 6.2.3.2), the total (clean) drainage water discharged during the MODU drilling programme is estimated to be 7,133 m^3.

When drilling with WBM, drain waters may be directed to the cuttings chute for discharge if they are uncontaminated. This effluent may contain surplus rig wash detergent that is an HOCNS Category E chemical.

Based on an average estimate usage rate for rig wash detergent concentrate of 250 gallons per year, and a maximum likely period for discharge of rig wash waters of 426 days it is estimated that the maximum amount of rig wash detergent concentrate that would be discharged is approximately 292 gallons (1.11 m^3). In addition, water will be discharged as the result of water use on the rig. Approximately 300 m^3 of water would be discharged into the sea per well drilled, equating to approximately 900 m^3 during the overall MODU drilling programme.

Oily water collected will be treated by passing through a three-filter system and discharging treated effluent to sea through an oil sensor which monitors the oil in water content. If the oil in water content exceeds 15 ppm the stream is diverted back through the oily bilge water tank for re-treatment in order to meet international standards. Residual oil (sludge) is collected and transported to shore for disposal. Onshore waste disposal site options are currently being assessed (Section 5.7).

Cooling water

Seawater will be used for equipment and plant cooling on the MODU. It will be uplifted at a rate of 230m^3/hr and will be discharged below the sea surface at a temperature of approximately 30^{0}C. The uplifted seawater is not subject to any antifoulant treatment. Any bio-fouling is manually removed periodically during maintenance routines.

Based on the results of thermal plume dispersion modelling for cooling water discharge undertaken for similar facilities, the thermal plume is expected to cool to ambient temperatures within tens of metres of the discharge point.

5.2.2.3 Other wastes

Solid and liquid waste generated on board the Istiglal will be stored in appropriate skips or containers before being transferred to a ship for transport to shore for disposal. Waste streams will be classed into one of the following categories:

?? non-hazardous combustible solid waste such as waste paper, wood and cardboard;
?? non-hazardous, non-combustible waste such as scrap metal;
?? hazardous solid waste such as paint cans and empty chemical containers; and
?? hazardous liquid wastes such as liquid oily wastes.

All toxic waste will be correctly identified and manifested so that it can be safely transported in accordance with the International Maritime Dangerous Goods (IMDG) classifications and then correctly disposed of onshore.

Liquid wastes such as waste lube oil will be transported to shore for disposal. Other liquid waste such as detergents used for cleaning purposes will also be temporarily stored prior to shipping back to shore.

Food waste will be discharged to the sea following grinding to <25 mm and are considered in the sanitary discharges presented above.

All garbage generated on-board the rigs will be segregated and stored then sent to shore for disposal at an approved site

Table 5.8 presents a summary of wastes produced for the MODU drilling programme.

Table 5.8 Estimated waste generation from the Istiglal during the drilling programme (426 days)

Type	Classification	Unit	Quantity
Domestic/General Waste	Non-hazardous combustible solid waste	t	80
Oil Rags, Wood & Packaging	Hazardous solid waste	t	36
Oil Based Mud Residues	Hazardous liquid waste	t	65
Thread Protectors	Non-hazardous solid waste	t	17
Liquid Oily Wastes	Hazardous liquid waste	m^3	19
Acids & Alkalis	Hazardous liquid waste	t	1
Fluorescent Tubes	Hazardous solid waste	number	800
Scrap Metals	Non-hazardous solid waste	t	22
Empty Drums (55 gal.)	Hazardous solid waste	number	77
Empty Drums (25 ltr.)	Hazardous solid waste	number	188

At the time of writing, a Waste Management Strategy for the Shah Deniz Stage 1 development and related BP Caspian region projects (e.g. ACG Phase 1) was being developed (Section 5.7). An element of this Strategy is the identification of appropriate onshore waste disposal sites for the waste streams identified above.

5.2.3 Well suspension and rig removal

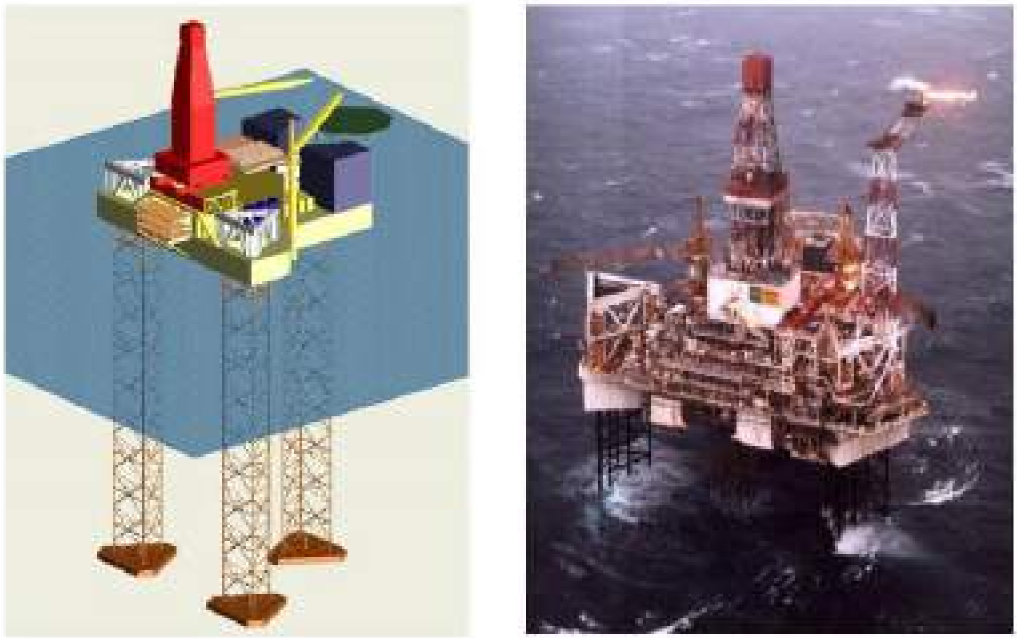
Each well will be temporarily suspended using cement and mechanical plugs to isolate any hydrocarbons and over-pressured formations. A corrosion cap will be installed on the sub-sea wellhead following retrieval of the BOP and riser system. This suspension program will be designed to allow ease of access to the well following installation of the fixed platform.

5.3 Drilling and production platform

5.3.1 Description

Long-term drilling and production operations in the Shah Deniz field will be accomplished through the installation of a combined drilling, production and accommodation facility. This platform will be of a proprietary design known as a Technip-Geoproduction 500 (TPG500) (Figure 5.12). The TPG500 design is a three-legged jack-up structure with each leg embedded into the seafloor. The deck structure of the facility is designed to float such that when the structure arrives on location, the legs can be jacked down through the deck until they reach the sea floor and the deck is then raised or jacked up on the legs. Once the TPG-500 structure has been installed, it will be commissioned and drilling and production will be carried out from the platform. Produced gas and condensate will be exported from the platform, via two separate pipelines, to a new, dedicated onshore terminal at Sangachal.

Figure 5.12 The self-installing TPG500 (proprietary) drilling rig



5.3.2 TPG500 transport, fabrication and assembly

The TPG500 will consist of a deck structure and three legs. The deck structure is to be manufactured as four strips, each of which will be able to float under its own buoyancy. The four strips will be fabricated out-of-country and will be towed into the Caspian Sea through the canals to the north of the Caspian. The hull strips will be treated as "dumb barges" and there will be a requirement to ballast each hull strip. A total of 2,000 t of ballast water will be required to trim all four hull strips to the required draft. The ballast water will not be treated with any marine growth inhibitors. During transit through the canal system, there will be a requirement to de-ballast and re-ballast each strip to ensure that the optimum draft is maintained in different canal water depths. The ballasting process will be undertaken in accordance with established operational procedures and marine ballast change requirements that are applicable to barge and river-ships transiting the canal system.

Once into the Caspian Sea, the four strips will be taken to one of the fabrication/assembly yards located in Azerbaijan where they will be mated to form a single deck structure. This mating process will either be conducted on dry land in which case it is referred to as "dry-mating", or the strips will be mated partially while still afloat in which case the operation is referred to as "wet-mating".

The legs of the structure will be partially fabricated out-of-country but they too will be assembled in Azerbaijan at the same yard as the deck.

The drilling template will be fabricated in country as a single frame structure and will be installed by the Istiglal prior to commencement of MODU drilling. Some components of the template may be manufactured out-of-country.

5.3.2.1 Assembly yard upgrade

Although the existing yards located in Azerbaijan have been used for the fabrication of large offshore installations in the past, preparation of the TPG500, in terms of assembly and fabrication of the component parts, may require that some changes be made to the assembly/fabrication yard irrespective of which yard is chosen for the work. At the time of writing, it is almost certain that an existing yard will be used for platform assembly work. Appropriate environmental assessments will be completed and approvals sought for before any yard upgrade work commences. Similarly, should a new location for the development of a new yard be selected, the construction project would be subject to a separate ESIA.

Yards such as the South Bay facilities at Baku, that could potentially be used for the assembly work, already have most of the facilities required for platform assembly work and hence would need very little upgrade. Any upgrade work of existing facilities that may be required may include such activities as road upgrade, refurbishment of existing buildings including offices, toilet units and warehouses, upgrade of sewerage systems and water supply infrastructure and potentially, the construction of a temporary camp for platform assembly workforce.

5.3.2.2 Principal platform assembly tasks

The principal tasks that will be conducted at the assembly yard are:

?? receipt of equipment and components from out-of-country;
?? mating of the four deck strips;
?? assembly of the legs and foundations;
?? fit-out of topsides equipment
?? pre-commissioning and commissioning of the platform deck equipment; and
?? preparation for float-out of the deck complete with legs.

Receipt of equipment and components from out-of-country

The four deck strips will be constructed in such a way as to be buoyant. Each of the four strips will be brought into the Caspian though the canals in the north of the Caspian and will be delivered to the assembly yard by sea.

The deck strips will be ballasted in order to achieve the correct trim for sea-passage and the ballast water will be removed from the strips upon arrival at the fabrication yard. The ballast water, that will contain corrosion inhibitor, will be removed and disposed of via water disposal routes established for this and other projects.

If the strips are to be dry-mated, as described below, they will be individually positioned on the quayside in preparation for the mating operation.

Further equipment required for the structure will either be brought in by sea following the route taken by the deck strips or will be delivered to site by either road or a combination of road and rail. Much of the equipment required on the deck structure will however, be installed in the out-of-country fabrication yards.

Mating of the four deck strips

As mentioned, there are currently two options under consideration for the mating process of the four deck strips, dry mating and wet mating. The difference between these two processes is described below.

Dry-mating

In a dry-mating operation, the four deck strips are elevated to enable welders to access the underside of the strips. The four strips are then successively joined together to form one coherent deck structure by welding the strips together along the top, side and underside seams where the strips abut. The mating operation in this case would either take place on one of the skid-ways at the assembly yard or in a dry dock. Once the sections have been mated, the deck structure is transferred to the adjacent waters.

Wet-mating

In a wet-mating operation, the four hull sections are floated into position adjacent to the quayside. The upper-butted joints are then welded together. While in the water, it is clear that the underside seams cannot be welded and therefore the structure needs to be placed in such a position that welders may access the underside in order to complete the mating process. The bottom seams are welded together by constructing cofferdams around the deck.

Assembly of the legs and foundations

The legs are constructed of three long cylindrical sections with cross members supporting a triangular shape to the leg in cross-section. The leg sections and cross members will be assembled by using forged nodes. The main leg sections and the cross members will be partially fabricated out-of-country. These pre-fabricated components will be delivered to the construction yard by rail or by vessel having been brought into the Caspian by river barge through the canal system to the north. Once delivered to the construction yard, the components will be assembled as legs. The legs may be fabricated as vertical or horizontal sections with sections being installed in the deck structure as they are completed, thus building up the legs rather than fabricating them in one piece before insertion to the deck structure. Fabrication of the legs will require welding of components as received in the yard. The assembled sections of the legs will then be lifted into place by means of cranes or by utilising the jacking capabilities of the hull structure.

Pre-commissioning of platform deck equipment

Much of the equipment required on the TPG500 will be installed on the deck strips at the original fabrication yards. This equipment will be installed, tested and mechanically completed in the out-of-country fabrication yards as far as this is possible. Commissioning following mating of the deck strips in-country will be concerned with ensuring the integrity of the various connections (i.e. electrical, piping, etc.) between each strip as well as ensuring that the equipment has suffered no damage in transit.

In country hydrotesting will be limited to pipe work fabricated in country and therefore will be of small quantities. The current plan for disposal of hydrotest water used in the assembly yards is via a suitable water disposal route established for this and other projects. Options are currently being assessed and include deep-well injection at Lokbatan and treatment and re-use in the cement manufacturing process at the Garadag Cement Plant. In addition, ecotoxicology tests are being undertaken to assess the feasibility of discharge to sea of treated hydrotest water.

Nitrogen/helium leak testing will be used to test the system integrity during commissioning prior to introduction of hydrocarbons.

The power generation equipment will be commissioned and will be capable of running on diesel.

Preparation for platform float-out

The deck structure is designed to be buoyant when the four deck strips have been mated and the legs inserted. The TPG500 can thus be considered at this stage to be a vessel and can be towed out to the field by tugs. Once the deck structure has been mated and the three legs installed, sea fastenings will be required prior to float-out of the vessel. The sea fastening will include provisions to ensure that any movable objects are secured. Sea fastenings are temporary fixtures and are removed once the vessel arrives on location. Prior to float-out the structure will also require classification as a vessel and this will be completed by a competent certifying authority that ensures, amongst other things, that the vessel is seaworthy. Thereafter, tow cables will be attached to the vessel and it will be towed by three tugs to the proposed drill location. The installation will be towed into shallow water to allow the suction cans, required to establish a firm suction anchor in the field, to be attached to the lower end of the legs.

5.3.2.3 Emissions and discharges at the TPG500 assembly yard

The TPG500 assembly contract had not been awarded at the time of writing this document and therefore, final details in regards to the number and type of equipment that will be used was not available. The emissions estimate is based on the following assumptions:

?? assembly programme duration: 10 months (30 days per month);
?? working day duration: 12 hours;
?? number of cranes: 5;
?? number of trucks; 10;
?? number of mini-buses: 20;
?? number of other diesel equipment; 5;
?? power generation: 0.5 MW diesel generator; and
?? number of workers: 600.

Atmospheric emissions

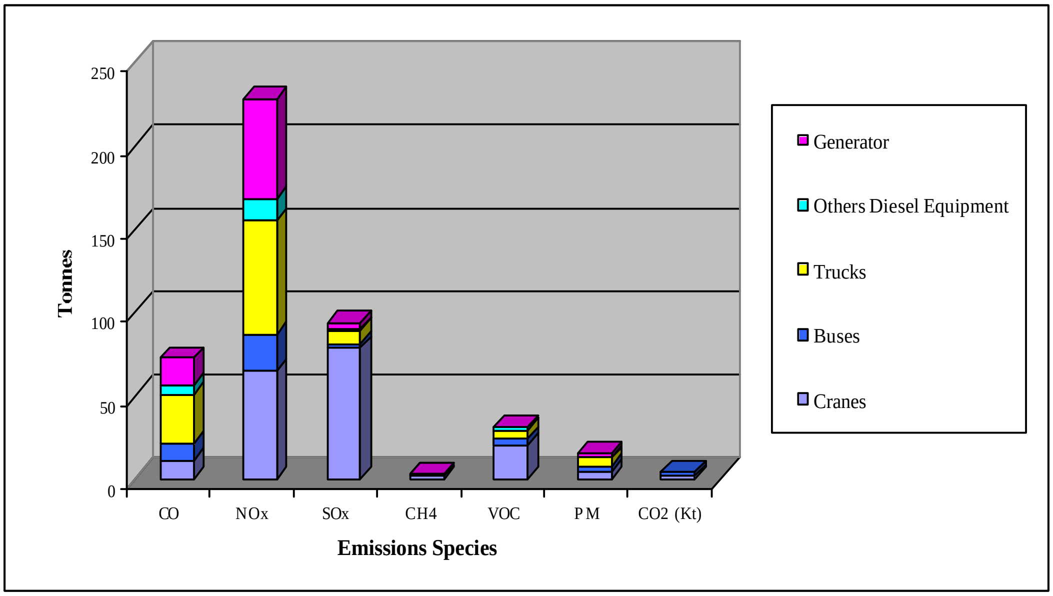
The principal sources of atmospheric emissions in the TPG500 assembly yard will be:

?? vehicle and crane exhaust; and
?? the power generator.

Emissions such as welding emissions during assembly of the platform will be negligible and hence, are not included in the estimate.

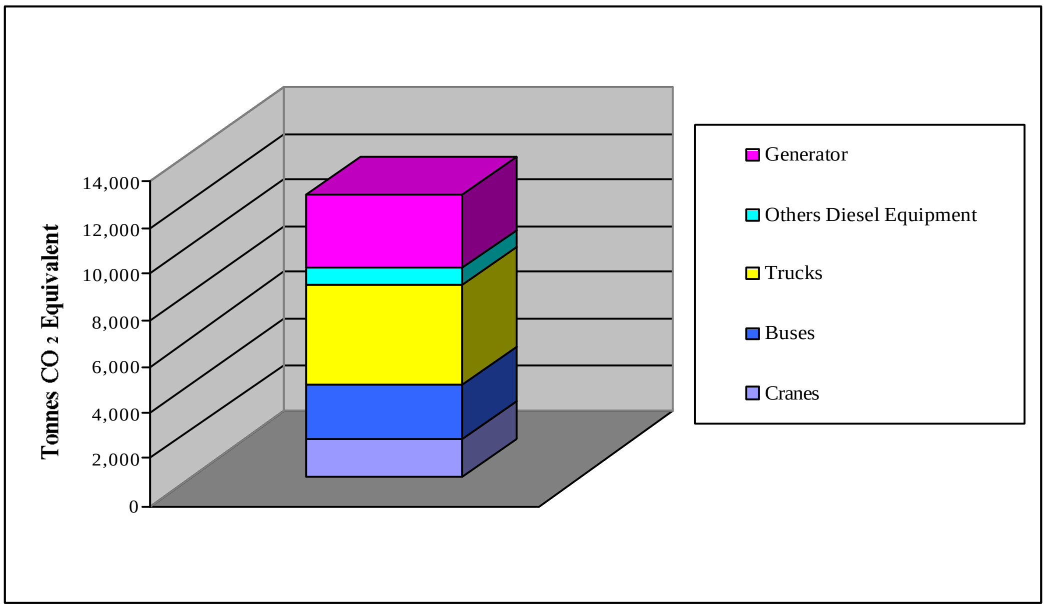
Figure 5.13 presents the estimated emissions by species and source that will be released to the atmosphere during the TPG500 assembly programme. Figure 5.14 presents the estimated quantities of Green House Gas (GHG) emissions (CO_2 and CH_4).

Figure 5.13 Estimated atmospheric emissions generated during TPG500 assembly



Note: Units of CO_2 are kilotonnes.

Figure 5.14 Estimated GHG emissions generated during TPG500 assembly



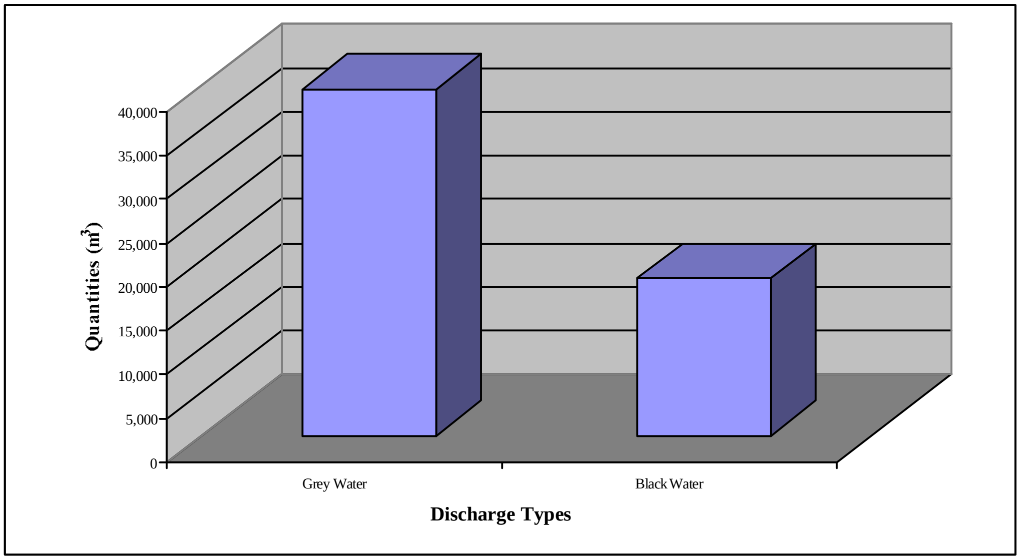
Aqueous discharges

Sanitary waste will be generated during platform assembly activities at the yard. The key assumptions for deriving the estimated amounts of sanitary waste generated are:

?? 600 temporary workers for a period of 10 months (300 days);
?? each person will generate 0.22 m^3/dy grey water; and
?? each person will generate 0.10 m^3/dy black water.

Estimated amounts of sanitary wastes are presented in Figure 5.15.

Figure 5.15 Estimated amounts of sanitary waste generated at the TPG500 assembly yard



Sanitary waste is the principal aqueous waste that will be generated, although it may not be discharged. Other liquid wastes include hydro-test water and drainage. Drainage water will be dealt with in the existing yards drainage system. Hydro-test water will be disposed of in accordance with the BP waste strategy and in accordance with Azerbaijan requirements.

Solid waste

There will be little significant solid waste generation in the yard. Whatever waste is generated will however, be disposed of in accordance with the BP waste strategy.

5.3.3 TPG500 float-out and installation

The seabed at the proposed TPG500 installation site comprises a layer of sand approximately 2 m to 4 m in depth, overlying a 0.5 m to 2 m clay layer. Below this clay layer there is a further 16 m of sand under which lies dense consolidated clay. In order to ensure a stable installation, the feet of the TPG500 will be secured by means of 8 m deep x 30 m diameter suction cans at the bottom of the legs fitted in shallow water prior to tow-out to the proposed platform location.

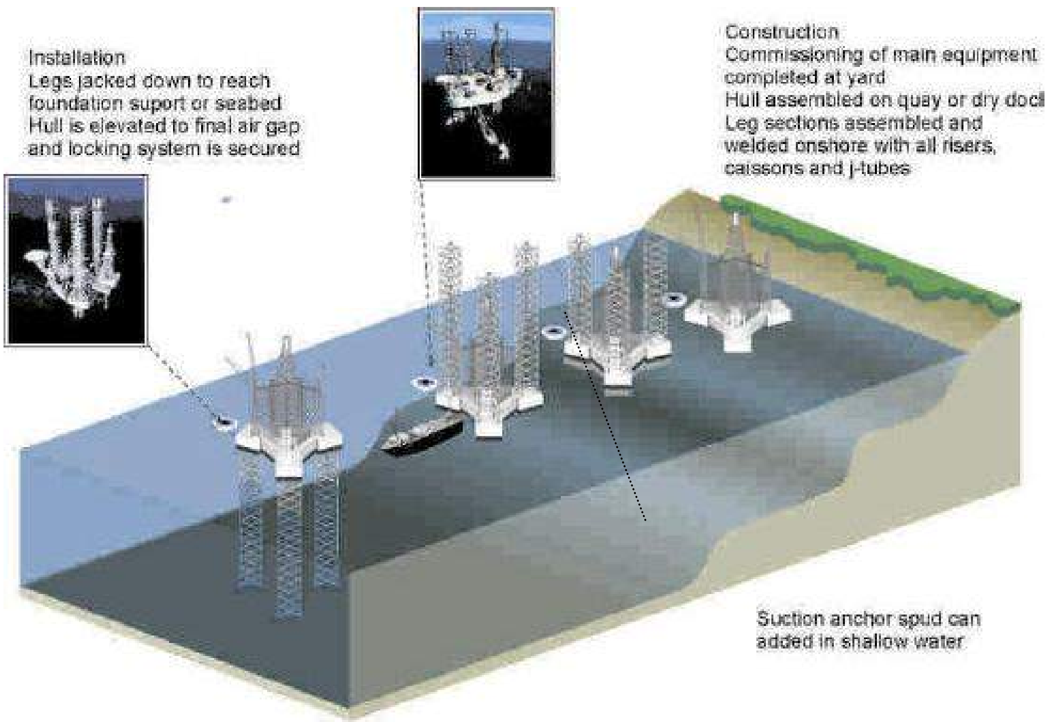
After tow out from the yard, the TPG500 will be taken to a shallow water location where the suction cans will be added. The TPG500 will then be towed out and floated into position over the installation location.

The legs will then be lowered down through the deck structure and the suction cans at the base of each leg will be sunk into the seabed by means of fluidising the seabed in the immediate vicinity of the skirts. Fluidisation of seabed sediments will be achieved by introducing suction to the seabed via pre-installed pipe work on the TPG500. Fluidising the sediments will allow the skirts to sink into the seabed under the weight of the platform facility. Once the fluidisation ceases the seabed will settle and the skirts will form suction anchors. This process is reversible meaning that the facility may be removed at the end of its production life.

The installation of the suction cans will disturb the seabed as the substrate is fluidised but this effect will be very localised. There will be no significant transfer of material into the water column as a result of this operation.

With the feet of the legs secured to the seabed, continued jacking of the legs through the deck structure then results in the deck being lifted clear of the water until the platform deck is approximately 11 m above the sea surface. The deck structure is then locked onto the legs. The three-legged structure and independent jacking mechanism for each leg means that the deck can be levelled if necessary. The construction and installation of the TPG500 is illustrated in Figure 5.16. Installation of the TPG500 will take approximately 10 days and will require four tugs.

Figure 5.16 Float-out and installation of the TPG500



5.3.3.1 Emissions and discharges during TPG500 float-out and installation

Estimates of quantities of emissions and discharges during TPG500 float-out and installation are based on the following assumptions:

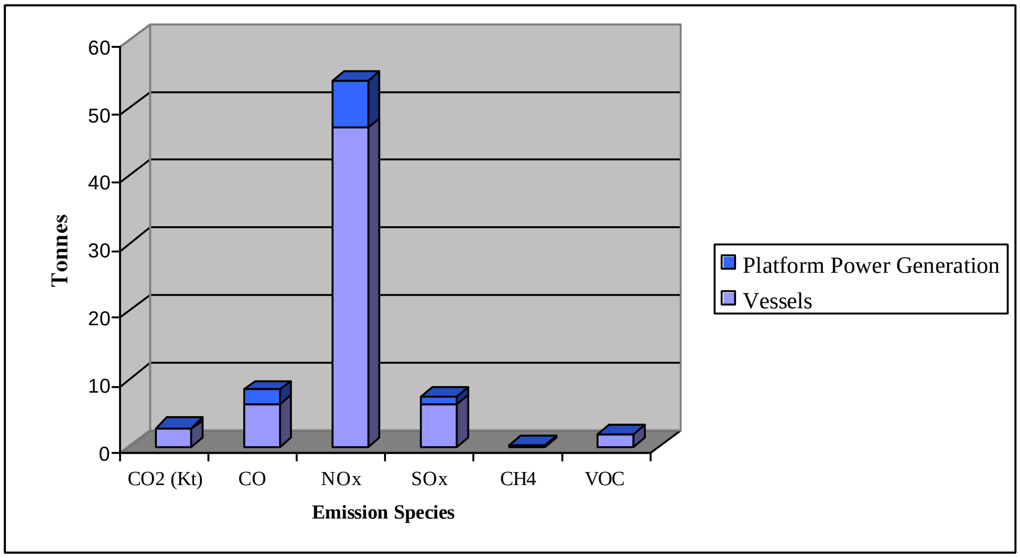
?? four tow tugs with 15 POB each;
?? diesel consumption of 20 t/dy for each tug; and
?? ten day duration for float-out and installation activities including use of platform power generation (2 MW) required for life-support systems on the installation during float-out.

Atmospheric emissions

The primary source of emissions during float-out and installation activities will be vessel exhaust gases.

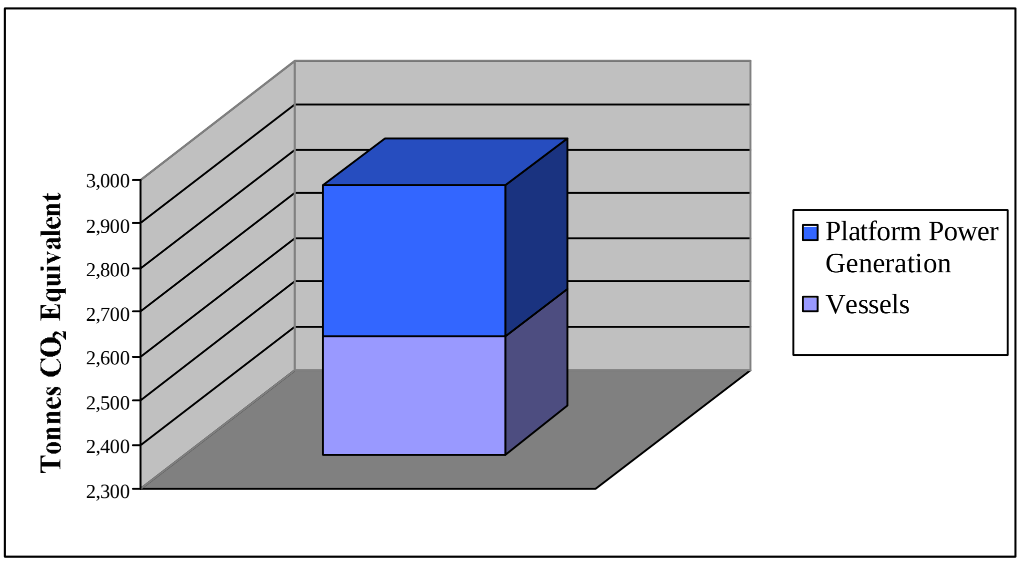
Figure 5.17 presents the estimated quantities of atmospheric emissions released to atmosphere during the float-out and installation operations. Figure 5.18 presents the estimated GHG (CO_2 and CH_4) emissions.

Figure 5.17 Estimated atmospheric emissions generated during TPG500 float-out and installation



Note: Units of CO_2 are kilotonnes.

Figure 5.18 Estimated GHG emissions generated during TPG500 float out and installation



Aqueous discharges

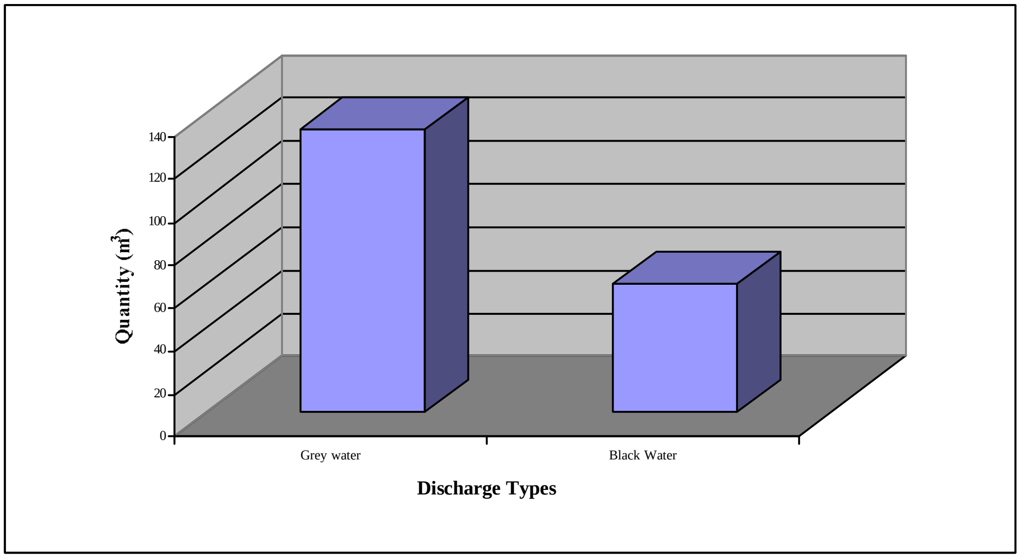
Sanitary waste will be generated throughout the duration of the TPG500 float-out and installation activities. The estimated levels of sanitary waste generation during the TPG500 float-out and installation are presented in Figure 5.12. The estimates are based on:

?? a programme duration of 10 days;

- ?? 15 POB each vessel; and
- ?? four vessels.

Figure 5.19 presents the estimated amounts of sanitary waste discharged to sea during platform float-out and installation.

Figure 5.19 Estimated amounts of sanitary waste generated during TPG500 float-out and installation



Solid waste

There will be no significant generation of solid waste during TPG500 float-out and installation. Whatever waste is generated will however, be disposed of in accordance with the BP waste strategy (Section 5.7).

5.3.4 TPG500 commissioning and hook-up

Most of the commissioning required for the assembled platform will be conducted in the in-country assembly yards. There will however, be a requirement for some commissioning activities to be conducted following installation at the offshore location to ensure that systems are tested and certified as functioning correctly. It should also be noted that the production process equipment cannot be fully commissioned until the pre-drilled wells are tied back to the platform and the platform commences hydrocarbon production. Tie back of the pre-drilled wells will require the installation of risers to the wells. The risers, once attached to the wells, will terminate in wellheads on the platform in the well-bay area. From the wellheads the process flow is commingled through a manifold.

In commissioning and start-up there are fundamentally five components that need to be commissioned, although each of these runs in a continuous sequence:

- ?? commissioning of life support systems;
- ?? the wells;
- ?? the platform process;
- ?? the export pipelines; and
- ?? the Sangachal terminal.

The commissioning of these components will be optimised but it may be necessary for each component to be commissioned independently of each other.

Commissioning of life support systems

Commissioning the life support systems on the installation involve ensuring that essential services and utilities are available. These essential utilities include:

?? firewater pumps;
?? seawater pumps;
?? drains;
?? sewage system;
?? lifeboats;
?? access and escape routes; and
?? deluge system.

Well commissioning and clean-up

In order to be able to introduce hydrocarbons on to the platform, the pre-drilled MODU wells will be commissioned. This involves entering the suspended well with drill string in order to displace the mud left in the well with completion brine. The mud is returned to the mud pits on the platform where it is treated and stored for future use. The quality of the returned mud is monitored and when the interface between the mud and completion brine is reached, the fluids are diverted directly to storage for transfer to shore for treatment and disposal.

Completion brine can be circulated and filtered a number of times to remove solids from the well and minimise the potential damage to the formation. The fluids used apply sufficient hydrostatic head to ensure that the formation fluids are unable to flow to surface during completion operations. All completion fluids will be contained at surface and back-loaded to shore for re-cycling except any additional volume displaced by the steel volume of the completion and the surface working volume, which will be stored for use in later wells. It is estimated that a maximum volume of approximately 480 m^3 (3,000 bbls) of mud/brine mix will be present. Once the well is full of 'clean' completion brine (i.e. with no mud), the completion is run down-hole and the well is perforated.

Immediately following perforation, the hydrocarbons flow, displacing the completion brine to a storage tank for potential future use. The well is then allowed to flow at a high rate in order to clean the well-bore of any debris left over from the perforation and to ensure efficient production from the reservoir. The hydrocarbons produced during well clean-up will be separated and flared in a temporary flare boom package.

It is anticipated that the first well will be cleaned up to temporary flare at a maximum flow-rate of 100 MMscfd (2.8 million m^3/day), for one day in order to avoid damaging the reservoir. With condensate being produced at approximately 58 bbls per 1 MMscf of gas, a maximum of approximately 5,800 bbls condensate could also be flared during a single well clean-up event. Depending on the performance of the first well clean-up it is anticipated that subsequent wells can be cleaned through the process and therefore, result in no additional flaring. It may be necessary however, to also clean-up the second well to the temporary flare at the same rate.

Platform process commissioning

During platform process commissioning, leak testing using a nitrogen/helium mix will be conducted on the:

?? flow-lines;
?? clean-up package; and
?? riser hook-up spools.

Immediately prior to start-up, checks will be performed on valve position and other system checks will be performed in order to ensure that all equipment is correctly set-up for start-up.

Pipeline commissioning

As described below (Section 5.4.6), it will be necessary to de-water the pipelines prior to start-up of the production process since the alternative would require process start-up to produce sufficient hydrocarbon at sufficient pressure to displace the hydrotest water in the pipeline. It is considered that this presents a risk that can be mitigated by dewatering the pipelines prior to platform (TPG500) start-up and for this reason, this is the base-case plan for platform commissioning. The linkage between pipeline dewatering and the terminal commissioning is discussed below (Section 5.4.6).

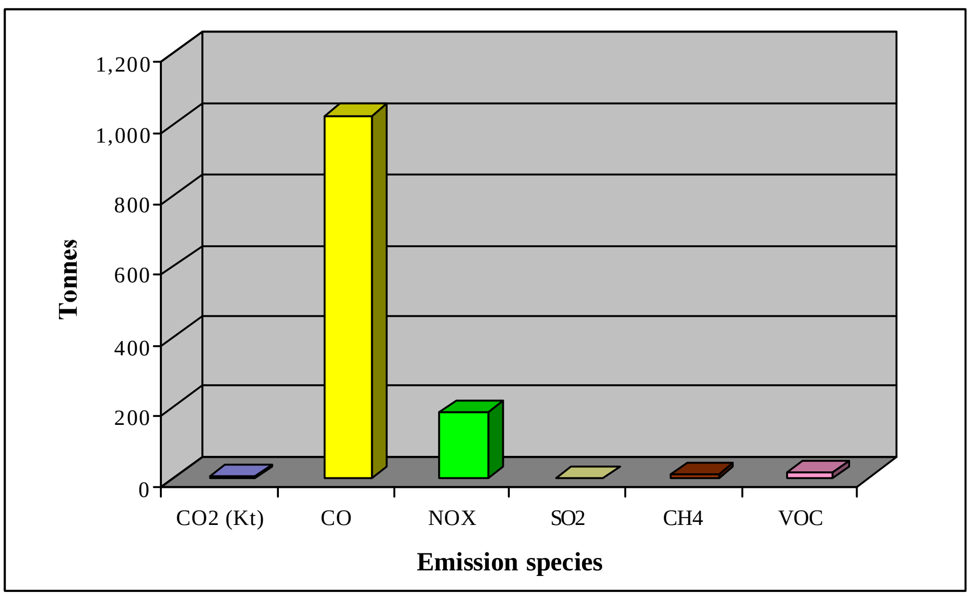
Terminal commissioning

Terminal commissioning is discussed in Section 5.5.4.3.

5.3.4.1 Atmospheric emissions

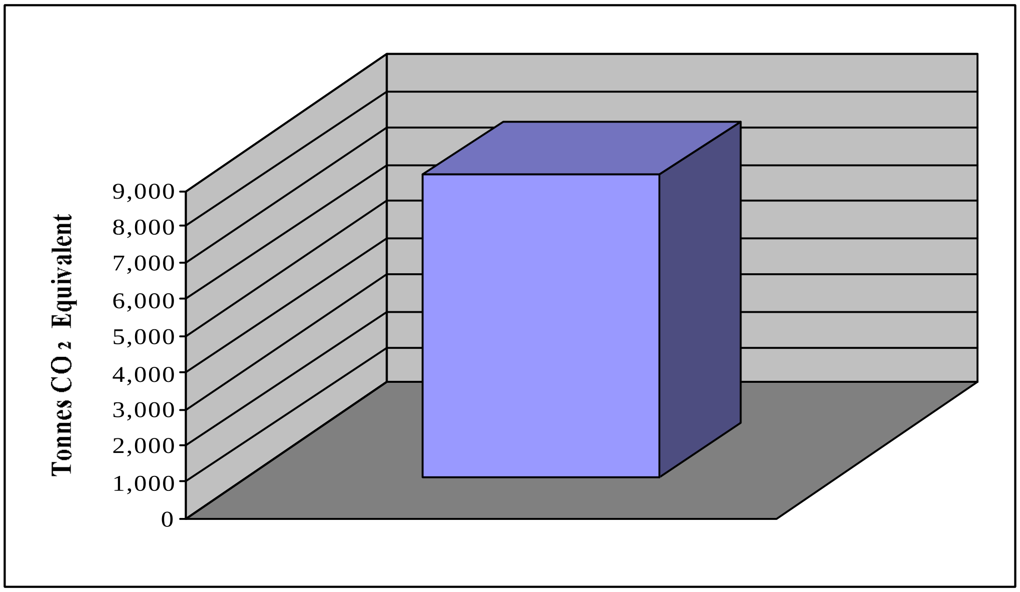
The maximum atmospheric emissions resulting from flaring of hydrocarbon product during well flowing have been estimated as presented in Figure 5.20. Estimated GHG (CO_2 and CH_4) emissions are presented in Figure 5.21.

Figure 5.20 Estimated atmospheric emissions from flaring during TPG500 commissioning per well clean-up



Note: Units of CO_2 are kilotonnes.

Figure 5.21 Estimated GHG emissions generated from flaring during TPG500 commissioning per well clean-up



5.3.4.2 Aqueous discharges

It is not anticipated that there will be any significant aqueous discharges during TPG500 commissioning.

5.3.4.3 Solid waste

It is not expected that any significant solid waste will be generated during TPG500 commissioning. Whatever waste is generated will however, be disposed of in accordance with the BP waste strategy.

5.3.5 Platform drilling

5.3.5.1 Platform selection

This section describes the drilling programme to be carried out from the TPG500. This aspect of the programme is termed "platform drilling" to distinguish it from the earlier MODU drilling programme.

5.3.5.2 Platform drilling programme

Operations

Wells drilled from the TPG500 are expected to access hydrocarbons within a 5km radius. The accessible volumes are based on a drilling reach of up to 3.2 km horizontal departure and up to 2 km of anticipated well drainage radius. Following installation of the TPG500 platform, it is expected that six platform wells will be drilled in addition to the three pre-drilled wells to develop these accessible volumes.

To maintain plateau production levels in later years, it is anticipated that five additional off-platform wells will be required to access gas in the southern part of the Stage 1 development area. Depending on actual technical limitations with extended reach drilling at that time, these wells may be provided as sub-sea completions in water depths of approximately 350 m. The wells would be tied back to the host TPG-500 platform by sub-sea flow-lines.

The appropriate timing and layout of the sub-sea part of the Stage 1 development will be determined by data collected from reservoir surveillance activities during the first few years of production from the TPG-500 platform. Flexibility to adapt plans as a result of reservoir performance would be maintained through the allocation of spare slots in the platform specifications. The sub-sea development (manifold duster strategy and well numbers) and the number of platform wells may be varied based on field production performance and drilling experience.

Well and casing plan

The platform production wells to be drilled from the TPG500 will be drilled in the same way as the wells drilled from the MODU. Waste WBM and cuttings generated during the drilling of the 28” section will be disposed of to seabed. Remaining hole sections will be drilled using a synthetic oil based system (SOBM), with the cuttings and SOBM recovered at the surface for transport to and disposal onshore.

At the time of writing, the estimated volume of cuttings per well drilled with both WBM and NWBM are the same as those described for the MODU wells (Section 5.2.1.3). The total volume of WBM cuttings discharged from the platform wells assuming a total of six (6) wells will be approximately 1,608 m^3 (3,216 t).

As with the MODU drilling programme, cuttings from all sections drilled with NWBM will be brought onboard the rig and passed through the solids control system, re-circulating reconditioned mud down-hole and storing removed cuttings and spent mud for ship-to-shore, onshore treatment and disposal. The base case for cuttings transfer is for cuttings to be routed via the shale shaker, through a “cuttings blower” to holding tanks (25 t storage containment) on-deck and then onto similar tanks on supply vessels for ship to shore; ship tanks may be off-loaded onshore or cuttings may be transferred by ‘cuttings blower’ at the off-load point for treatment elsewhere onshore. The shipboard tanks will comprise a number of tanks on two or three supply vessels. Additional tanks for use as buffer storage will also be available on platform deck. The greater the number of tanks on deck, the greater the reduction in shutdown time.

An alternative option under consideration is to slurrify the cuttings with NWBM on-deck and then pump the resultant slurry straight to the supply vessel. Although this reduces the offshore handling and constraints imposed by deck storage limitations, onshore processing becomes more difficult as base oils need to be recovered and returned offshore for re-use.

The total volume of NWBM cuttings contained for onshore treatment and disposal from the platform wells assuming a total of 6 wells will be 8,112 m^3 (16,224 t).

Cementing

As with the MODU wells, casing will be run and secured into place with cement following the drilling of each hole section down to the $8^1/_2$” hole section. The 30” conductor will however, be driven and will not need to be cemented into place. The cementing programme for the platform wells will be consistent with that discussed for the MODU wells (Section 5.2.1.3).

Well logging

Wells will be logged as required during the platform drilling programme using the methods as described in the MODU well drilling programme (Section 5.2.1.3).

Well completion and clean up

After each platform well is drilled to total depth it will be filled with mud and will be completed and perforated in the same way as described for the three MODU pre-drilled tie-back wells (Section 5.3.4).

The clean-up flow from the platform wells can be passed through the production process, with all hydrocarbons and well debris being sent to either the production or test separator where the hydrocarbons are separated and sent to shore via the respective pipelines. The well debris is removed from the separator and sent to shore via supply boat for treatment and disposal.

5.3.5.3 Drilling hazards

Drilling hazards and mitigation measures adopted to counter these hazards were discussed in the MODU drilling section (Section 5.2.1.4). Similar mitigation measures to counter drilling hazards during platform drilling will be adopted. These may however, be modified following the results of the MODU well programme and through improvements in technology. Likewise, contingency chemicals used for the drilling programme will also be selected following the results of the MODU drilling programme.

5.3.5.4 Platform well work-over

Well maintenance and work-over activities would be expected to occur on a periodic basis after all wells have been drilled and completed. All work-over and well maintenance operations will be conducted from the TPG500.

5.3.5.5 Emissions and discharges during platform drilling

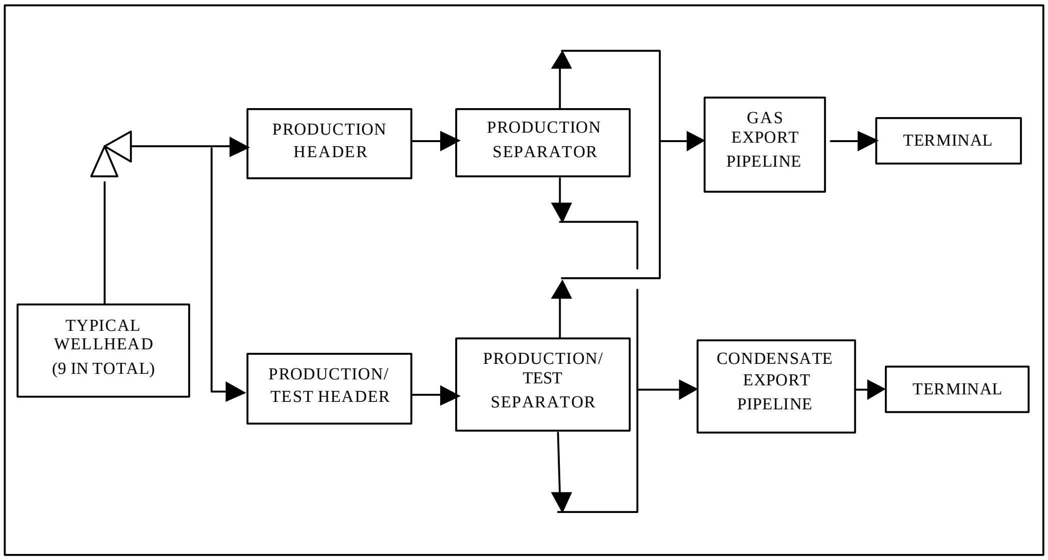
Atmospheric emissions and aqueous discharges will be generated during the TPG500 platform drilling programme. Estimates of the quantities of the emissions and discharges are considered in conjunction with platform operations as presented in Section 5.3.7.2.

5.3.6 Production operations

5.3.6.1 Production process

The production process on the TPG500 is a simple process of separation of liquid from gas. The two streams, condensate/water and gas will then exported by means of two pipelines to the reception and processing terminal at Sangachal, with some gas used on the platform as fuel gas. The process is shown graphically in the Figure 5.22.

Figure 5.22 Process flow diagram of the TPG500



5.3.6.2 Production separation

Production from the platform wells will be co-mingled through a production header and passed to a single stage 2-phase vertical separator, operating at 152 barg, where gas is separated from condensate. The separator will be designed to be suitable for operation over a 30-year life period. The separator will be able to operate through a turn down 4% to 100% on each phase (gas and condensate/water). Design operating parameters for the production separator are:

??	temperature (°C):	54;
??	pressure (barg):	152;
??	gas rate (MMscfd):	900;
??	condensate rate (bpd):	54,260;
??	produced water rate (bwpd):	2,650; and
??	sand (lb/MMscf):	up to 0.1.

5.3.6.3 Test separator and metering

In order to test flow rate, composition and other parameters from individual wells, it is possible to route the production from any single well to a test separator. The production stream will be separated in the same way as the main production stream and the separated products, gas and condensate/water, will be routed back into the main production stream prior to export. Design operating parameters for the test separator are the same as the production separator.

5.3.6.4 Pig launcher

Both the gas export and condensate export pipelines will have pig (pipeline inspection gauge) launchers to allow pigging of the pipelines. The principal reason for pigging is to remove wax.

The gas pipeline will be pigged approximately once or twice per year. The pigs will be launched via the offshore pig launcher and will be received in the pig receiver at the Sangachal terminal. The pigs may comprise of simple spheres or may have a more complex geometry designed to produce a scraping action along the pipeline. Intelligent pigs capable of gauging the inside on the pipeline may also be used intermittently for the purpose of corrosion and pipeline integrity monitoring.

There will a higher propensity for wax build-up in the condensate line and thus pigging will be required on a far more frequent basis. To reduce the number of times the condensate pig launcher has to be opened, pigs will be introduced to the launcher in sets of six to seven. These sets of pigs will be contained within cassettes that allow the release of one pig at a time and with a release frequency of approximately two days, a seven-pig cassette will mean that the pig launcher in only required to be opened once every two weeks. Prior to opening, the pig launcher will be heated externally to melt any wax and to evaporate any condensate that is still present after drain/venting. This will minimise the potential for hydrocarbon spill when the door is opened. Any residual hydrocarbons present (small quantities) will be captured by a drip tray located under the pig launcher door and sent to the hazardous open drain decanting tank where there are hydrocarbon recovery facilities.

5.3.6.5 Chemical injection

Monoethylene glycol (MEG), corrosion inhibitor and wax inhibitor will be injected downstream of the pig launchers on each of the two pipelines.

MEG will be delivered to the platform by means of a 4" pipeline that will be piggybacked on the condensate export pipeline. The MEG will be injected into both export pipelines for the purpose of preventing hydrate formation, since MEG will absorb any free water in the system. The MEG will be separated from both gas and condensate and will be regenerated to remove the water it has absorbed at the Sangachal terminal. This regenerated MEG will be then re-exported to the platform and thus, the MEG will effectively be in a closed loop system. Small volumes of MEG may be carried over into the condensate and gas export from the Sangachal terminal and in addition, small quantities of MEG will be lost during the regeneration process. These losses will be replaced at the terminal but there will be no gross discharge of MEG to the environment.

MEG serves a second function on the platform. If closed, the down-hole safety valves in each of the wells cannot be opened until pressure is equalised across them. In order to equalise the pressure across the valves and allow them to open, MEG will be injected upstream of the safety valves. As the pressure is equalised and the valves open, this MEG will then be carried through the process and exported to the Sangachal terminal for treatment as described above. MEG is also injected at the wellheads to prevent hydrate formation.

In addition to MEG, corrosion and wax inhibitors will be injected into the export pipelines downstream of the pig launchers. These inhibitors will be proprietary chemicals and will not be discharged to the offshore environment from the TPG500 platform. The inhibitors will be delivered to the platform by means of a tank that will be decanted into fixed storage containers on the platform installation. The inhibitors will either be partially carried over with product at the Sangachal terminal but the bulk of the chemicals will be separated out with water at the terminal and will be disposed of along with produced water. The percentage of inhibitor that is carried over with product will depend on the chemical partition co-efficient, a parameter that is chemical-specific.

5.3.6.6 Overpressure protection

The separators are protected from overpressure by a High Integrity Pressure Protection System (HIPPS). Should the pressure in the separators rise above normal operating pressure, this will cause a back-pressure on valves located upstream of the vessel's inlet. This increase in pressure causes the HIPPS valves to close thus preventing any further increase in pressure in the separators. In this way, the separators will be protected from damage by overpressure. There are also process safety valves that provide a mechanical means of overpressure protection and these have bursting discs to prevent hydrocarbon passing to vent. The HIPPS helps to prevent unnecessary PSV actuation and was an integral part of the decision to opt for venting rather than flaring.

5.3.6.7 Sand monitoring

As it is anticipated that small quantities of sand will be produced along with the well fluids, there will be sand probes upstream of the choke valves on all production flow-lines. Based on current operational experience and project data it is estimated that sand production will occur at a rate of up to 0.1 lb per MMscf gas. At the peak of production with a production capacity of 900 MMscf/d it is estimated that 90 lb of sand will be produced with the reservoir fluids each day.

The sand will drop out in the production separator and will be removed as necessary. Once removed, the sand will be containerised and sent to shore for disposal at an appropriate disposal site that will be identified under the BP Waste Management Strategy (Section 5.7).

5.3.7 TPG500 platform utilities

5.3.7.1 Power generation

Power required for all purposes on the platform will be produced by means of dual-fuel generators that include closed loop cooling water systems and some degree of waste heat recovery. It is planned that these generators will be fuelled, in preference, on gas but during start-ups will be run on diesel. The platform power requirements are as detailed in Table 5.9.

Table 5.9 Platform power generation requirements

Description	Power Requirement	Duration
Base load – principally HVAC[1] requirements:	2.0-2.5 MW	Continuous load for 30-year design life.
Drilling requirement:	0.5-7.3 MW	Variable load for 73 day well construction period (theoretical maximum 15 wells can be drilled from platform – current plan is 6 platform wells to be drilled from mid 2005 for approximately 3.5 years).
Drilling Contingency:	2.5 MW	Temporary if a well has to be suspended.

1 HVAC = Heating and Ventilation Air Conditioning.

5.3.7.2 Fuel gas

After passing through the production separator, gas will be removed in side-stream from the main gas process stream for the purpose of use as fuel gas. The fuel gas will be passed through a heater and then to a knockout drum to remove any remaining liquids. The gas will subsequently be passed through a second heater and then filtered in the final step of conditioning for use as fuel gas. All fuel gas produced on the platform will be used for power generation in the dual-fuel generators. A maximum fuel gas rate of 2.5 t/hr is required during the drilling phase but this will reduce to approximately 1 t/hr once drilling is completed.

5.3.7.3 Utility water

Uses of utility water are:

?? potable water;
?? cooling; and
?? firewater.

These are discussed below.

Potable water

Potable water will be produced by means of reverse osmosis (RO) of seawater. The seawater is first conditioned using an activated carbon filter. Following conditioning, the water will pass to two RO membranes located in pressure tubes where water passes through to the collecting system. The desalted water, after passing through the RO membranes, will be re-mineralised by passing through a solid media. This replaces the need for liquid chemicals.

Reject water, or that remaining water upstream of the RO membranes will be salt-enriched brine. The RO membranes are designed to operate at approximately 25% recovery, which means that for 1.25 m^3/h potable water produced by each membrane, 3.75 m^3/h reject water will be produced. With an original salinity of 13‰, the rejected water will have a salinity of approximately 19‰ and will contain the following ion concentrations:

?? Ca^{2+}: 447.4 mg/l;
?? Mg^{2+}: 961.2 mg/l;
?? Na^{+}: 3 989 mg/l;
?? K^{+}: 101 mg/l;
?? Ba^{2+}: 0.13 mg/l;
?? Sr^{2+}: 12.4 mg/l;
?? Cl^{-}: 7029 mg/l;
?? SO_4^{2-}: 4027.5 mg/l; and
?? HCO_3^{-}: 288.4 mg/l.

This brine will be discharged to sea directly from the hull of the TPG500.

During drilling, both membranes will be operational producing 2.5 m^3/hr of fresh water and 7.5 m^3/hr of reject water. After drilling, when the platform personnel decreases significantly, only one RO membrane will be required probably on an intermittent basis.

Cooling water

Cooling water is required on the platform in the quantities presented in Table 5.10.

Table 5.10 Platform cooling water requirements

Cooling Water User	Drilling Phase		Post Drilling Phase	
	Flow Rate (m^3/hr)	Return Temperature (°C)	Flow Rate (m^3/hr)	Return Temperature (°C)
1st Stage Cooling:				
Hull HVAC:	197	17	197	17
Mud Tank HVAC:	48	17	0	-
Drilling Cooling:	266	17	0	-
Alternator Cooling:	28	27	11	27
2nd Stage Cooling:				
Power Generation Cooling:	415	35	166	25
3rd Stage Cooling:				
Chilled Water Units:	100	35	100	35
Total Returned to Sea	**539**	**35**	**208**	**35**

1. 2nd Stage Cooling taken from 1st Stage outlets at 17°C.
2. 3rd Stage Cooling taken from 2nd Stage outlets at 20°C.
3. Total seawater return is sum of 1st Stage cooling requirements discharged at 35°C.

Cooling water dispersion studies were completed in order to identify the optimum depth of discharge in terms of environmental factors (i.e. World Bank Guideline requirements of +/- 3°C within 100 m of release point) and engineering requirements of no interference with the seawater uptake (i.e. -50 m; see below). Modelling investigated thermal plume dispersion for discharge depths of -10 m, -30 m and -50 m LAT and assessed the effects of the discharge under summer and winter meteorological conditions and mixing regimes. Results indicated that all discharge depths meet the World Bank guideline. A discharge depth of -20 m was chosen as the project's base case.

Firewater

Principal fire protection will be provided by means of a firewater ring-main system. The firewater will be dosed with chlorine and copper using the same system as that used to dose the uplifted seawater stream on the platform (see Section 5.3.7.4).

Should the firewater system be activated, it will be supplied by two firewater pumps, both driven by dedicated diesel generators, with a maximum flow-rate of 1,000 m^3/hr, representing 100% of total demand. Firewater ring-main pressure will be maintained by means of small jockey pumps. This means that small volumes of water can be released; for example, for testing of individual components within the system without the main firewater pumps being activated. The fire pumps will be tested for about 30 minutes each week at 1,000m^3/hr and at 1,500m^3/hr for a maximum of 4 hours, once per year. Other components will be tested on a rotational routine. The firewater system feeds:

?? the process and drilling area fire water deluge systems;
?? process and drilling area hydrants;
?? process and drilling area monitors; and
?? in-hull hose-reels.

The full deluge system will be tested once every five years. During such tests the firewater will either drain via the deck drains or through the open drains system and will discharge to the sea.

5.3.7.4 Seawater lift

All water requirements on the platform will be met by means of taking water, through lift pumps, from the surrounding seawater. There will be three 50% seawater lift pumps. The seawater lift pumps will be electrically driven and will have a lift capacity of a maximum of 900 m^3/h. Each pump will be located in its own seawater lift caisson that is protected from ingress of gross solids by bars across the intake. The intake depth will be -50m LAT.

Antifouling treatment

Uplifted seawater and firewater will be treated with an anti-foulant to prevent marine growth and corrosion within the seawater system. The antifouling system to be adopted is the Bio Fouling Copper Chloride (BFCC?) system which involves pulsed dosing of 50 ppb chlorine and 5 ppb copper. The BFCC? copper-chlorine process operates on a one minute in every five basis; that is, 20% of the time resulting in an average concentration of 1 ppb copper and 10 ppb chlorine in the discharge cooling water stream.

Seawater for the BFCC? system will be drawn by pumps from a depth of greater than -50 m below the sea surface and will subsequently be passed to the platform topsides for use before discharge back into the sea via an 900 mm diameter caisson, at a depth of 20 m below the sea surface. The present system design for the TPG500 has a base design operational rate of 900 m^3/hr for the discharge of cooling water into the sea.

Once passed through the cooling medium, the seawater temperature will have increased to approximately 30?C. At the point of discharge, there will be a temperature differential between the discharged cooling water and the receiving water body. The magnitude of the differential will be different in summer and winter. This is discussed further in the Environmental Impact Assessment (Chapter10).

The project design requirement is that discharged cooling water will be within 3?C of ambient seawater temperature no more than 100 m from the platform in alignment with IFC Environmental Health & Safety Guideline, Oil and gas Development Offshore, 2000 guidelines.

5.3.7.5 Heating, ventilation and air conditioning

The Heating, Ventilation and Air Conditioning (HVAC) system will be designed to cool the accommodation and hull during the summer months and to heat it during the winter months. Heating and cooling will be principally achieved by the circulation of warmed or cooled air through those areas to be conditioned. This circulated air also has the additional effect of providing overpressure in the accommodation areas and thus acts to prevent the ingress of potentially explosive gas. The system will be designed to maintain the accommodation areas at a temperature of between 24^{o}C and 27^{o}C during the summer months and between 18 ^{o}C and 20^{o}C during winter months. In technical rooms, for example workshops and storage areas, these ranges are between 28^{o}C and 35^{o}C during summer and 5^{o}C and 20^{o}C during winter. The circulation of air in the system also ensures that there is a constant replenishment of fresh air to the accommodation with a range of one to six air changes per hour dependent on the number of people using particular areas of the accommodation so that the system provides fresh air at a rate of between 30-50 m^3/h/person.

Cooling is achieved by means of a heat exchanger that transfers heat from a refrigerant R134A to cooling water, whereas heating will be achieved by means of electrically powered heaters. It is anticipated that little or no refrigerant will be lost from what will be a closed system.

5.3.7.6 Venting

There is no permanent flare on the platform and any production upset that requires release of gas will result in the gas being released by means of a cold vent that will be located at the top of a 120 m stack. Under normal operating conditions, all gas recovered from the wells will be exported to the onshore terminal or used as a fuel gas on the TPG500. The quantity of gas that would be vented during normal operations (i.e. fugitive emissions) would be very small. It is not considered feasible to re-compress these fugitive emissions for utility uses or export. Larger volumes of gas will only be vented during emergency situations and before routine maintenance.

Routine maintenance activities are estimated to release approximately 16 t of gas per year and a full platform blow-down, in which the production will be shut-in and the inventory in the process will be released, will vent approximately 43 t of gas. It should be noted, however, that once the platform has reached a stable operation, a full platform blowdown is likely to be a rare occurrence, with the process design ensuring the number of instances of full platform shutdown is minimised.

5.3.7.7 Diesel use and consumption rates

Diesel will be delivered to the platform by supply boat and will be transferred to a raw diesel storage tank by hose. There are two main diesel storage tanks each of which can contain a maximum of 242 m^3. These storage tanks are located in the hull of the TPG500 and are an integral part of the structure. The diesel will therefore, be treated by passing it through a filter/coalescer to remove any water present and will be subsequently stored in a diesel storage day tank. Any water removed from the diesel will be passed into the contaminated open drain system.

The anticipated use and consumption of power on the platform is given in Table 5.11.

Table 5.11 Power consumption requirements onboard the TPG500

Description	**Usage**	**Max Consumption (m^3/hr)**
Power Generation:		
No Fuel Gas:	Intermittent (after first 3 months)	2.8[(1)]
Fuel Gas:	Continuous (after first 3 months)	0.17[(2)]
Emergency Diesel Generator:	Intermittent – during test or emergency use only	0.55
Firewater Pumps:	Intermittent – during test or emergency use only	0.3
Cranes:	Intermittent – during crane use	0.15

1. When fuel gas not available, this is maximum diesel consumption in five engines.
2. When fuel gas is available, diesel used as 'pilot fuel'.

For the first three months before the wells are tied back to the platform, the generators will be run on diesel. After tie-back and when fuel gas is available, the generators will be switched to gas and will remain powered by this fuel for the majority of drilling and production programme. Fuel gas will not be available when the platform is not producing and at this time the rig will revert to diesel use for all its power requirements.

5.3.7.8 Drainage

Closed drains

The closed drain system will collect hydrocarbons within the process areas and returns all material to the process. The system will be closed and results in no discharges to the environment other than respiration through vents.

Open drains

There are fundamentally two types of open drain defined by the area the drains serve. These are as follows:

1. drainage from hazardous areas; and
2. drainage from non-hazardous areas.

Potentially contaminated water that drains to the open drain system from hazardous areas will first go to a decanting tank where liquid hydrocarbons will be skimmed off and collected in a tote tank for transfer to shore and disposal as per the Waste Management Strategy (Section 5.7). The treated water will then be discharged to a caisson (depth -50m) which has further hydrocarbon removal facilities from where it will mix with seawater and be dispersed.

The decanting tank will be designed to treat the maximum expected drainage volume and hydrocarbon content to an instantaneous free hydrocarbon in water content of less than 30 ppm at the outlet of the decanting tank. The hydrocarbon content of the water discharged from the caisson will be lower than this level and will be monitored to ensure compliance with the 30 ppm standard.

All drainage from non-hazardous deck areas is collected and sent directly to the same submerged caisson for discharge. Areas used for storage of chemicals or where diesel is present are individually bunded and drained manually to a tote tank for transfer and disposal onshore.

Drainage from drilling areas, which contains large quantities of mud, will be collected and recycled to the active mud system.

All potential inputs to the drainage system have been identified and under normal operating conditions there will be no flow of process hydrocarbons to the open drains with the majority of liquids sent to the drain being uncontaminated rain and deck wash-down water. Small quantities of hydrocarbons which are discharged to the open drains will be as a result of infrequent maintenance activities such as breaking into a line which has already been drained to the closed drains system or from small accidental spills. Both the size and the frequency of these inputs will be minimised through the adoption of a strict housekeeping policy and environmental awareness campaign on the platform. The resulting intermittent flow of oily water to the open drains will therefore, be of small volume and the monthly average hydrocarbon-in-water concentration of the discharge will be substantially less than the 30 ppm discussed above.

5.3.7.9 Sewage

The base-case for sewage treatment on the TPG500 is to use a customised sewage treatment plant after maceration. The plant will consist of three main components as follows:

?? a feed sump;
?? aeration and settling tank; and
?? a chlorination tank.

All three units will be located in the TPG500 hull and the final discharge, via a submerged caisson. The sewage system will meet the following standards for the effluent:

?? a total residual chlorine content between 0.5 mg/l to 2.0 mg/l;
?? no observable floating solids and less than 150 mg/l of suspended solids;
?? a faecal coliform bacteria count not greater than 200 per 100 millilitres; and
?? The BOD_5 of the treated effluent will be 50 mg/l.

The treatment system consists of a lifting sump that will recover black water and will feed an aeration tank combined, with a peripheral settling tank. At the outlet of this biological aeration tank, chlorination tablets will be added and final the chlorination tank will collect both grey and black water. Discharge chlorine concentration in the discharge will be less than 1 mg/l with occasional excursions to less than 2 mg/l. After treatment through the system the effluent will be routed to the seawater discharge caisson where there will be a high degree of dilution.

Predicted volumes of discharges are discussed below in Section 5.3.7.10.

5.3.7.10 Platform drilling and production emissions and discharges

Atmospheric emissions

Atmospheric emissions released during the platform (TPG500) drilling and production programme will occur as a result of the following activities:

?? power generation;
?? fugitive emissions from process equipment; and
?? combustion emissions from vessels and helicopters.

Emission estimates were calculated on the basis of a number of assumptions. These are discussed below. It should be noted that after drilling activities have been completed (approximately three and a half years after installation of the TPG500), emission to atmosphere would be constant for the remainder of the project. The primary source of atmospheric emissions during the latter years will become power generation as drilling will have stopped.

Power generation

Atmospheric emissions were derived from the power profile. It was assumed that power would be generated by four dual-fuel reciprocating engines running on natural gas. It was however, assumed that for the first three months before tie-back is complete, the generators will be run on diesel. Subsequently, they will be run on gas for most of the time (i.e. >99%). During drilling, the peak power requirements will be approximately 8.5 MW for about 25% of the time. For the remaining 75% of the time, power requirements will be 5 MW. For three months before platform drilling starts, the wells will be tied back requiring 4.1 MW.

It is assumed that 2.5 MW will be required to operate the TPG500 throughout post-drilling platform production operations.

Vented emissions

Atmospheric vented emissions for production activities were estimated from the following activities :

?? condensate pig launching (20 depressurisation /year);
?? gas pig launching (four depressurisation /year);
?? three (max) gas depressurisations per year for the separator vessels; and
?? one gas depressurisation every five years for the production / test headers.

Fugitive emissions

Fugitive emissions were derived from component counts provided in the most up-to-date P&IDs available at the time of writing and recognised industry emission factors.

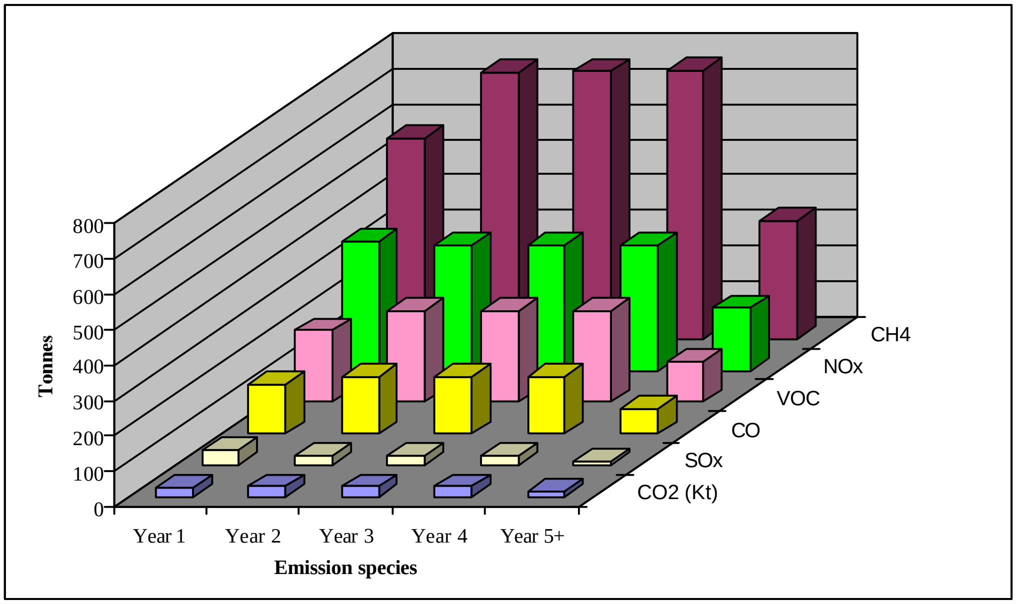
Transport emissions

Transport combustion emissions will be generated by marine vessels and helicopters. The following basic assumptions were used to derive the atmospheric emissions for all activities at the platform:

?? one standby vessel with a diesel fuel consumption of 3 t/day;
?? one supply vessel with a diesel fuel consumption of 6 t/day;
?? supply vessel will make seven trips per week and
?? a typical supply vessel return trip duration is 10 hours.
?? a helicopter has a fuel consumption of 0.24 t/hr;
?? the helicopter will make four return trips per week; and
?? a typical helicopter return trip duration is 1.5 hours.

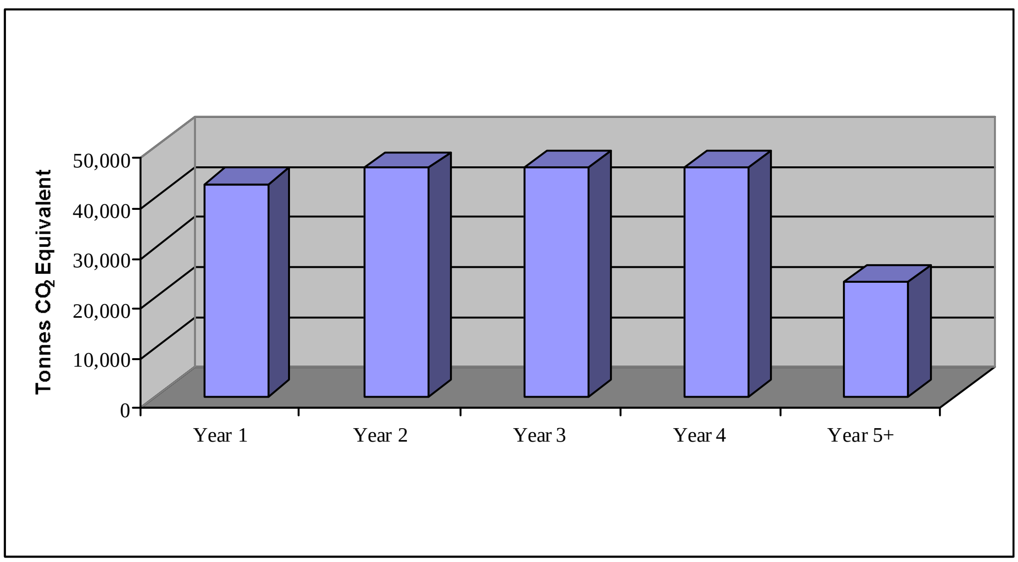
Total estimated atmospheric emissions from the offshore drilling and production activities are presented in Figures 5.23. Figure 5.24 presents the estimated quantity of GHG emissions.

Figure 5.23 Estimated atmospheric emissions during platform (TPG500) drilling and production



Note: Units of CO_2 are kilotonnes.
"Year 5+" refers to Years 5 to 30 inclusive, the life of the project.

Figure 5.24 Estimated GHG emissions during TPG500 operations



Note: "Year 5+" refers to Years 5 to 30 inclusive, the life of the project.

Aqueous discharges

Sanitary waste will be generated throughout platform drilling and production activities. It is assumed that each crew member will generate 0.22 m^3/dy of grey water and 0.10 m^3/dy of black water. The key assumptions for deriving the estimated amounts of sanitary waste generated are:

?? 110 POB the TPG500 during drilling operations (980 days);
?? 18 POB the TPG 500 during production operations (365 days per year) including up to 110 POB during production work-over activities (60 days per year);

?? 15 POB one supply vessel (122 days per year); and
?? 5 POB one standby vessel (365 days per year);

It should be noted that food waste will be discharged to the sea following grinding to <25 mm..

Figures 5.25 presents the estimated amount of sanitary waste that will be discharged to sea during the platform (TPG500) drilling operations.

Figures 5.26 presents the estimated annual amounts of sanitary waste that will be discharged to sea during the platform (TPG500) production operations.

Figure 5.25 Estimated total amount of sanitary waste discharged to sea during platform drilling operations (980 days)

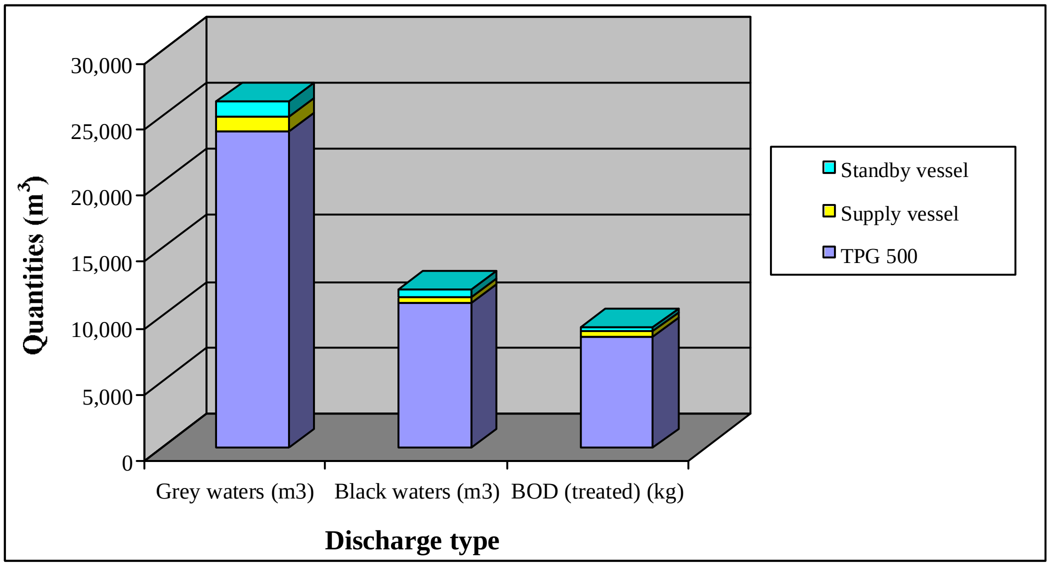
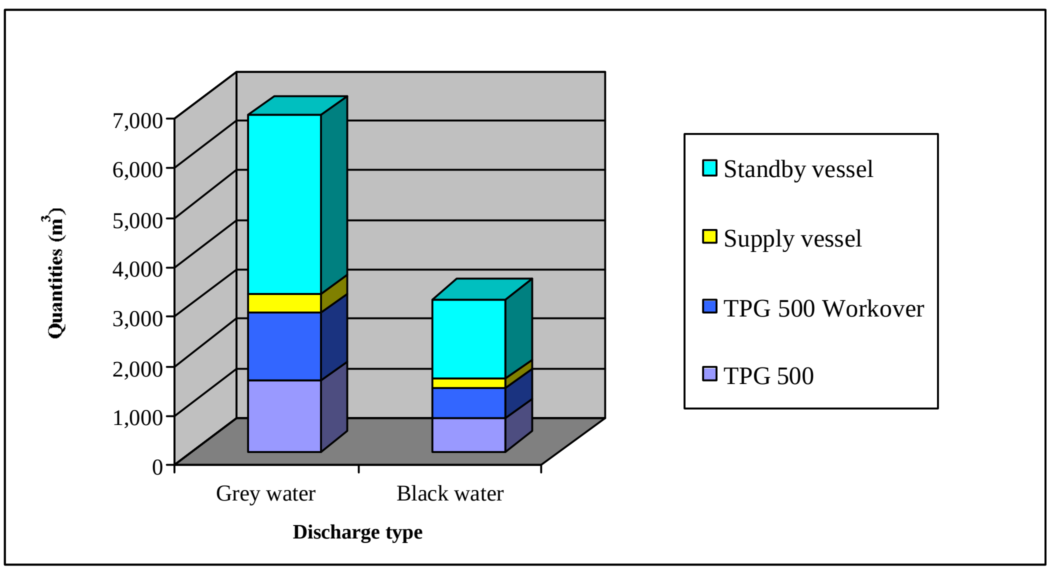


Figure 5.26 Estimated annual amounts of sanitary waste discharged to sea during platform production operations



5.3.8 Decommissioning

Decommissioning activities will be undertaken in accordance with the requirements of the Shah Deniz PSA. Specifically, Article 14.2(g) of the PSA states that:

"Not later than one (1) year prior to the Calendar Year in which seventy (70) percent of the Petroleum identified in the Development Programme are expected to be recovered, Contractor shall prepare an abandonment plan and estimate of the cost of abandonment operations for approval by the Steering Committee. Annually thereafter Contractor shall examine the estimated cost of abandonment operations and, if appropriate, revise the estimate including such revisions as may be necessary to take into account subsequent Discoveries."

In addition, Article 14.2(d) states that:

> *"If, at any time, Contractor recommends abandonment of a fixed asset within the Contract area prior to the termination of this Agreement, SOCAR may elect, within thirty (30) days of receipt of Contractor's recommendation, to continue using such fixed asset, in which event SOCAR shall be responsible for abandoning such fixed asset as and when it decides, and the appropriate portion of the Abandonment Fund shall be transferred to SOCAR at the time it commences abandonment of such fixed asset or termination of this Agreement, which ever is earlier."*

The TPG500 is designed as a permanent fixed platform although the concept allows almost complete removal and relocation of the platform. The decommissioning activities described below will be a single event, which will take place at the end of the field life.

Taking the platform from its operational state to being ready for removal requires:

- wells, process and pipeline decommissioning;
- re-commissioning of leg jacking mechanisms & installation of temporary equipment;
- jacking down and re-floatation of TPG500 for relocation; and
- onshore or near-shore dismantling or reuse of the platform facility.

These are briefly described below. As decommissioning will take place approximately 30 years in the future, detail on the programme may vary according to the technology and experience available at that time. The description below is based on current thinking and practices.

5.3.8.1 Wells, process and pipeline decommissioning

At the end of the field life, the production wells will be suspended, plugged and abandoned with all conductors and completions removed to below the seabed in accordance with current industry/IMO requirements.

The topsides process and pipeline equipment will be taken out of service and decommissioned and all hydrocarbon and associated production contaminants will be removed from the process and pipeline systems by flushing through with water to the onshore terminal. This process will produce oil, sand, sludge and scale wastes onshore and suitable treatment and disposal options will be assessed at the time.

After flushing, the pipeline risers will be cut to separate the pipeline from the TPG500.

5.3.8.2 Re-commissioning of leg jacking mechanisms and installation of temporary equipment

In order to be able to raise the legs from the seabed, the leg jacking and locking mechanisms will be re-commissioned and the foundation suction pumps will be made ready or reinstalled to enable the legs to be lifted in a reversal of the installation procedure.

It will be necessary to install temporary sea water lift equipment to provide cooling and fire fighting facilities during the decommissioning period, although the platform systems will be used for as long as possible until platform jacking down and tow. Power generation will be provided by the platform diesel generators.

5.3.8.3 Re-floatation of TPG500 for relocation

The TPG500 will be removed by lowering the hull onto the sea surface and then jacking up the legs free of the seabed, using the suction pumps to free the leg foundations. This method of removal means that little offshore deconstruction will be required other than de-coupling risers from the export lines, detaching and removing the production tubulars and conductors described earlier.

Once the legs have been lifted and locked the TPG500 can be towed back to shore. The suction cans will be required to be removed at a location with a water depth of approximately twenty metres. When removed the tow to shore can continue.

5.3.8.4 Onshore dismantling

The design of the TPG500 enables it to be reused in a different location or converted for another use (e.g. a drilling jack-up) and it is possible that at the end of the Shah Deniz field life, the reuse option would be considered, thus eliminating the need for any significant onshore dismantling.

If reuse is not feasible, the TPG500 will be taken either to a dry-dock or a quayside for dismantling. This is basically a reversal of the construction process. As the dismantling process proceeds, components of the platform would be removed from the structure and placed on a lay-down area to allow access by workers during the deconstruction process. The objective of this process is to prepare the various constituent parts of the structure to a condition whereby they can be reused, re-cycled or disposed of as waste.

Equipment and infrastructure (e.g. cabling, etc.) would be removed from the deck and hull sections until a bare shell remains. During this process, any contaminated components will be identified, removed, tagged and isolated.

The dismantling philosophy would be to maximise potential recycling and reuse of all materials and to minimise wastes, although at the time of writing it is not possible to quantify or even necessarily identify all waste types that would be generated during onshore dismantling.

5.3.8.5 Emissions and discharges

At the time of writing, it is not possible to estimate the quantity of emissions to atmosphere and discharges to sea that would result from decommissioning activities. Estimates of these should be prepared and assessment of the environmental effects completed at the time a full decommissioning plan is prepared.

5.3.9 Subsea completions

Pending the capability of well drilling with an extended reach, the access to reserves from the E3 location will be established with up to five wells. The design basis for the subsea completions is based on the requirement that production levels (gas contract) can be maintained utilising five production wells. It is considered that the technology is available in the Caspian region to develop these wells, including lay-barge for installation of the inter-field pipelines. Studies are however, being completed for the best development option. In case the wells are drilled from the TPG500, then cuttings discharge would be similar and in addition to that from E2 wells. These wells are unlikely to be developed before five years after first gas.

5.3.9.1 Wellheads and manifolds

The base case under consideration for the development of the E3 location wells is a five well cluster.

Figure 5.27 illustrates the proposed subsea five-well configuration.

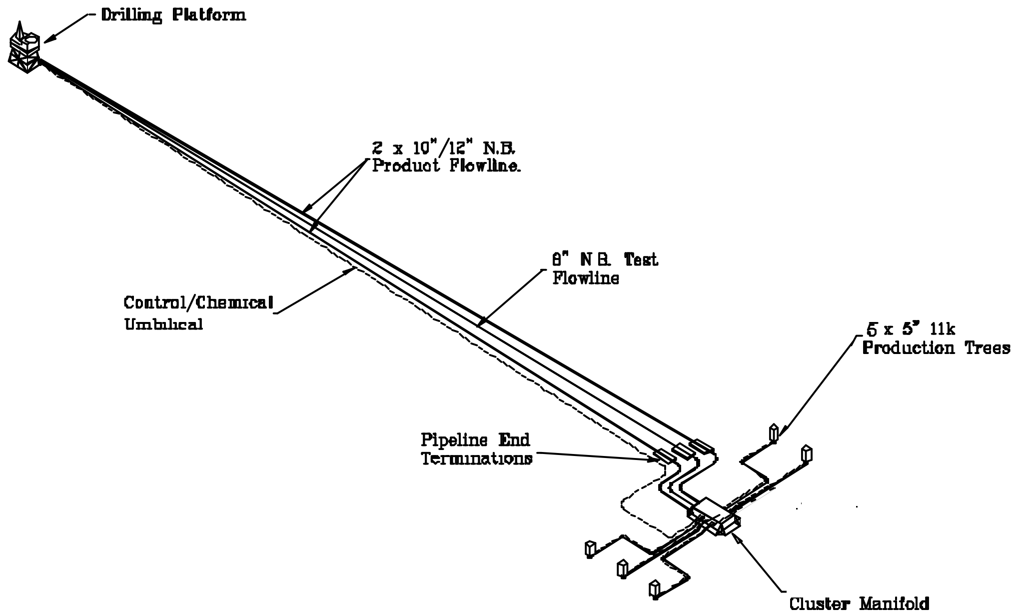
5.3.9.2 E2-E3 inter-field flow-lines

The base-case for Shah Deniz E2-E3 inter-field flow-lines is to install:

?? two 12” flow-lines;
?? one 8” test-line;
?? one umbilical for control systems; and
?? a five-slot template.

An expandable pigging system is also proposed to service both lines. Inter-field pipelines will be protected in accordance with international standards and practises.

Figure 5.27 Subsea five-well configuration at the E3 drilling location and inter-field pipelines to E2 location



5.4 Pipelines

As described in Section 5.3 above, the gas and condensate produced offshore at the TPG500 drilling and production platform will be exported to the Sangachal terminal by subsea pipelines. In addition, the substantial quantity of MEG required to keep the pipelines free from hydrate formation will be delivered to the TPG500 by means of a dedicated MEG pipeline. There will therefore, be a requirement to install:

?? one 94 km 26” gas pipeline between the offshore and onshore facilities;
?? one 94 km 12” condensate between the offshore and onshore facilities; and
?? one 94 km 4” MEG pipeline piggybacked on the 12” condensate line between the offshore and onshore facilities.

5.4.1 Pipeline design

All three pipelines will be constructed in carbon steel. In addition to the operational temperatures and pressures predicted at production, the pipelines are designed according to a set of established environmental design criteria for the offshore and onshore development area. The design criteria for the pipelines includes but are not limited to, the following parameters:

?? temperature (seawater, atmospheric);
?? seawater properties (level fluctuations, density, salinity);
?? sediment characteristics (elasticity, sheer stresses);
?? marine fouling (loading on pipeline structure from marine growth);
?? wave and current characteristics (velocity forces, storm stresses, wind stresses, pressure forces); and
?? geo-hazards (mud, volcano, seismic activity and effects of fault displacement).

Stability and stress analyses have been conducted using these parameters to ensure that the pipelines are suitable for the environmental conditions in the development area. Predicted fault movements have been safely accounted for within the pipeline design. Additionally, where required, spool pie ces will be inserted into the pipeline to allow free expansion and to reduce axial stresses to acceptable levels.

The pipelines will be coated to provide corrosion protection and the 26” and 12” export pipelines will be concrete coated to provide additional weight that will ensure stability of the pipelines on the seabed. The concrete coating has the additional benefit of providing mechanical protection against impacts. While the pipelines are protected against corrosion externally, they will also be susceptible to corrosion on the internal surfaces. The design of the pipeline systems will therefore, incorporate corrosion allowances to ensure that the integrity of the pipeline will not be compromised.

Table 5.12 details both the materials that will be used for the external coating and the corrosion allowance of the pipelines. It should be noted that along the length of the pipelines the thickness of the concrete coating or density will vary depending upon the stability requirements at that section of the pipeline. Although the MEG line will be not concrete coated, its stability will be ensured by attachment to the 12” condensate line.

Table 5.12 External pipeline corrosion protection

Pipeline	Wall Thickness (mm)	Coating	Corrosion Allowance (mm)
26" gas	20, 21.6, 23.4 and 24.4	Asphalt enamel or 3-layer polypropylene	3-8
12" condensate	16.3, 18.7,and 20.6	asphalt enamel or 3-layer polypropylene	4-8
4" MEG	6.4 and 7.1	3-layer polyethylene and 3-layer polypropylene	1

Additional external corrosion protection has been incorporated into the pipeline design through the use of sacrificial anode cathodic protection. Conventional "half shell bracelet" type anodes will be used and attached to the pipeline at regular intervals and secured by copper cored insulated cables. The MEG line does not have anodes directly attached but will be cathodically protected through electrical connection to the 12" line.

5.4.1.1 Other materials

The pipelines will be connected and fitted with a series of joints, tees and valves. These are all standard units and are designed inline with the relevant international industry standards.

5.4.2 Proposed route

The proposed route for the pipelines is shown in Figure 5.28. During the pipeline route selection process, surveys were conducted along the route to evaluate:

?? seabed morphological features;
?? platform approaches (for the Stage 1 and later Stage developments);
?? existing installations and infrastructure (e.g. platforms and pipelines);
?? areas of seabed debris, wrecks; and
?? shipping lanes, fishing areas and exclusions zones.

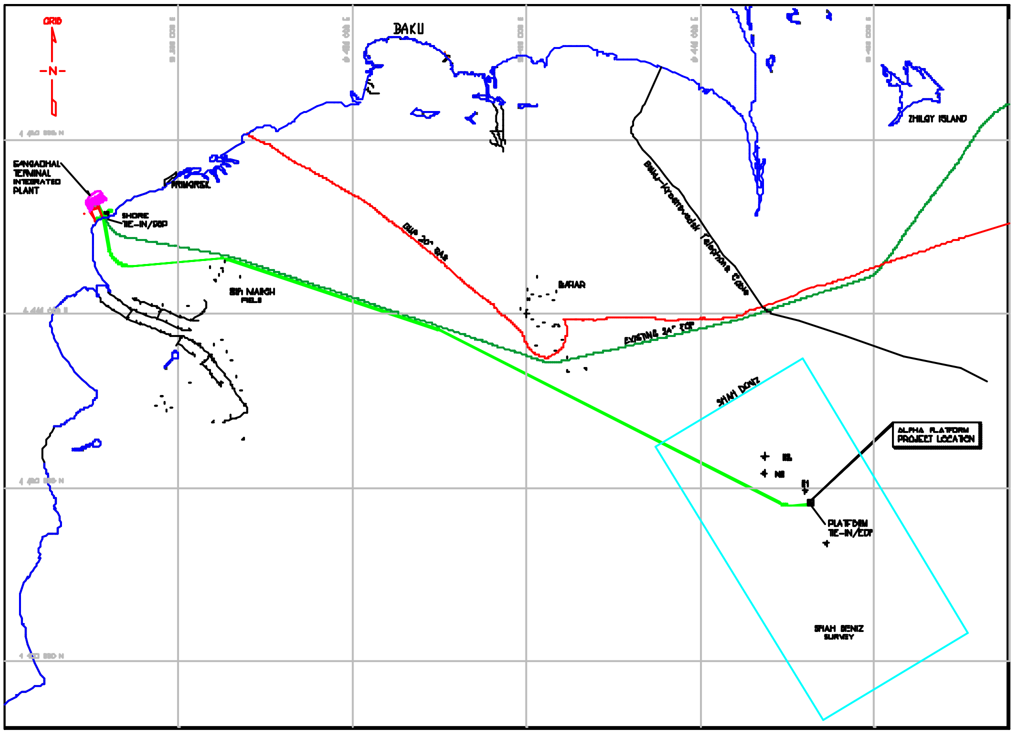
Pipeline design criteria were also considered.

At time of writing, further geotechnical surveys were underway to establish the stability of a number of important seabed features. One key feature that is being appraised is the collapse caldera of the extinct Shah Deniz ("Bahar") mud volcano. Other geomorphological features being investigated include:

?? seabed topography (slope stability);
?? fault lines; and
?? areas of seabed subsidence or potential subsidence (slump features).

The main pipeline route (for all three pipelines) passes eastward from the platform across the mud volcano but keeping a safe distance from the geomorphological slump feature. The route then runs in a north-easterly direction to intercept with the ACG FFD pipeline corridor approximately 43 km from the shoreline. The intercept point was selected to avoid the Bahar mud volcano feature and provide a safe standoff distance of approximately 4 km from its centre. Nearer to shore the route passes to the north of an area of offshore platforms known as the "8th of March Field".

Figure 5.28 Pipeline corridor options Shah Deniz Contract Area to landfall

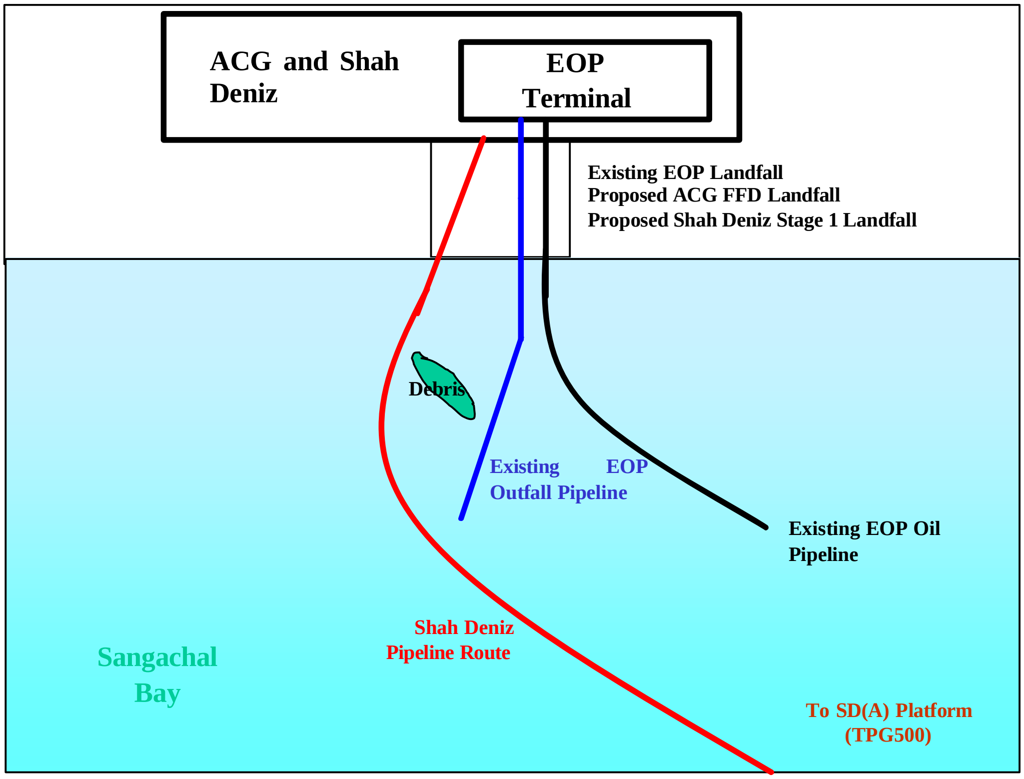


In the nearshore area (i.e. between the "8th of March Field" and shoreline), the proposed base-case pipeline route deviates from the ACG corridor to bypass the Early Oil Project (EOP) outfall pipeline before running more or less parallel with the outfall to the landfall site (Figure 5.29). This landfall site is slightly to the south-east of the proposed ACG FFD landfall site.

The onshore pipeline route will run in a relatively direct route to the Sangachal terminal facility from the landfall site. This onshore section of the pipeline will be approximately 2.6 km long from the landfall to the terminal and will cross a number of existing facilities as follows:

?? one crossing of the road (Baku-Astara Highway);
?? one crossing of the railway; and
?? multiple crossings of third party pipelines / service lines (various diameters) and facilities.

Figure 5.29 Pipeline corridor landfall in relation to EOP outfall and oil pipeline



5.4.3 Pipeline fabrication

The grade of marine steel required for pipeline construction is not available locally in Azerbaijan and as a result, the pipeline will be constructed out-of-country and subsequently transported into the country either by the Don Volga canal system into the Caspian or via the existing rail network. It will be likely that the pipelines will also be concrete coated out-of-country although options to undertake this work in-country are being investigated.

The requirement for transportation of the pipe sections to the proposed development area is a function of the weight and size of the individual units. The total number of vessels, vehicles or rail carriages required for transportation may vary, depending on the number of sections that may be carried in one load. There is an option to concrete coat the pipeline at a Baku facility and this has the added benefit of reducing the size of the pipe units and hence the transportation requirements.

The pipeline sections will be transported to a lay-down area prior to the installation phase. It is intended that the lay-down area will be one or more sites that have previously been used for this purpose. Various options for pipe section storage are currently under assessment and the selected option will partly depend upon whether the pipeline is coated in or out-of-country. If the pipe is pre-coated, the sections may be taken to a lay-down area at the SPS yard (north of Sangachal Bay). If coating is to be conducted in Azerbaijan, the pipe sections will most likely be taken to the Zikh Yard (located between the Sangachal terminal and Baku) and loaded from there onto pipe supply vessels that will deliver pipe sections to the lay-barge during the installation process.

5.4.4 Pipeline installation

5.4.4.1 Installation schedule

It is proposed that the pipelines will be installed between 1Q 2004 to 2Q 2005.

5.4.4.2 Pipe-lay and support vessels

The pipe-lay vessel selected for the installation of the Shah Deniz pipelines is the "Israfil Guseinov" (Figure 5.30). This vessel has previously laid up to a maximum pipe diameter of 24" and will require some refurbishment and overhaul prior to laying the Shah Deniz pipeline diameters proposed. The ACG Phase 1 export pipelines will however, be laid prior to the Shah Deniz Stage 1 pipelines and therefore, some refurbishment and/or upgrade to the vessel will have already been carried out in preparation for the ACG pipelines. The vessel will however, need to be upgraded again in order to facilitate piggyback pipe-lay of the 4" MEG pipeline as required by the Shah Deniz project.

Figure 5.30 Pipelay barge "Isralif Guseinov"

The "Israfil Guseinov" will be supported by a number of vessels that will be required for the purposes of supply and operations. These vessels are listed in Table 5.13 together with the anticipated period of operation.

Table 5.13 Vessel requirements for Shah Deniz pipe-lay operations

Type/Description of Vessel	Number of Vessels	POB	Duration of Operation (days)
Lay-barge:	1	220*	175 (+ 44 for tie-ins)
Anchor handling vessel:	2	15	175 (+ 44 for ties-ins)
Pipe-haul vessel:	2	14	175
Tugs:	2	26	175
Survey/supply boat:	1	26	175 (+ 44 for ties-ins)

* It is noted that up to an additional 10 POB may be required for the pipeline piggyback operations.

These vessels will be sourced from KMNF Alliance Companies in Baku and all vessels will meet MARPOL and SOLAS requirements.

5.4.4.3 Pipe-lay vessel utilities

Sanitary wastes

All vessels proposed for use in the installation programme will be equipped with certified sewage systems capable of treating effluent to MARPOL standards for solid size and chlorine content. Water from showers, sinks and laundry (grey water) will be discharged directly overboard without treatment, although it will be possible to divert these discharges to the sewage treatment plant if required. Sewage (black water) will be treated to meet all existing and anticipated national and international requirements. The final effluent will be treated to a BOD (Biological Oxygen Demand) of 40 mg/l, suspended solids 40 mg/l and coliform 200 MPN (Most Probable Number) per 100 ml prior to discharge (World Bank and EXIM standard). Sewage sludge from all operational vessels will be transported to shore onboard the pipe-haul barges to a designated reception facility to be identified in the project's Waste Management Strategy (Section 5.7).

Galley food waste will be treated in a macerator prior to discharge to meet specifications of the MARPOL 73/78 Annex IV Regulations for the Prevention of Pollution by Garbage from Ships which requires that the waste be broken down into particles of <25 mm diameter.

Hazardous and non-hazardous wastes

Other wastes generated onboard the operational vessels (pipe-lay barge, supply and support vessels) will be segregated according to the following categories:

- non-hazardous combustible solid waste such as waste paper, wood and cardboard;
- non-hazardous, non-combustible waste such as scrap metal;
- hazardous solid waste such as paint cans and empty chemical containers; and
- hazardous liquid wastes such as liquid oily wastes.

Wastes will be stored and transferred to shore for disposal at an appropriate facility that will be identified in the project's Waste Management Strategy (Section 5.7).

Drainage

Vessel drainage will be classified into the following categories:

- clean areas without potential for contamination where discharge is directly to sea;
- normally dirty areas where the normal status is total containment and recovery;
- possibly dirty areas where there is total containment and recovery potential; and
- normally clean areas where there is manual or automated intervention potential.

For these types there are three main drainage routes, accompanied by manual/mechanical clean up where appropriate, as follows:

- discharge to sea (clean water only);
- to the oily bilge water tank for treatment and discharge of the treated effluent to the sea and transport of the 'sludge' onshore; and
- to the waste oil tank.

Power generation

Power generation onboard the pipe-lay vessel will be provided by five diesel generators rated at 1,150 kW each.

5.4.4.4 Pipeline installation methods

Offshore installation

Marine installation operations will occur within an exclusion zone that will extend for 1,000 m across the proposed pipeline corridor. During installation, exclusion buoys will be placed around the lay-barge installation area to indicate that the area is an exclusion zone and to ensure that other vessels do not encroach upon the area of activity. As pipe-laying progresses, the exclusion buoys will be moved along the route. These will remove the need for a chase-boat that might otherwise be required during the installation period.

The lay-barge will be used to install pipelines in all water depths from the TPG500 to the beach surf zone at Sangachal (8 m water depth). The lay-barge will be fitted with welding stations, an inspection station where the integrity of the weld will be examined and field-joint coating stations. As discussed above, the 26" and 12" pipelines will also have an existing coating of concrete to give negative buoyancy and mechanical protection.

During installation, the pipeline will be laid from the stern of the lay-barge. The pipeline will be held in place by the tensioning system, which allows the next section of the pipe to be welded onboard the barge. The lay-barge lays pipe in an S-Lay configuration meaning that the pipeline lies on the seabed in the horizontal position, rises up through the water column and curves back to the vessel to assume a horizontal position such that pipe joints are added to the pipeline in a horizontal orientation. Once the weld is completed its integrity will be checked by non-destructive examination (NDE) and visual inspection. The weld area (field joint) will then be coated for protection with anti corrosion material, bracelet anodes will be attached to the pipeline and the barge moved forward to repeat the process.

The tensioning system on the lay-barge maintains a controlled and constant deployment rate, whilst reducing bending stresses that could threaten the pipeline structure. As the pipeline is deployed, it is supported by the stinger to control the installation "S" curvature of the pipeline. During installation of the 12" condensate line, the 4" MEG line will be installed piggyback style. The 4" pipeline will be welded on a separate firing line and the completed section will be attached to the 12" line as it moves off the stern of the vessel. The attachment will comprise mechanical attachment to keep the 12" and 4" lines together. In addition, the 4" line will be electrically connected to the 12" line such that the "throw" from the sacrificial anode cathodic protection on the 12" line will be sufficient to protect the 4" line.

The pipe-laying operation is continuous with the barge moving progressively forward as sections of the pipe are welded, inspected, coated and deployed. The Israfil Guseinov will be held in position by eight to ten anchors (depending on the weather), which also serve to move the vessel forward by pulling on a system of the four forward anchors whilst simultaneously slacking off on the six stern anchors. As pipe-laying proceeds, the anchors are periodically moved forward. A total of two anchor handling tugs (with one more on standby) will assist the pipe-lay barge and will pick up and move the anchors along the route as pipe-laying proceeds. The distance of this varies but is typically every 500 m to 600 m of pipeline length. The anchor spread of the pipe-lay barge is typically 600 m to 700 m either side of the pipeline, depending upon the water depth. Pipe-haul vessels will transport pipe sections to the installation site from the pipe storage yard. Some of these vessels will also collect wastes generated from the operations on board the pipe-lay vessel, including sewage sludge and transport these wastes to shore for disposal.

The offshore sections of the pipelines will generally be laid directly on the seabed and will not be trenched except in areas where the route crosses the mud volcano and where the seabed is too uneven. Stability of the sections that are laid directly on the seabed will be provided by the concrete coating. Grout bags will be used for any required freespan corrections.

Nearshore installation

Beach-haul

Marine installation will begin in the nearshore zone and move offshore. The draft of the pipe-lay barge restricts the operation of the vessel in shallow water and, as mentioned previously, the lay-barge can only operate in water depths of greater than 8 m. Thus, a number of works will be required to bring the pipeline ashore. Pipeline pull onshore will occur from the lay-barge using a shore-based winch. The pipelines are kept afloat during this shore-pull exercise by means of floatation pontoons attached to the pipelines. This means that the pipelines can only be pulled until they are grounded.

In order to maximise the distance that the pipes can be pulled ashore, a temporary channel will be dug into the shoreline for both the 26" and 12" pipes and these will be allowed to flood. This will allow the pipelines to be pulled across the nearshore and into a part of the shore that is not normally covered by the sea. The trenches will be backfilled leaving the shoreward end of the pipes uncovered and creating an earth "cofferdam". The "coffer dams" or pits will be pumped dry and the shore section of the pipelines will be trenched to meet the end of the pipelines in the cofferdam. Option requires the pull direction to be deflected onshore thus a "sheave" rigging arrangement will be set-up to angle to pull. The sheave will most likely be constructed using sheet piles as anchors.

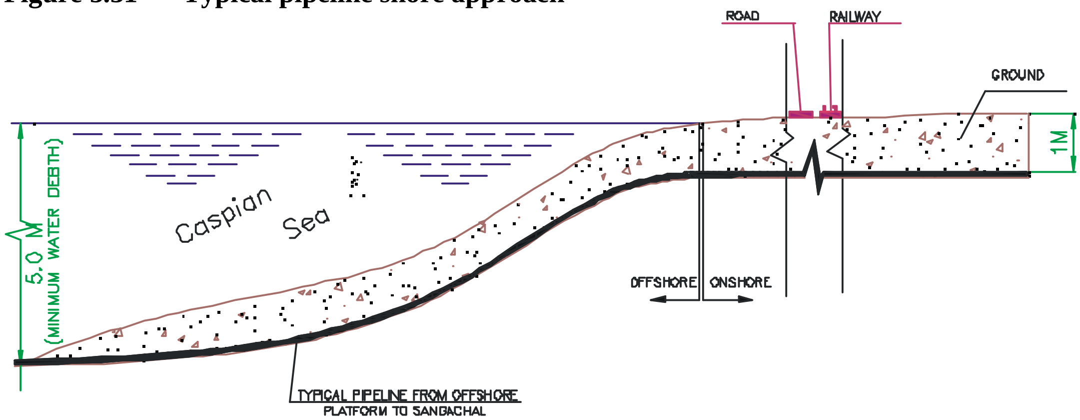
Existing access to the shore is present at the site, although there may be the requirement to upgrade areas of the site to ensure it is capable of withstanding all construction loads (materials, equipment and vehicles) required for landfall operations. This may include the upgrade of the access road and provision of temporary drainage within the construction site to protect existing waterways and to control storm water runoff from the area. This is work is likely to have already been completed for the ACG Phase 1 development.

Nearshore trenching

The nearshore section of the pipelines will be trenched for two reasons. The first is that it will provide protection to the pipes, in particular from vessels grounding on them. The second reason for trenching is that it will assist in the pipe-laying operation since the 26" and 12" pipelines can only be pulled ashore as long as they float. In order to ensure the maximum distance the pipes can be pulled, trenches will create the necessary depth of water. The base case plan for trenching is to trench the pipelines in water depths of less than 5 m (depending on the natural fluctuation of the Caspian Sea level) with a pipeline trench requirement design to a depth of 1 m from Top of Pipe (TOP).

The trench will be constructed both before the pipeline is installed (termed pre-lay trench) and whilst the pipeline is in place (termed the post-lay trench). The length of the trench will be approximately 1,500 m but may be up to 2,000 m in order the clear the end of the EOP outfall pipeline. The width of the "pre-lay" section of the trench (i.e. that out to the 2m depth contour) will depend on the strength of *in situ* seabed material but may be up to 8 m. The "post-lay" section between the 2 m and 5 m depth contours will be approximately 3 m wide. The trench will be left to naturally backfill. A typical pipeline shore approach is shown in Figure 5.31.

Figure 5.31 Typical pipeline shore approach



Finger pier

A finger pier will be built in Sangachal Bay to allow access for an excavator to enable the trenching activities in the nearshore areas and to assist with the onshore pull. The two export lines, 26” gas and 12” condensate will be laid on either side of the finger pier that is created with the 4” line being laid in the same trench as the 12”. The pier will be installed in the nearshore by dumping aggregate in the shallow marine zone to achieve the required clearance above sea level. The final details of the operation have yet to be finalised, although it is envisaged that the following vehicles will be required during this process:

?? low loadin g lorries/trucks and other vehicles (e.g. 4WD vehicles);
?? backhoe digger/dredger; and
?? crane.

The pier will be of a design to support vehicle access. The planned width of the pier will average 4 m to 5 m (approximately 10 m at its base) and will extend out to approximately the 2 m water depth contour (i.e. a distance of approximately 50 m to 100 m). The current base case option is to remove the pier after installation of the pipelines. Once installation of the pipelines in the nearshore zone is complete, all materials deposited at the area (aggregate, sheets piles and other material) will be removed from the site and will be disposed of at an appropriate facility to be identified in the project’s Waste Management Strategy (Section 5.7).

5.4.4.5 Onshore installation

The onshore section of the pipelines from the shoreline to the terminal will be buried to a nominal depth of 1 m from Top of Pipe (TOP). All topsoil removed from the trenches to be excavated will be placed aside and stored so that it may be used for later reinstatement of the route in order to maintain the environmental characteristics of the area. Every effort will be made to avoid disturbance to this soil while it is stored during pipe-lay operations. This means that the pipeline corridor can be very effectively re-instated using the same soil as was originally found in the area. By placing the topsoil to one side it will be maintained in good condition and will thus assist in rapid recovery of the area following re-instatement of the corridor.

Once the topsoil has been removed, the pipe will be laid out in sections and these will be welded on-site to form a continuous length. A trench will be excavated to one side of the pipeline which is subsequently lifted by side-boom and placed in the trench. The trench will then be backfilled and the topsoil replaced as the spread is re-instated to the original condition. A typical pipeline spread is shown in Figure 5.32 with the topsoil laid to one side of the spread prior to placement of the pipeline in the trench (ditching). Figure 5.33 shows a typical pipeline side-boom used for handling the pipeline during installation.

Figure 5.32 Onshore pipeline installation

Figure 5.33 Typical spread and side -boom

Prior to installation, a survey of the route will be conducted to establish where preparatory works may be required. As with the shoreline works, existing access along the onshore route is available, although there may be the requirement to upgrade areas along the route to ensure it will be capable of withstanding all construction loads (materials, equipment and vehicles). Such upgrade may include the improvement of the access road and provision of temporary drainage within the construction site to protect existing waterways and to control storm water runoff from the area. All working areas will be clearly marked by a timber post fence to ensure the safety of operations and the public.

As noted earlier, the onshore pipeline routes will cross a road, a railway line and various third party pipelines/service lines. Road and rail crossings will be achieved by using uncased bored crossings or non-conductive casing. These will be run under the obstruction and the annulus between the pipeline and boring/casing will be sealed. Exposed lengths of pipelines and cables will be supported at all times and particular care shall be taken to support the trench sides such that undermining of services is avoided. This method ensures that pipeline crossings can be made without the need for excavation or interference to the services. Road and rail crossing methods are illustrated in Figure 5.34

Where the pipelines are to cross existing services, reinforced concrete protective slabs shall be placed over the pipelines at the crossing point. These will extend beyond the pipes for at least 150 mm on either side and at least 3 m either side of the service being crossed, separated from the pipeline by at least 150 mm of fine grained material. Slab settlement will be minimised by careful selection of backfill material and through material compaction. On completion of backfilling operations, permanent surface warning tiles shall be placed on the pipelines to indicate their points of intersection with other services. Service crossing methods are illustrated in Figure 5.35.

Figure 5.34 Pipeline road and railway crossing methods

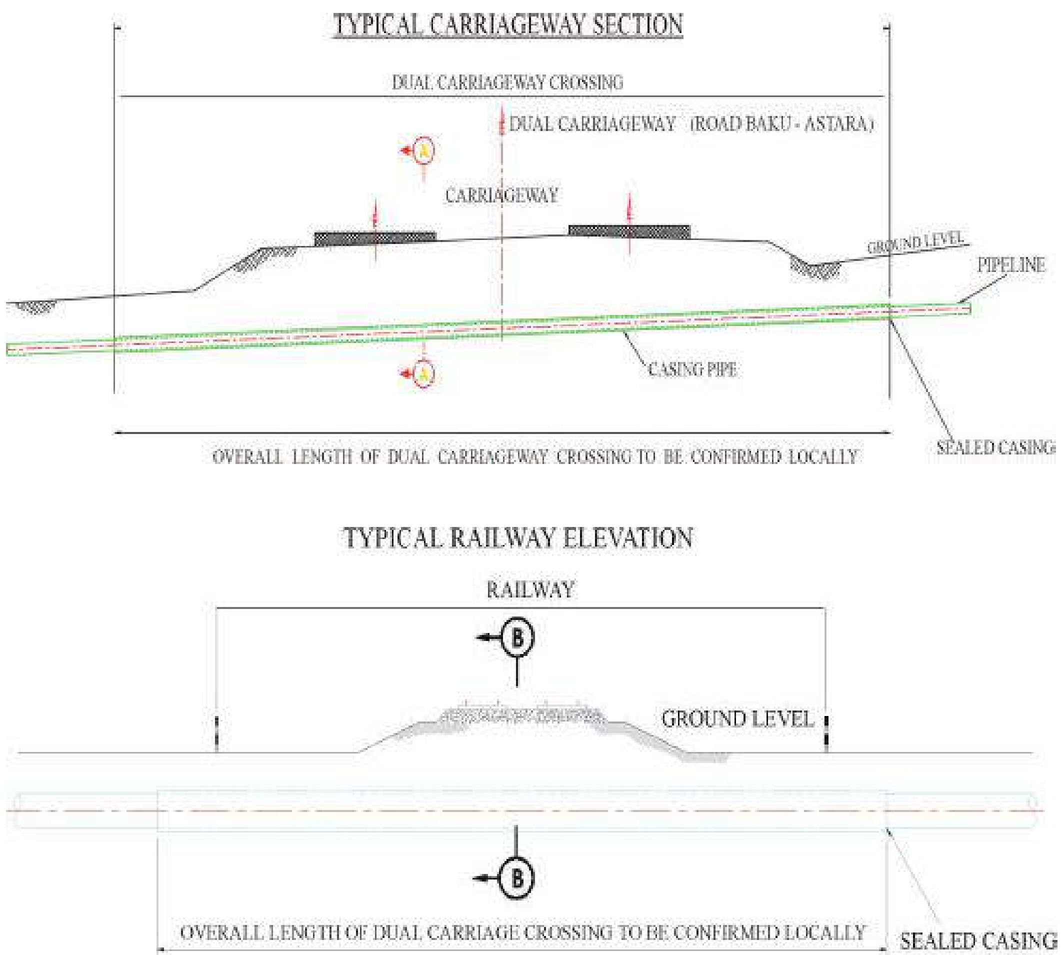


Figure 5.34 Pipeline road and railway crossing methods (continued)

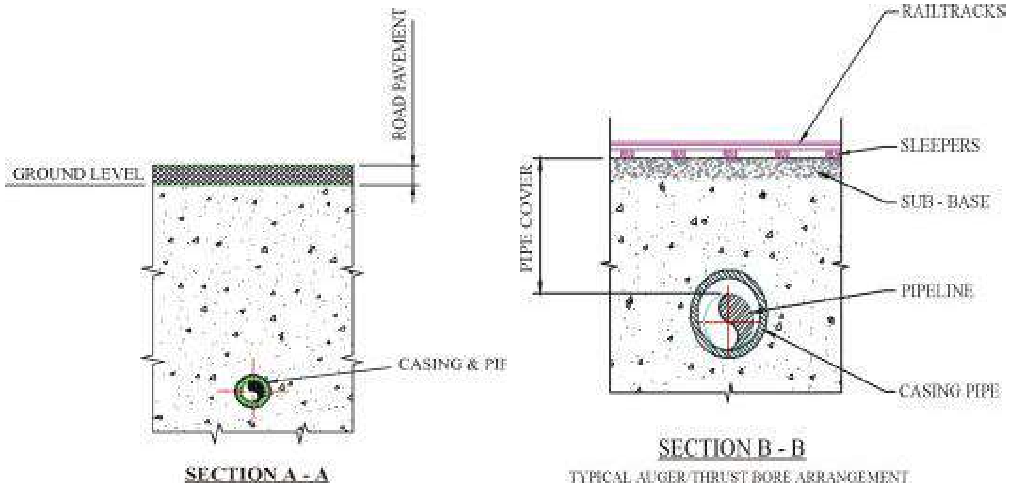
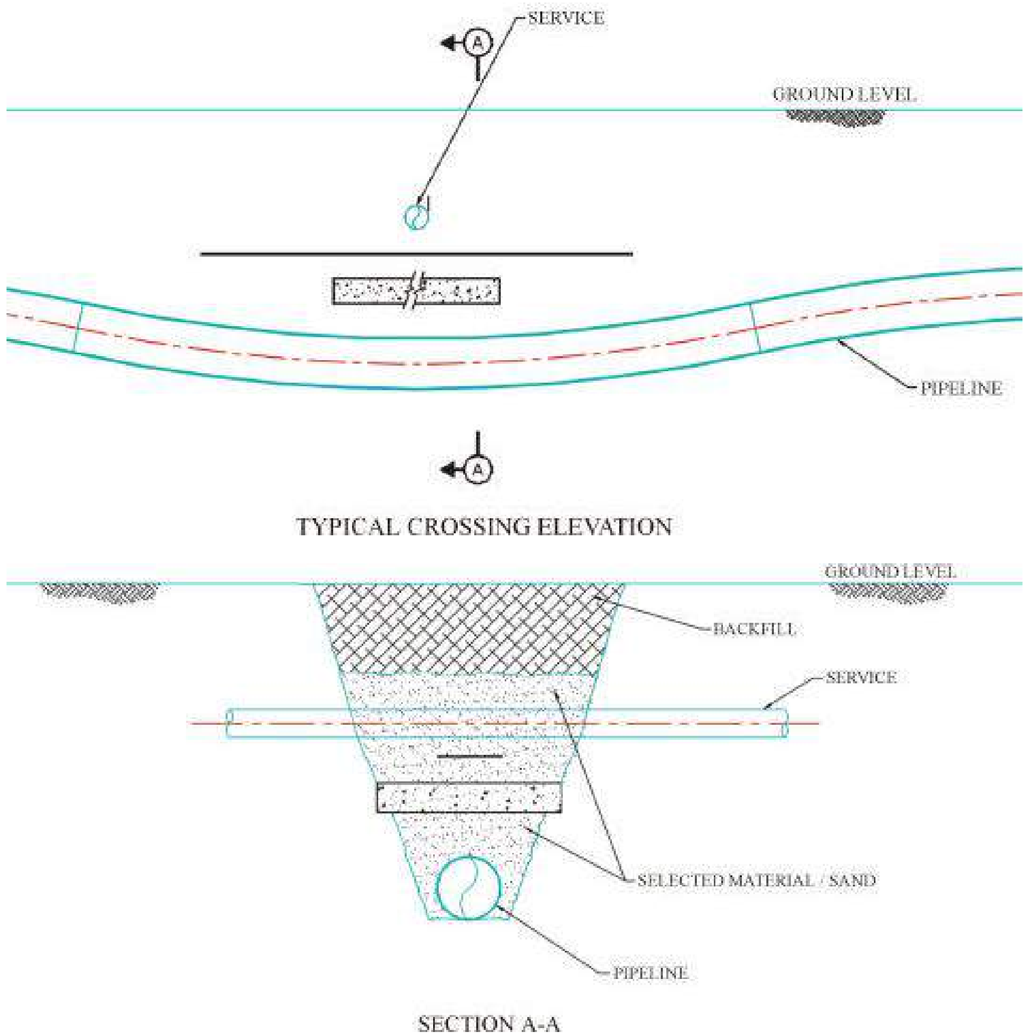


Figure 5.35 Pipeline service crossing method



5.4.5 Pre-commissioning

Installation of the pipelines will be completed before the offshore facilities are in place. Offshore a lay down head will be attached to an abandonment and recovery cable and the 26" and 12" pipelines lowered by winch to the seabed at the tie-in location. The cable will be detached and attached to a marker buoy and the pipelines left on the seabed. The pipelines will then undergo pre-commissioning that will include:

- ?? inspection of the pipelines to ensure that they have not been damaged during installation; and
- ?? hydro-testing to ensure that the pipelines have suitable and sufficient strength and joint leak integrity.

Inspection will be by Remote Operated Vehicle (ROV) with onboard camera and any damage remediated by the pipe-lay vessel. The pipelines will then be flooded with filtered seawater. Additives will be used to protect the pipelines from internal corrosion the precise details of which are being evaluated and have not been finalized. These are however, expected to include an oxygen scavenger and a biocide.

After flooding with test water, the 26" and 12 " pipelines will be fitted with several pigs, positioned in the lay-down head and each actuated by valves, such that the pigs can be released individually when required for the purposes of gauging. The pipelines will then be gauged to ensure that the diameter has not been compromised along the route.

The pipelines will then be fitted with a test head before being hydrostatically pressure tested to one and a half times the normal operating pressure with the pressure held for a "minimum hold period". After the initial leak test, the pipeline will be left flooded for approximately six months until the offshore facilities are in place.

5.4.6 Tie-in and commissioning

Once the TPG500 has been installed on location and prior to start up there will be various hook up activities to complete. The offshore pipelines will be tied-in to pre-installed risers on the jack-up structure and production risers from the seabed drilling template to the well heads. Carrying out these operations will require the use of a number of vessels, possibly including the pipe-lay vessel, operating as a dive support vessel. The offshore tie-ins will be carried out by divers, who first measure the gap between the unconnected sections of pipe and, after fabrication and positioning of the spools on the seabed, remove the blind flanges from the spool and connect to the riser. Concrete mattresses will be placed over the spools.

Once the pipeline system is connected, the entire system will again be hydro-tested for a minimum hold period to check for leaks. Pending a successful integrity test and as the pipeline is brought into service the hydro-test waters will be, in a controlled manner, pneumatically driven from the pipeline.

The disposal options for hydrotest water are currently under evaluation and have not been finalised but the base-case is to drive the water out of the pipeline from the platform pushing it to the onshore terminal for subsequent onshore disposal by injection into a dedicated disposal well. Other disposal route options currently under evaluation include:

- ?? transfer to the Garadag Cement Plant to the north of Sangachal terminal for use in the cement manufacturing process;
- ?? disposal to sea offshore; and

?? treatment and re-use as irrigation water as part of a possible landscape management programme around the terminal.

In regards to disposal offshore, Caspian-specific ecotoxicology tests of the hydro-test water additives would be conducted before a decision to pursue this option is made. The best environmental solution for disposal of hydro-test water will be used in alignment with the terms of the PSA.

Based on the pipelines design and specifications, the quantities of hydro-test water will be as shown in Table 5.14.

Table 5.14 Predicted volumes of hydro-test water

Pipeline and Diameter	Volume of Hydro-test Water (m^3)
26” gas export from SD	28,430.69
12” condensate export from SD	6,284.78
4” MEG import to SD	742.80
Total	**35,458.27**

Note: Table assumes a pipeline length of 94.533 km.

5.4.7 Pipeline operations

The Stage 1 offshore facilities platform will export gas by means of the new 26” gas line and will export condensate by means of the 12” condensate pipeline. During operation of the export lines, in order to minimise hydrate formation and corrosion, methanol and a proprietary corrosion inhibitor will be injected into the lines (Section 5.3.6.5). The pipelines are designed to require very little maintenance. A pipeline integrity management system will however, be developed for these pipelines and will include:

?? side scan sonar and visual inspection surveys by ROV with camera onboard;
?? internal intelligent pig surveys;
?? corrosion monitoring; and
?? flow rate monitoring.

If the integrity of the pipelines is found to be compromised in any way, remediation measures will be employed. This may include activities such as pipeline free span correction using grout bags or corrosion repairs.

In addition to pipeline integrity tests, the 12” pipeline will require frequent pigging to remove accumulated wax build up from the condensate. The condensate has a relatively high wax content and as a result, pigging operations will be required approximately every three days to push the wax to reception facilities at the terminal. The options for treatment and disposal of wax is discussed in Section 5.5.4.8.

5.4.8 Emissions and discharges from pipeline installation and commissioning

5.4.8.1 Atmospheric emissions

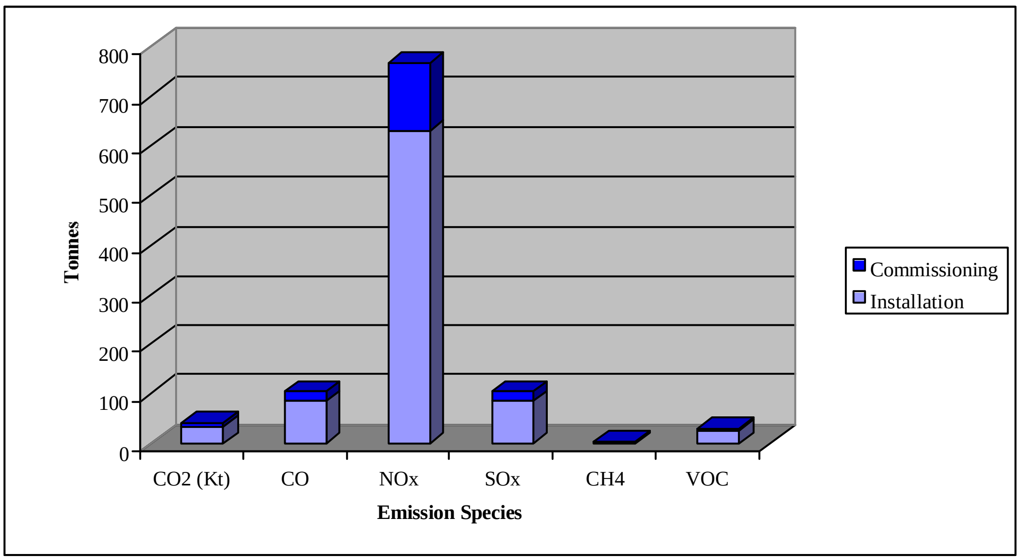
The vessel spread for installation and operation of pipelines is discussed previously. The following sections itemise and quantify the operational wastes expected from these vessels and utilities. The emissions were derived on the basis of the following key assumptions:

?? Installation:
- one lay- barge / saturation diving support vessel (220 POB[4]) requiring 20 tonnes per day diesel for 218 days;
- two anchor handling vessels (15 POB each) requiring 6 tonnes per day diesel each for 218 days;
- two pipe haul vessels (14 POB each) requiring 6 tonnes per day diesel each for 175 day;
- two tugs (26 POB each) requiring 15 tonnes per day diesel each consumption each for 175 day; and
- one survey vessel (26 POB) requiring 6 tonnes per day each diesel consumption for 218 days.

?? Commissioning:
- five vessels (15 POB each) requiring 6 tonnes per day each diesel for 90 days; and
- one lay- barge / saturation diving support (220 POB) requiring 20 tonnes per day diesel consumption for 90 days.

Estimated atmospheric emissions during the installation and commissioning period are quantified in Figure 5.36 and 5.37.

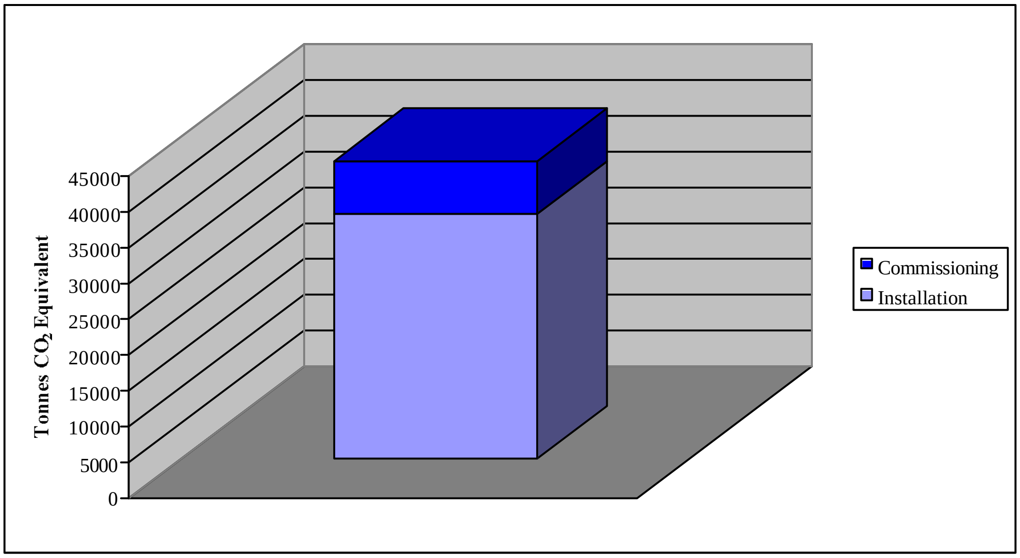
Figure 5.36 Estimated atmospheric emissions during pipeline installation and commissioning operations offshore (tonnes)



Note: Units of CO_2 are kilotonnes.

[4] It is noted that the number of POB may increase by approximately 10 people due to the pipeline piggyback installation operations.

Figure 5.37 Estimated GHG emissions during pipeline installation and commissioning offshore



5.4.8.2 Aqueous discharges

Sanitary waste will be generated throughout the duration of the pipeline transportation, installation and commissioning activities offshore. The key assumptions for deriving the estimated amounts of sanitary waste generated are as listed above in Section 5.4.8.1. It is also generally assumed that each crew member will generate 0.22 m^3 / day of grey water and 0.10 m^3 / day of black water (BOD at 240 mg/l). Figure 5.38 presents the estimated amounts of sanitary waste that will be discharged to sea during these activities.

Figure 5.38 Estimated amounts of sanitary waste discharged to sea during pipeline transportation and installation operations offshore

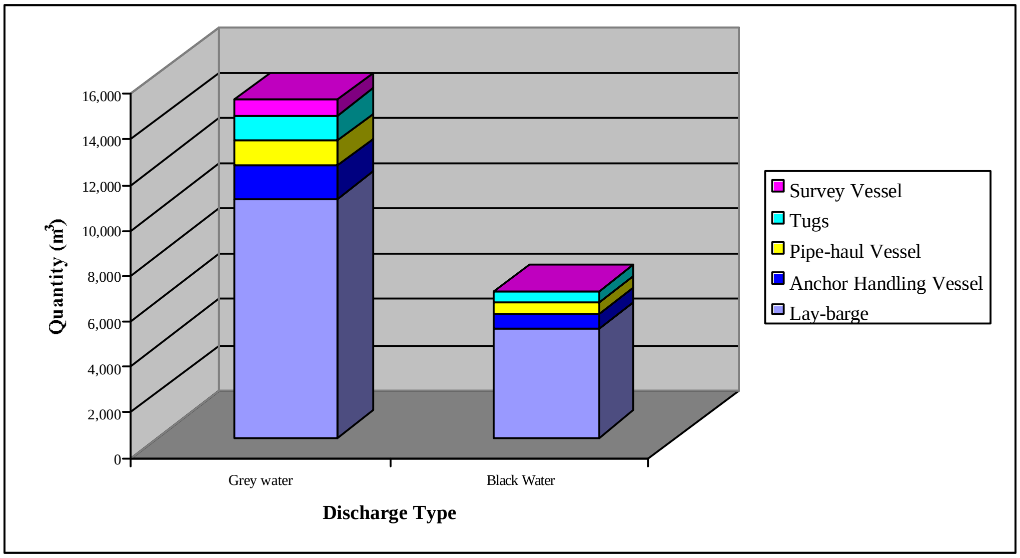
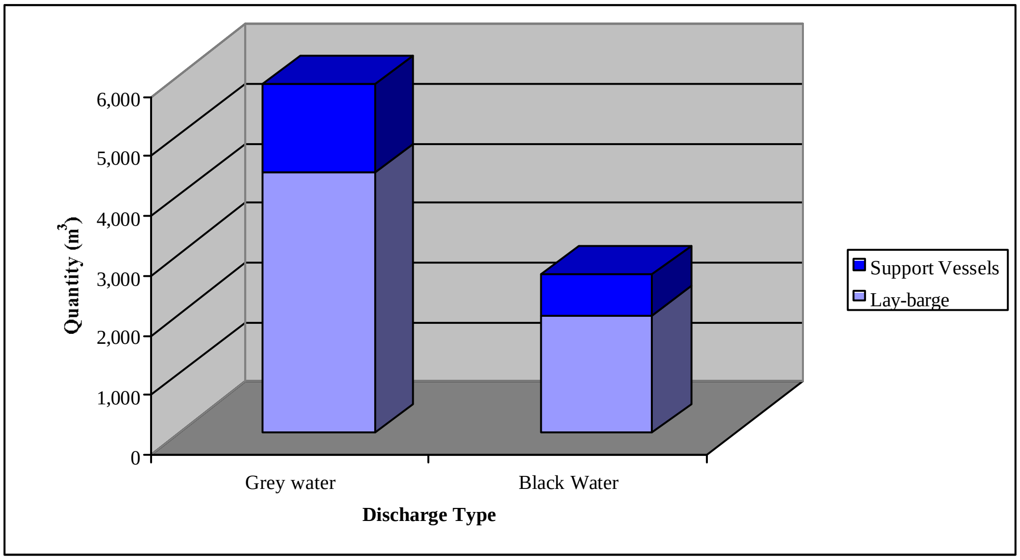


Figure 5.39 presents the estimated amounts of sanitary waste that will be discharged to sea during pipeline commissioning activities.

Figure 5.39 Estimated amounts of sanitary waste discharged to sea during pipeline commissioning activities



The short length of the pipelines onshore indicates that the atmospheric emissions associated with installation and commissioning operations will be minimal when compared with similar activities offshore and therefore, have not been quantified.

5.4.8.3 Hazardous and non-hazardous wastes

It is not possible to quantify exactly how much waste will be generated during the pipeline installation programme. Wastes types and volumes presented in Table 5.15 have been estimated for a six-month pipe-laying programme.

Table 5.15 Estimated waste types and volumes for a six-month pipeline installation programme offshore

Category/Waste type	Annual Waste Generated (per annum)			
	<1 Tonne	<10 Tonne	<100 Tonne	>100 Tonne
Non-Hazardous Combustible Solid Waste				
Paper and cardboard	?			
Wood		?		
Food Waste		?		
Non-Hazardous Non Combustible Solid Waste				
Electrical wire	?			
Scrap metals		?		
Scrap electrical materials	?			
Hazardous solid waste				
Empty drums		?		
Filters		?		
Rags		?		
Sand/shotblast materials		?		
Absorbents (spill clean-up)	?			
Clinical Waste	?			
Hazardous liquid waste				
Oil				?
Paints	?			
Thinners	?			

Source: The above waste estimates were derived from waste forecast provided by Halliburton Brown & Root (2001).

5.4.9 Pipeline decommissioning

As discussed in Section 5.3.8, the Shah Deniz PSA stipulates the broad requirements for decommissioning of project facilities. Article 14.2(g) describes the requirements relating to the preparation of an abandonment plan and Article 14.2(d) describes the provisions for hand-over of facilities to SOCAR should the Contractor elect to abandon a fixed asset prior to the termination of the PSA.

There are fundamentally two options for decommissioning the export pipelines:

?? abandon *in situ*; and
?? complete removal.

5.4.9.1 Abandon *in situ*

When pipelines are abandoned *in situ*, they are generally cleaned to remove hydrocarbons and either flooded with seawater or cement slurry. Pipes are severed from the risers on the seabed while shore crossing sections are typically removed from beyond the surf zone and across the beach. Where pipeline landfalls are protected by trenching, the trenched sections may be left in place if decommissioning is likely to have a significant environmental effect. Thus, an assessment of the impact of the different options is required nearer to the time of the decommissioning since the on-site conditions will change through time.

5.4.9.2 Complete removal

The option of pipeline removal involves an extensive marine deconstruction activity and requires pipeline cleaning procedures similar to those associated with abandonment *in situ*. Pipe cleaning is followed by a process of pipe cutting and removal in sections. This is either performed with a reverse of the installation using an “S-lay” configuration. With the reverse lay process, the marine spread proceeds much in the same way as the laying process but removing rather than adding sections of pipe. The process is considerably faster than the laying process but the attendant risks are very similar to pipeline installation in terms of emissions, discharges, marine spread, disturbance, dropped object and pipeline crossing. There is however, a significant additional risk involved in pipeline removal in that the pipeline, having been in hydrocarbon service, must be inerted prior to dismantling. The risk associated with attempting to dismantle a pipeline that has been used for hydrocarbon service, both to personnel safety and to the environment, may be sufficient alone to preclude this option. Furthermore this option is relatively labour intensive and involves further seafloor disturbance associated with vessels anchoring, and removal of sections of the pipe that have become buried.

5.5 Onshore Facilities

5.5.1 Description

The Shah Deniz gas and condensate reception and processing terminal will be constructed alongside the existing AIOC EOP and planned ACG Phase 1 oil receiving and processing terminals at Sangachal. As described in Section 5.4 the gas and condensate will be delivered via two dedicated marine pipelines to the onshore reception and processing terminal. Gas and condensate will be conditioned and stabilised for export into the export pipelines. The onshore terminal shall process the incoming gas through two trains (50% load each). Received gas will be dehydrated and conditioned to meet the pipeline transportation and sales gas specifications. Gas conditioned for transportation and sales will be transferred from the terminal to an export pipeline system that will deliver the gas to the Turkish market at a point on the Georgia-Turkey border. Stabilised liquid condensate will also be produced at the terminal for export as a product commingled with ACG crude oil in the Northern Export Route (NER) pipeline, Western Export Route (WER) pipeline or the Main Export Pipeline (MEP).

The key design parameters for the terminal are as follows:

?? design capacity:	two gas process trains to treat a total of 900 MMscfd;
?? operating pressure:	110 barg inlet, 90 barg outlet;
?? turndown:	150 MMscfd for each train;
?? gas Processing:	dehydration plant, turbo-expander for dew point control
?? condensate storage:	floating roof storage tank capacity of 165,000 bbls
?? condensate export:	Via ACG through BTC or existing pipeline Infrastructure
?? export Compression	2 x 100% motor driven centrifugal compressors
?? design life:	35 years.

The terminal design has drawn on simplicity and ease of construction in order to meet the tight project execution schedule. The layout of the terminal also takes account of possible future expansion of the gas terminal capacity from the initial annual quantity of 5.02 billion cubic metres (bcm) up to 18 bcm. The terminal utilities and support functions will also integrate with the AIOC EOP and ACG Full Field Development (FFD) facilities wherever there is economic justification for doing this.

Gas dehydration to meet pipeline transportation and gas sales specification will be achieved by means of gas expansion and recompression with a turbo-expander and compressor set for high pressure export. The gas will be processed through two 50% trains, with the gas dehydrated to an adequate dew pointing level. The two 50% trains will each provide a nominal capacity of 31,000 bpd stabilised condensate. Cold recovery by means of a gas-gas heat exchanger will be used.

The pressure drop that will exist between the terminal inlet and gas export pipeline is such that an export compressor will be required to take gas from the turbo-expander compressor to boost it up to the export pipeline entry pressure. A standby export compressor will also be provided to avoid breaks in production during a compressor outage.

The export gas will be metered to custody transfer standard before transfer to the export pipeline. The gas metering system will be based on multiple meter runs and will include an online chromatographic system, pressure and temperature measurement and a metering unit control panel (UCP). The UCP will contain all the necessary hardware and software functionality to perform flow calculations to the required custody transfer standards.

Control of the Shah Deniz gas production rate will be provided by means of turbo-expander inlet valves. The choke valves on the offshore wells will be adjusted to give control of the gas flow to the onshore terminal.

5.5.2 Synergy with ACG

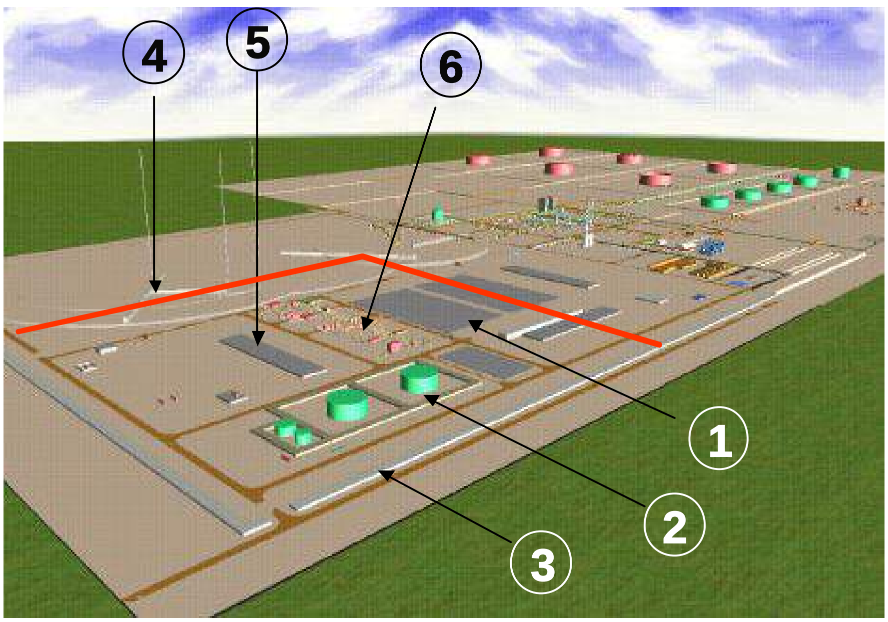
The general Sangachal terminal will have a layout that places the Shah Deniz project adjacent to the AIOC terminal facilities. BP will operate both projects and there are some inherent synergies, to the benefit of both projects that can be obtained in the construction, design and operation of the terminal.

5.5.3 Proposed terminal layout and design principals

The layout of the gas terminal (Figure 5.40) has been designed after consideration of the following factors:

?? predominant environmental conditions, particularly the prevailing wind direction and surface water run-off from the nearby hills;
?? natural slope for the slug catcher and site drainage;
?? potential ignition sources such as fired heaters and flares up-wind of major sources of hydrocarbon release;
?? adequate separation distances between process, utility, storage and permanently manned areas in order to avoid escalation of a fire and to minimise risk to personnel;
?? central location for utilities and support functions that are common to the Shah Deniz and AIOC facilities;
?? minimisation of land take and visual impact; and
?? the routing of the incoming and export pipelines and the main access to the site.

Figure 5.40 Proposed terminal layout



1. Utilities.
2. Condensate storage tank.
3. Security dyke.
4. Flare system.
5. Slug / surge catcher.
6. Gas processing facilities.

The terminal construction necessitates the acquisition of additional areas of land, in order to provide space for the new facilities and equipment to be installed. The total land acquisition area for the ACG FFD and Shah Deniz terminal facilities comprises 730 ha including the 256 ha previously acquired by AIOC of which 40.5 ha are taken up by the existing EOP terminal. Within the land acquisition area a total 428 ha are required for the ACG FFD and Shah Deniz FFD terminal facilities (including existing facilities). The remaining area between the terminal boundary and the outer limits of the land acquisition boundary amounts to 302 ha and this area will form a development exclusion zone within which no further developments will be permitted throughout the lifetime of the terminal. The outer limits of the development exclusion zone will be pegged, rather than fenced, in order to allow access to herders and grazing animals and to maintain a general right of way.

Table 5.16 presents the actual planned areas in hectares for each component of the terminal facilities.

Table 5.16 Proposed terminal facilities land-take area breakdown

Terminal Areas	Areas (ha)
Existing EOP:	40.5 ha
Shah Deniz terminal area:	33.3 ha
ACG/Shah Deniz flare area:	34.7 ha
BTC pump station:	2.5 ha
Drainage channel:	22.5 ha
New access road:	2.5 ha
Workers camp area:	13 ha
ACG Phase 1 terminal facilities:	41.8 ha
ACG Phase 2 facilities:	24.1 ha
ACG Phase 3 facilities:	24.7 ha

5.5.4 Terminal construction schedule

Terminal facilities development commenced in January 2002 with initiation of the Early Civil Work Programme (ECEWP) (Section 5.5.5). The work is being undertaken for both Shah Deniz Stage 1 and ACG Phase 1 terminal facilities and will take about six months to complete.

Following completion of the ECEWP, construction work on the ACG Phase 1 terminal proper will commence immediately. Shah Deniz terminal facility development will commence approximately six months after completion of the ECEWP. When construction work commences for Shah Deniz terminal, activities will continue until the completion of commissioning (with gas) in mid 2005. Table 5.17 shows the key activities leading to start up and operation of the terminal.

Table 5.17 Schedule of Shah Deniz project

Activity	Period			
	2002	2003	2004	2005
Site clearance and early civil engineering (Shah Deniz & ACG)				
Tanks design & procurement				
Steel manufacture & delivery				
Tanks roof fabrication				
Tanks side panel fabrication (out of country)				
Tanks transportation				
Foundation preparation				
Erection (2 main tanks)				
Provision of construction camp (Shah Deniz & ACG)				
Civil works				
Building construction/structural erection				
Major equipment installation				
Pipe fabrication				
Pipe installation				
Minor equipment installation				
E&I outfitting				
Testing of equipment and facilities				
Initial commissioning of process with gas				
Final commissioning of process with gas				

5.5.5 Early Civil Engineering Works Programme

An ESIA for the ECEWP was submitted to the MENR in November 2001 and was approved in December 2001. The following section summarises the key aspects of the programme. Full details can be found in the ECEWP ESIA (AIOC, 2001).

The ECEWP will include a number of activities as follows:

?? the clearing, grading and levelling of land in the area on which the ACG Phase 1 terminal, the Shah Deniz Stage 1 terminal and the BTC pump station will be built;
?? the excavation of a flood protection drainage channel and construction of a bund wall on three sides of the proposed terminal site;
?? the construction of a security dyke along the south-eastern boundary of the terminal site;
?? the construction of a security perimeter fence and lighting;
?? the construction of a new access road for the terminal site and railway crossing along with two additional roads within the terminal site;
?? potentially, the construction of a temporary camp to house the ECEWP workforce; and
?? relocation and potential modification of utilities services.

A safety exclusion zone will be established around the terminal site boundary and fenced off to exclude any persons or grazing animals entering into an area where they may be harmed. Additionally, as operations at the EOP terminal will continue during the ECEWP and through later construction activities, a designated control zone of 25 m will be established around the EOP terminal to ensure the safety of existing processes at the site.

The ECEWP activities will be supported by a number of utilities provided by the contractor and these will include power generators and sewage treatment facilities. Water for the site will be provided by connection into an existing water line that runs to the south of the terminal. This water line provides water to Baku city. Measures will be taken to ensure that the water use requirements for the ECEWP will not affect the supply to current users.

An overhead power cable crossing the work site will be relocated. The preferred approach for movement of the power line is to completely install the new section of the line without disruption to the existing service prior to tying it in to the service. It is anticipated that power supply will be disconnected for approximately three hours during tie-in.

Vegetation clearance and land levelling of the ground proposed for construction of the terminal facilities is necessary. Ground levelling is required to correct the existing 0.5% gradient across the site and levelling operations will be carried out using standard “cut-and-fill” method. Vegetation clearance will only occur in areas where the land is to be levelled for terminal construction.

The terrain around the terminal consists of compacted clays and the terminal site area is relatively flat and bordered by hills to the northwest such that any rainwater runoff from the hills is channelled towards the terminal, the speed of which is assisted by the lack of absorbance of the compacted clay. Flash floods represent therefore, a real risk to the terminal and flooding has been experienced in the EOP terminal during previous years. For this reason it is necessary to provide flood protection for the terminal facilities by means of a drainage channel to be excavated around the terminal expansion area. The channel will be excavated to a depth of 2.0 m at its deepest point with a channel bottom width of approximately 30 m. The surface of the drainage ditch will be left as natural material with concrete coated supporting walls installed at the corner points to prevent erosion due to accelerated water flow at these points. Each side of the drainage channel will be approximately 10 m wide and sloped to a gradient of around 1:10 resulting in an average channel surface width of approximately 50 m.

On the terminal side of the drainage channel, a bund will be constructed to produce a perimeter flood protection dyke. The dyke will extend from ground level to a height of 2 m above the surface. A security fence will also be installed on the inside perimeter of this bund.

In recognition of national guidelines and PSA requirements, a security dyke approved by the Azerbaijan Ministry of Defence (MOD) will be built as an extension of the existing security wall on the seaward side of the EOP terminal by MOD authorised contractors.

Fencing will be installed outside the dyke, providing security and controlled access to the road. The security fence will be constructed to a height of 1.83 m.

It is currently envisaged that a total of three new roads are required at the site and will be constructed as part of the ECEWP as follows:

?? a new 6 m wide site access road of approximately 2.8 km in length running from the main Baku-Astara Highway;
?? a new 6 m wide south access road of approximately 1.26 km in length running parallel to the existing EOP terminal from the new site access road; and
?? a 3.6 m wide security wall road of approximately 1.62 km in length as a continuation of the existing EOP terminal security road to the south of the terminal security dyke.

Each road will be covered with a gravel substrate with soil stabiliser applied to the top base layer. Following construction of the terminal and prior to terminal operations, a bitumen top layer will be applied to the surface.

The final new access road design will balance railway crossing safety requirements and land-take considerations. It is possible that a new railway crossing point will be provided as part of the design.

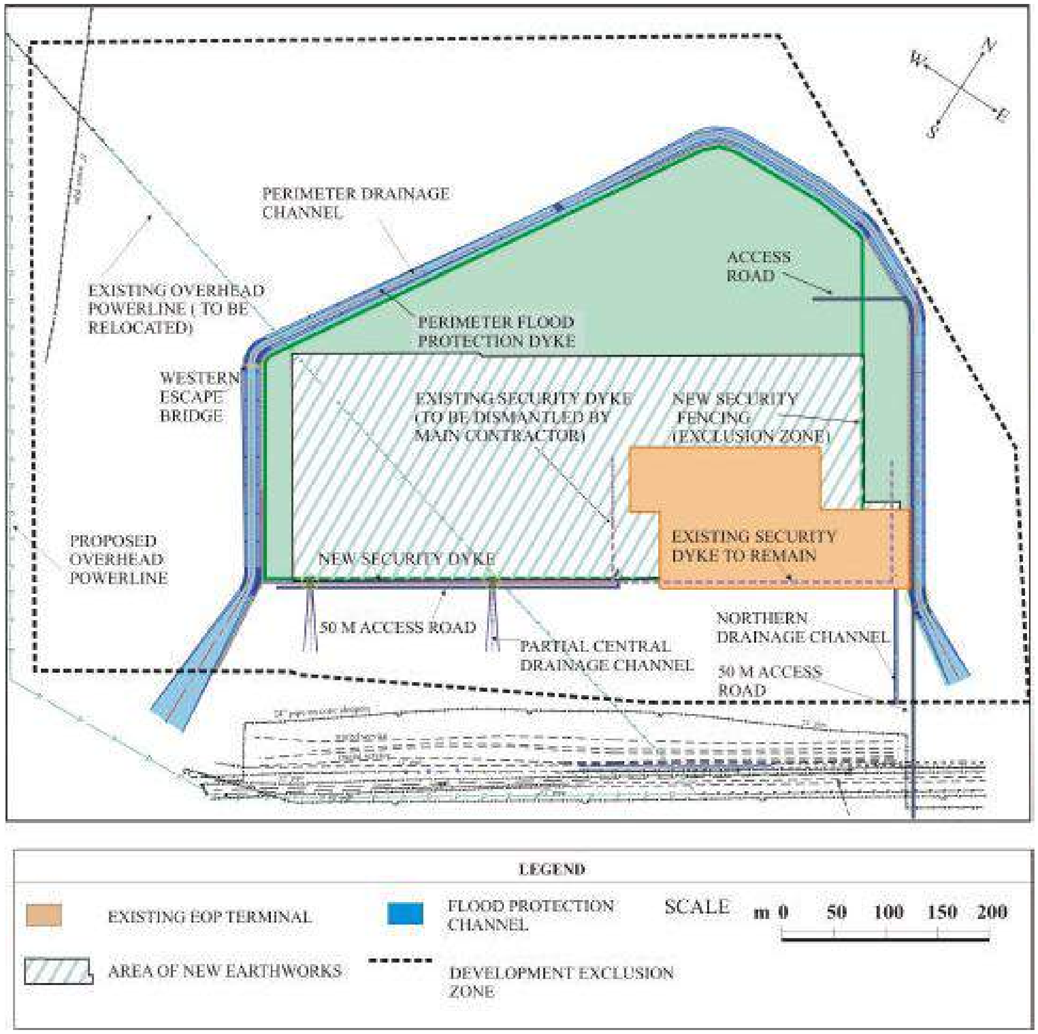
The areas that will be affected by the ECEWP are presented below:

?? Vegetation clearance and ground levelling for the ACG Phase 1 terminal expansion facilities, Shah Deniz terminal facilities, ACG/Shah Deniz flare area and BTC pump station:	112.3 ha.
?? Construction of the drainage channel (c. 5 ha outside the terminal land take area):	27.5 ha.
?? Construction of the new access road (c. 5 ha outside the terminal land take area):	7.5 ha.

In addition, between 10 ha and 15 ha will also be affected as a result of materials lay down, bund wall and fencing construction.

The location of ECEWP activities is illustrated in Figure 5.41.

Figure 5.41 ECEWP activity location



Although not part of the ECEWP an accommodation camp will be constructed on a dedicated site within the land acquisition area to house some of the workforce required for the main terminal construction programme. Site preparation works for this camp is anticipated to commenced midway during the ECEWP.

Throughout the ECEWP programme special attention will be given to the integration of the ECEWP with the activities of the main terminal construction contract. AIOC/BP is particularly committed to the coordination of construction synergies between the ECEWP and main construction work programme, such as earth work sequencing, excess soil holding grounds, water supply, provision of utilities and, accommodation and waste management to help improve the overall efficiency of the terminal construction programme. The terminal construction will be conducted under three separate contracts with the award dates of these scheduled to maximise the constructability input from each contractor and synergise construction issues such as HSE planning, resourcing and training.

5.5.6 Terminal construction

The Shah Deniz Stage 1 terminal will comprise the following principal components:

?? a gas system including reception, conditioning, recompression, flare, fuel gas system, metering and export facilities;
?? a condensate system including reception, stabilisation, storage, metering and export facilities; and
?? utilities.

5.5.6.1 Construction sequence

The function and operation of these components is described below. The terminal construction will occur in two main phases; preliminary civil engineering works as described above and the main construction period.

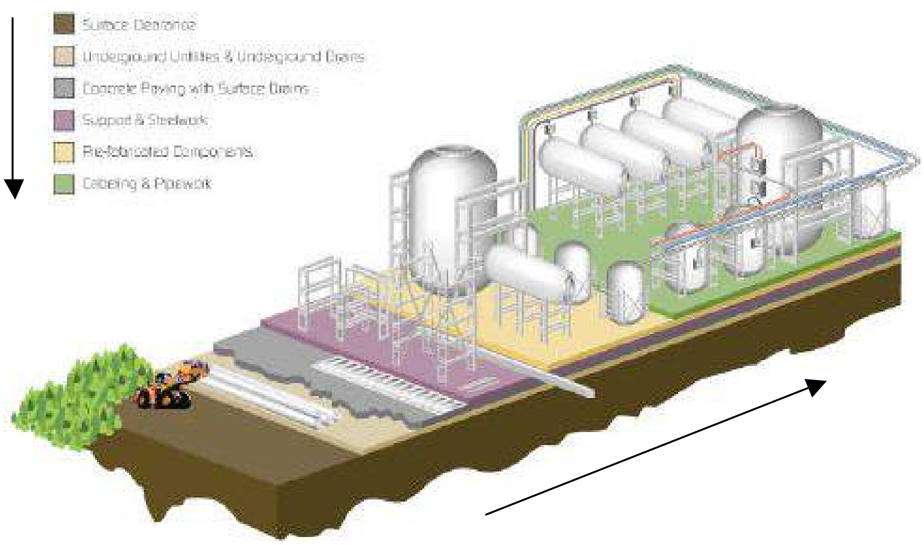
Activities for the construction of the terminal will follow the following sequence:

?? Engineering and design.
?? Procurement.
?? Fabrication and construction including:
- Civil works:
  - foundations;
  - underground works; and
  - tank foundations.
- Buildings:
  - foundations;
  - structures;
  - finishing and architectural works;
  - electrical works; and
  - mechanical works.
- Steel works:
  - shop fabrication; and
  - site erection.
- Piping works:
  - shop fabrication, testing and painting;
  - site erection;
  - installation of valves; and
  - flushing and testing.
- Equipment erection:
  - static equipment;
  - rotating equipment;
  - heavy lift equipment; and
  - utilities equipment and systems.
- Electrical works:
  - shop fabrication of supports & trays;
  - site erection of supports & trays;
  - cabling;
  - installation of fittings & accessories;
  - installation of equipment and devices;
  - earthing;
  - heat tracing; and
  - terminations.

- Instrumentation:
  - shop fabrication of supports & trays;
  - site erection of supports & trays;
  - cabling;
  - instrument fit up;
  - instrument piping, fittings & accessories; and
  - installation of control valves.
- Telecommunications:
  - shop Fabrication of supports & trays;
  - site erection of supports & trays;
  - cabling including fibre optic and co-axial;
  - installation of equipment and fittings; and
  - terminations.
- Fire and safety:
  - shop Fabrication of supports & trays;
  - site erection of supports & trays;
  - cabling;
  - installation of detection systems, junction boxes & marshalling boxes;
  - terminations; and
  - fire water systems.
- Insulation, passive fire protection and coating:
  - shop fabrication of claddings;
  - insulation;
  - erection of cladding;
  - passive fire protection; and
  - painting.
- Commissioning and start up:
  - pre-commissioning tests and checks;
  - preparation of commissioning dossier;
  - commissioning of utility systems;
  - commissioning of process systems following introduction of hydrocarbons;
  - start up assistance.

The sequence of construction activities is shown graphically in Figure 5.42.

Figure 5.42 Sequence of terminal construction activities

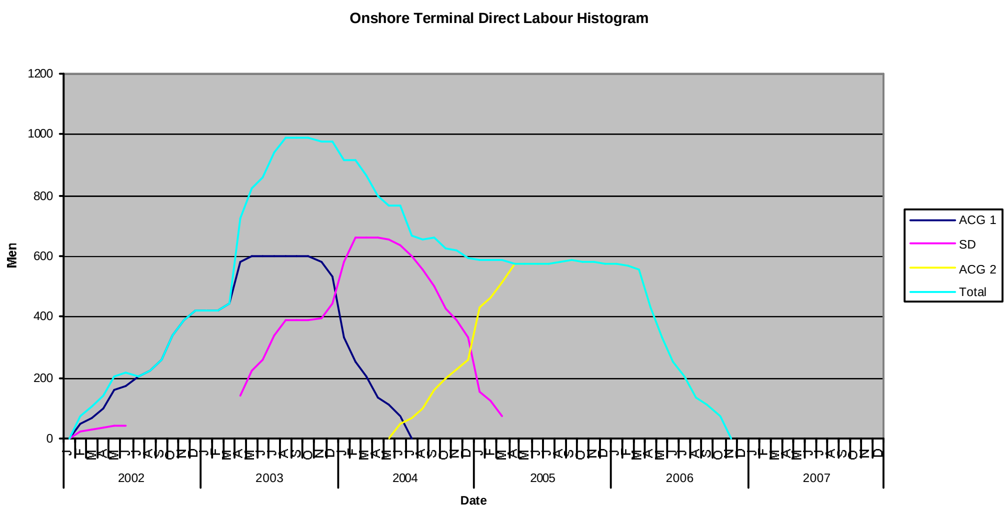


5.5.6.2 Workforce size and accommodation camp

The main Shah Deniz terminal construction period is anticipated to begin in the second quarter of 2003 with completion planned for the 2Q 2005. It is anticipated that approximately 1,000 personnel will be needed at the peak of the programme when ACG Phase 1 and Shah Deniz are being constructed.

The construction workforce size for all projects and the anticipated personnel levels per project is presented in Figure 5.43.

Figure 5.43 Construction workforce size (all projects) and anticipated personnel levels per project



Construction personnel will include expatriate and local workers. A minimum of 75% of the workforce will be sourced locally from the area around Sangachal or from elsewhere in Azerbaijan. A large proportion of the workforce, including all expatriate workers, will be accommodated in a construction camp located outside the existing security wall of the terminal. The camp will be sized for 500 workers and will be fully equipped with residential quarters, recreational facilities, shops and bar. Prior to the completion of the camp, the majority of workers will travel to the site from Sangachal, Umid, Sahil and existing camps.

The Shah Deniz and ACG terminal acquisition area will be maintained as a restricted access area after site clearance. The bund and drainage ditch serve to maintain a controlled area and also serve as a physical barrier to dissipate noise, dust and visual disturbance from construction operations affecting local residents. The east side (seaward side) of the terminal will be bounded by a security wall run between the accommodation camp and area established for terminal facilities. The exclusion of the camp will enable external personnel, such as delivery services to gain access to the premises without entering the terminal operational areas. A mesh fence and security entrance will provide security for the construction camp.

5.5.6.3 Terminal component fabrication, installation and commissioning

Expansion of the Sangachal terminal requires four main resources as follows:

?? equipment (items installed for terminal operations, such as storage tanks, compression and dehydration facilities);

?? plant (construction equipment, such as trucks and earthmovers);
?? materials (gravel, water etc); and
?? a labour force.

The majority of equipment proposed for installation as part of terminal expansion will be fabricated outside of Azerbaijan and transported into the country from international yards as completed components ready for assembly. Transportation methods and routes are under evaluation and are further discussed in Section 5.6.

The terminal process modules fabricated in out-of-country facilities will be tested and certified for mechanical completion on the original fabrication premises. Upon installation at the terminal site, these components will be hydro-tested and commissioned prior to start-up.

Terminal hydro-testing will be achieved by filling the process system with water and raising the pressure in the equipment to 1.5 times the normal operational pressure. The hydro-test water will be supplied from the existing potable water connection and at present, it is considered that there is no need to add chemicals (e.g. corrosion inhibitor; antifouling agent) to this water due to the fact that it is fresh water and the hydro-test procedure will be of short duration (i.e. limited opportunity for bio-fouling). Following hydrotesting, the water used will be disposed of using an appropriate disposal method.

There are three hydro-test water disposal route options under consideration. These are as follows:

?? Injection down a dedicated onshore disposal well: The existing oil field at Lokbatan has been identified as a potential site for a dedicated water disposal well. If this option is available (see below) and selected, all hydro-test water will be piped to the facility and disposed of by down-hole injection;
?? Water re-use at the Garadag Cement Plant: The Garadag Cement Plant would receive hydrotest water and feed it into the kiln, the exact method being dependent on the chemical character of the water; and
?? Direct discharge to the terminal flood protection channel.

Investigation into and the potential development of onshore injection wells at Lokbatan is being driven by the ACG Phase 1 project. This project does not require the injection facility until 2007 when produced water production is expected to occur. The Shah Deniz Stage 1 project will require a disposal route for the terminal hydro-test waters before this date and therefore, in the event that the injection facilities are not available or are found to be inappropriate (e.g. high risk), an alternative disposal route will required.

The Garadag Cement Plant can re-use hydro-test water in the cement production process. Its capacity is however, limited and depending on what other wastewater sources are being received by the plant, it may not be possible for it to take the Shah Deniz hydro-test waters in which case and alternative disposal route will be required.

Discharge of hydro-test waters to the terminal flood protection channel is perhaps the simplest and most attractive disposal route. The water would be subject to quality testing prior to discharge to confirm that no chemicals of concern have contaminated the water during the hydro-test procedure. In the event that chemicals of concern are found, the water would be either treated prior to discharge or an alternative disposal route used. Should discharge of hydro-test water to this disposal route be pursued, potential environmental effects would be fully investigated and the approval of the MENR to use this discharge route sought prior to actual discharge.

Following hydrotesting, the process trains including the modules, piping and equipment will be commissioned. The commissioning of the Shah Deniz facilities requires four basic components to be brought on stream as follows:

?? offshore production wells;
?? offshore separation and export facilities;
?? export pipelines; and
?? onshore treatment facilities.

Commissioning of the Sangachal terminal gas treatment facilities will require the use of gas to start-up various pieces of equipment prior to gas being available from the TPG500. In order to effectively commission the plant, gas may be obtained from the EOP terminal. The small volumes of gas used during commissioning will principally be disposed of by flaring.

5.5.6.4 Terminal construction utilities

Power generation and diesel systems

It is likely that the construction contractor will utilise diesel generators for power supply to avoid the variability in local supply. A back-up supply will however, be provided by means of a direct connection to the mains supply.

Diesel for power generation (as well as for vehicles and equipment operations) will be held in storage tanks at the worksite that will be installed during the ECEWP. These tanks will be bunded in accordance with standard industry practice, ensuring that the bund is sufficient to contain 110% of the largest storage tanks. In addition, diesel storage and refuelling facilities will be constructed on a concrete slab to avoid potential contamination of the soil. Diesel will be transported to the site by tanker and delivered to the tanks via a closed transfer system. Refuelling procedures will be in place to prevent spills and spill clean up materials will be kept onsite for use in the event of a spill.

Sewage and wastewater

Sewage and wastewater generated at the terminal will be collected for activated sludge digestion. The system works by collecting the effluent from a number of pump pits around the terminal site and removing non bio-degradable products by passing the waste stream through a screen. The remaining wastes are then passed through a reactor tank which contains bacteria. The bacteria in the tanks digest the organic waste and leave a small amount of solids as residual wastes that can be used as a fertiliser.

Treated water leaving the reactor tank has a greatly reduced BOD_5 and can be further treated with small amounts of chlorine to remove any active bacteria. The system operates to the following standards:

?? BOD_5: 50 mg/l;
?? COD: 100 mg/l;
?? pH: 6-9;
?? residual chlorine: 0.2 mg/l;
?? total suspended solids: 50 mg/l; and
?? total coliforms: <400 MPN/l.

The above standards mean that the water exiting the system is of sufficient quality to be used for dust suppression or irrigation if required, rather than disposal. During the wet months, water treated to irrigation standards will be discharged to the drainage system or routed via the existing EOP outfall if there is no irrigation requirement.

5.5.6.5 Terminal construction emissions and discharges

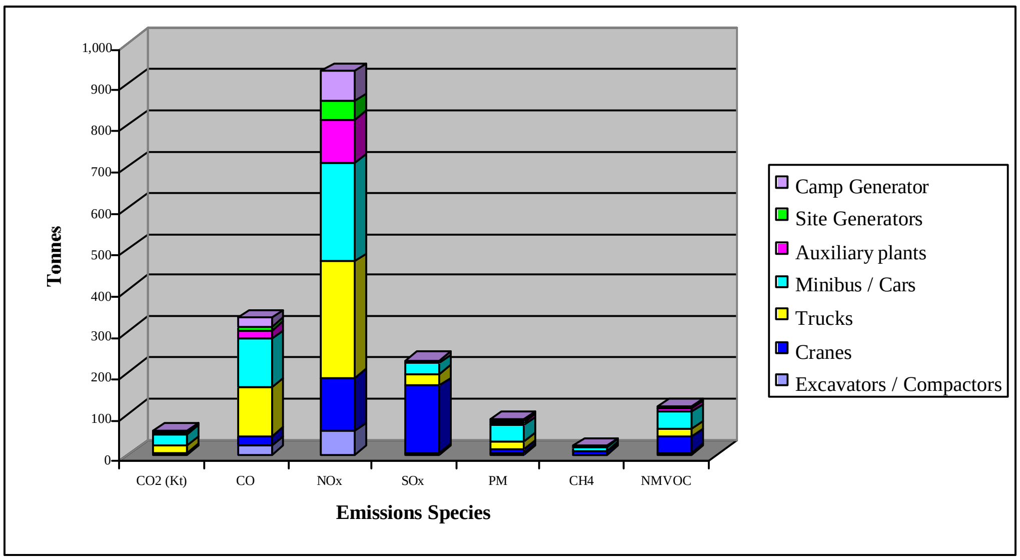
Atmospheric emissions

The principal atmospheric releases associated with terminal construction activities are expected to include emissions from:

?? earthworks (foundation excavation; ground compaction);
?? construction and delivery vehicle emissions (diesel powered equipment, cranes, excavators);
?? cranes;
?? power generation at construction camps (refer below);
?? welding fumes and paint fumes; and
?? construction power generation.

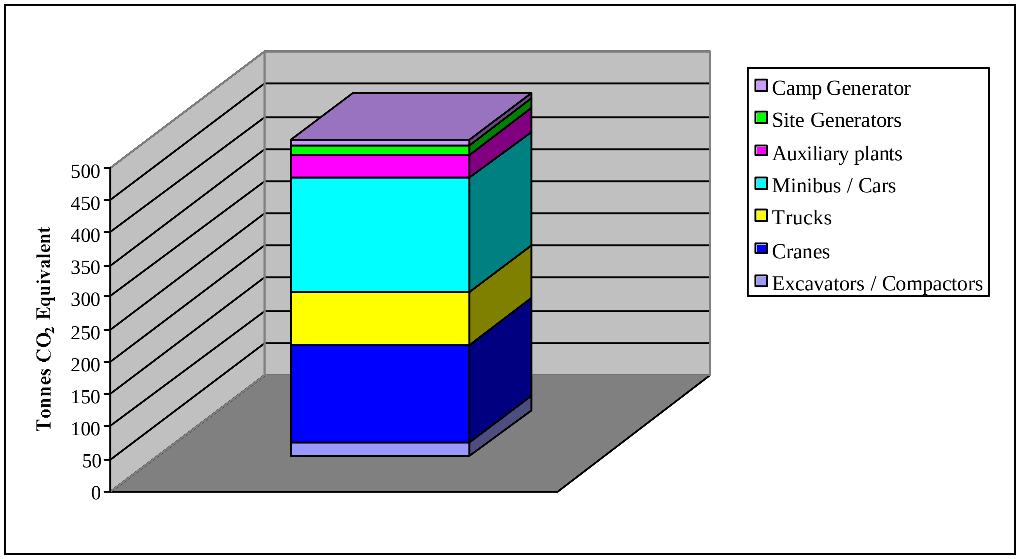
The estimated emissions for all plant and facilities engaged in the construction programme are presented in Figures 5.44 and 5.45.

Figure 5.44 Atmospheric emissions from terminal construction



Note: Units of CO_2 are kilotonnes.

Figure 5.45 Total GHG emissions from terminal construction



Noise emissions

Noise emissions associated with the Shah Deniz terminal construction activities will arise from a number of sources including:

?? site grading equipment (e.g. bulldozers);
?? foundations and underground services installation;
?? building access roads and parking areas;
?? building construction; and
?? operation of the construction camp.

The estimated number of plant and their respective sound power and sound pressure level, according to British Standard 5228, are presented in Table 5.18 below.

Table 5.18 Noise emission level of plant

Plant	Sound Power Level (L_W) (dB)	Sound Pressure Level (L_P) as 10m L_{Aeq} (dB)	British Standard 5228 Reference
5 Cranes	109	81	C6.18
10 Trucks	98	70	C7.121
10 Trucks	105	77	C3.59
5 Compactors	108	80	C3.118
5 Excavators	109	81	C3.89
4 Generators (500kVa)	104	76	C7.49

Sewage wastes

Sanitary waste will be generated throughout the duration of the construction / assembly activities. The key assumptions for deriving the estimated amounts of sanitary waste generated are:

?? 1,000 construction workers on site throughout the duration of the works (ACG and Shah Deniz;

?? each construction worker will generate 0.22 m^3/dy of grey water;
?? each construction worker will generate 0.10 m^3/dy of black water; and

Table 5.19 present the predicted amounts of sanitary waste that will be discharged during construction operations.

Table 5.19 Estimated amounts of sanitary waste discharged construction operations per annum

Parameters	Estimated Volume
Grey water	80,300m^3
Black Water	36,500 m^3

Hazardous and non-hazardous wastes

Wastes generated during the construction period may consist of the following:

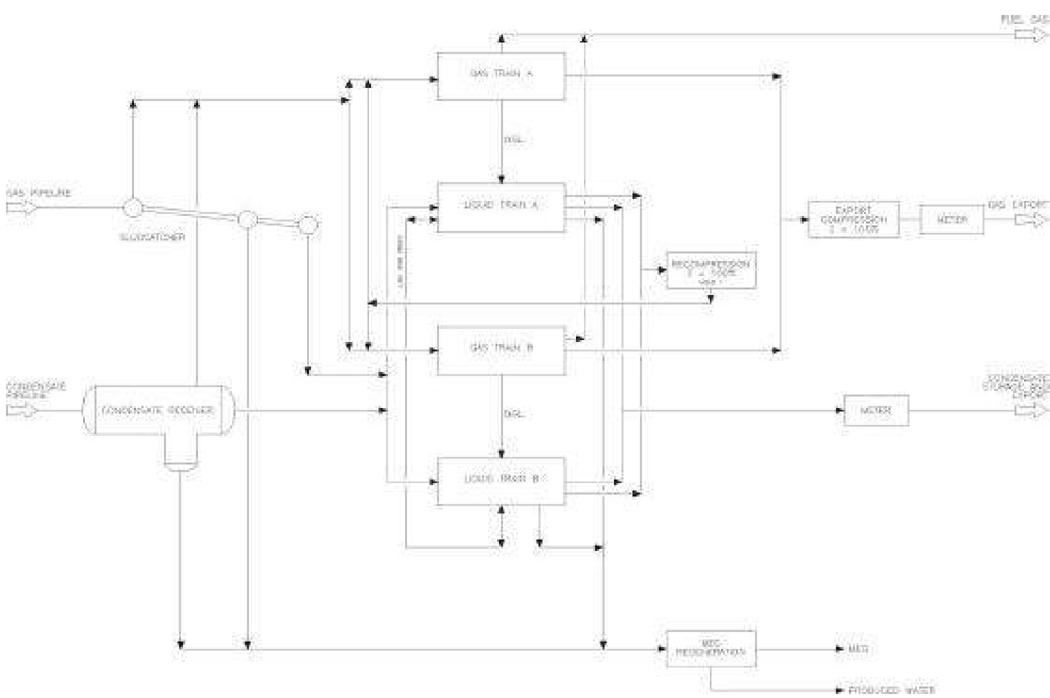
?? non-hazardous combustible solid waste such as waste paper, wood and cardboard;
?? non-hazardous, non-combustible waste such as scrap metal;
?? hazardous solid waste such as paint cans and empty chemical containers;
?? hazardous liquid wastes such as liquid oily wastes.; and
?? vehicle tyres.

All wastes will be segregated and stored for treatment and/or disposal and will be controlled by means of careful documentation, handling and transportation, as detailed in BP's Waste Management Procedure (Section 5.7).

5.5.7 Terminal operations

The onshore terminal process is summarised in Figure 5.46 below.

Figure 5.46 Schematic of the Shah Deniz terminal process



5.5.7.1 Gas reception facilities

Hydrocarbons will arrive at the onshore terminal via separate condensate and wet gas pipelines. The arrival temperatures will range between 5°C and 25°C depending on the season. Lower gas arrival temperatures may be experienced at high flow-rates due to expansion cooling. The arrival pressure will be approximately 110 barg.

A slug catcher will be required to handle any slugs of fluid that might be generated in the wet gas pipeline and to ensure a steady flow of condensate to the downstream separation and stabilisation system. The slug catcher will be designed with separate condensate and water draw-off lines, with an appropriate control system, to avoid draw-off of water only immediately after the arrival of a slug. In consideration of the very large inventory of high pressure, flammable hydrocarbons in the slug catcher, due attention shall be given to its location and means of protection.

The slug catcher shall be rated for the pipeline design pressure, with a pressure specification break on the gas and liquid outlet lines; alternatively a HIPP's system will be used to protect the slug catcher which can then have a lower design pressure.

5.5.7.2 Gas processing

As discussed, the gas must be dehydrated and conditioned to meet the pipeline transportation and sales gas specifications. The sales gas hydrocarbon dew point will be achieved by means of gas expansion and recompression with a turbo-expander and compressor. Cold recovery will be utilized by means of a gas-gas heat exchanger.

The pressure drop that exists between the terminal inlet and gas export pipeline is such that, at its lowest, the gas pressure will be 58 barg, recompression will increase the gas pressure to 70 barg and then up to 90 barg. An export compressor will achieve the recompression of the gas to the required export pipeline pressure. A standby export compressor will be provided to avoid production curtailment during a compressor outage.

The export gas will be metered to custody transfer standard before transfer to the export pipeline. The metering UCP will contain all the necessary hardware and software functionality to perform flow calculations to the required custody transfer standards.

Control of the Shah Deniz gas production rate shall be achieved by means of the turbo-expander inlet valves. The choke valves on the offshore wells can also be adjusted to give control of the gas flow to the onshore terminal.

5.5.7.3 Condensate stabilisation, storage and export

As discussed, the Shah Deniz project proposes to export the condensate. The Shah Deniz condensate has high wax content and as a result, the condensate pipeline will be pigged frequently to control wax build-up. Pipeline pigging will generate large quantities of wax, which must be melted before the condensate can be processed further. When pigging is conducted, the pig receiver will be heated so that the wax arriving ahead of the pig will be received in liquid form. This will allow re-injection of the wax into the condensate stream that will both enrich the condensate and provide an effective and efficient means of disposal of the wax. It is anticipated that approximately 1,200 tonnes per year of wax will be pigged from the condensate export pipeline between the TPG500 and Sangachal terminal. The pig receiver can accommodate two pigs and with pigging frequency of every three days, this means that the pig receiver will be opened every six days. There will be small amounts of wax left in the pig receiver associated with the pigs. This wax will be removed in the pig receiver area that will be kerbed and will have no drains, thereby preventing the possibility of spillages entering the drains system. Any spilled wax will be collected and disposed of or recycled.

A reliable means of condensate heating will be provided that enables rapid start up of the process. Heat recovery from hot stabilised condensate is proposed via a circulating water system that can be heated with hot oil at start-up.

For processing of the condensate, two 50% stabilisation trains will be provided each with a nominal capacity for 31,000 bpd condensate. This corresponds to 15% over capacity for re-processing of off-specification condensate and to cater for uncertainties in reservoir fluid gas-condensate ratio. The overall stabilisation system shall be capable of 9:1 turn down to cater for start up at low production rates. The condensate shall be stabilised to achieve True Vapour Pressure (TVP) of 0.95 bara at 50ºC.

Condensate stabilisation will be achieved in a stabiliser column. Stabiliser tray hydraulics shall be specified for 4:1 turndown.

All flash gas generated in the stabilisation process will be recovered and compressed using a single compressor. The flash gas shall be routed to the gas processing plant with no gas being flared during normal operation. The condensate stabilisation system and flash gas compression shall be capable of handling a range of feed compositions and in particular, higher propane and butane contents.

The inlet processing will include a separator and coalescer (to remove bulk water and reduce scaling of heat exchangers). A high level of aqueous phase removal is desirable, both to minimise chemical losses and to avoid potential problems in the condensate stabilisation system.

The condensate should be stored above the wax appearance temperature of 40°C and it may be necessary to heat the tanks to maintain this temperature during periods of low production or during shutdowns.

The main condensate storage tank capacity shall be nominal 55,000 bbls corresponding to just over one day's production at the Maximum Daily Contract Quantity (MDCQ). This will ensure that gas production is unaffected by short term outages of the condensate export system.

An off-specification condensate storage tank and return pump will be provided for use during start up and shut down of the plant. This tank represents three days production with a capacity of 25,446 m^3. Any vapour generated in the tank will be recovered and burnt in the fired heaters.

Custody transfer standard metering will be provided for the condensate export line. The metering systems will be based on multiple meter runs and will include a bi-directional meter prover, sampling system, density analysers, pressure and temperature measurement and a metering UCP. The UCP will contain all the necessary hardware and software functionality to perform flow calculations to the required fiscal standards.

5.5.7.4 Mono Ethylene Glycol regeneration

MEG is utilised offshore in the gas and condensate pipelines for hydrate suppression. MEG is also used in the gas plant for hydrate suppression and dehydration. The MEG regeneration facility will be sized to regenerate 10,000 kg/h of MEG. This equates to 1,000 bpd of production water and provides a significant margin over the predicted early years continuous production rate of 480 bpd of condensed water and allows for limited breakthrough of produced aquifer water.

Condensed hydrocarbons from the MEG regeneration process shall be returned to the process. Water produced from the MEG regeneration process shall be pumped to the ACG produced water disposal facility.

Two tanks each with seven days storage shall be provided, for lean and rich MEG to allow for shutdowns in the regeneration equipment. The tank capacity shall also include for spare inventory of chemical to allow time for re-supply of losses.

The lean MEG will be pumped offshore in a 4" pipeline. The design of this line allows for increased water production from the wells, which is expected later in field life. As the MEG pipeline to the offshore platform would be difficult to upgrade later when water production reaches predicted levels, the line is sized to have an ultimate capacity of 16,000 kg/h of MEG for the future predicted water breakthrough rates of 2,650 bpd, which are predicted to occur from year 10 onwards.

5.5.7.5 Heating system

Offshore there is no process heating. Electrical heaters will provide utility heating and will maximise waste heat recovery from the power generation engines used in the HVAC system. A proprietary hot oil system will be used to supply the heat loads of the process and MEG regeneration system. There will be one 30 MW fired heater and one 30 MW waste heat recovery unit (WHRU). The WHRU will comprise 22 MW waste heat recovery and 8 MW supplementary firing. It is estimated that supplementary firing will be required for approximately one hour every three days in order to melt wax following pigging operations.

It is unlikely that fresh supplies of hot oil will be readily available in the local vicinity. A spare inventory of hot oil shall be held on site. A tank shall be provided to receive hot oil from equipment being drained for maintenance with a make-up pump to return the oil to the system. The hot oil system will be designed as a 300# ANSI system to minimise the leakage potential.

To maximise heat recovery from the process system a hot water system shall be provided to compliment the hot oil system. The heat source for this system will be process streams from the condensate stabilisation column. Start-up of this system will be from the hot oil system.

5.5.7.6 Chemical injection

The chemicals currently identified as being required on the terminal are anti-foamer, emulsion breaker, methanol, gas phase corrosion inhibitor, water phase corrosion inhibitor and biocide. Tank or drum storage shall be provided for 30 days supply. Methanol shall be stored in a pressurised vessel to avoid breathing losses. Pumps in continuous injection service shall be spared.

5.5.7.7 Flare

All hydrocarbon vapours generated during, plant upsets and emergency blow-down shall be routed to the flare system for safe disposal by combustion. Separate high and low pressure (HP and LP respectively) flare systems will be necessary to handle the range of vapours to be disposed of.

A flare recovery system shall be installed on the HP and LP flare headers to recover the relatively small quantities of gas from depressurisation of equipment for maintenance, blanket gas, leaking relief and control valves. HP gas will be compressed into the HP fuel gas stream and LP gas will be compressed into the LP fuel gas line. The flare tip will be provided with automatic ignition and will burn any gases in excess of the flare recovery system capacity.

Although the flare will not normally be lit, there will be occasions when the flare will have to be used to burn excess gas, for example during a plant-shut-down. When this occurs, in the worst-case that would mean flaring of the entire plant inventory, approximately 8.3 MMscf. The flare rate would exponentially decay over a period of approximately 15 minutes.

5.5.7.8 Control and instrumentation

The gas terminal control system shall be the main centre for control of the terminal with additional capability to control the offshore platform if required. Also the control system provided by the midstream project for the pipeline shall be provided ideally using the same system suppliers and located in the same terminal control room giving the same operator interface. Consideration shall be given to providing system architecture and 'feel' for the operators that is similar to the ACG FFD oil terminal and locating the two systems in a common central control room (CCR).

The gas inlet system is protected from overpressure by a High Integrity Pressure Protection System (HIPPS) that is installed upstream of the slug catcher.

In addition, there will be gas detectors located over the entire plant for the purpose of leak detection. These detectors will be linked to the fire and gas panel such that if leaks are detected they will initiate the fire protection system.

5.5.7.9 Utilities

Sewerage

As discussed above in Section 5.5.4.5, it proposed to cease discharge of effluent (from the EOP terminal) to Sangachal Bay and to develop a Waste-water Treatment Plan (WTP) that will be designed to produce effluent that meets World Bank discharge/irrigation standards. The new plant will service the main terminal buildings. The disposal route for treated effluent will be irrigation or disposal to a licensed facility.

The remote buildings on the terminal will be provided with a septic tank. Wastewater will be pumped out to road tanker for disposal in the wastewater treatment plant for the terminal. Pump out frequency will be approximately once every three months. In all cases sewage wastes will be treated to World Bank standards as a minimum for the operational phase.

Drains

The drains management philosophy for the terminal design is as follows:

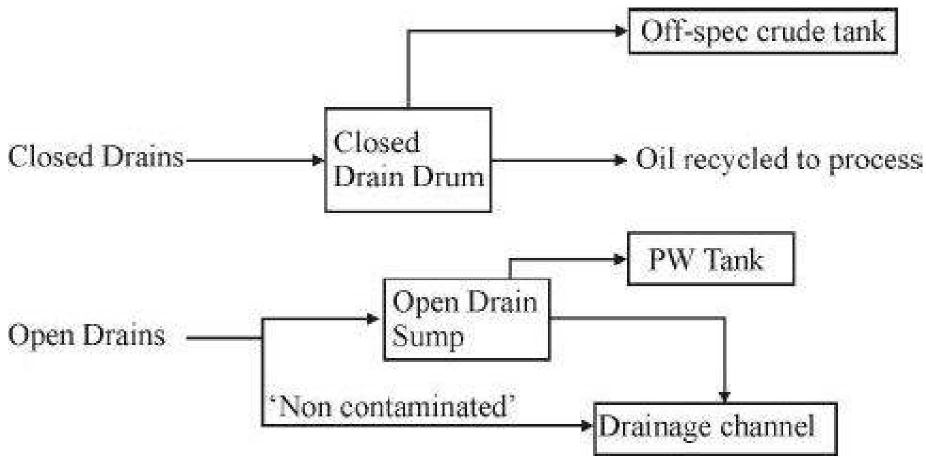
?? bunded areas containing significant amounts of water soluble chemicals will be manually isolated from contaminated drains system;
?? large spills of chemicals will be trapped in bunded area and removed for separate treatment and disposal;
?? small spills will be mopped up and residual chemicals flushed into contaminated drains system using copious amounts of water;
?? bunded areas under process equipment to be permanently open to contaminated drains in order to prevent accumulation of oil under equipment and potential pool fires; and

?? oil storage tank bunds to be manually isolated from both contaminated and non-contaminated drain systems.

Fire fighting systems will use water-soluble foam. During a fire the volume of water/foam that enters the contaminated drains system will exceed the first flush hold up volume. Therefore foam will enter the non-contaminated drains via the sump overflow. Foam also enters the non-contaminated drains due to the spray application of firewater. The contaminated drains philosophy during a fire is for the prevention of standing pools under process equipment in order to minimise potential for escalation.

The terminal drainage system is illustrated in Figure 5.47 and is further discussed below.

Figure 5.47 Terminal drainage system



Open drains

Contaminated water

The open drain system is designed to collect the maximum predicted precipitation for Sangachal over a fixed time period and has an allowance for fire monitor or fire hose use in the drains collection sump. There is no planned normal overflow to the Caspian from the open drain system. Any free oil or contaminants will be removed before the water is pumped to the produced water system.

Only in the very rare event of a major incident at the Sangachal terminal, where the use of very large volumes of firewater is required, is any overflow of drainage possible and therefore allowed to flow to the Caspian. This is a very rare event and is not part of the normal operations at the terminal

Regardless of the probability of such an event occurring, overflow from the drainage system would be taken from the bottom of the sump and will only occur after a period of time, during which most oil contamination will have floated to the surface for collection. This will remove the contamination from the water before discharge and reduce the risk of contamination of the Caspian should such an event occur.

The contaminated water sump will carry out oil/water separation with recovered oil pumped back to the process. Contaminated water will be pumped to the produced water system for disposal. Chemicals required for injection into contaminated water may include oxygen scavenger and scale inhibitor. An open drains system will be provided to collect and treat contaminated surface run-off from drip trays and paved areas around equipment containing hydrocarbon liquids. All equipment that contains some inventory of hydrocarbon will be located in a kerbed area, draining to the sump. The collected water shall be routed to a sump where it will be treated to remove the bulk of the oil/condensate. A second biological treatment step will remove all free oil and reduce the oxygen demand to a level where the water can be discharged to the local hydrological system.

Non-contaminated water

Storm water will drain to open ditches located on either side of the Shah Deniz site. In some cases these ditches will drain to the soil while in other cases the ditches will be concrete lined. The storm water will be discharged off site into natural watercourses running overland in the vicinity of the Sangachal terminal towards the Caspian Sea. The storm water will include any drainage from roads and non-process areas of the site.

Fire fighting water

Fire fighting systems will use a water-soluble foam. During a fire the volume of water/foam that enters the contaminated drains system will exceed the first flush hold up volume. Water/foam will therefore, enter the non-contaminated drains via the sump overflow. Water/foam will also enter the non-contaminated drains due to the spray application of firewater. The contaminated drains philosophy during a fire is for the prevention of standing pools under process equipment in order to minimise potential for escalation.

Closed drains

A closed drains system, draining to a collection drum will be provided to collect hydrocarbon liquids when draining equipment and piping for maintenance. The drum will be vented to the flare gas recovery system and the collected liquids shall be pumped back to the process for recovery.

Fuel gas

Sales gas will normally be used for fuel to ensure a dry, clean supply of gas. The fuel gas system shall comprise heating, pressure let-down, scrubbing and filtering. During start-up the fuel gas supply shall be taken from the slug catcher. Back-up fuel gas will be from EOP/ACG FFD. The system shall be designed to give specification in excess of that required by engine manufacturer.

Water supply

Municipal supply fresh water will be taken from the EOP terminal to supply minor consumers in the process plant and the terminal buildings. The water will be sterilised, by means of either exposure to a UV source of through use of a silver filter, to potable quality before supply to the buildings.

Stand-by diesel generation

Diesel is required for the emergency generator and will be supplied from the EOP terminal. Diesel clean-up will ensure quality and remove sulphur. This generator is for emergency use only and will not be used during routine operations on the site.

Plant air

A compressed air system is required to provide instrument and plant air. Two, 100% compressors and dryers shall be provided plus separate plant and instrument air receivers.

A continuous nitrogen generation unit shall be provided for:

?? purging of the flare tips downstream of the flare gas recovery system
?? purging of compressor seals; and
?? equipment inerting for maintenance.

Power generation

The entire Sangachal terminal is to be self-sufficient in power. Power generation will be by RB211 low-NO_X gas turbine. The generators will be gas fuelled. The frequency and voltage levels for the terminal must be compatible with the adjacent AIOC oil terminal (i.e. 50 Hz, high voltage 11 kV 3 phase; medium voltage 6.6 kV, 3 phase; low voltage 400 V, 3 phase and 230 V single phase).

Fire protection system

Appropriate passive and active fire protection shall be provided. Active fire protection shall comprise a firewater system, with foam to extinguish oil pool fires, particularly around the condensate storage tanks. The storage tanks will be floating roof design with rim seals to prevent loss of hydrocarbon through the roof.

Water spray systems, including appropriate use of deluge and monitors shall be considered in areas of particular risk including major hydrocarbon vessels and the storage tanks. In addition, appropriate areas will be fitted with CO_2 systems. No halon or any CFC fire suppression systems will be used.

Facilities shall be provided for the emergency blow-down of equipment and piping containing hydrocarbons at pressure. Emergency shutdown and F&G systems shall be provided.

5.5.7.10 Emissions and discharges

Atmospheric emissions

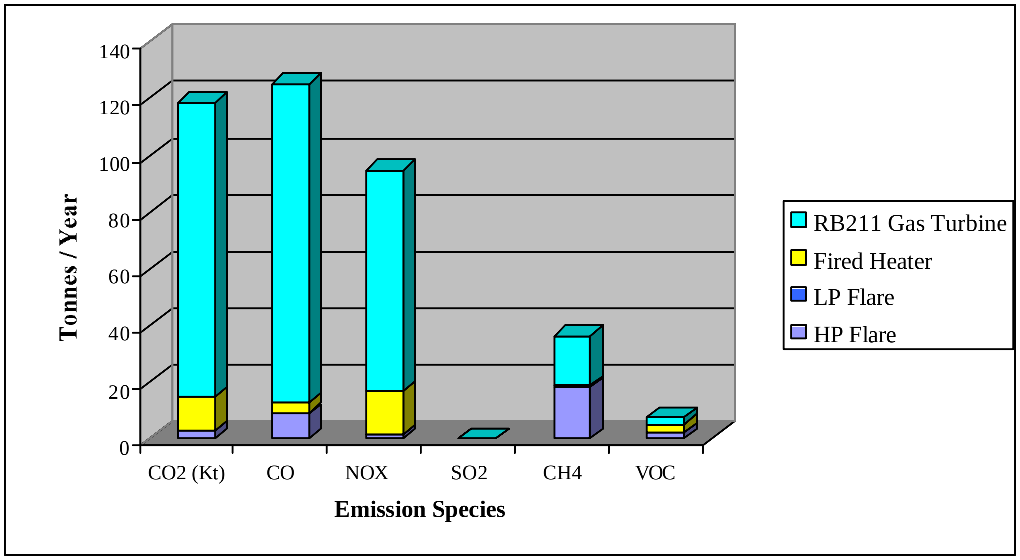
Emissions to the atmosphere resulting from operations at the terminal are anticipated to arise through:

?? fugitive emissions from crude oil storage;
?? heater treaters;
?? power generation (turbines); and
?? flaring.

These are discussed below.

The main emitters on the proposed terminal development will be the RB211 low NO_X gas turbine, the fired heater and the HP and LP flares. Other minor contributors to emissions would be the emergency diesel generator (tested for one hour per week) and firewater pump (tested for one hour per week). Annual emission estimates by source (excluding minor contributors) are presented in Figure 5.48. It should be noted that as the Shah Deniz Stage 1 development is targeting a gas production rate of 900 MMscfd the annual emissions from the terminal would remain constant.

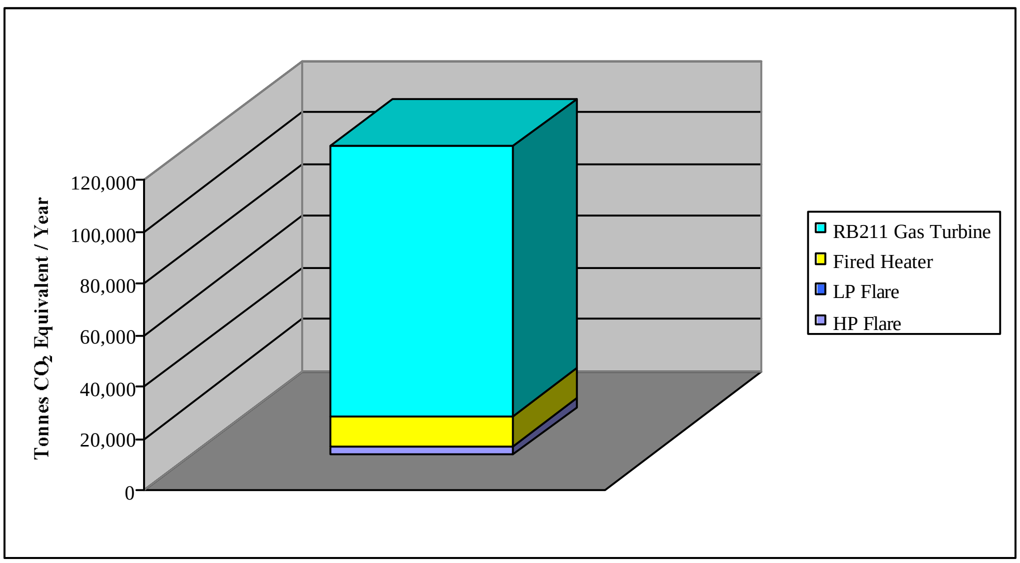
Figure 5.48 Estimated annual atmospheric emissions from terminal operations



Note: Units of CO_2 are kilotonnes.

Figure 5.49 illustrates the relative contributions of GHG from each emission source.

Figure 5.49 Estimated annual GHG from terminal operations



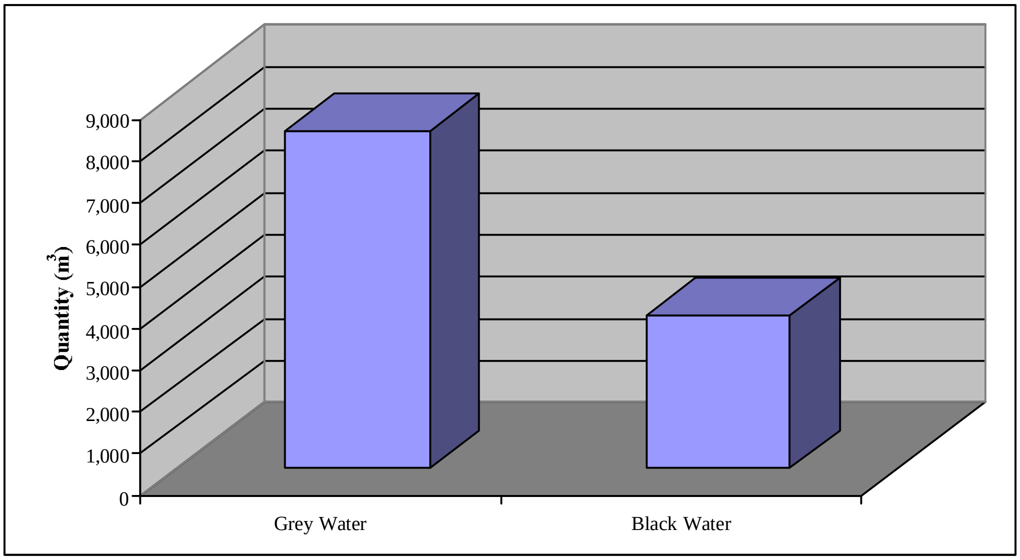
Aqueous discharges

Sanitary waste will be generated throughout the duration of terminal operations. The key assumptions for deriving the estimated annual amounts of sanitary waste generated are:

?? 100 workers on site throughout terminal operations (EOP, ACG and Shah Deniz);
?? each construction worker will generate 0.22 m^3/dy of grey water; and
?? each construction worker will generate 0.10 m^3/dy of black water.

Figure 5.50 present the predicted amounts of sanitary waste that will be discharged during construction operations.

Figure 5.50 Estimated annual amounts of sanitary waste discharged during terminal operation



Hazardous and non-hazardous wastes

While hazardous and non-hazardous wastes will be produced during terminal operations, the total quantities of these will not be significant especially in comparison to that produced during terminal construction and commissioning. All wastes will be segregated and stored for treatment and/or disposal and will be controlled by means of careful documentation, handling and transportation, as detailed in BP's Waste Management Procedure. Additional measures such as re-use and recycling will further reduce the level of waste.

5.5.8 Terminal decommissioning

As discussed in Section 5.3.8, Article 14.2(g) of the Shah Deniz PSA sets out the terms and conditions for decommissioning of the Shah Deniz Stage 1 project facilities including the establishment of an abandonment fund. In addition, Article 14.2(d) stipulates that should the Contractor elect to abandon a fixed asset prior to the termination of the PSA, then SOCAR may elect to continue using such fixed assets in which case SOCAR will be responsible for their abandonment.

Following decommissioning of the process on the Sangachal terminal, it is proposed that the terminal will be dismantled and the land returned to its former use. This will initially require that the process equipment is first decommissioned and then cleaned and inerted, prior to dismantling. It is likely that most or all of the equipment dismantling and further deconstruction of the equipment will take place within the confines of the terminal. Largely this means that should a spillage occur during the dismantling process can be contained within the site drains. Deconstructing the equipment components would follow the same process as that described for the onshore dismantling of offshore components, as described in Section 5.3. It should be noted however, that extensive dismantling and deconstruction will only take place on site when the entire terminal has ceased to function. If there is a requirement to decommission parts of the plant while leaving other parts live, then the decommissioned components will have to be transported off-site for further breakdown due to the safety risks associated with the use of cutting techniques used for steel component deconstruction in the vicinity of live gas and oil process plant.

Ultimately, once the process equipment has been decommissioned, deconstructed and removed off-site, the facilities and civil engineering features of the site will have to be removed as the restoration process continues. Thus, utilities such as power generation and sewage treatment will cease to be functional and the equipment associated with these activities removed. Finally, the concrete base that the process equipment is built on will have to be broken up and removed. This will primarily be performed by means of mechanical earth moving equipment, pneumatic drill and, in certain instances may require the use of explosives to further break-up the concreted components.

The drains will have to be removed wherever possible and the substrate back-filled, although many drains and will, in all probability, be left *in situ*. The large flood protection drainage channel around the terminal should be backfilled and the security dyke levelled. During most of this decommissioning and deconstruction process, the security fences will be left in place and these will not be removed until the final use of the land has been decided upon and until the majority of restoration work have been completed, in order to keep animals out of the area as well as keeping people out.

The steel components may be transferred to a foundry and the smaller re-usable components such as pumps, motors and valves will be sold for re-use. High value metals will be salvaged for re-use. Aggregates generated in the base breakdown process either can be used for part of the back-fill or may be transported to other locations where it may be used for construction purposes.

It should be noted, however, that the site may have a far higher re-use value if some of the facilities are left in an operational condition and therefore, all re-use options will be considered when current terminal use reaches its operational end-point.

5.6 Transportation and logistics

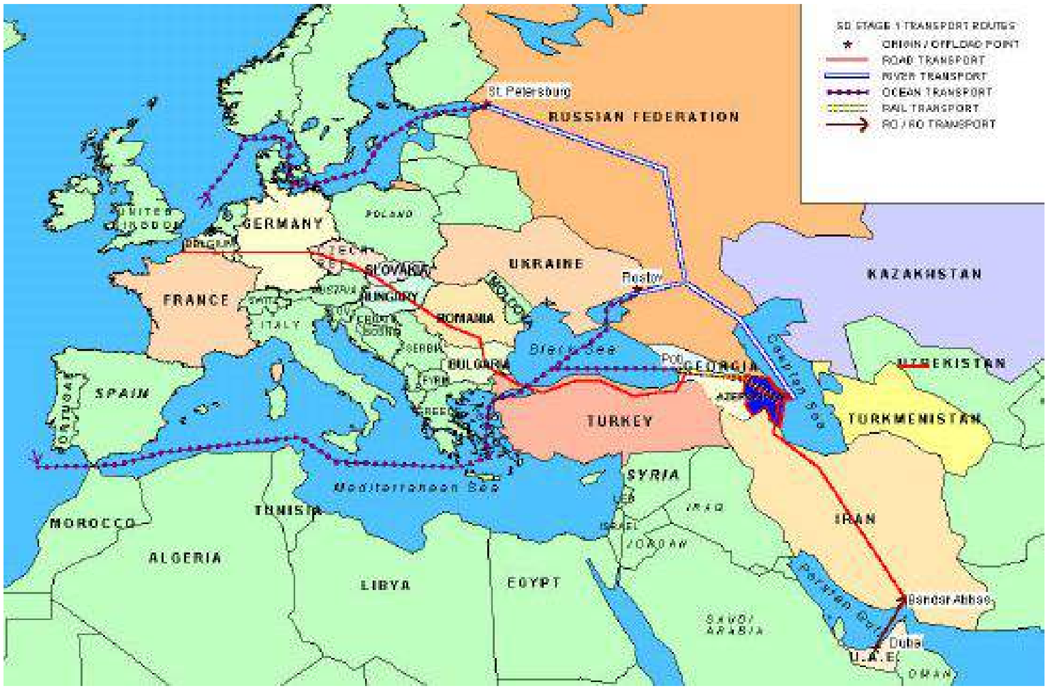
5.6.1 Introduction

As mentioned in previous sections, many of the project components and material for the Shah Deniz project will be fabricated or obtained outside of Azerbaijan and will be transported into the country. The following sections detail the proposed routes and transportation methods that will be utilised.

Although Azerbaijan is virtually landlocked, there are various possible transportation options available to bring modules, equipment and other supplies into the country. Transportation and logistics studies are ongoing and will further refine transportation options and routes.

The main transport routes are limited by origin of the goods, size, seasonal and flag restrictions, the optimisation of which will determine the final route. An overview of current options is presented in Figure 5.51.

Figure 5.51 Transportation route options for Shah Deniz Stage 1



BP has endeavoured to promote transport synergies (integrated logistics) with its other concurrent Caspian projects (such as ACG Phase 1 and 2, Azerbaijan-Georgia-Turkey, BTC) wherever schedules allow. The ACG Phase 1 and Shah Deniz projects share one logistics manager and the AGT projects also share one manager. This will enable the co-ordinated transportation of similar items to minimise the overall load on the transport routes in Azerbaijan.

This section summarises the options for transport into the region and presents the current preferred transport options for each of the major project components:

?? offshore development;
?? sub-sea pipelines; and
?? onshore components.

At the time of writing, many of the project transportation options are under evaluation. As a result, the transportation information set out below is preliminary and further logistics will be defined as the project develops.

5.6.2 Transport options

For purposes of most international procurement programmes, transport via sea freight is normally the preferred method of transit, which then involves the discharge of cargo at various ports for onward transit by road, rail or river.

Excluding sea freight in the Caspian, transportation by ocean going vessel is not covered within this document.

5.6.2.1 Road

There are a small number of viable routes for road transport into Azerbaijan. The preferred overland options are from Europe through Turkey and Georgia and from the United Arab Emirates (UAE) via Roll-on/Roll-off (RO/RO) ferry where appropriate. Other routes exist into Azerbaijan via Kazakhstan and Daghestan but border controls at these routes are operationally difficult.

Cargo originating in Europe can reliably be transported overland via the Turkish route with typical transit times in the range of 14 days. Weather and border crossing delays can however, cause transit times to reach 21 days. There are limitations on this route in Georgia during the winter months, especially through the mountainous sections of the road.

Cargo originating in the UAE can be transported via international trailer by RO/RO ferries crossing the Persian Gulf. Upon entry into Bandar Abbas port, the road trailers then proceed through Iran, which has a well-developed and maintained road network. In Azerbaijan, the road condition deteriorates but the route continues to serve as the major throughway from Iran. Normal trailer load transit time is 12 days with oversized loads taking up to 40 days.

It is considered by the joint project logistic groups that more road hauliers will have to be encouraged to service Baku or the existing hauliers encouraged to increase their fleet sizes. The number of vehicles and drivers currently available are not however, a limitation and once traffic levels are publicised, the required level of resource are expected to materialise. The downturn of some other projects in the Caspian region will also assist by reducing the demand on road hauliers and thereby freeing-up resources for the Shah Deniz and other BP projects.

5.6.2.2 Rail

The most viable option for rail transport into Azerbaijan is via the Black Sea port of Poti in the Republic of Georgia. Other rail routes into the country are subject to political disturbances. The rail system provides a direct route which enables Black Sea vessels to discharge cargo directly onto rail facilities for onward transit into Azerbaijan. This route is suitable for medium sized to smaller loads.

Transit times through Georgia are dependent on local infrastructure including electricity supply and border delays, however it is typically in the range of four to eight days from Poti to Baku.

There is also a railway line through Russia to Azerbaijan. Cargo transported along this route may be collected for transportation at the port of Riga.

5.6.2.3 River

The only means for water transport into Azerbaijan is via the Russian Federation's inland river systems; the Baltic-Volga river system or the Don-Volga system. Both of these systems flow into the Caspian at the Russian port of Astrakhan.

The Baltic-Volga system requires off-loading from ocean going vessels in the Baltic to river ships because of vessel draft restrictions, typically at St. Petersburg. The system is currently restricted to Russian Federation or CIS flag vessels. Foreign-flagged vessels would require a Russian tug or a charter agreement with a Russian operator to use the route. Vessels are subject to clean ballast requirements when leaving the system such that ballast water quality must be similar to that flowing into the Caspian from the Volga. Vessels can then continue onward to Azerbaijan once in the Caspian, using the recognised Astrakhan-Baku transit route.

Russian river ships are able to make the entire trip without any off-loading required. There are however, operational restrictions for these river ships in European and Mediterranean waters.

Transit time through the Baltic-Volga system is typically 11 to 13 days, with an additional two days required for transit to the Baku area. Once the vessel is unloaded, another two-day trip back to the river system is required, resulting in a round trip of approximately 30 days.

The other river option is the Don-Volga canal system. The system comprises the Don River, Tsimljanskiy Reservoir, Volga-Don Channel, Volga River, connecting the Black Sea, via the Sea of Azov, to the Caspian Sea port of Astrakhan in Russia. The system contains a series of 13 locks. Like the Baltic-Volga system, the Don-Volga also requires a Russian or CIS flagged vessel. Transit time is usually between seven and nine days.

Both the Baltic-Volga river system and the Don-Volga canal system are closed between November and April/May because much of the system freezes. In addition, vessels may be delayed or prohibited passage in August due to sturgeon runs in these rivers.

It is considered that there are enough river ships available to meet the Shah Deniz and other projects' needs. It is believed however, that a close focus must be kept on any projects' traffic not under BP control (e.g. construction equipment) and other projects in the region that may want to significantly use this resource.

5.6.2.4 Air

Scheduled airfreight flights operate several days a week from European airports and the UAE. These services are all passenger-carrying services and are suitable for only small to medium loads.

Larger and outsize loads would require charter of aircraft that can be undertaken at most airports throughout the world. The larger aircraft carrying heavy loads are however, restricted to using airports with long runways. The runway at Baku is only 2,707 m that limits the selection of aircraft and cargo to smaller and lighter loads.

5.6.3 Project transport options

As part of the project procurement strategy, preliminary analysis of transport requirements for Shah Deniz has been undertaken and a number of options selected. It is possible however, that as the project schedule and other requirements are further defined that variations in this plan may occur.

The sections below outline the options for each task of the development; that is, offshore components, pipelines, terminal and other. As discussed, project options may be refined as the project schedule and requirements are further defined.

5.6.3.1 Offshore development components

The various sections of the TPG500 platform to be prefabricated in international yards will require transport to an assembly/construction yard in Azerbaijan. The prefabricated structures include four strips to be used to form the deck structure, partially fabricated leg sections and parts of the drilling template.

The preferred option for transportation of the jacket components is by rivership on the inland river system to the Caspian, via either the Baltic-Volga or the Don-Volga system. Transport of the TPG500 components is intended to commence in March 2003 with the final delivery around September 2004. Seasonal restrictions on the river system will mean that no transportation of these larger components will occur in the winter months when the rivers and north Caspian are frozen.

In addition to the larger components requiring delivery, it will also be necessary to transport equipment and supplies such as piping and other bulk material. It is anticipated that these items will be transported via international trailer between March 2003 and May 2004. although the origin of the shipment was not known at the time of writing.

5.6.3.2 Pipelines

As the grade of marine steel required for subsea pipelines is not available in Azerbaijan, the pipe sections, wye pieces and associated protection structures and check valves will be fabricated outside and transported into the country.

It has not yet been determined whether the pipe sections will be concrete coated prior to transportation but this will influence the type of transport and number of shipments as size is a limiting factor. International trailers cannot be used for this movement and it is planned that the pipe sections will therefore, be transported via rivership from July 2003 until the river system closes for the winter after which time transport will commence by rail from Poti. It is anticipated transport via rail will continue through January 2004.

Road movement of pipeline section is only envisaged for the transport of the pipe sections from the onshore storage yard to the onshore installation sites. In addition, the transportation of all valves and manifolds to lay-down yards will be via the road system.

5.6.3.3 Onshore terminal

Much of the fabrication and construction for the Shah Deniz terminal will be undertaken in the Baku area of Azerbaijan. Most equipment and material may however, require import such as steel equipment modules, pipe and piping.

Steel and steel components will be procured from abroad and will be transported to Baku via rail and rivership. It is anticipated that transport will commence by rail in March and April 2003. With the reopening of the Don-Volga in May, transport will then begin through this system until July 2003.

Piping, bulks and other equipment will be transported to Azerbaijan via international trailer between August 2003 and March 2004. It is also possible that rivership will be utilised for shipment of abnormal bulk items.

Transfer of the equipment and facilities from the lay-down area to the terminal construction site will be by road. Transfer to the site may initially be by means of a series of large convoys. Other traffic use on the road will not be prohibited during these periods of equipment transfer and transport management plans will be developed for the construction programme.

5.6.3.4 Other equipment and materials

It is envisaged that other smaller equipment and supplies will be transported into Azerbaijan via international trailer from Europe or the UAE. As it not yet known where these items will be procured, a route can be finalised at this time. It is thought that trailers will be commissioned mid-2003 through to mid-2004.

5.6.4 Contracting strategy

The ACG project created a philosophy of a two-tier logistics contracting strategy comprising of a principal freight forwarding contractor plus additional contractors under frame agreements to tender for major shipments as the project's and therefore, specific shipment scope, develops. This strategy and the ACG selected contractors have been adopted by the Shah Deniz project.

5.6.5 Logistics costs economics

Baku is an expensive destination in terms of logistics. The combination of a semi land-locked location and the requirement to transit and utilise the resources of many countries all add to the complexity and therefore cost of delivering cargo into the country. The EOP[5] spent 30% of procured value on logistics.

The Shah Deniz and ACG projects have budgeted approximately 18% of procured value for logistics and are looking to reduce costs against this figure. It is hoped that this will be achieves through:

?? a logistics contracting strategy;
?? effective cross project consolidation (e.g. every extra tonne of freight loaded on an international trailer from Europe to Baku saves up to US$800);
?? use of cost effective shipping routes (e.g. 150 trailer loads shipped, as an alternative, by river ship would save in the region of US$1M); and
?? avoiding clashes for the same resources; BP's integrated logistics strategy is aimed at avoiding separate projects or even individual projects competing for the same scarce resources that may lead to increasing market rates.

5.6.6 HSE issues

All four appointed logistics contractors have HSE plans that have been reviewed and accepted. It is considered that these plans are most effective in controlled areas, for example, storage locations and ports but are much more difficult to check, measure and review for effectiveness for remote operations; that is, for trucks or rail cars on route, river ships in the canals and so on. An initiative has been commenced to review the HSE strategy in these instances and to agree an enhanced approach to the subject.

5.7 Waste management

The Shah Deniz Stage 1 development will generate a number of waste streams during assembly/construction, pre-commissioning, installation, commissioning, operation and decommissioning activities. Figure 5.52 illustrates these waste types and their source project activity.

[5] EOP = Early Oil Project.

Figure 5.52 Shah Deniz Stage 1 waste types

Shah Deniz Stage 1 Development

MODU (Istiglal) Drilling	TPG500 Assembly	TPG500 Drilling and Operations	Pipeline Installation and Operation	Terminal Construction	Terminal Operations
Emissions from power generation Flare emissions Drilled cuttings Drilling mud Cement waste Completion fluid Contingency chemicals Oils/lubricants Cooling water Clean drainage Oily drainage Sanitary waste Hazardous wastes Non-hazardous wastes	Emissions from power generation Hydrotest water Oils/lubricants Bilge water Clean drainage Oily drainage Chemical waste Sanitary waste Hazardous wastes Non-hazardous wastes Scrap metal	Emissions from power generation Flare emissions Vented emissions Drilled cuttings Drilling mud Cement waste Completion fluid Contingency chemicals Cooling water Clean drainage Oily drainage Produced water Sanitary waste Hazardous wastes Non-hazardous wastes	Emissions from power generation Hydrotest water Bilge water Clean drainage Oily drainage Chemical waste Oils/lubricants Pigging sludge Sanitary waste Hazardous wastes Non-hazardous wastes Scrap metal	Emissions from power generation Hydrotest water Oily waste Clean drainage Oily drainage Chemical waste Oils/lubricants Sanitary waste Hazardous wastes Non-hazardous wastes Scrap metal	Emissions from power generation Flare emissions Clean drainage Oily drainage Oils/lubricants Chemical waste Sanitary waste Hazardous wastes Non-hazardous wastes

Table 5.20 presents the optional disposal methods for the major waste streams including:

?? WBM and SOBM drilled cuttings;
?? hydrotest water;
?? produced water;
?? un-contaminated drainage waters;
?? contaminated drainage waters; and
?? sanitary wastes.

Table 5.20 Summary of major waste stream disposal routes

Waste Stream	MODU Drilling (Istiglal)	Platform Well Drilling (TPG500)	Construction of TPG500	TPG500 Operations	Pipelines	Terminal Construction	Terminal Operations
WBM drilled cuttings	Discharge to seabed	Discharge to seabed	N/A	N/A	N/A	N/A	N/A
SOBM drilled cuttings	Ship-to-shore for treatment and disposal (i.e. bio-remediation, re-use in the Garadag Cement Plant or landfill).	Ship-to-shore for treatment and disposal (i.e. bio-remediation, re-use in the Garadag Cement Plant or landfill).	N/A	N/A	N/A	N/A	N/A
Produced Water	N/A	N/A	N/A	Sent to terminal with the condensate for separation and treatment.	N/A	N/A	Injection in dedicated onshore disposal wells. Garadag Cement Plant.
Hydrotest water	N/A	N/A	Injection in dedicated onshore disposal wells. Garadag Cement Plant.	N/A	Injection in dedicated onshore disposal wells. Garadag Cement Plant. Offshore disposal (discharge to sea).	Injection in dedicated onshore disposal wells. Garadag Cement Plant.	N/A
Un-contaminated drainage waters	Discharge to sea	Discharge to sea	Discharge to sea	Discharge to sea	N/A	Discharge via soak away	Discharge via soak away
Contaminated drainage waters	Treatment then discharge to sea	Treatment then discharge to sea	Treatment then discharge via soak-away	Treatment then discharge to sea	N/A	Treatment then discharge via soak away	Treatment then discharge via soak away
Sanitary waste	Treatment then discharge to sea	Treatment then discharge to sea	Treatment and transfer to municipal system	Treatment then discharge to sea	N/A	Water treatment plant to retention pond then irrigation	Water treatment plant to retention pond then irrigation

5.7.1 BP waste management strategy

As noted in Table 5.21, there are a number of disposal options being utilised by the Shah Deniz Stage 1 project. All wastes will be controlled by means of careful documentation, handling and transportation and a detailed Waste Management System will be developed.

Wastes can be classified into five main waste streams as follows:

?? non-hazardous (domestic wastes) such as paper, cardboard and packaging;
?? non-hazardous non-combustible solid waste such as scrap metal and electric cables;
?? solid hazardous wastes such as oily sands, oily rags, thread protectors, medical wastes, batteries, paint cans, tyres and fluorescent tubes;
?? liquid hazardous wastes such as liquid oily wastes, pigging wax, glycols, acids and alkalis; and
?? SOBM drilled cuttings.

The BP Waste Management Strategy addresses all of the waste issues associated with the Shah Deniz Stage 1 development. The principles underlying the guidelines for waste management are as follows:

1. All waste management sub-contractors should be reputable, with expertise in the management of domestic, construction and hazardous wastes.
2. Waste management sub-contractors should take control of responsibility for wastes as close to the point of generation as possible. Where wastes are generated offshore the waste contractor should take possession of the waste at the port.
3. A fully documented custody chain for all wastes is required from generation to final disposal.
4. The main contractor and waste management sub-contractors must demonstrate a commitment to waste minimisation and provide details of minimisation programmes.
5. The main contractor and his waste sub-contractor must demonstrate a commitment to recycling and provide details of recycling plans.
6. Land filling leaves a permanent legacy and only that waste for which no other economic disposal route can be identified should go to landfill.
7. The transportation of waste should be minimised.
8. No discharges can be made to surface water or groundwater, including rivers, streams (including seasonally dry watercourses), or to the Caspian Sea, unless a discharge consent has been issued by the appropriate regulatory authority.

The overall waste strategy for the project adopts the following hierarchy:

?? prevention;
?? reduction;
?? re-use;
?? recover;
?? recycle;
?? remove; and finally
?? disposal.

A number of alternative strategies are under evaluation for the treatment and/or disposal of wastes from the development. A draft Integrated Waste Management Strategy has been developed for BP Caspian Sea (BPCS). The report comprehensively appraises the waste streams generated by existing BPCS operations in the Caspian region and identifies the waste streams that are anticipated to be generated by the Shah Deniz Stage 1 development and subsequent stages of the proposed Shah Deniz FFD programme.

The draft WMS report recommends the development of some or all of the following facilities to ensure sound environmental management of the various predicted wastes streams:

?? a waste transfer station located close to the port area for the receiving, handling and recycling of offshore generated wastes that includes the following facilities:
  - a quarantine area for incorrectly documented and unidentified waste;
  - an oil water separation plant for bilge water and washing waters;
  - a segregation area for metals, batteries, fluorescent tubes, timber, plastics etc.;
  - a neutralising plant for acids and alkalis;
  - steam cleaners for thread protectors, empty drums and oily containers;
  - solid phase incinerators for domestic and hazardous solid wastes;
  - a liquid phase incinerator for waxes and hazardous liquids;

?? a facility at Serenja to be developed with the following capability:
  - thermal desorption plant for the treatment of drill cuttings; and
  - bioremediation facilities for the treatment of drill cuttings.

?? a landfill to be developed either at Serenja or at an alternative site for the disposal of hazardous and non-hazardous incinerator residues plus hazardous wastes that cannot be incinerated.

5.7.1.1 Non-hazardous (domestic waste)

The potential disposal route for non-hazardous (domestic) wastes is for incineration in a solid phase incinerator under consideration followed by landfill of the incinerator ashes. The alternative is to construct a specific domestic waste landfill and for the disposal of non-incinerated domestic waste.

5.7.1.2 Non-hazardous non-combustible solid waste

It is recommended that these wastes are recycled. The insulation from electric cables can be stripped from the metal and both the metal and plastic recycled. Scrap metal can similarly be recycled.

5.7.1.3 Solid hazardous waste

There are a number of recommended disposal routes for solid hazardous wastes dependant on the type of waste generated. The solid phase waste incinerator under consideration could incinerate oily rags, coveralls, absorbents, filters and medical wastes with the incinerator ash being sent to a designated hazardous landfill site. An alternative would be to incinerate these wastes in the Garadag Cement Plant kiln. Otherwise these wastes could be sent directly to a specific hazardous waste landfill facility.

Batteries and empty paint cans could be landfilled or recycled. Paint cans could also be incinerated and the metals recycled. The preferred disposal route for thread protectors would include steam cleaning, then segregation of the plastic and metal for recycling. Wastewater could be sent for disposal down-hole through a dedicated injection well with the produced water stream or sent to the Garadag Cement Plant for use in the cement production process. Tyres would be recycled wherever possible but could be sent to the Garadag Cement Plant kiln. Fluorescent tubes will be crushed using a tube crusher followed by transfer of the residues to landfill. Sewage sludge would be landfilled as would shot blasting grit. Oil contaminated sand and soil will be treated the same way as NWBM cuttings (see below).

5.7.1.4 Liquid hazardous wastes

As with solid hazardous wastes there are a number of options for the disposal of liquid hazardous wastes depending on type. A specific liquid waste incinerator is also under consideration and this would be used for the disposal of hazardous liquids such as glycols. An alternative to the liquid waste incinerator is to send these wastes to the Garadag Cement Plant kiln or containment and landfilling. Acids and alkali liquid wastes would be neutralised and filtered to remove the salts, with the water then transferred for disposal either with the produced waters or to Garadag Cement Plant. Liquid oily wastes would be recycled in the Sangachal terminal process.

5.7.1.5 SOBM drilled cuttings (hazardous)

A number of options are under consideration for the treatment of SOBM cuttings that are shipped-to-shore for disposal. These include

?? construction of a thermal desorption plant;
?? bioremediation using biopiles or land-farming at a designated facility;
?? transfer to the Garadag Cement Plant cement kiln; and
?? soil washing.

Oily sand and any contaminated soils removed from construction facilities will also be treated with the cuttings.

5.7.2 Waste quantity estimates

5.7.2.1 Solid and liquid waste "five-year look-head"

As part of the development of the waste management strategy and programme for the Shah Deniz Stage 1 development, a "five-year waste look-ahead" has been developed that provides the best possible estimate of the types and quantities of waste that will be generated during the following project activity suites:

?? in-country assembly, construction and commissioning;
?? drilling (MODU and TPG500);
?? offshore production (excluding drilling); and
?? onshore terminal build and early operation / pipeline build.

Tables 5.21 through 5.24 respectively present the estimates for these project activity suites.

Table 5.21 In-country assembly, construction and commissioning

Waste type	Unit	Annual quantity				
		<1	1-25	25-100	100-500	>500
Domestic / general waste	mt					?
Oil Rags, wood and packaging	mt					?
Oily soils and sands	mt		?			
Liquid oily wastes	m^3		?			
Medical wastes	m^3	?				
Hazardous liquid wastes	mt				?	
Acids and alkalis	mt		?			
Batteries	mt		?			
Paint cans and sludges	mt		?			
Tyres	number		?			
Fluorescent tubes	number		?			
Scrap electrical cables	mt		?			
Scrap metals	mt				?	

Table 5.22 Drilling (MODU and TPG500)

Waste type	Unit	Annual quantity				
		<1	1-25	25-100	100-500	>500
Domestic / general waste	mt				?	
Drill cuttings	mt					?
Pigging wax	mt			?		
Oily soils and sands	mt				?	
Oil based mud residues	mt			?		
Thread protectors	mt		?			
Scrap metals	mt			?		

Table 5.23 Offshore production (excluding drilling)

Waste type	Unit	Annual quantity				
		<1	1-25	25-100	100-500	>500
Domestic / general waste	mt				?	
Oil Rags, wood and packaging	mt			?		
Oily soils and sands	mt		?			
Liquid oily wastes	m^3		?			
Medical wastes	m^3	?				
Hazardous liquid wastes	mt		?			
Batteries	mt	?				
Paint cans and sludges	mt		?			
Fluorescent tubes	number	?				
Scrap electrical cables	mt		?			
Produced water	m^3					?
Scrap metals	mt			?		

Table 5.24 Onshore terminal build and early operation and pipeline build

Waste type	Unit	Annual quantity				
		<1	1-25	25-100	100-500	>500
Domestic / general waste	mt					?
Bilge waters	m^3					?
Tank washings	mt				?	
Thread protectors	mt			?		
Liquid oily wastes	m^3				?	
Medical wastes (sharps)	m^3		?			
Medical wastes	m^3			?		
Hazardous liquid wastes	mt					?
Acids and alkalis	mt	?				
Batteries	mt		?			
Paint cans and sludges	mt		?			
Tyres	number				?	
Fluorescent tubes	number					?
Scrap electrical cables	mt					?
Scrap metals	mt					?

6 Environment Description

6.1 Introduction

An important part of the environment description process is establishing an understanding of the features and processes that characterise the environment in which project activities are proposed to be implemented. This chapter reviews the information available for the offshore area in and near to the Shah Deniz Contract Area.

6.2 Offshore environment

6.2.1 Data sources and review

A summary of existing baseline information is provided in Table 6.1.

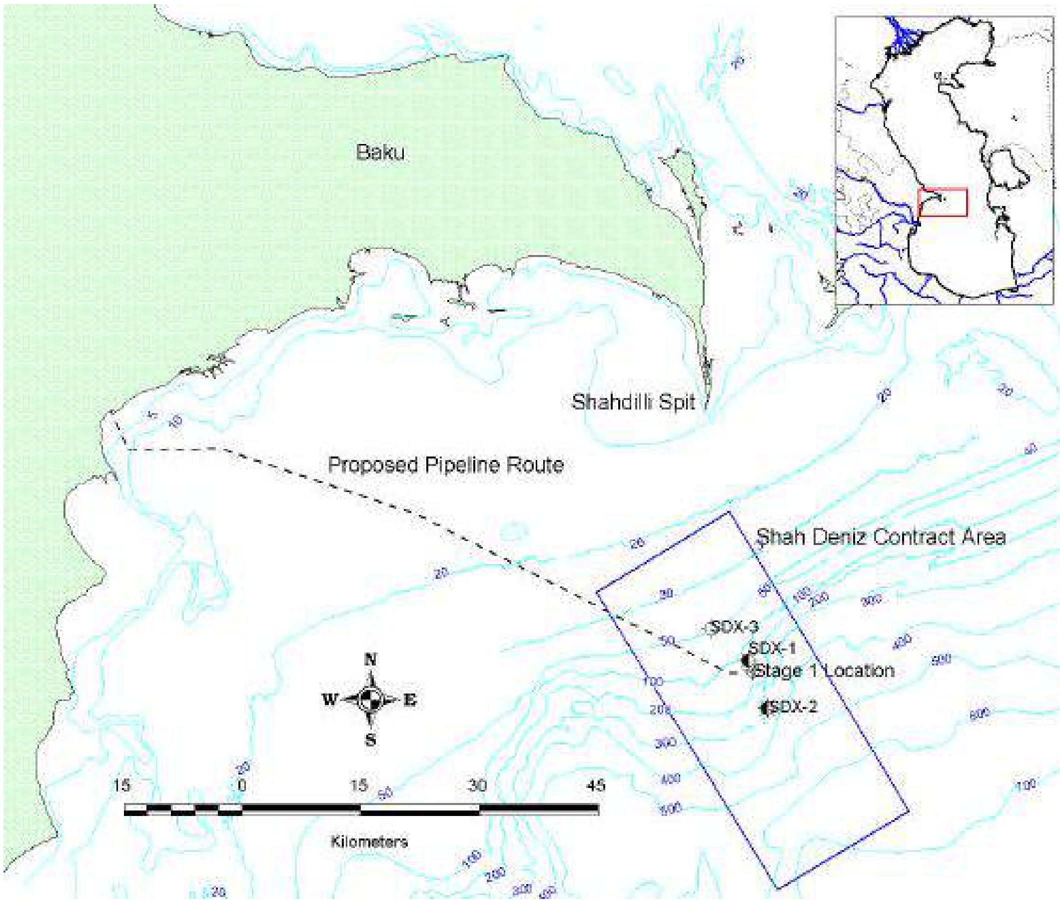
Table 6.1 Existing Shah Deniz Contract Area baseline information

Date	Title
1998	Environmental baseline study
1998	Environmental impact assessment
2000	SDX1 Post well survey
1998	The Shah Deniz exploration standards
2000	The Shah Deniz production standards
2000	Seasonal fish monitoring Sangachal Bay
2001	Seasonal fish monitoring Sangachal Bay
2001	Stage 1 Platform baseline Survey
2001	SDX3 Post Well Survey

6.2.2 Shah Deniz Contract Area location

The Shah Deniz Contract Area (the Contract Area) lies approximately 15 km south of the Shahdilli Spit, Apsheron Peninsula at its closest point. It is approximately 44 km in length and has a maximum width of 19.6 km. It occupies an area of approximately 858 km^2 (Figure 6.1).

Figure 6.1 Location of Shah Deniz Contract Area in relation to the Apsherson Peninsula and Shahdilli Spit



6.2.3 Offshore meteorology

6.2.3.1 Air temperature and humidity

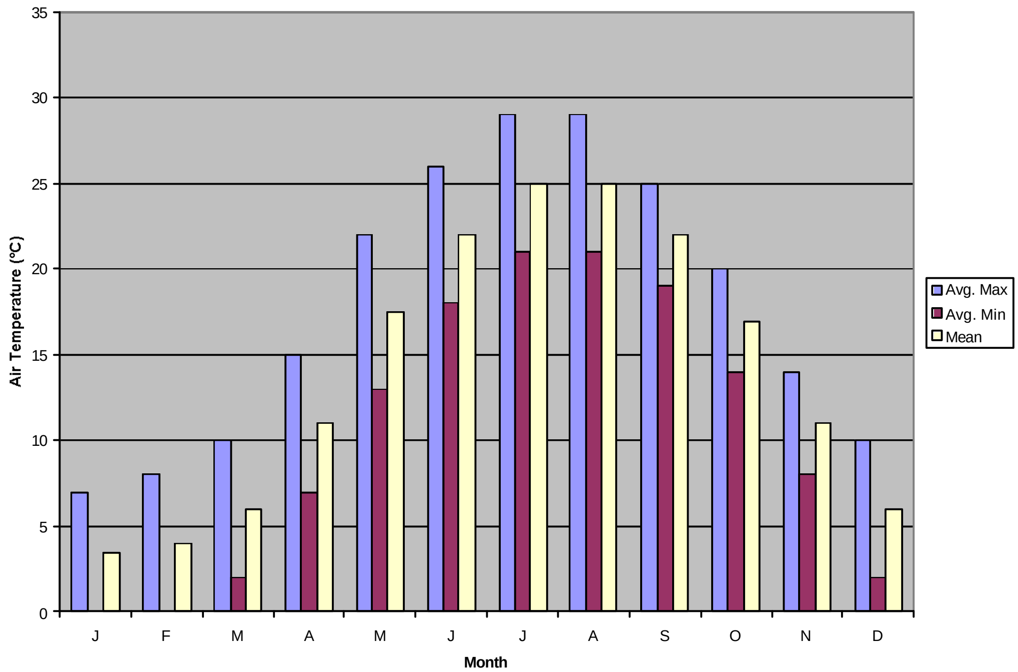
In summer air temperatures in the offshore area are similar to those of the rest of the Middle Caspian (approximately 25°C). In winter temperatures drop to 5-6°C, which is 7-8°C warmer than northern areas of the Caspian. In exceptional winter circumstances temperatures may drop to below freezing. Monthly mean temperatures are provided in Table 6.2 and Figure 6.2 below.

Table 6.2 Monthly mean air temperatures (°C) of offshore Apsheron Peninsula

Air Temp.	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Avg. Max	7	8	10	15	22	26	29	29	25	20	14	10
Avg. Min	0	0	2	7	13	18	21	21	19	14	8	2
Mean	3.5	4	6	11	17.5	22	25	25	22	17	11	6

Source: Woodward Clyde, 1995.

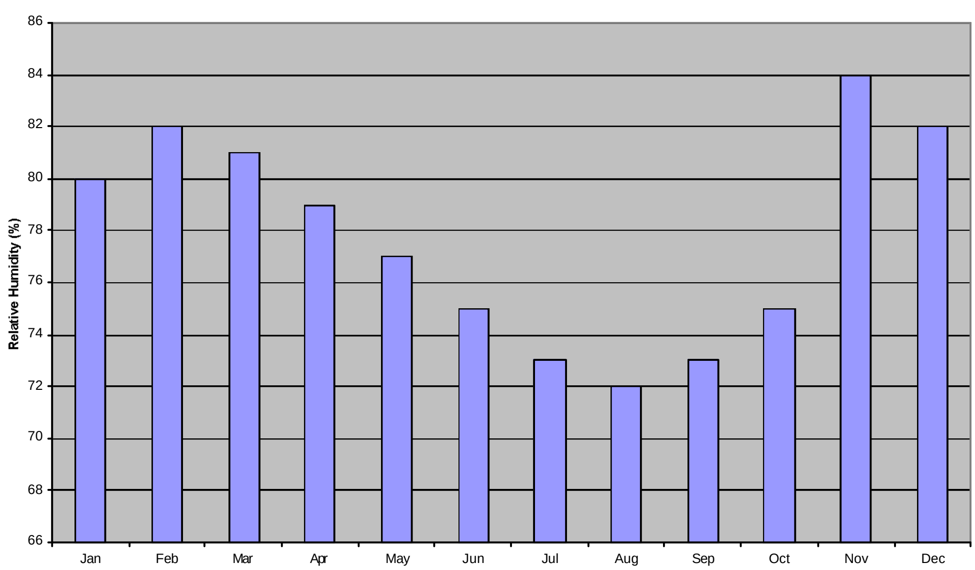
Figure 6.2 Monthly mean air temperatures (°C) of offshore Apsheron Peninsula



Source: Woodward Clyde, 1995.

Figure 6.3 shows the relative humidity for the area, which increases marginally in the winter months and is lower in the summer months.

Figure 6.3 Average re lative humidity in the Caspian



Source: Woodward Clyde, 1995.

6.2.3.2 Precipitation

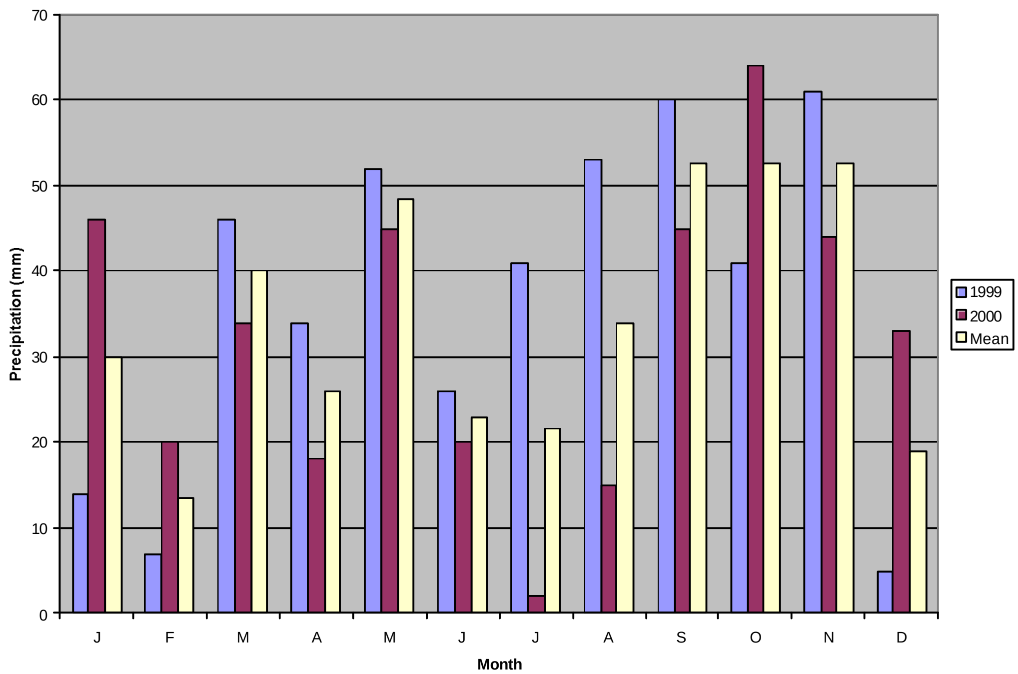
The Apsheron Peninsula experiences relatively dry summers and winters with rainfall increasing in the spring and autumn months. Figure 6.4 shows annual rainfall for the area for 1999 & 2000. It is expected that rainfall in the Shah Deniz Contract Area would be similar to the data listed in Table 6.3.

Table 6.3 Apsheron Peninsula 1999 and 2000 rainfall data (mm)

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
1999	14	7	46	34	52	26	41	53	60	41	61	5	440
2000	46	20	34	18	45	20	2	15	45	64	44	33	386
Mean	30	13.5	40	26	48.5	23	21.5	34	52.5	52.5	52.5	19	413

Source: FAO, 2001.

Figure 6.4 Apsheron Peninsula precipitation for 1999 and 2000 (mm)



Source: FAO, 2001.

6.2.3.3 Wind regime

The Apsheron Peninsula experiences high annual average wind speeds of 6.2 - 8.0 m/s. Storm winds are frequent with wind speeds in excess of 15 m/s being recorded on 60 to 80 days per year. In comparison, other areas of the Caspian experience storm winds only 20 to 30 days per year. Storm winds are most common in winter and mid-summer (Table 6.4).

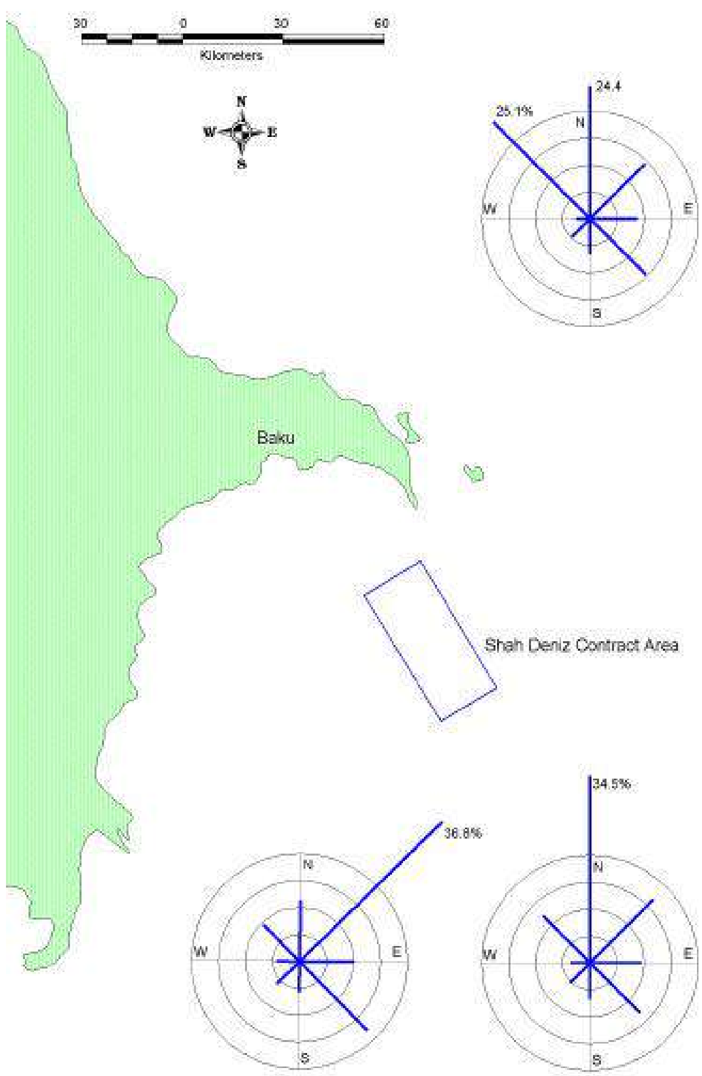
Table 6.4 Seasonal wind frequency of the Caspian Sea

Wind Direction	Seasonal Percentage Occurrence				
	Winter	**Spring**	**Summer**	**Autumn**	**Annual**
NW/NNW	16.6	19.4	24.8	16.9	19.5
N/NNE	10.4	10	16.9	11.2	12.2
NE/ENE	11.6	8.4	8	9.5	9.3
SE	18.7	24.8	19.3	22.7	21
SE	22.6	13.2	6.6	17.5	14.9
Cyclonic	6.8	4.3	1	3.4	3.9
Slight	13.3	19.9	24.4	18.8	19.2

Source: Koshinsky, 1975.

Figure 6.5 shows a summary of geostropic wind computed from isobars on weather maps from 1980-1989. The figure shows three wind vectors for three locations, representing the relative frequency and direction of the wind over this period.

Figure 6.5 Frequency and direction of winds around the Shah Deniz Contract Area



6.2.3.4 Fog and visibility

Moisture saturated air which can result in fog can be found within the Shah Deniz Contract Area during the winter months. There is approximately a 10% chance of these conditions occurring and a fog forming.

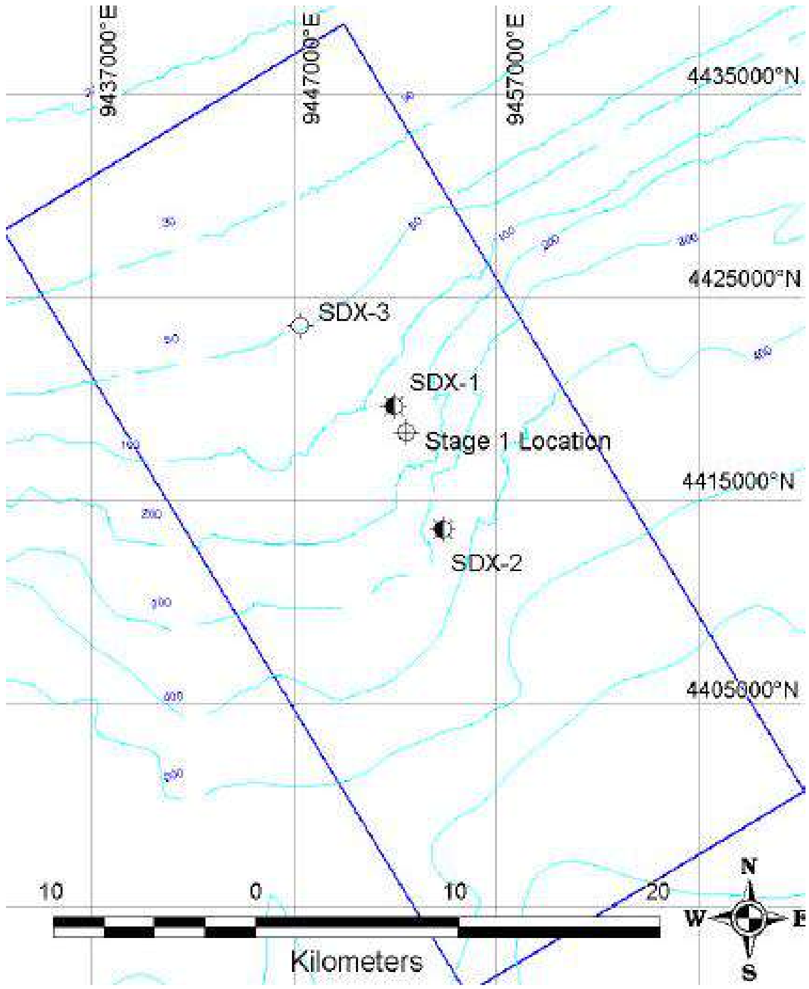
6.2.4 Offshore oceanography

6.2.4.1 Bathymetry and topography

The North Caspian Sea covers about 25 % of the Caspian Sea's total area, while the Middle and South are about equal in size at approximately 37 % each. The water depths and thus the water volumes contained in the three parts however, differ greatly. The whole Caspian Sea contains approximately 79,000 km^3 of water with the North, Middle and South, Caspian Sea areas containing 0.5 %, 33.9 % and 65.6 % of the total sea volume respectively. The corresponding mean water depths are 4 m, 181 m and 350 m..

Bathymetry in the Shah Deniz Contract Area has a general trend to slope to the southeast. There is a strong depth gradient in the Contract Area with water depths ranging from less than 40 m in the northeast of the Area to over 700 m in the southeast (Figure 6.6).

Figure 6.6 Bathymetry in the Shah Deniz Contract Area


9437000°E
9447000°E
9457000°E
4435000°N
4425000°N
4415000°N
4405000°N
SDX-3
SDX-1
Stage 1 Location
SDX-2
10
0
10
20
Kilometers
N
W
E
S

6.2.4.2 Currents and water circulation

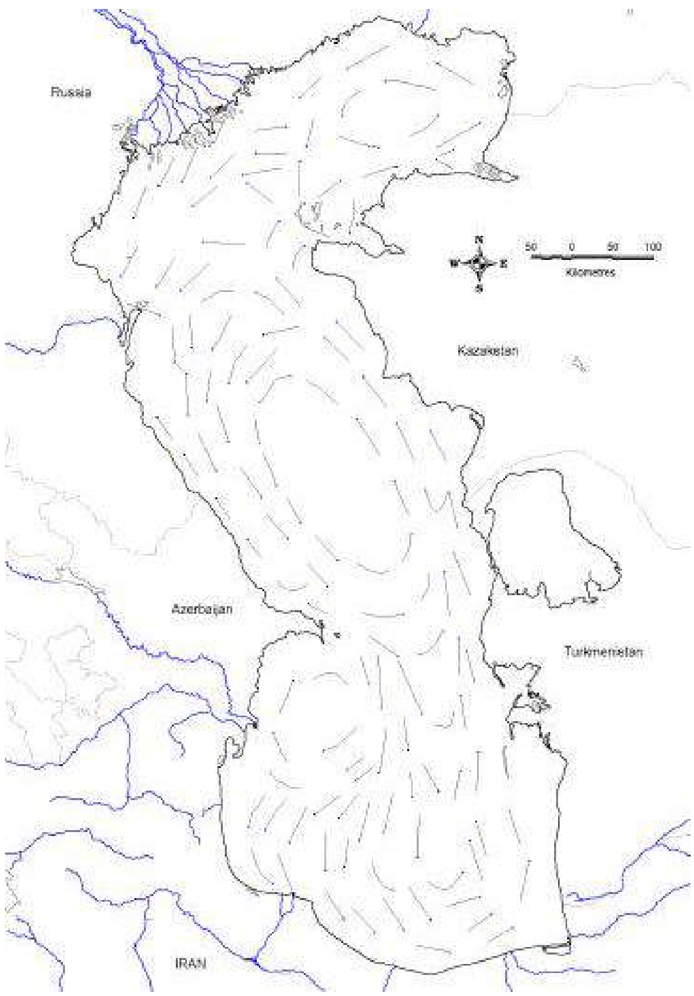
The Caspian is land-locked and consequently, tidal movements are much less significant than in oceanic areas. Currents in the Caspian are principally wind driven and tend to be small and transient. Nevertheless the benthic surface sediments distribution indicate that bottom currents are periodically strong enough to influence relief.

Despite quite rapid sediment accumulation rates, there are seabed areas where thin surface sediments and ridge structures are found. These are mainly along the shallow water shelf edges, some parts of the basin slopes and across the Apsheron Ridge.

Residual currents

The late spring river flows, particularly from the Volga, create a southwards flow of at depth down the west coast of the Middle Caspian. This may also drive counter currents up the east coast and set up a residual circulation in the South Caspian. Wind driven circulation is however, the principal feature in the Caspian. Figure 6.7 shows the pattern of residual currents in the Caspian Sea.

Figure 6.7 Residual current pattern in the Caspian Sea



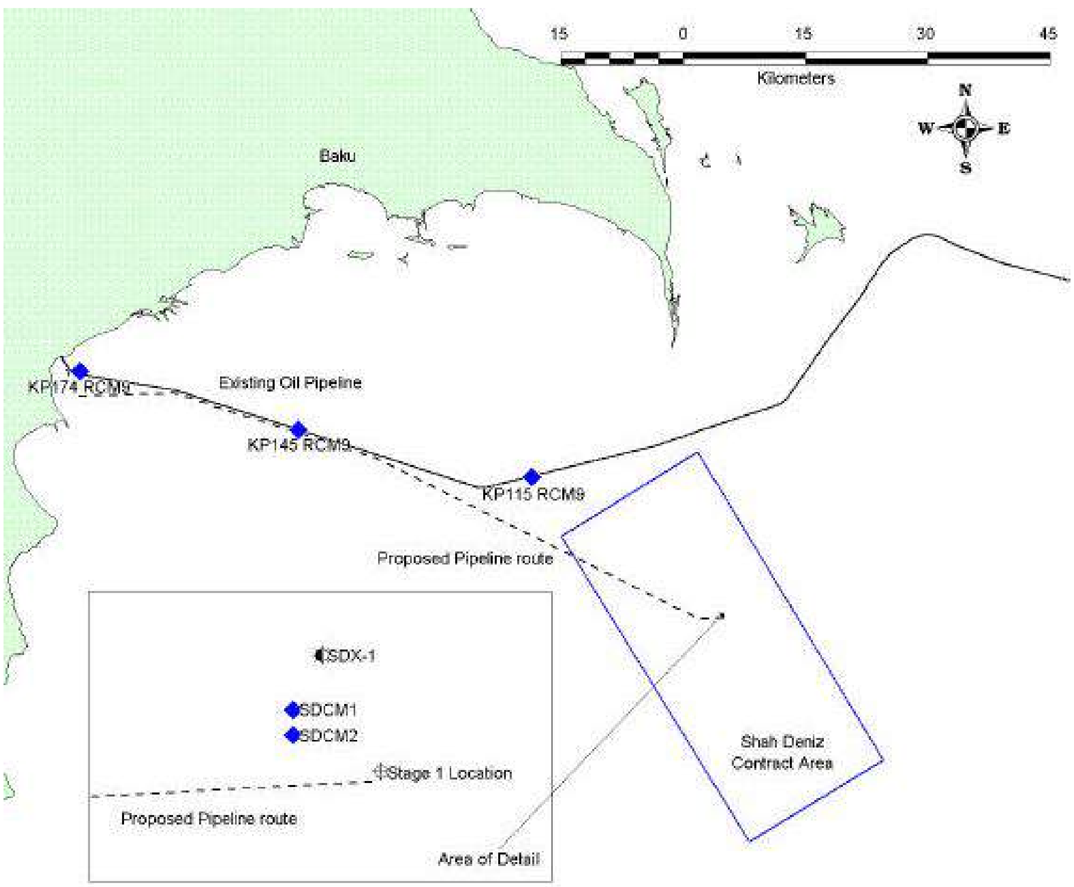
Source: Woodward Clyde, 1995.

Wind driven currents and subsurface currents

Usually, current patterns correspond to the main wind fields with the strongest and most stable currents occurring in the surface water layers and corresponding to the regional wind action that covers wide areas of the Caspian Sea. Thus, with northerly winds, a southern surface current generally prevails. Similarly with southeasterly winds, the resulting surface currents are usually in a northwest direction. These currents are greatly influenced by the configuration of coastlines and seabed relief.

Current measurement data has been collected in the Shah Deniz Contract Area along the proposed pipeline route and just to the north of the Contract Area. Figure 6.8 shows the locations of current meter deployment. Data was collected from KP174, KP115 and KP145 from October 1999 to May 2000.

Figure 6.8 Current meters deployed in vicinity of the Shah Deniz Contract Area



The average current speeds recorded by the two meters in the Shah Deniz Contract Area (SDCM1 and SDCM2) where less than 0.15 m/s. The two current meters measured the variation in current speed with depth. The strongest currents were observed in the upper layers. Three water masses where identified as follows:

- a near surface layer where the current speed decays comparatively rapidly with depth;
- a mid-water layer from 60 m to 90 m where the speed is relatively uniform; and

- a near bottom layer from 90 m to the bottom (130 m) where the speed again decays rapidly with depth.

Flow direction at all depths was polarised along a northeast to southwest axis and in general aligned with the bathymetry. Flow was predominantly towards the southwest which is when the strongest currents were observed with brief reversals towards the northeast evident at all depths. The mean flow rotated anti-clockwise with depth from southwest near the surface to south-southwest near the bottom.

The three current meters located outside the Contract Area only recorded current speed and direction at a single depth, near the seabed. Current speeds generally decreased from east to west and the average current speed at the nearshore monitoring sites was 0.08 m/s. Mean current direction was irregular at the three locations. At KP115, the dominant current direction was to the southwest consistent with the two meters deployed in the Shah Deniz Contract Area. The dominant current direction at the nearshore site (KP174) was to the south whilst at KP145 it was to the north.

6.2.4.3 Waves

The surface wave regime generally follows the prevailing wind patterns. The area of greatest wave development extends from the western portion of the Middle Caspian Sea Basin down and across the central section of the Apsheron Ridge. Maximum expected waves are around 10 m in height with a 10 second period. The directionality and seasonality in wave fields is shown in Tables 6.5 and 6.6. The data for wave heights and periods is from measurements taken at Bulla Island which is slightly south of Sangachal. Data on the seasonal variation of wave heights is from measurements taken at Oil Rocks (approximately 30 km to the north east).

Table 6.5 Directionality of waves at Bulla Island

Wave	Direction of Motion							
	N	NE	E	SE	S	SW	W	NW
Wave heights (m)	1.2	0.6	0.4	0.4	0.4	0.6	-	0.9
Wave periods (s)	2.8	2.1	1.5	2.3	1.4	1.7	1.0	1.5

Source: Israilov, A., 1977.

Table 6.6 Seasonality in wave heights at Oil Rocks

	Days/ Month												Days / Year
Wave height (m)	1	2	3	4	5	6	7	8	9	10	11	12	
0.1 - 1.0	1	5	11	14	18	14	10	11	9	8	7	5	119
1.1 - 2.0	16	16	10	10	8	10	9	10	11	14	13	16	143
2.1 - 3.0	5	4	5	3	3	4	6	5	6	6	6	6	59
3.1 - 4.0	2	2	3	2	1	2	5	3	2	1	3	2	28
4.1 - 5.0	2	1	1	1	0	0	1	2	1	0	1	1	11
5.1 - 6.0	0	0	1	0	1	0	0	0	1	1	0	1	5

Source: Tambovtseva, L. P., 1975.

The 100-year wave height data indicate a maximum wave height of 16.7 m. A 1996 storm modelling study carried out on behalf of AIOC confirmed this.

6.2.4.4 Sea temperature

During the winter, the surface water temperature in the Shah Deniz Contract Area is about 5 to 6 °C. Water temperature reaches its maximum during July and August when temperatures of 25 to 26 °C are common. Temperatures at depth in the South Caspian Sea remain at about 6 °C all year round. In extreme winters, a flow of dense cold water is believed to flow under warmer and less dense surface waters from the North Caspian Sea to the southern Caspian Sea.

During the summer months a stratified water column develops with a thermocline at water depths of between 20 and 60 m. The depth to the thermocline will increase during the summer months as surface water temperatures increase. As the autumn turbulence increases and sea surface temperatures decrease, the thermocline is driven deeper but is still observable into the winter. As the wind stresses continue during the winter and into the early spring, the thermocline breaks down. It builds up once more when calmer and warmer climatic conditions return in the late spring. Within the Caspian Sea, there may be considerable variability in the characteristics of the thermocline on an annual basis and from area to area.

6.2.4.5 Salinity

The average salinity of the Caspian Sea is approximately 12.9 ‰. The lowest salinity is found in the shallow North Caspian Sea but for offshore areas of the Middle and South Caspian Sea, seasonal and spatial differences in salinity are less than 1 ‰ ranging between 12.5 and 13.4‰. Near the river deltas on the western coast, salinities may reduce to 12 ‰ and in shallow bays on the eastern coast values can reach 14 ‰ due to increased evaporation.

6.2.4.6 Sea water chemistry

The Caspian Sea contains waters of oceanic origin which have been diluted and changed due to river outflows. This process has led to a lessening of the relative contents of chlorides in the general salt mass and a relative increase in carbonates, sulphates and calcium compounds (Blinov, 1962).

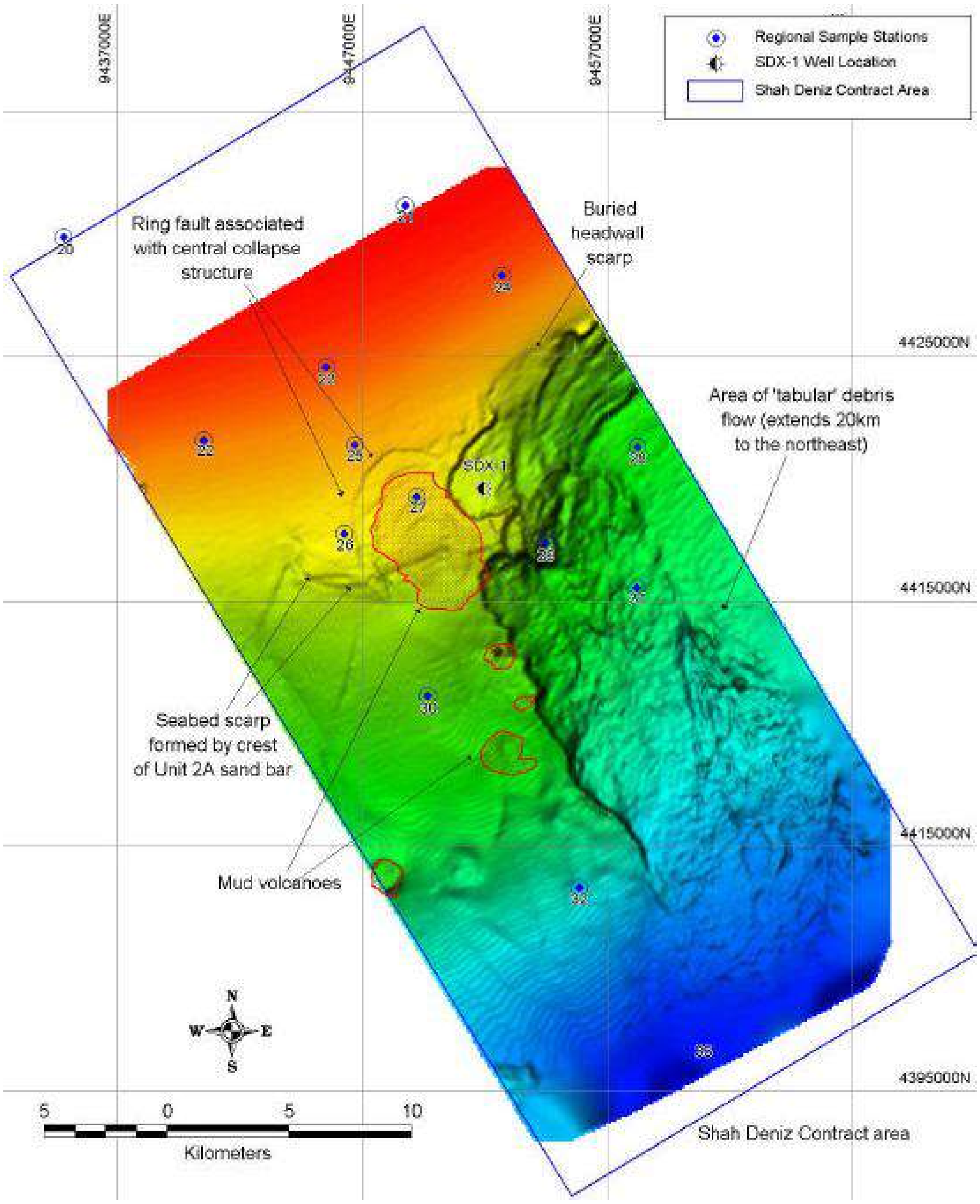
Offshore areas of the Caspian Sea, including the Contract Area, are characterised by high oxygenation of the surface waters in the winter months and saturation levels in the spring due to increased water mixing during the winter and phytoplankton activity in the spring. During summer months the water column becomes stratified and this results in a lowering of oxygen levels below the thermocline.

6.2.5 Offshore physical environment

6.2.5.1 Seabed geomorphology

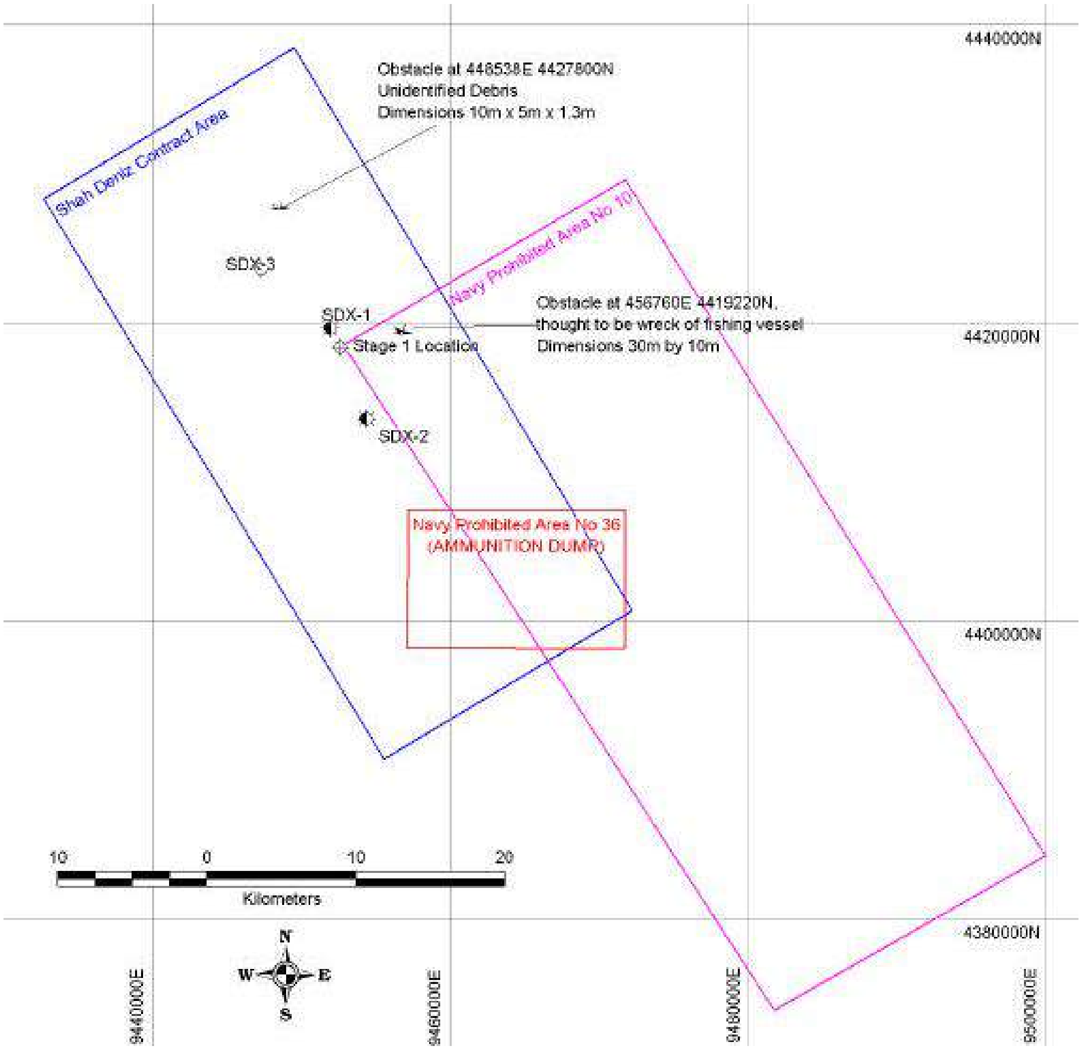
A prominent feature of the Shah Deniz Contract Area are nine mud volcano vents in the centre and an area of slope instability to the east. Figure 6.9 shows the location of the five largest mud volcanoes. In general they can be considered to lie in a southeastly orientation along the centre of the Area. Data from a recent geophysical site survey of Shah Deniz indicates that activity at the largest mud volcano in the centre of the Contract Area is presently focused on the flanks of the structures with a distinct separate mud volcano cone in the south of the area and several smaller mud mounds in the south and southeast. These mounds may be the result of peripheral mud seepage from the larger central structure. Accumulations of mud volcano output material at the seabed and also at depth in the sediment sequence, suggest the presence of mud volcano activity at the site over relatively long geological timescales.

Figure 6.9 Seabed features and locations of regional sampling stations



The Shah Deniz Contract Area is partly overlain by two naval prohibited areas (Figure 6.10). "Area 36" lies in the southeastern corner of the Contract Area and is thought to contain dumped munitions. The second prohibited area, "Area 10", dissects the Contract Area and lies over the southeastern quarter. This is a special regime area, the exact status of which is currently unclear.

Figure 6.10 Naval prohibited areas in the Shah Deniz Contract Area



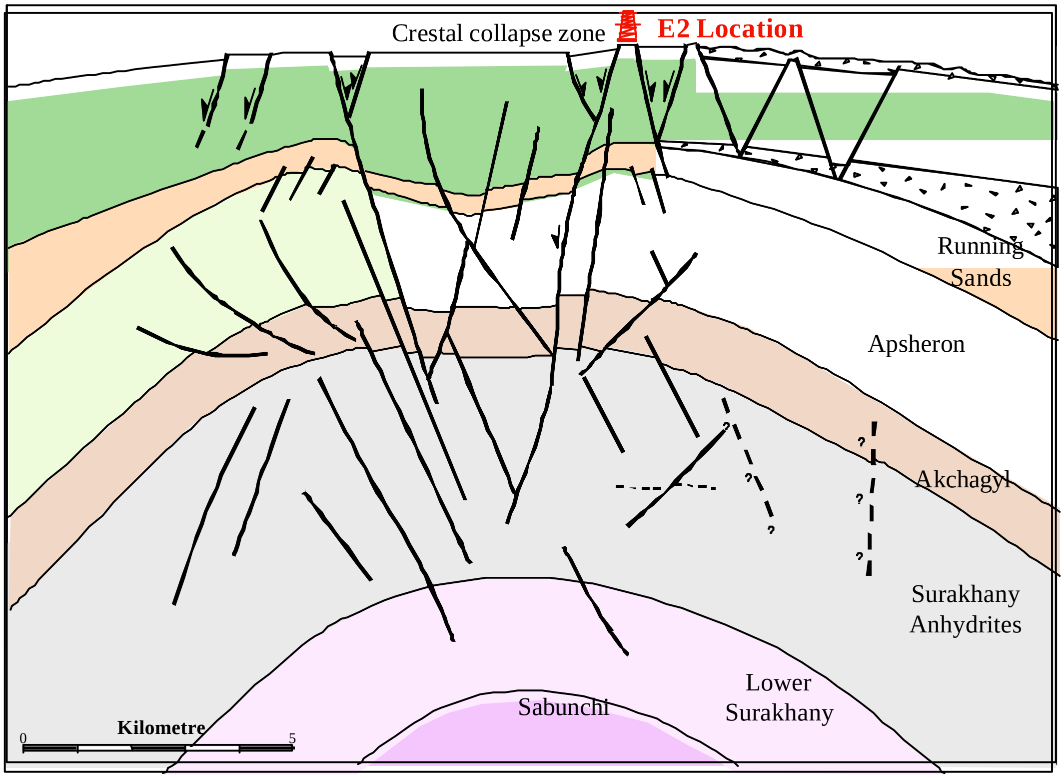
A recent geophysical site survey of the Shah Deniz Prospect indicated the presence of two seabed obstacles. The first is thought to be the wreck of a fishing vessel, of dimensions 30 m by 10 m at location 456760E 4419220N. The second is an unidentified item of dimensions 10 m by 5 m by 1.3 m, located at 448538 E 4427800 N.

6.2.5.2 Geology

The Shah Deniz Stage 1 drilling location (E2 site) lies adjacent to a mud volcano. Topographic relief on the seabed over the Shah Deniz Contract Area varies between ~50 m in the north to >600 m to the southeast. The main geological structure is a doubly plunging anticline with extensional faults in the upper section, an intermediate neutral zone free of significant faulting and compressional faults at depth. Extensive shallow faulting is present in the Surahkany formation and above, at the top of the anticline structure. The east flank has suffered significant seabed slope failure that is controlled by a series of shallow (i.e., <800 m) extensional faults. The faults are believed to sole out in the Running Sands interval however, they may extend deeper (i.e., below seismic resolution).

Figure 6.11 illustrates the subsurface lithological intervals and generic faulting around the proposed Shah Deniz Stage 1 development offshore drilling location (E2 site).

Figure 6.11 Schematic of subsurface geology beneath the proposed Shah Deniz Stage 1 drilling location (E2 site)



The Akchagyl interval consists of a claystone-dominated sequence with traces of silts. The clays are distinctively dark grey, firm, sub-fissile and sub-blocky, becoming silty in parts. Occasional thin sandstones are also developed which are generally very fine grained and calcareous. Overlying the Akchagyl are claystones and sandstones of the Apsheron formation. These claystones are medium grey, firm occasionally silty and non calcareous, while the sands are very fine grained with a moderate to good calcareous cement.

Beneath the Akchagyl are the claystones of the upper Surakhany formation which are pale grey to grey, brownish and locally pale yellow/brown. The claystones are earthy but occasionally smooth and waxy. They are soft to very firm and occasionally moderately hard. Thin Anhydrites also occur within 150 m of the top of this formation.

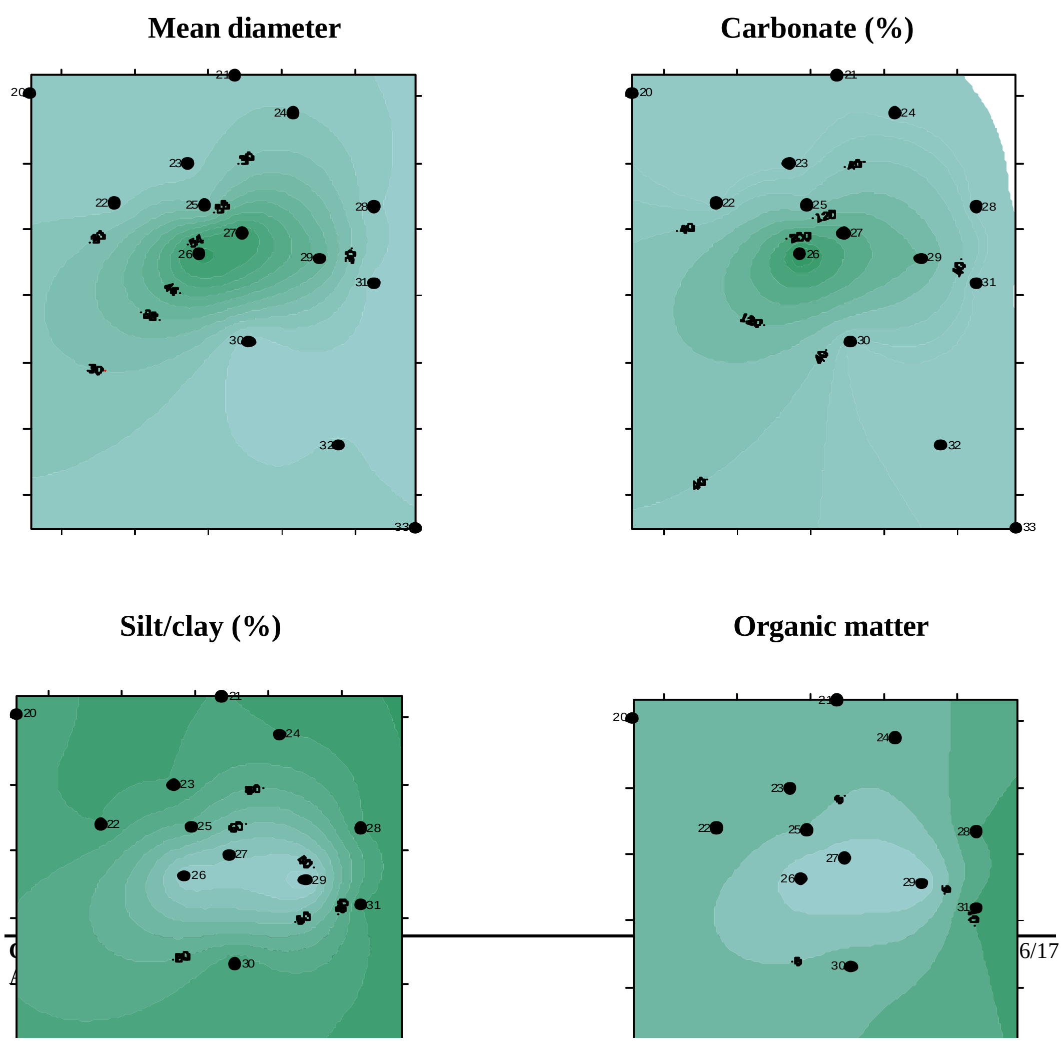
The Upper Surakhany interval (beneath the Surakhany Anhydrites) consists of a claystone dominated sequence with thin siltstones and sandstones. The claystones are medium brown, occasionally pale grey to pale brown, soft - firm and moderately calcareous. The claystones grade in part to pale grey and pale brown siltstones that are soft, crumbly and moderately calcareous. Occasional sands up to 7 m thick also occur within this section and are pale brown to white, soft, friable and very fine grained with a moderate calcareous cement.

The Sabunchi formation is composed of light to medium-grey, olive-yellow-grey and yellowish-brown, calcareous, sub-blocky claystone with occasional thin beds of sandstone, siltstone and traces of translucent grey, white, and green angular anhydrite. The upper third is predominately claystone. The lower portion contains inter-beds of very fine to fine-grained, translucent, and grey quartz sandstone.

6.2.5.3 Seabed sediments

The surface sediments in the Shah Deniz Contract Area are predominantly composed of fine clays and silts with occasional deposits of shell debris. Silt/clay content is typically greater than 90 %, with median particle diameter of the order of 7 µm and an average organic matter content of about 7 %. In both the baseline (March 1998) and the post-well surveys (SDX1, 2000; SDX3, 2001) sediments at a cluster of three stations near the location of the SDX1 well, to the south and west differed substantially from this overall picture (Figure 6.12). These stations are located near the reported location of the central mud volcano (Figure 6.9). At these three stations, the sediment consisted primarily of shell debris and sand with comparatively high carbonate content and particle sizes and low organic and silt/clay content.

Figure 6.12 Regional stations: spatial distribution of key sediment properties



6.2.5.4 Seabed chemistry

Trace metal concentrations in surface sediments in general showed little systematic variation over the Shah Deniz Contract Area and were characteristic of natural uncontaminated Caspian Sea sediments with the exception of mercury and copper. For these two metals, concentration is more clearly related to depth (and/or distance from land). Mercury concentrations decline with increasing depth, while the converse is true for copper. Barium and lead concentrations showed no trend across the Contract Area but in some sediments from closer to the well site, substantially higher concentrations were found These may be attributable to recent drilling as well as previous drilling activity by SOCAR.

Total hydrocarbon concentrations were similar in the 1998 and 2000 surveys with median values of 411 and 383 ug/g respectively. These values are similar to the shallower ACG Contract Area and along the existing EOP pipeline route from Chirag-1 to Sangachal. There was a slight trend of decreasing concentration with increasing depth and distance from shore.

Over the Shah Deniz Contract Area as a whole, successive surveys in 1998, 2000 and 2001 have indicated a progressive reduction in total hydrocarbon concentration (on average, about 40% per station between 1998 and 2001). No corresponding changes in PAH or heavy metal concentrations have been observed.

6.2.6 Offshore biological environment

6.2.6.1 Phytoplankton

Water samples were not collected during the 1998 baseline survey. In a survey conducted in 2000, the limited data collected from five sampling stations suggests that diatoms dominated the surface water samples while samples taken at mid-water depth or deeper, were dominated by blue-green algae. The distribution of species between stations and depths was however, extremely patchy and there was no consistent pattern in community composition. *Thalassionema nitzschoides* was by far the most abundant organism but was present in very variable numbers; the other organisms present in surface samples were of much lower and less variable abundance. The diatom *Rhizosolenia calcar-avis* was most uniformly distributed being present in all surface water samples and in all but one deeper water sample.

In samples collected in deeper water (mid-water to seabed), the blue-green algal species *Phormidium ambiguum* was present in relatively large numbers at some stations. The dinophytes *Pyrophacus*, *Prorocentrum* and *Henodinium* were present in small numbers at most stations but with a patchy distribution. The pattern of biomass distribution was much less variable than that of abundance. This was primarily due to the presence of the large diatom *Rhizosolenia* in relatively uniform numbers in all but one sample. Due to its large size, *Rhizosolenia* often dominates the plankton biomass.

Overall, phytoplankton diversity, abundance and biomass were extremely low in samples collected in the 2000 survey. Only 10 phytoplankton taxa were recorded compared to approximately 50 recorded in the baseline survey of the ACG Contract Area. This might be partly attributable to seasonal conditions at the time of sampling. In late summer, when a strong thermocline has been present for several months, it is possible for primary production to be reduced to low levels as a consequence of progressive nutrient depletion of surface waters.

In water samples collected in 2001, the phytoplankton community was more abundant and was dominated by the diatom *Chaetoceros wighamii* and dinophytes of the genus *Prorocentrum thalassionema*. *Rhozosolenia* were present but were not numerically important at most stations.

Phytoplankton biomass ranged from 0.003 to 0.09 mg/l in July 2000 and from 0.13 to 0.45 mg/l in June 2001.

6.2.6.2 Zooplankton

Zooplankton samples were collected during the 2000 and 2001 post-well surveys at five stations on each occasion. The community in 2000 was dominated overall by the Copepoda (i.e., 88 % of total numbers, comprising mainly *Limnocalanus grimaldi*, *Eurytemora grimmi* and *Eurytemora minor*). Cladocera accounted for 7 % of total numbers and were dominated by the genera *Polyphemus*, *Evadne*, *Pleopis* and *Cercopagis*. Copepod, *nauplii* and the planktonic larvae of molluscs and barnacles accounted for 5 % of total numbers and varied 20-fold in abundance between stations. The alien ctenophore *Mnemiopsis* was recorded as present but not quantified. Zooplankton diversity, abundance and biomass were all low. No rare or unusually sensitivity species of zooplankton or phytoplankton were observed in the water samples collected during the 2000 survey.

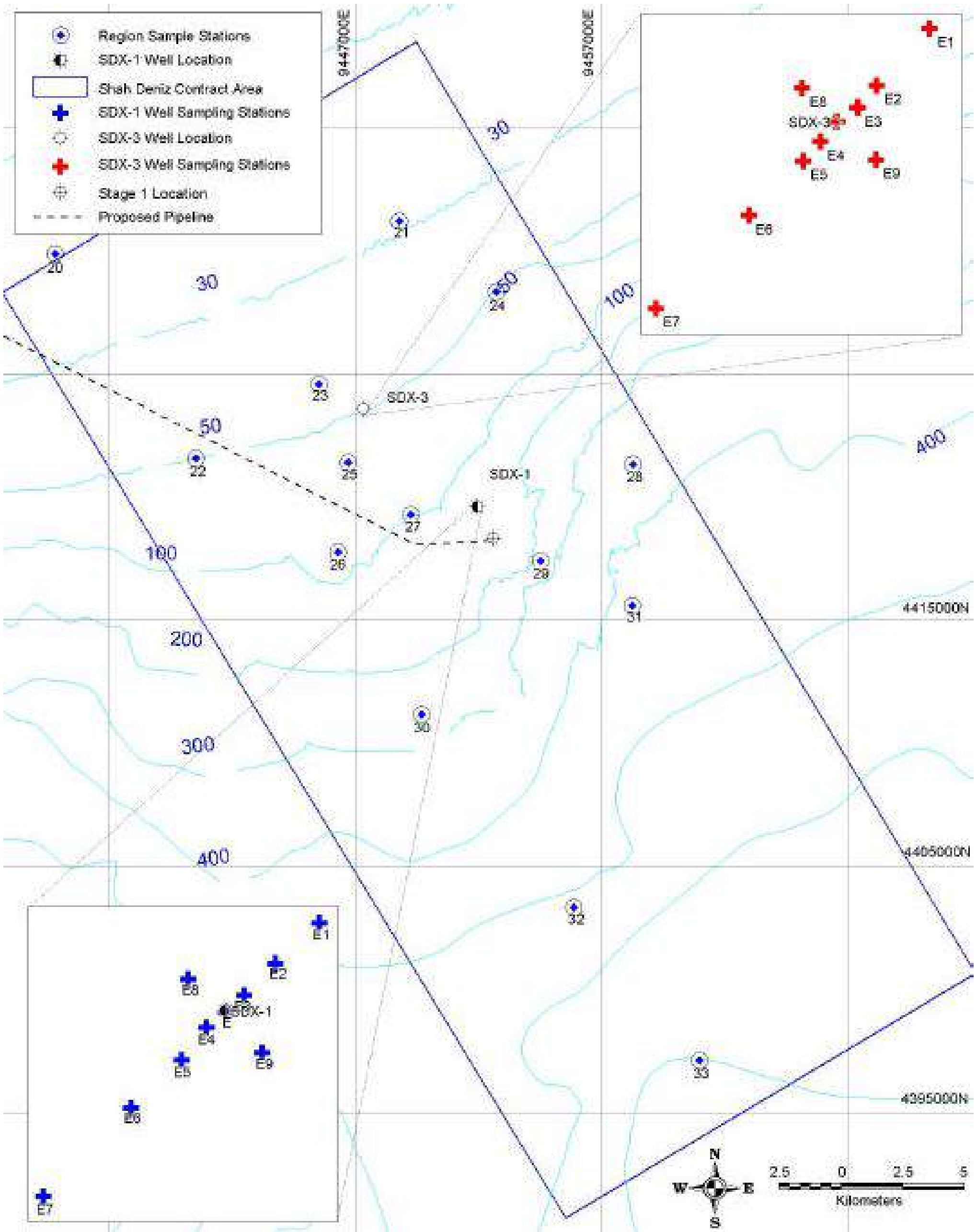
The community in 2001 was dominated by the copepods *Eurytemora* and *Acartia; Limnocalanus* was virtually absent. Cladocera, *nauplii* and larvae were present but accounted for only a small proportion of total numbers. *Mnemiopsis* eggs were recorded but no adults were present in the samples.

Zooplankton biomass ranged from 10-800 mg/m^3 in 2000 and from 8-540 mg/m^3 in 2001.

6.2.6.3 Benthic Communities

Macrobenthic surveys have been carried out on three occasions in the Shah Deniz Contract Area (1998, 2000 and 2001) at a group of 13 regional stations. A post-well survey was also carried out in 2000 of nine sampling stations around the SDX1 well site location and a further post-well survey was conducted in 2001 at the SDX3 well site location (Figure 6.13). In all surveys, the macrobenthic fauna retained on a 0.5 mm sieve were identified and enumerated and chemical analysis completed on a range of parameters. Only qualitative comparisons can be made between the 1998 baseline and the 2000/2001 post drilling surveys as only one replicate sample per station was analysed in the 1998 survey while five replicate samples per station were analysed in the 2000 post-drilling survey and three replicates were analysed in the 2001 post-drilling survey.

Figure 6.13 Sample station locations



The characteristics of the regional stations appear to be influenced by two primary factors: depth and the presence of mud volcano vents. The effects of these influences are clearly reflected in the physical and biological properties of the samples. The general health of the biological communities observed at the regional stations can be approximately judged by comparison with information available from other surveys in the South Caspian region (Table 6.7).

Table 6.7 Comparison with other survey data

Survey	Diversity	Abundance (per m^2)	Biomass (g/m^3)
Shah Deniz post well 2001 (SDX3)	1.69-2.34	142-3390	0.1-73.3
Shah Deniz post well 2000 (SDX1)	1.23-3.53	174-4084	0.1-51.8
Shah Deniz baseline 1998	0.4-3.1	100-6700	ND
Sangachal baseline 1996	1.65-2.58	323-3689	ND
AIOC baseline 1995	1.65-3.83	17-3900	ND
Appraisal 1 & post well 96/97	3.06-3.78	--	ND
Chirag mid-drilling 1998	1.0-3.24	6-4734	29.8
GCA 3 & 4 1997	0.77-2.20	26-1696	ND

ND = No Data.

The statistics for the Shah Deniz baseline and post-well surveys are very similar to each other although a wider range of dominance values was recorded in the baseline survey. The range of values also corresponds to the ranges reported from other surveys in the South Caspian region. In all but one of the instances cited above, the range for most statistics was wide indicating a substantial degree of heterogeneity within each of the survey areas. The exception was the AIOC appraisal well 1 and post well survey in 1996/97 where diversity, evenness and dominance were unusually uniform between samples.

Biologically, the shallow water stations are characterised by low diversity of amphipod and gastropod species coupled with a relatively high abundance of polychaetes and the bivalve Abra. Stations in deeper water and those around the mud volcano vent area have a much greater diversity of amphipods and gastropods. Sediments in the vicinity of the mud volcano contained higher carbonate contents and were coarser in comparison with other regional stations. The two deepest stations are inhabited mainly by a small number of 'cosmopolitan' species - those that are present and often abundant, at almost all stations. There was, in the 2000 survey, a clear relationship between total abundance (number of individuals) and depth. This relationship was not so well developed at the time of the 1998 baseline survey.

The following group of taxa dominated the biology of the regional stations (1998, 2000 and 2001 surveys):

- Polychaete: *Hypania invalida*;
- Oligochaete: *Isochaetides michaelseni*;
  Psammoryctides deserticola;
  Tubificidae spp. Indet. ;
- Amphipod: *Derzhavinella macrochelata*;
  Corophium spinulosum;
  Corophium spp. ;
- Cumacean: *Stenocuma diastyloides*; and
  Schyzorinchus eudorelloides.

In all regional surveys, abundance was highest in the group of central stations (26, 27 and 29) where sediments were coarsest and trace metal and hydrocarbon concentrations were lowest. In both surveys, the presence of taxa such as Nereis, Cerastoderma, and Abra was confined to stations located in the shallowest water in the north of the survey area (e.g. station 20). Median biomass at the regional stations was similar in 2000 and 2001, at 9.06 and 10.6 g/m^3 respectively. Median biomass at the SDX1 and SXD3 locations (post-drilling) was 0.47 and 5.6 g/m^3 respectively.

The Shah Deniz seabed biological communities were healthy and reasonably diverse in 1998, 2000 and 2001 with no indication of any adverse trends in the period between the surveys. In general, the composition of the communities was dominated by small, short-lived organisms well-adapted to existence in fine, silty sediments. Overall, the data indicate that the quality of the environment in the Shah Deniz contract area is good and that no deterioration has occurred since 1998.

6.2.6.4 Fish

Although the most well known fish of the Caspian are its sturgeon (of which there are five Caspian Sea species), there are over 100 other fish species, many of which are of commercial importance. Like the benthos, most fish species are endemic; some are of Mediterranean origin and a few, for example the Caspian salmon and the inconnu, have come from northern waters via the rivers. The diversity of fish fauna of the Caspian is quite modest, the total number of species being less than that of the Black Sea. Around half the species found in the Caspian are of fresh water origin and are mainly concentrated in the low salinity waters of the North Caspian. Whilst most species in the waters off Azerbaijan are marine, there are a number that return to freshwater to spawn. These are known as anadromous fish and include most of the sturgeon, the Caspian salmon and some species of shad.

The fish of the Caspian can be divided into four groups, catagorised by their feeding and reproductive strategies, as follows:

- 'marine' fish which spend their entire life cycle in the Caspian Sea including gobies, kilka (*Clupeonella*), the majority of shad (*Alosa*) and mullet (*Liza.*) species;
- anadromous species which feed in the open waters but when mature, migrate to the rivers to spawn including sturgeon (with the exception of the sterlet), the Caspian salmon (*Salmo trutta caspius*), the Black Sea roach or kutum (*Rutilus frisii kutum*) and the Caspian barbel (*Barbus brachycephalus caspicus*);
- semi-migratory species that feed in coastal areas and spawn during flood conditions in the river deltas including the cessan carp (*Cyprinus carpio*), zander (*Stizostedion lucioperca*), Caspian bream (*Abramis brama orientalis*), sabrefish (*Pelecus cultratus*), and vobla (roach) (*Rutilus rutilus caspicus natio*); and
- freshwater fish which spend their entire lifecycle in the riverine and delta areas including the sheatfish (wells catfish) (*Silurus glanis*), tench (*Tinca tinca*) and northern pike (*Esox lucius*).

The fish species of the Caspian Sea can also be categorised according to their feeding behaviour and preferences:

- phytoplankton feeders (some species of carp);
- zooplankton feeders (some species of shad);

- detritus and phytobenthos grazers (mullet species);
- benthic and near bottom invertebrate feeders (*Acipenser* spp. of sturgeon, vobla, and bream); and
- piscivores species (include species of shad, zander and the beluga sturgeon).

Feeding areas for fish in the Caspian are localised in the coastal areas in water depths of less than 75 m. However, a few fish, such as some species of shad and kilka feed offshore in water depths of over 100 m or 200 m respectively.

6.2.6.5 Commercially important fish found in the Shah Deniz Contract Area

A number of resident and non-resident fish species inhabit the Shah Deniz Contract Area several of which are of commercial importance. The most important commercial species include the big eye kilka (*Clupeonella grimmi*), anchovy kilka (*Clupeonella engrauliformis*), big eye shad (*Alosa saposhnikovi*) mullets (*Liza auratus* and *L. salines*) and sturgeon (*Acipenseridae*). The distribution and abundance of these species varies with depth and season. The following sections provides, based on existing literature, an overview of the vertical distribution of fish.

Big eye kilka (*Clupeonella grimmi*)

The big eye kilka is endemic to the area and inhabits the middle and southern Caspian at a depth of 20 to 200 m. Big eye kilka are found in upper water layers in March - April but descends to 16 to 32 m in summer and autumn. They feed in schools mainly on zooplankton (including copepods and mysids) and small fish. They spawn both in the middle and south Caspian reaching reproductive age in two years. Fecundity of the species ranges from 7.6 to 29.5 thousand eggs per spawning period (V.A.Derevyagin, 1973). The main spawning period for these fish is between January and April whilst there is a later, less significant period between July and October. Kilka lay their eggs in deeper waters which are then carried to the surface by vertical water movement and the juveniles released.

Anchovy kilka (*Clupeonella engrauliformis*)

This species inhabits water deeper than 15 m in the Middle and South Caspian Sea. The highest concentrations are found at depths between 50 to 200 m. Availability of its main food source, the zooplankton *Eurytemora,* influences its daily and seasonal distribution. Local concentration of kilka hence depend on the availability of food and the changes associated with daily and seasonal vertical migrations of zooplankton. Zooplankton typically migrate to surface waters during the evening and spend the night feeding in the surface water and during periods of higher light intensity descend to avoid predation.

Embryos and larvae of the anchovy kilka may also be found in the Shah Deniz Contract Area. Anchovy kilka spawn from May until December. The main part of the spawning population (80%) spawns in the western part of the South Caspian from October until December. Spawning occurs both in the coastal waters at depths of 20 to 25 m, and at 200 m in offshore areas.

Big eye shad (*Alosa saposhnikovi*)

Although big eye shad migrate from the south through the Shah Deniz Contract Area in the spring, they will also use the area as a site for over wintering. The fish inhabit deeper water of the south Caspian according to water temperatures and food availability. The majority of the big eye shad migrate through the Contract Area to coastal areas in the North Caspian in late spring to early summer to spawn at water depths of no more than 1 to 6 m, peaking in May. Their main migration route is along the west coast of the middle Caspian. They return to the south Caspian during November. They feed mainly on large crustaceans and small species of fish.

Mullet (*Mulgidae*)

The two mullet species *Liza aurata* and *L. saliens* can also be found in the Shah Deniz Contract Area. These fish spawn in the south and middle Caspian during the summer months of June and July. Although no mullet spawning grounds have been identified in the Contract Area they are believed to over winter in the middle Caspian which includes the waters of the Shah Deniz Contract Area. Mullet are omnivorous with no particular food preferences, feeding on detritus, periphton and smaller benthic organisms.

Sturgeon (*Acipenseridae*)

Sturgeon abundance in the Middle Caspian is at its peak during the spring and autumn. During the spring these fish pass through the Area as they migrate from over wintering areas in the south to spawning areas in the north Caspian. Sturgeon will also be present within the Shah Deniz Contract Area during other periods of the year. In autumn, the sturgeon migrate back from the north and return to over wintering areas in the southern Caspian. The exact timing of the migrations will depend on a number of environmental variables such as water temperature and availability of food. Four of the five sturgeon species found in the Caspian are listed in the International Union for the Conservation of Nature (IUCN) Red List as "Endangered"[1], with the remaining species listed as "Vunerable".[2]

Recent fisheries data

The Complex Environmental Research Laboratory (CERL) carried out seasonal (April, August, October, December) surveys in the waters of the Gunashli field in the ACG Contract Area between 1999-2001. Due to the close proximity of the Shah Deniz and ACG Contract Areas, the findings of the surveys are reported here. This data can however, only be used as an approximate guide to the status of fish populations in the Shah Deniz Contract Area.

Sampling effort focused on collecting anchovy kilka, big-eyed kilka and black back shad using nets deployed at fixed depths for fixed periods. For kilka, nets of appropriate mesh size were deployed at depths of 20 to 30 m for six hours. Catch size, length and weight statistics were compiled for each survey and a subsample of fish (usually five individuals of each species) was examined for histopathological abnormalities.

1 A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.
2 A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

Data for 1999 and 2000 indicate a seasonal trend in abundance for anchovy kilka and big-eyed kilka. Black back shad were present only in small numbers in 1999 and 2000 and were absent in the April 2001 catch. In 1999, numbers of both species of kilka were highest in April and August (catch size of approximately 200 fish of each species). In 2000, numbers in April and August were lower than in 1999 (i.e., roughly 50-100). In both years, numbers were in the approximate range of 10 to 50 in October and December. Data are available only for April and August 2001 at present but these indicate a substantial decline in the numbers of fish caught with a total of only 17 individuals of both species in April and none in August.

The age of both species of kilka appears to have declined over the reported survey period. In 1999, the age range was reported as 2 to 3 years in the April-October surveys. In 2000, age was reported as two years in April and August and 1 to 2 years in October and December. Fish in the April 2001 catch were recorded as 1 to 2 years old.

There was limited evidence of change in average length of kilka and shad over the period of the surveys but there was some indication of a reduction in weight between successive years. The average weight of shad declined by approximately 25% between 1999 and 2000 and a decline of a similar magnitude was observed in both species of kilka between 2000 and 2001. In many instances however, the sample sizes are too small to adequately reflect population characteristics.

Histopathological study of gonads, liver and spinal muscle revealed no abnormalities with functional significance. In April 2001, a single male anchovy kilka was observed to display some signs of feminisation.

The observed reduction in numbers and age of kilka are consistent with the results of over-fishing, although CERL scientists have also suggested that competition with the ctenophore *Mnemiopsis* might be responsible for the apparent decline. It is not clear at present however, that *Mnemiopsis* is able to compete effectively over the distance and depth ranges of kilka populations. It must also be borne in mind that sampling was conducted at fixed depths and that one effect of *Mnemiopsis* competition in surface waters could be to alter the depth at which kilka feed.

The data, although limited in scope, suggest strongly a need for more comprehensive data gathering to fully define the current status of kilka. There is no indication that local populations are damaged by oil industry activities but there are a number of possible reasons for the apparent decline between which it is not possible to distinguish on the basis of the data reviewed for this ESIA report.

6.2.7 Results of fish tissue analysis

The following information is derived from data collected in the ACG Contract Area. This information is included here to provide a general indication of trace metal and hydrocarbon concentrations in fish populations of the Middle Caspian Sea.

During the September 1995 and December 1995 ACG baseline surveys, a total of 13 samples of fish tissue (whole body) were analysed for trace metals and hydrocarbons. In eleven samples, the number of fish analysed was less than the minimum recommended by the International Council for the Exploration of the Seas (ICES). Analysis was carried out mainly on *Clupeonella* (pelagic) and gobies (demersal) and the report indicates that the latter were sampled in September and the former in December. The September 1995 data set contained one sample with exceptionally high trace metal and low hydrocarbon content; no explanation is available for this anomaly and the data have been omitted from Table 6.8.

Table 6.8 Results of fish tissue analysis

Parameter	September 1995	December 1995
	Concentration ($\mu g/g^{1}$ except NPD and PAH = ng/g^{1})	
Zinc	22-46	27-49
Iron	27-41	27-39
Strontium	10-20	12-17
Total hydrocarbon	15-62	12-36
NPD	20-110	78-150
US EPA 16 PAH	17-46	28-41
Trace Amounts		
Molybdenum	0.2-0.4	ND
Nickel	0.2-0.3	ND
Chromium	0.3-0.5	0.2-0.4
Barium	2.4-7.0	0.7-1.2
Copper	1.2-3.0	0.8-1.1
Manganese	1.8-5.3	1.5-4.0
Not Detected (ND)		
Cadmium	ND	ND
Lead	ND	ND
Cobalt	ND	ND
Mercury	ND	ND
Vanadium	ND	ND
Beryllium	ND	ND
Arsenic	ND	ND
Selenium	ND	ND
Tin	ND	ND

ND = No Data.

In both surveys, the majority of trace metals were either not detected or were very close to the analytical detection limits. Only zinc, iron and strontium were consistently quantifiable, and the ranges for each of these metals were very similar in both surveys. The report comments that trace metal concentrations were in general higher than reported for the North Sea. There is however, no direct evidence to evaluate whether the concentrations in fish from the Contract Area are within the normal range of tolerance or whether they represent a potentially stressful condition. The trace metal concentration ranges were considered to be similar to those reported from analysis of fish in the vicinity of oil industry operations in the Arabian Sea.

Total hydrocarbon concentration ranges were similar in both surveys and the report suggests that a substantial fraction of the total hydrocarbon tissue burden might be attributable to natural (biogenic) sources. A significant Unresolved Complex Mixture (UCM) was however, observed in gas chromatograms, something that is not a common feature of data reported by the authors of the report for North Sea fish. Aromatic hydrocarbon concentrations were considered to be similar to those reported from other sea areas.

6.2.7.1 Seabirds

Ornithological surveys in the late 1950's recorded between 160-180 bird species in the Apsheron Peninsular area (Gambarov, *et al.*, 1958; Gambarov, 1960; Mustafaev *et al.*, 1968). Over 200 species were identified during recent surveys and the majority of these species can be found in the Shahdilli-Pirallahi area (Sultanov and Kerimov, 1998 and 1999).

According to these most recent surveys, the average abundance of birds along the Apsheron coastline up to Pirsagat Cape is 668 individuals per kilometre. The highest density of bird population occurs between Pirallahi island – Beuk Tava – Shahdilli Cape. There is a direct relationship between the number of species and the winter conditions experienced on the Apsheron Peninsula. Every three to five and 10 to 11 years, when the coldest winters occur, the number of individuals can increase a few times and especially in respect to swans, pelicans and geese.

Table 6.9 indicates the most abundant bird species that reside within the area. Other nesting species are moorhen (*Gallinula chloropus*), coot (*Fulica atra*), purple gallinule (*Porphyrio porphyrio*), great white egret and little egret (*Ardea alba* and, *Egretta garzetta)* purple heron (*Ardea purpurea*), shelduck (*Tadorna tadorna*), ruddy shelduck (*Tadorna ferruginea*), Caspian plover and little ringed plover (*Charadrius dubiu and C.alexandrinus*) and the black-winged stilt (*Himantopus himantopus*).

Table 6.9 Bird count data from the Apsheron Peninsula

Location	Cormorant *Phalacrocorax carbo*	Herring gull *Larus argentatus*	Common tern *Sterna hirundo*	Sandwich tern** *Sterna sandvicensis*	Total
Shahdili	100	3000	6000	2000	
Garabattag Island	190	50			
Bolshaya Plita Island	60	1500			
Malaya Plita Island	30	500			
Podplitochny Island	180	1200			
Yal Island	200	3000			
Islands Koltish, Dardanell, Greben		100			
Goo Island	30	100			
Light house sign		100			
Pirallahi island* (30)	50	250			
Jilov Island		200	140		
Total	**840**	**10,000**	**6,140**	**2,000**	**18,980**

* Nesting on oil rigs around the island.
** Endangered species.

Migration, feeding and nesting patterns

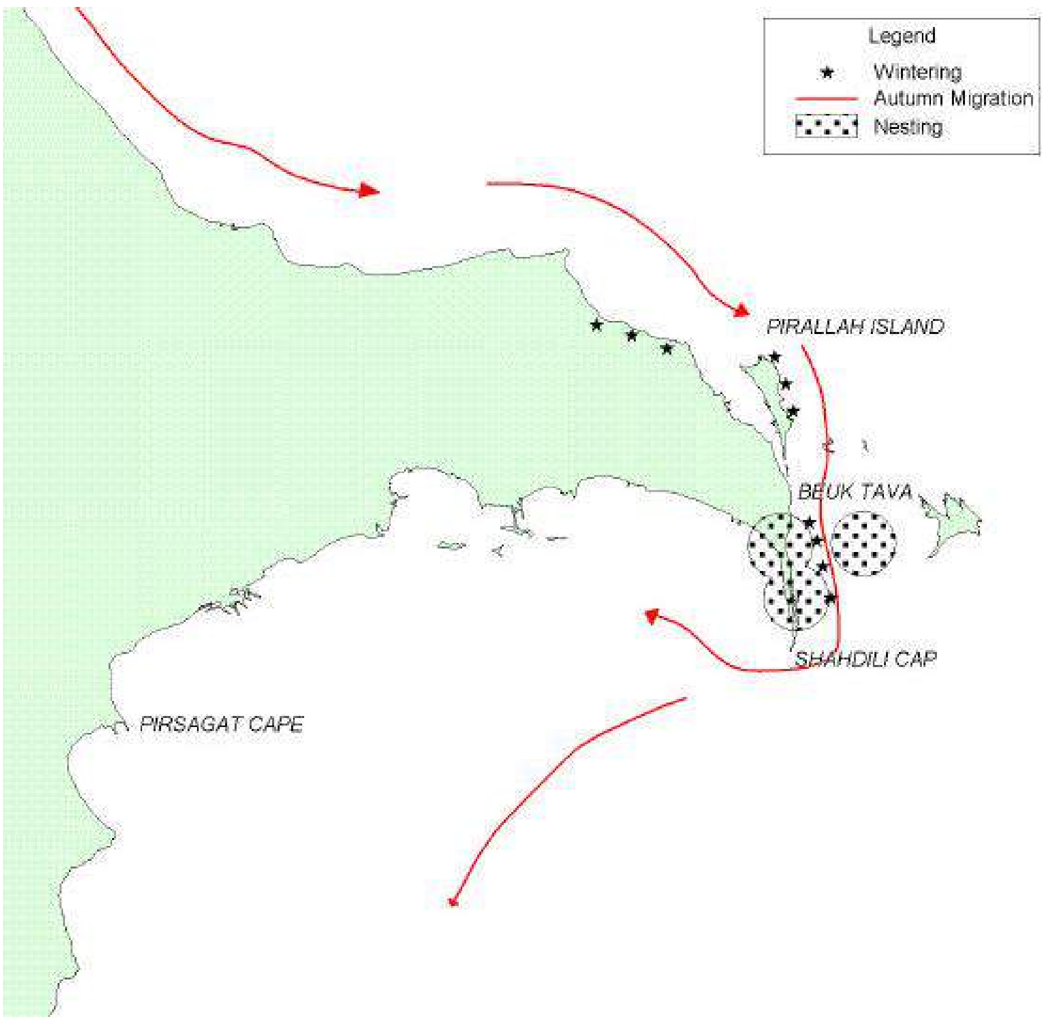
The majority of the species found in the Apsheron Peninsula (41 %) use the area during the migration period. Thirty-four percent are resident species whilst the remaining 25 % use the area for over wintering purposes. Bird species residing in the Apsheron Peninsula can be categorised according to their feeding habits as follows:

- birds feeding on fish including grebe, cormorant, gull, tern and egret;
- birds feeding on plants or invertebrates including grebe (partially), swan, goose, duck, coot and stint; and

- predators that feed on birds or relatively large fish including white tailed eagle and harrier.

The main breeding season is from late March through April when bird numbers will be highest. Nesting gulls, terns, cormorants and stints are restricted to mainly uninhabited islands and abandoned oil rigs. Other species such as coots (*Fulica atra*), moorhen (*Gallinula chloropus*), great white, little egrets (*Ardea alba, Egretta garzetta)*, purple gallinules (*Porphyrio porphyrio*), shelduck and ruddy shelduck (*Tadorna tadorna*, *T. ferruginea*) prefer reeds and small water bodies whereas the Caspian plover and little ringed plover (*Charadrius dubius*, *C. alexandrinus*) favour open areas of shrub. The location of the main nesting and overwintering areas with the main migration routes is provided in Figure 6.14.

Figure 6.14 Autumn migration, nesting and over wintering distribution of birds on the Apsheron Peninsula



Pressures and problems

Illegal hunting is a major concern in the Shahdilli area where geese, ducks and coots are regularly captured. A further concern is the historical pollution. It difficult to assess whether historic pollution, illegal hunting and habitat loss has a significant impact upon local bird populations due to the lack of systematic and regular bird counts over past years. Table 6.10 below highlights the key bird populations' activities over the course of a year as well as the key data gaps for these activities.

Table 6.10 Key activities of birds on the Apsheron Peninsula

Activity	Month 1	2	3	4	5	6	7	8	9	10	11	12
Breeding	Data Gap	Data Gap	Data Gap	Medium	High	High	High	Low	Data Gap	Data Gap	Data Gap	Data Gap
Over wintering	High	High	Low	Data Gap	Data Gap	Data Gap	Data Gap	Data Gap	Low	Low	Medium	High
Migration	Data Gap	Medium	Low	High	Medium	Low	Data Gap	Low	Low	Medium	High	High
Feeding nearshore	High	High	Medium	Medium	Low	Low	Low	Low	Low	Medium	High	High
Feeding offshore	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Medium
Numbers of species	Medium	Medium	High	High	High	Medium	Low	Low	Medium	High	High	Medium
Numbers of individuals	High	High	Medium	Medium	Medium	Medium	Low	Low	Low	Medium	Medium	High
Vulnerability to disturbance	High	High	High	Medium	Medium	Medium	Medium	Low	Low	Medium	High	High

Key (Level of Activity)	High	Medium	Low	Data Gap

6.2.7.2 The Caspian Seal

The Caspian Seal (*Phoca caspica*) is the world's smallest seal species. It was classified in the 1993 IUCN Red List as "vulnerable". This classification is based on the potential threat posed by the degradation of both the Caspian ecosystem and Caspian Seal terrestrial habitat.

About 80% of the total seal population migrates to the middle and southern Caspian between May and June to feed in areas rich in pelagic fish species. During late summer and early autumn, many seals move offshore to feed in deeper waters which include the Shah Deniz Contract Area. They feed here until September when the majority of them migrate to the north.

The late January survey of 1996 [3] from Sumgait to Lenkoran showed that approximately 1,100 seals remained on the eastern tip of the Apsheron Peninsula during the winter. Notable haul out sites on the Apsheron Peninsula include Shahdilli Spit and nearby islands such as Zhiloy Island. Caspian seals have been observed in the Contract Area during a number of environmental surveys as well as by personnel working on the Chirag 1 platform. Approximately 1,100 Caspian Seals were counted during the helicopter survey of seal haul-out sites in the vicinity of the Apsheron Peninsula in January 1996 (Duck, 1996). This number is probably a fraction of the seals that would be expected to be present in this area in spring and summer since 90 % of the seal population is reported to be in the North Caspian in winter (Badamshin, 1966).

The Caspian Seal currently has no special status on the CITES list of endangered species but a recent spate of deaths since April 2000 has led to serious concerns regarding the survival of this species. An international team of scientists, working as part of the Caspian Environment Program's Ecotoxicology Project (ECOTOX) concluded that canine distemper virus (CDV) infection was the primary cause of this massive die-off. These mammals have now been entered on the IUCN Red List as "vulnerable" on the general basis of the degradation of the Caspian sea ecosystem.

In addition to CDV mortality among the Caspian Seal, pesticides and industrial pollutants are the cause of severe habitat destruction and poisoning. Their environment and food source is affected as is their reproductive success. In 1997, over 70% of female Caspian seals were infertile.

Caspian seal tissue samples have been analysed for polychlorinated biphenyls (PCB) and chlorinated pesticides. Concentrations of PCBs were all found to be lower than that reported in Grey and Common Seals along the east coast of England while the concentrations for DDE (a metabolite of the pesticide DDT) were much higher than that reported for the east coast of England (Duck, 1996).

6.2.7.3 Marine reptiles

No data is currently available on the abundance and species of reptiles residing in offshore areas excepting anecdotal sightings.

6.2.8 Seabed characteristics in the vicinity of the Stage 1 platform location and along the proposed pipeline route

The proposed Shah Deniz subsea gas pipeline route and Stage 1 platform location are shown in Figure 6.15. For a portion of its length, the proposed route runs parallel to the existing ACG Chirag 1 to Sangachal subsea pipeline and indeed the pipelines will share the ACG route corridor.

A survey of the new section of the pipeline route from the proposed Stage 1 platform (SDA) location to the confluence with the ACG Chirag 1 to Sangachal pipeline was completed in June 2001. This data and existing information from the 1998 and 2000 survey of the Shah Deniz Contract Area has been used to provide a description of the proposed pipeline route and SDA. Figure 6.16 shows the sampling stations that are used in the description of the seabed characteristics for the proposed Shah Deniz Stage 1 facilities.

Figure 6.15 Proposed Shah Deniz subsea gas pipeline and existing ACG subsea oil pipeline routes

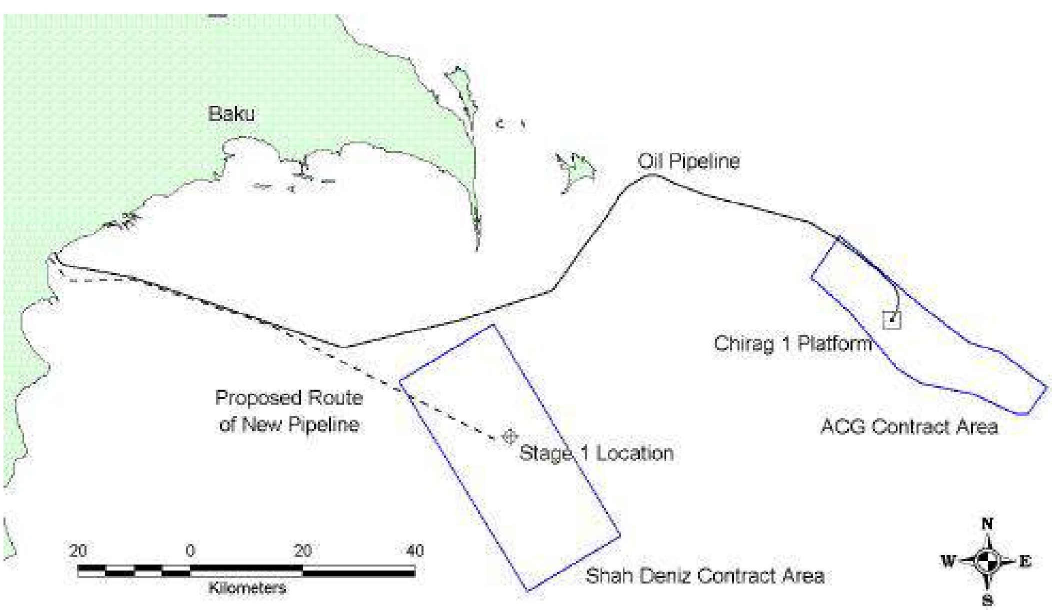
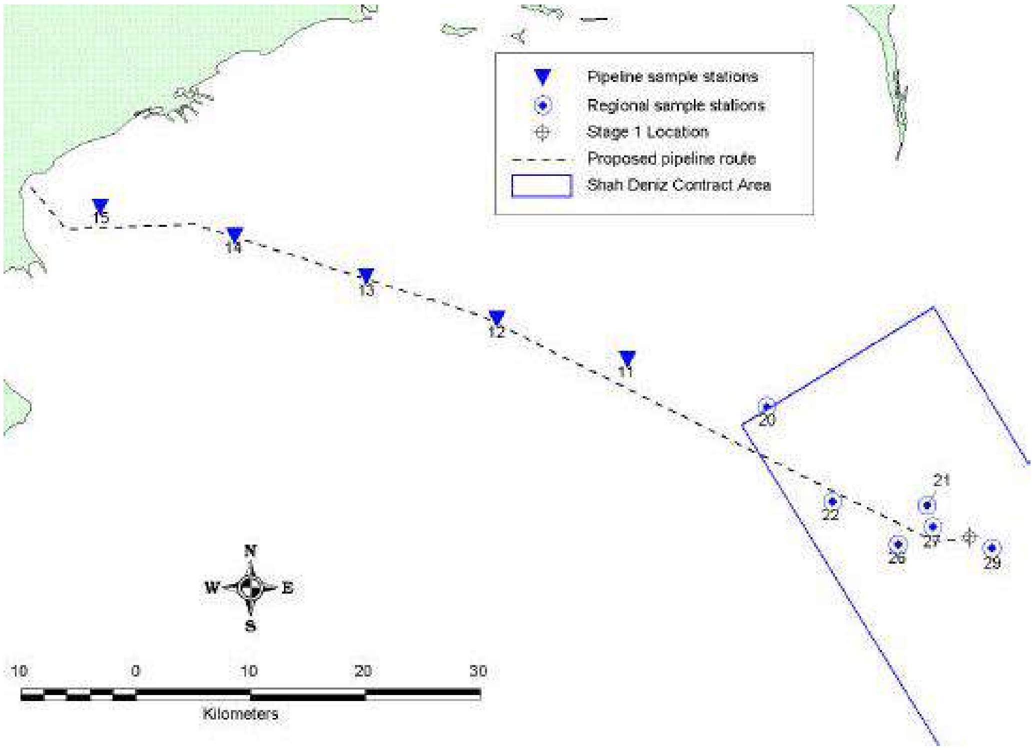


Figure 6.16 Sampling stations - proposed Shah Deniz pipeline route and Shah Deniz Stage 1 platform location



6.2.8.1 Physical and chemical characteristics of sediment

Based on existing information, the sediments along the majority of the proposed Shah Deniz gas pipeline route display a good correlation with depth; that is, as depth increases, sediment become increasingly finer grained with higher silt-clay and organic and lower carbonate content.

Sediments found closest to shore at stations 14 and 15 along the existing ACG subsea pipeline route were composed of coarse grained silt with higher carbonate content and lower silt-clay and organic content. Moving offshore, the sediment become increasingly finer grained with higher silt-clay and organic and lower carbonate content. Sediment samples collected from stations 12 and 13 were similar to sediments in the north east part of the Shah Deniz Contract Area at regional stations 20 and 22 and composed of fine to very fine silts (6-10 um) with low carbonate content (27 % to 29 %) and displayed high silt-clay (86 % to 98 %) and organic content of 4.4 to 4.7%. The sediments in the vicinity of the Stage 1 location in the central part of the Shah Deniz contract area are distinctive (regional stations 25,26,27, 29). The sediments are composed of medium to fine sands with high carbonate content and low organic and silt/clay content.

The levels of trace metals in the sediment follows the same general pattern of the sediment physical properties along the route. Low levels of trace metals and found in the coarse sediments in the vicinity of the Stage 1 platform. Highest levels of barium, chromium, iron, lead and mercury were recorded at stations 12 and 13 where the sediments were composed of fine to very fine silts with low carbonate content, high silt-clay content and organic contents of 4.4% to 4.7%. Zinc and copper displayed a different trend that being increasing concentration with decreasing water depth. Data on hydrocarbon concentrations in sediments within the Shah Deniz Contract Area and along the proposed pipeline route are available from reports of surveys conducted in 1998, 2000 and 2001. These include information derived from baseline surveys, post-well surveys, regional surveys and pipeline surveys. Two recent pipeline surveys cover contiguous segments from the Shah Deniz platform location to the existing ACG pipeline to Sangachal and from this intersection, to landfall at Sangachal.

The distribution of hydrocarbon concentration in the sediments surveyed can be interpreted as falling into five overall categories as follows:

1. The SD1 station (at the Shah Deniz platform location), together with Shah Deniz regional stations 26 (7 km west), 27 (4 km northwest) and 29 (2 km southeast), and the closest pipeline survey station (4 km west). At these locations, total hydrocarbon concentrations are low being within the range of 30-100 µg/g.
2. Other regional stations, distributed across the whole contract area, at which total hydrocarbon concentrations are in the range 370 to 430 µg/g
3. The shallow-water pipeline stations aligned in a southeast direction from Sangachal to a point approximately 20 km NW of SD1 (at the junction of the SD and ACG pipelines), where hydrocarbon concentrations are in the range 430 to 550 µg/g and are therefore similar to the regional stations
4. The pipeline stations between the SD1 station and the above junction, where total hydrocarbon concentrations are in the range 170 to 240 µg/g. Concentrations at these stations are intermediate between those reported for nearshore pipeline stations and those reported at the SD1 station and immediately adjacent stations.
5. SDX1 stations, where data from 1998 and 2000 indicate that background hydrocarbon concentrations are consistently in the region of 1,000 µg/g and are therefore approximately twice as high as 'typical' regional concentrations.

The above observations indicate that there is a region of seabed, including the SD1 station , where hydrocarbon concentrations are very low compared to surrounding areas. The sediments at stations within this region are distinctive in that all are classified as fine to medium sands whilst sediments surrounding this region are all classified as fine silts. They also have in common significantly lower trace metal concentrations than the finer sediments.

The available data indicate that the macrobenthic communities along the proposed pipeline route were heavily influenced by the sediment composition. Macrobenthic communities around stations 20, 21 and 22 were dominated by amphipods, bivalve and polychaete worms. Stations in the vicinity of the Stage 1 location have a much greater diversity of amphipods and gastropods than those of along the proposed pipeline route. In the middle part of the pipeline around station 12, large numbers of the barnacle *Balanus* where recorded. Biological communities in the shallower sediments along the existing pipeline (stations 12 to 15) were increasingly dominated by the alien bivalve *Abra* and polychaete *Nereis,* amphipods were absent at these stations.

6.2.9 Post drilling impact summary

Although post-drilling surveys are generally too limited in scope to make a reliable contribution to an overall environmental description, brief summaries of such surveys can be of use in identifying potential environmental vulnerabilities. This section briefly summarises the impact 'footprints' observed in the two post well surveys carried out in the Contract Area and identifies out any salient observations with respect to biological impacts.

The two post well surveys (SDX1 and SDX3) provide only a localised assessment of gross impact and the reports do not contain sufficient information to evaluate the rate or extent of ecological recovery.

6.2.9.1 SDX1 post drilling impacts

There was clear evidence of the physical impact of drilling operations with substantial deposits of synthetic base fluid at stations E (well centre), E4 and E5 (along SW axis on the monitoring transect). Identifiable traces of base fluid were detected at a number of other well-site stations. Sediment particle size distributions reflected this pattern.

Trace metal concentrations were predominantly comparable to regional background levels but there was a consistent relationship between barium and lead concentrations that might indicate the presence of WBM deposition. Other trace metal concentrations were lower at stations where barium and lead were higher suggesting that a degree of 'dilution' may have occurred during cuttings deposition.

Hydrocarbon concentrations at the well-site were higher than at the regional stations but were consistent with observations made during the 1998 baseline survey; after accounting for the presence of base fluid, the background concentrations do not appear to reflect any other significant recent inputs.

The community composition at the well-site was distinctive and was dissimilar to those observed at the regional stations. Amphipods (sediment-dwelling shrimps) and gastropods (small snails) were largely absent from the well-site stations which is in contrast to their abundance in many regional stations. Conversely, other taxa not common in the regional stations occurred frequently at the well-site stations; most notably the bivalve *Didacna* and the cumacean crustacean *Caspiocuma*.

The biological impact of drilling operations was most severe at stations E (well centre) and E4, SW of the well centre, where heavy deposits of drilling fluid were recorded; no macrobenthic fauna were present in samples from these stations. At other well-site stations, the community was slightly less diverse than at the regional stations. Biomass and abundance were substantially lower than at regional stations and there was a marked gradient of effect extending NE and (to a greater extent) SW from the well centre.

The biological data therefore indicate both:

- an underlying distinctiveness of community structure; and
- a clear 'footprint' impact of drilling operations extending approximately for 200 to 250 m around the well centre

It is possible that the relatively high background THC concentrations might contribute to the development of the community structure. The well-site stations did not however, extend a great distance from the well centre and this possibility cannot be tested at present. It is also possible that the community composition partly reflected relatively recent smothering by drill cuttings. The species present may be those most able to survive burial or those most able to rapidly re-colonise recently impacted sediments.

6.2.9.2 SDX3 post drilling impacts

There was a clear hydrocarbon footprint associated with the SDX3 well centre identifiable both in terms of total concentration and also in the proportion of linear alpha olefins (LAO) base fluid present. The footprint extended approximately 50 m northeast and 50 m southwest of the well centre and corresponded closely to the area of slightly coarser sediment and elevated lead concentration. Total hydrocarbon and base fluid concentrations at the SDX3 well centre and immediately adjacent stations were similar to those observed at comparable stations during the SDX1 post-well survey in 2000.

At the regional stations, the picture was generally one of stability in terms of sediment characteristics with little evidence of significant changes in sediment composition or heavy metal content from year to year. In contrast, although the pattern of hydrocarbon concentration appears relatively stable from year to year, there appears to have been a substantial and progressive decline in total concentration since 1998. At the SDX3 well site, the primary footprint of drilling activities extended clearly only to stations 3 (northeast) and 4 (southwest) in addition to the well centre itself. The footprint was detectable in terms of highly elevated hydrocarbon and lead concentrations and of slightly coarser sediment characteristics.

The number of species present at the well site stations was substantially lower than at the regional stations (41 compared to 72). This pattern was similar to but less marked than that observed in relation to the SDX1 post-well survey (91 species at regional stations, 30 at well site stations). In both instances however, most of the difference was accounted for by:

- the absence of gastropods at the well site stations; and
- a lower diversity of amphipods at the well site stations.

The biological community structure at the well location was primarily associated with percent base fluid, total hydrocarbon and lead concentrations (linked to stations SDX3, 3 and 4) and with iron, silt-clay content and organic content (linked most clearly to stations 1, 5, 6, 7 and 8). The species most distinctively associated with stations SDX3, 3 and 4 are either colonial (*Bouganvillea*, *Conopeum*) or are non-native (*Mytilaster*, *Balanus*, *Nereis*, *Rhithropanopeus*).

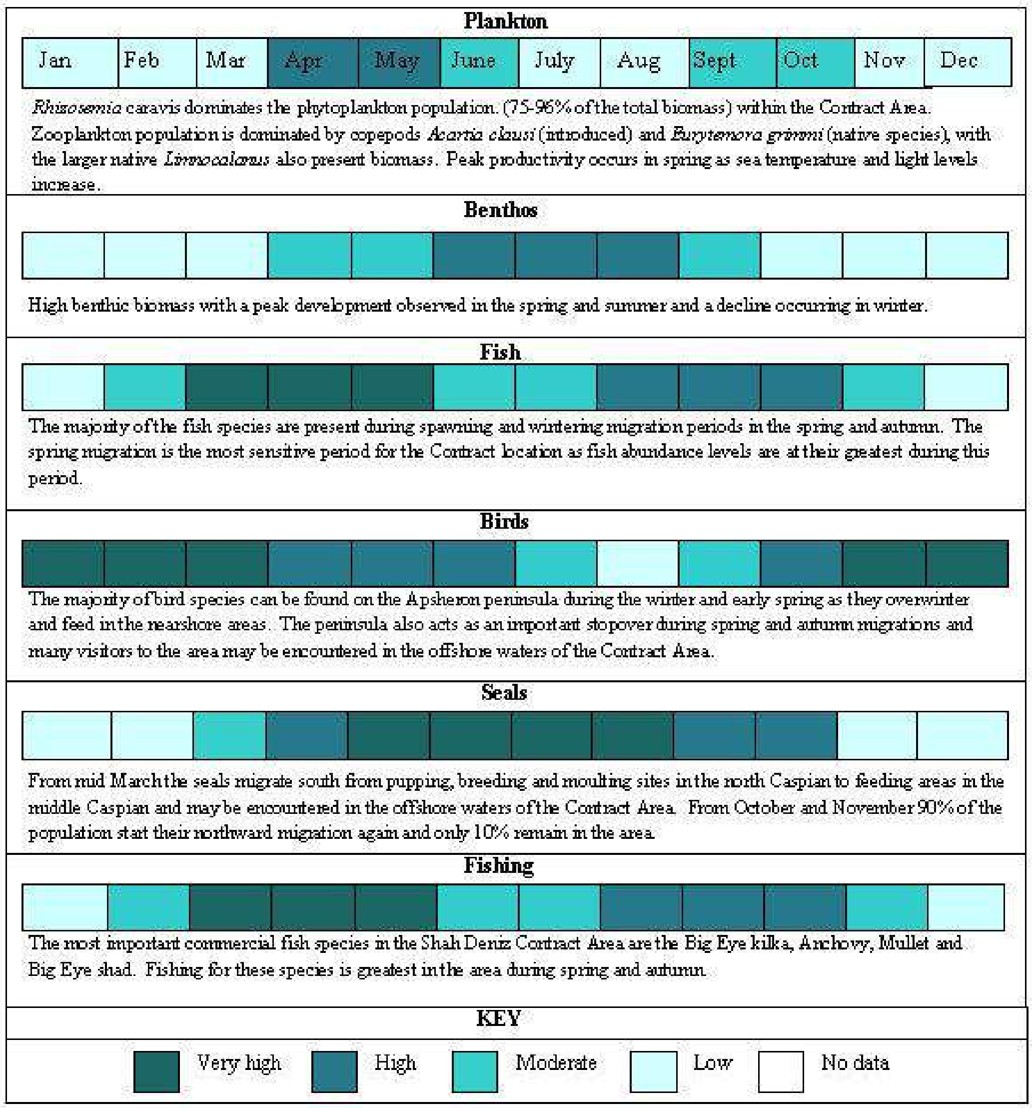
In general, the major direct impact of drilling can be summarised as being confined to stations within 50 to 100 m of the well centre being characterised by a substantial reduction in number of species (especially amphipods) and abundance (especially oligochaetes and polychaetes). There appears to be also a general, less clear-cut impact over the entire well site location reflected in substantially lower numbers of species but this is largely associated with the absence of sparsely-distributed taxa and is thus difficult to relate directly to specific environmental characteristics.

6.2.10 Summary of environmental sensitivity

A summary of the environmental sensitivities is provided in Figure 6.17. The key environmental sensitivities in the Shah Deniz Contract Area are associated with:

- the presence of numerous fish species that pass through the Contract Area during migration periods;
- spawning periods of anchovy and big eyed Kilka;
- the Apsheron Peninsula, serving as an important stopover for migrating birds;
- the presence of seals during the summer/spring and autumn migration periods; and
- spring time benthos and plankton recruitment and increase in productivity.

Figure 6.17 Key Environmental Sensitivities



6.3 Sangachal nearshore environment

6.3.1 Meteorology

6.3.1.1 Air temperature and humidity

The closest operational weather station, which is considered representative of the Sangachal region, is at Alyat approximately 30 km to the south. Data have been purchased for the Alyat site and interpreted for the purpose of this environmental description. The climate is classified as being warm, semi-arid steppe. Summers are warm with typical maximum air temperatures in the order of 35 to 40^0C. Rainfall is extremely limited, humidity is low and evaporation rates are high.

Alyat is in one of the warmest parts of Azerbaijan with an average annual air temperature of 14.6 ^{0}C. July is the warmest month when the average air temperature is 26.4 ^{0}C with a maximum recorded temperature of 41^0C (recorded in July). Historically, the lowest recorded air temperature at Alyat is -16^0C (recorded in January) whereas the mean minimum air temperature in January is 0^0C.

6.3.1.2 Precipitation

The region is one of the driest areas in Azerbaijan; the mean annual average precipitation is less than 150 mm. The majority of the rain falls between September and April with the driest months being between July and August when rainfall is typically 7 to 8 mm. Snowfall in the area on average occurs for 10 days per annum. Snow rarely settles on the ground for long periods of time.

6.3.1.3 Wind regime

The wind regime of Sangachal Bay is on a whole consistent with that for the Apsheron Peninsula although it is recognised that there is a local thermally driven wind system. The effects of the local system are most noticeable offshore resulting in a slight (1 to 2 m/s) offshore wind strength during the early hours of the morning, which then drops and becomes a stronger onshore wind as the land heats up. This thermal influence coupled with the meteorological dynamics of the region can result in strong winds occurring in the region with little forewarning.

In the Apsheron region as a whole winds greater than 5 m/s blow approximately 37 % of the time and winds greater than 10 m/s occur 18% of the time (ERT, undated). At Alyat, some 30 km south of Sangachal, the average wind speed is 3.6 m/s and for up to 100 days a year, wind speeds exceed 15 m/s. Under storm conditions, wind speeds greater than 25 m/s have been recorded.

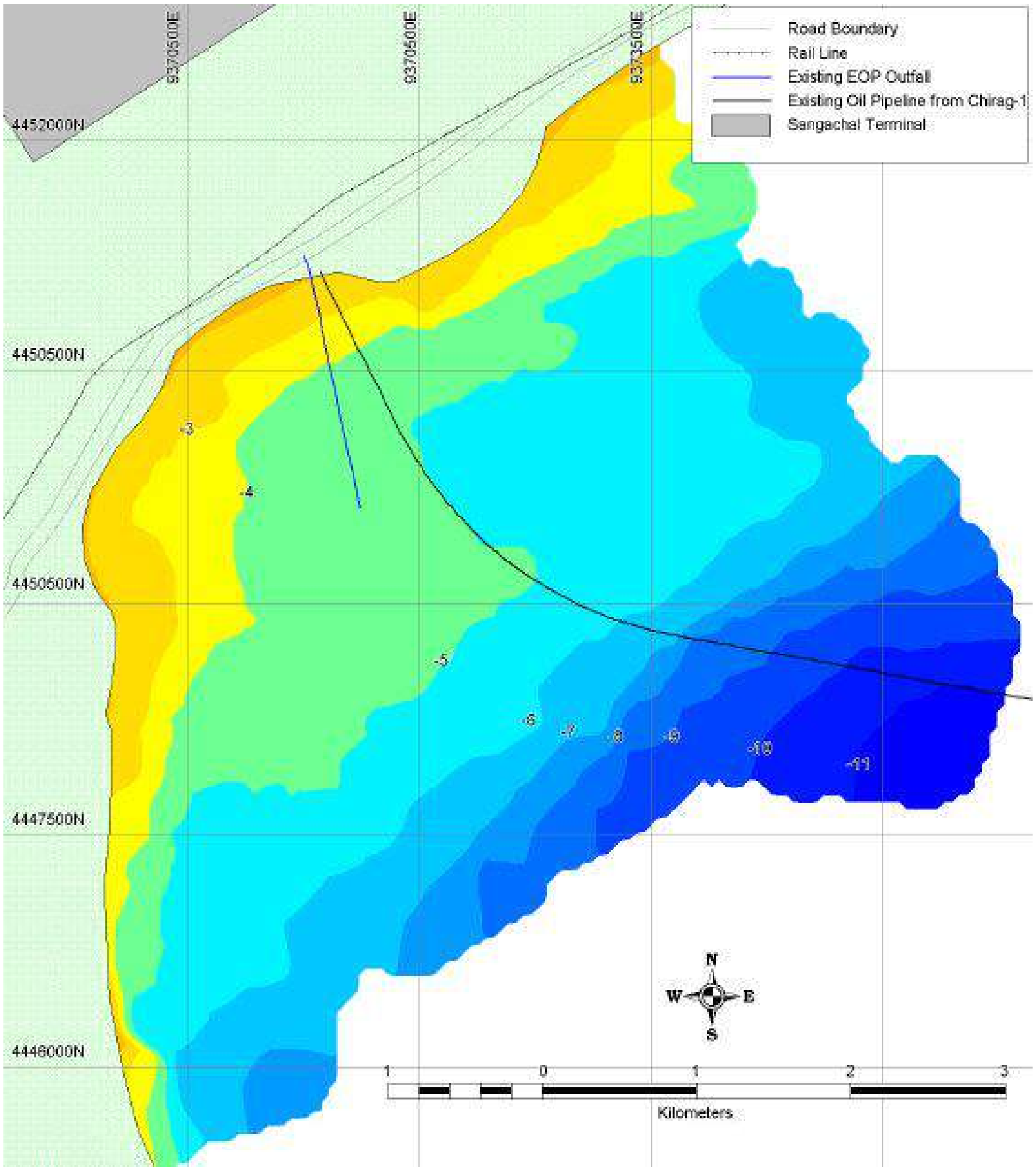
An analysis of wind records for the period 1980 to 1989 indicates that northeasterly winds blow for approximately 50 % of the time and southeasterlies for approximately 17 % of the time. For the remaining time winds are of variable speed and direction.

6.3.2 Oceanography in Sangachal Bay

6.3.2.1 Bathymetry

Sangachal Bay is a shallow bay that slopes gently from the shore and reaches a depth of 10 m approximately 3 km offshore. In the centre of the Bay is a slight depression that acts as a sediment sink. The recent acoustic survey of Sangachal Bay has provided the bathymetry chart shown in Figure 6.18. A detailed description of the sediment types, metal and hydrocarbon contaminants and the associated biological communities is provided Section 6.3.4.

Figure 6.18 Bathymetry of Sangachal Bay (depths in metres)

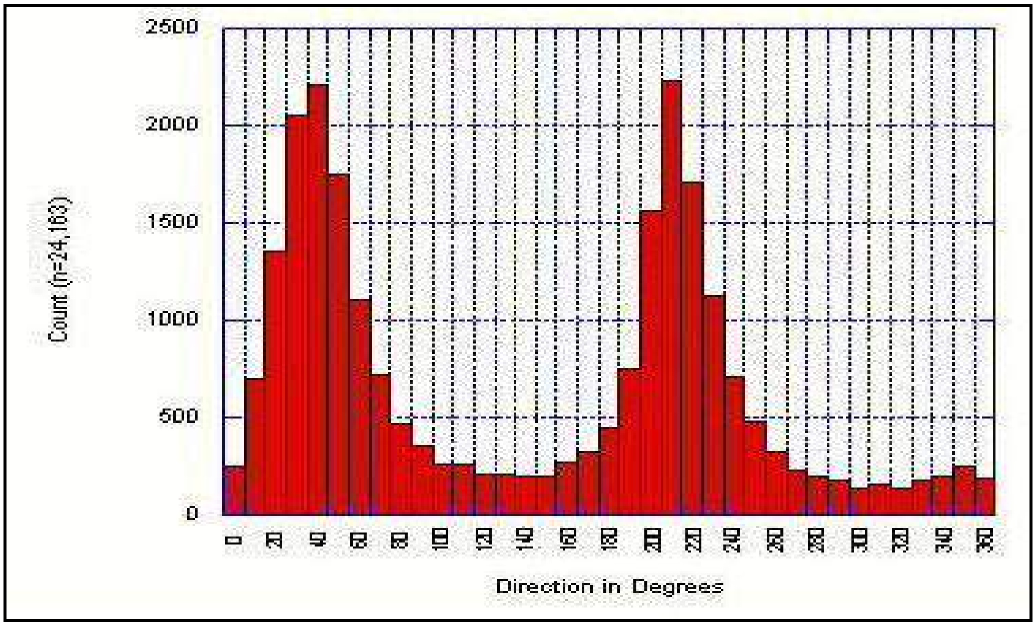


6.3.2.2 Currents and water circulation

The Caspian Sea is effectively non-tidal and water currents are mainly wind generated. Measurements of currents in the Bay were recorded by NeSA BV in two periods; 13 October 1999 to 15 December 1999 and 28 January 2000 to 11 May 2000. The data was collected from an Aanderaa RCM9 current meter deployed at around 3 m above the seafloor in 6 m depth of water approximately 2.5 km offshore. This data was analysed as part of this ESIA in order to develop an understanding of the nearshore oceanographic conditions of Sangachal Bay. As no seasonality was observed in the data, the two data sets were combined for analysis.

The NeSA BV data showed that the minimum current speed was 0.0 cm/s and the maximum approximately 42.5 cm/s (Figure 6.19).

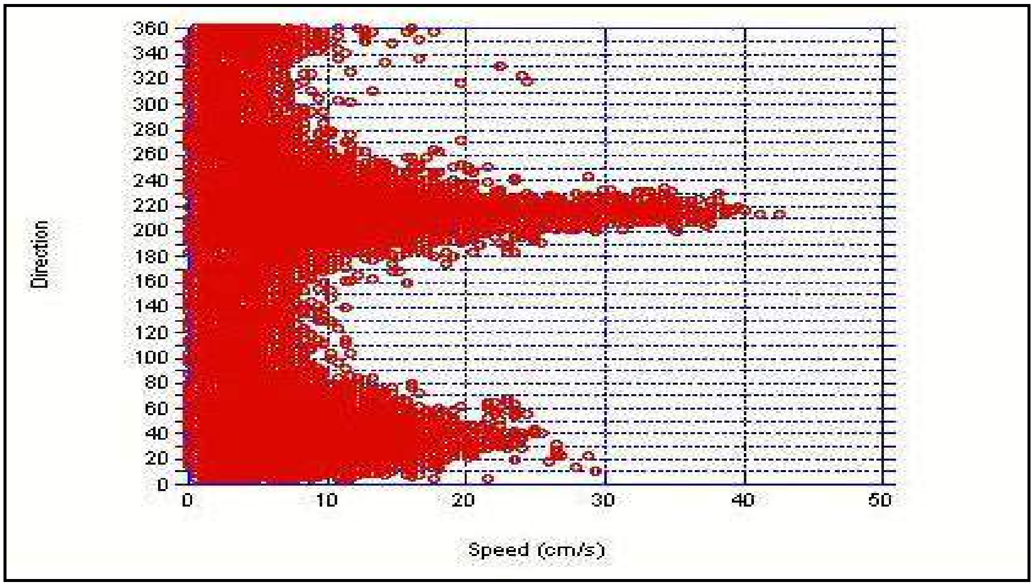
Figure 6.19 Distribution of current direction over complete NESA by record



The mean current speed was approximately 7.9 cm/s. Current direction was evenly distributed between flowing in a southwesterly direction and a northeasterly direction, down coast and up coast respectively (Figure 6.20). Higher current speeds were associated with the southwesterly direction currents.

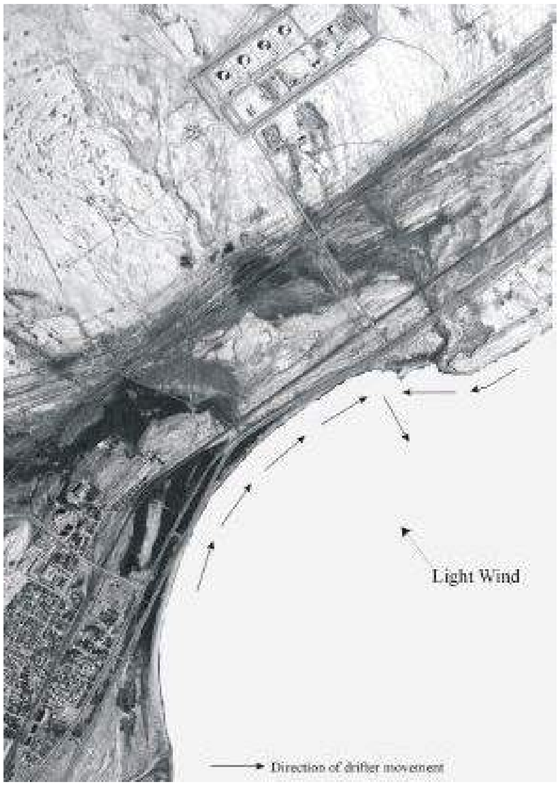
To develop a better appreciation of the oceanographic regime in the coastal area (i.e. that area where water depths are in the order of a few meters), two drifter studies were completed at seven and four (repeat) locations along the Sangachal Bay coast on separate days in June 2001. During the first day winds were light and from the southeast with wave height of approximately 20 cm. On the second day, two days later, winds were strong from the northeast and little or no wave action was observed.

Figure 6.20 Distribution of current speeds per direction



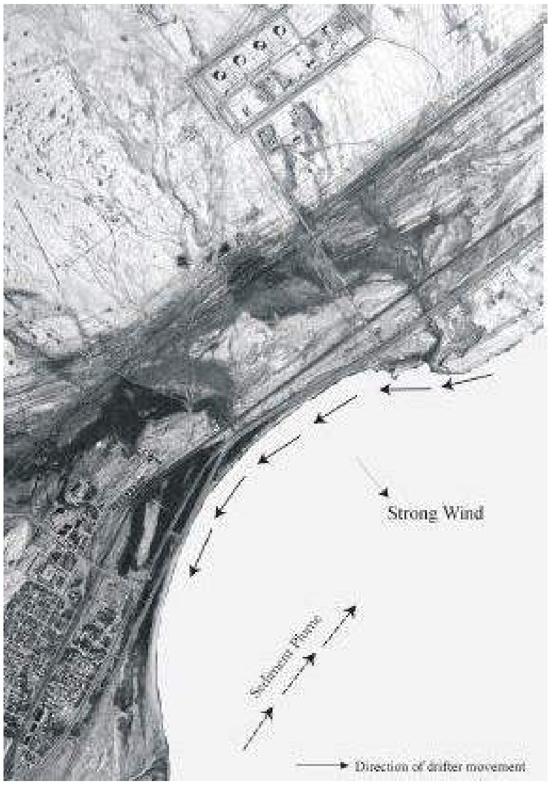
The results of the first drifter exercise indicate that a complex nearshore circulation pattern operates in the limited space of Sangachal Bay. The direction of drift was unexpected in that drifters released in the northern part of the Bay moved northwards and those released in the southern part of the Bay, southwards (Figure 6.21).

Figure 6.21 Inferred current direction - light southeast winds



Drifter speeds varied from 1 to 6 cm/s. Two drifters left in the wave break area northeast of the jetty showed a slow residual current to the northeast, concluded to be most likely associated with wave action.

Figure 6.22 Inferred current direction - strong northeast winds



The second drifter exercise showed that southerly currents with speeds varying from 17 to 22 cm/s were operating (Figure 6.22). A large sediment plume approximately 100 to 200 m offshore was however, observed to be moving in a northerly direction.

It is concluded from the drifter work that a complex nearshore current regime exists in Sangachal Bay. Currents have been observed to be moving in opposite directions over distances of a few kilometres. Currents are primarily wind driven but are also influenced and generated by waves. Shoreline configuration (i.e. shape and make-up) contributes to the behaviour of currents in the very nearshore zone and is itself shaped by the currents.

6.3.2.3 Waves

Due to the enclosed nature of the Caspian Sea the predominant waves are wind-blown rather than swell. Waves are a strong feature of this part of the Caspian Sea and wave heights can exceed 10 m in offshore waters during severe storm conditions. Longer time scale internal waves within the water column can give rise to short-term sea level fluctuations. The most marked of these arise from onshore and offshore winds, which cause surges and withdrawals of water along the coast, including the coastal water adjacent to the existing terminal.

6.3.2.4 Sea temperature

Sea surface temperatures measured during a recent annual fish monitoring study of the nearshore waters adjacent to the Sangachal terminal recorded a temperature range of between 6 and 30°C between January and July.

6.3.2.5 Salinity

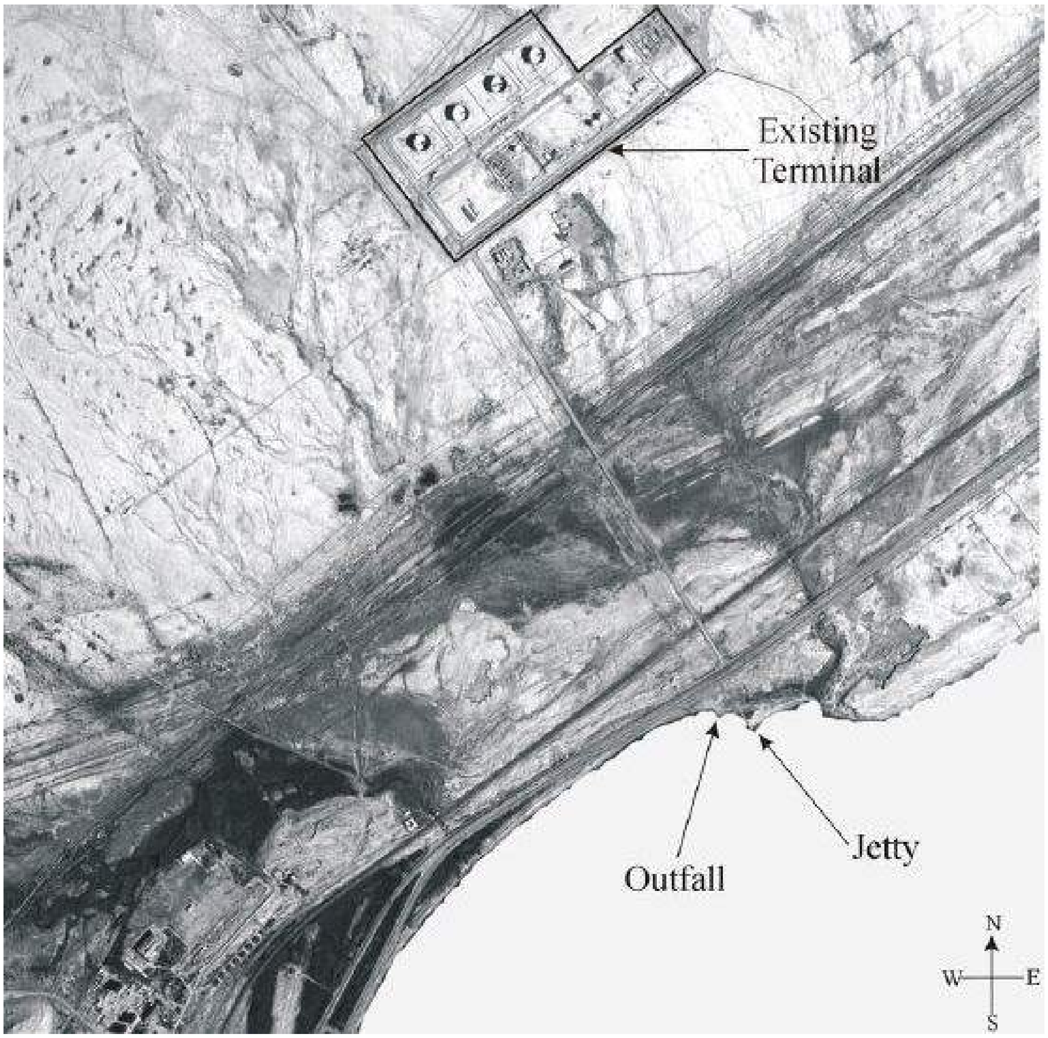
Seawater salinity of nearshore waters adjacent to the terminal recorded by ERT during the 1996 baseline survey were lower than those commonly quoted in published literature for the Caspian Sea (11.2-11.6 ‰, rather than 12-13 ‰) but are consistent with those recorded from surface waters in other recent surveys offshore (ERT, unpublished data). Limited measurements of ionic concentrations in Sangachal Bay indicated the salt content to be fairly typical of open seawaters of the Middle and South Caspian although slightly reduced chloride ion concentrations at the surface suggested fresh water input from the land.

6.3.3 Sediment dynamics in Sangachal Bay

A study of the sediment dynamics of Sangachal Bay based on observations made during field investigations was carried out in June 2001. A series of historical photographs, taken in January 2001, were used as a basis for comparison of present conditions as observed during the June field investigation.

The field investigation area was centred around the rock groyne jetty and concrete sewerage outfall structures on the Sangachal Bay coastline southeast of the existing Early Oil Project terminal. The location of jetty and outfall structure is shown in Figure 6.23.

Figure 6.23 Location of jetty and outfall structure in relation to existing terminal



The jetty location was chosen for the study because it was believed that considerable change to the coastal configuration had occurred as a result of the construction of the jetty and outfall.

By investigating the existing coastal configuration and analysing the pattern of sediment redistribution in the beach areas adjacent and near to the jetty and outfall following their construction, an insight can be gained into the nearshore dynamics of the area. This insight can be used as a basis from which predictions can be made in regards to the possible affects the subsea pipelines will have both in the short and long term.

It should be noted that the sea level in Sangachal Bay was higher during the June field investigation than that observable in the January 2001 photos (Figures 6.24 – 6.28). The exact cause of this rise is unknown.

Due to the higher water line, the lower section of the beach profile visible in some of the January-February 2001 photos was inundated during the June investigations thus making interpretation and comparison of past conditions with present conditions more difficult in some instances.

6.3.3.1 East of jetty

Fine sands with shells characterise the beach make-up northeast of the jetty. The beach sediments higher up the beach profile showed at least four layers of sediments and seagrass that had been deposited over time. Figure 6.24 shows a comparison of the beach area looking west towards the jetty from its eastern side between January 2001 and June 2001. Figure 6.25 shows a comparison of the beach area looking northeast away from the jetty. In both figures the accumulation of seagrass can be seen in June.

Figure 6.24 Sangachal coastline east of jetty looking west (towards jetty)

January 2001 June 2001

Figure 6.25 Sangachal coastline east of jetty looking east (away from jetty)

January 2001 June 2001

During the June survey the coast directly adjacent to the jetty consisted solely of shells with little or no sand. Figure 6.26 shows the difference in the beach profile near the jetty between January and June 2001.

Figure 6.24 Shoreline adjacent to jetty - eastern side

January 2001 June 2001

There are three main changes in the coastal configuration that can be discerned through the
comparison of the two photos as follows:

- it appears that there has been erosion behind the berm crest (or landward ridge); and
- sediment has been accumulated along the landward ridge.

There has also been erosion below the bottom of the jetty as shown in Figure 6.27.

Figure 6.27 Erosion at base of jetty - eastern side

January 2001 June 2001

Recent sedimentation around the jetty is limited to an area of 10 to 20 m near its tip on the eastern side. Further inland there appears to be older deposits that were redistributed by earthmoving equipment. The redistribution of sediment was possibly undertaken to reclaim some of the coast. This observation is supported by the 1999 AIOC document *Review of research and monitoring activities in Sangachal Bay and the AIOC Contract Area,* which hypothesizes that:

> *"…it seems likely that some structure existed prior to 1997, and this structure was extended or improved in October 1997."*

6.3.3.2 West of the jetty

The area adjacent to the jetty to the west is being eroded. The area that is currently the edge of the coast consists of fine sediment placed by earthmoving equipment. Figure 6.28a and 6.28b show the increased erosion and effect of sea level rise on the coast on the west side of the jetty. It should be noted, however, that the earlier photos show a different shoreline near the jetty. It is possible that some of the historical photos may be older than January 2001.

Figure 6.28a Erosion at base of jetty - western side

January 2001 June 2001

Figure 6.28b Erosion at base of jetty - western side

January 2001

June 2001

Slightly further west there is some accretion of sediment east of the outfall structure. Figure 6.28 shows the erosion that is occurring along the coast. Again, much of the existing coastline has been disturbed by earth moving equipment. This observation is supported by the 1999 AIOC document *Review of research and monitoring activities in Sangachal Bay and the AIOC Contract Area,* which states that:

> *"…the situation is complicated by the major disturbance caused by the construction associated with the landfalls of the outfall and oil pipelines…."*

6.3.3.3 South of the jetty and outfall structure

The coastline south of the jetty and outfall pipe consists of fine sediment and sand mixed with some seagrass. There are also rocky outcrops. In general, these areas do not appear to have undergone significant changes due to the construction of the jetty or the outfall structure.

6.3.3.4 Nearshore sediment transport assessment

Conclusions regarding sediment movement in Sangachal Bay are based on three main areas of evidence as follows:

- an observed sediment plume and nearshore eddy;
- a beach sediment and profile comparison – January 2001 and June 2001; and
- a critical shear velocity to grain size analysis.

6.3.3.5 Sediment plume and nearshore eddy

A recent aerial photo of the Bay (Figure 6.29) shows a northward travelling sediment plume emanating from the southern part of the Bay. A northward moving sediment plume was also observed during the June 2001 field investigation. This phenomenon suggests that a northerly direction current flow occurs in the southern part of the Bay close to shore. The current is evidently strong enough to mobilise sediment.

Figure 6.29 Sediment plume in Sangachal Bay

The photo also shows an eddy in the southern part of the Bay that may potentially be associated with a shear zone caused by a current running in a southerly direction interacting with the northward flowing current responsible for the movement of the sediment plume.

6.3.3.6 Beach Sediment and profile comparison - January 2001 and June 2001

The comparison of sediment analyses undertaken between 1996 and 2000 (see Section 6.3.3) indicates that a significant change in sediment distribution has occurred in Sangachal Bay over the last few years. This change strongly suggests that there is a dynamic sediment movement regime in Sangachal Bay.

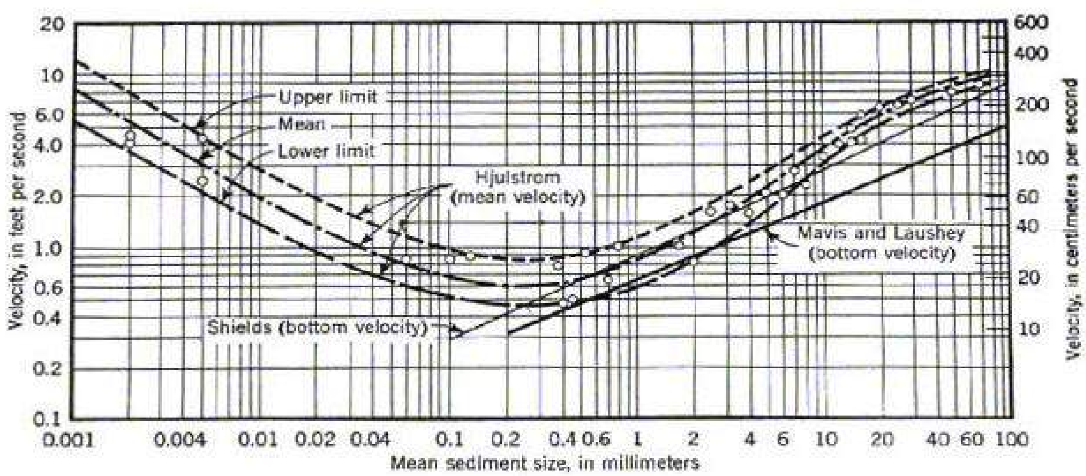
A comparison of evidence from historical photos (January 2001) to the results of the June 2001 field investigation into beach profiles and shoreline sediment distribution indicates that considerable change has occurred to the shoreline's configuration over a short period of time. Some of this change results from deliberate earthmoving works but much of it is also the result of natural processes including sea level rise and nearshore currents. These latter contributing factors in particular, suggest that the nearshore sediment movement regime is dynamic and that the sediments themselves are relatively mobile.

6.3.3.7 Critical shear velocity to grain size

Critical shear velocity to grain size can be used to determine sediment transport potential. Figure 6.30 presents the critical velocities for quartz sediments as a function of mean grain size.

If a maximum current speed of approximately 40 cm/s, as observed at the current meter station, is used it can be shown that currents operating in Sangachal Bay are sufficient to move many of the grain sizes found there. In fact, Figure 6.30 shows that a current speed of approximately 12 cm/s should be sufficient to transport some of the sediments found in Sangachal Bay. It should also be noted that wave induced orbital velocities have not been considered in this analysis. These orbital velocities, which have been estimated at over 1 m/s at the seabed for a 2 m wave with a 5 second period (ERT, undated), can be very important in the movement of larger diameter particles.

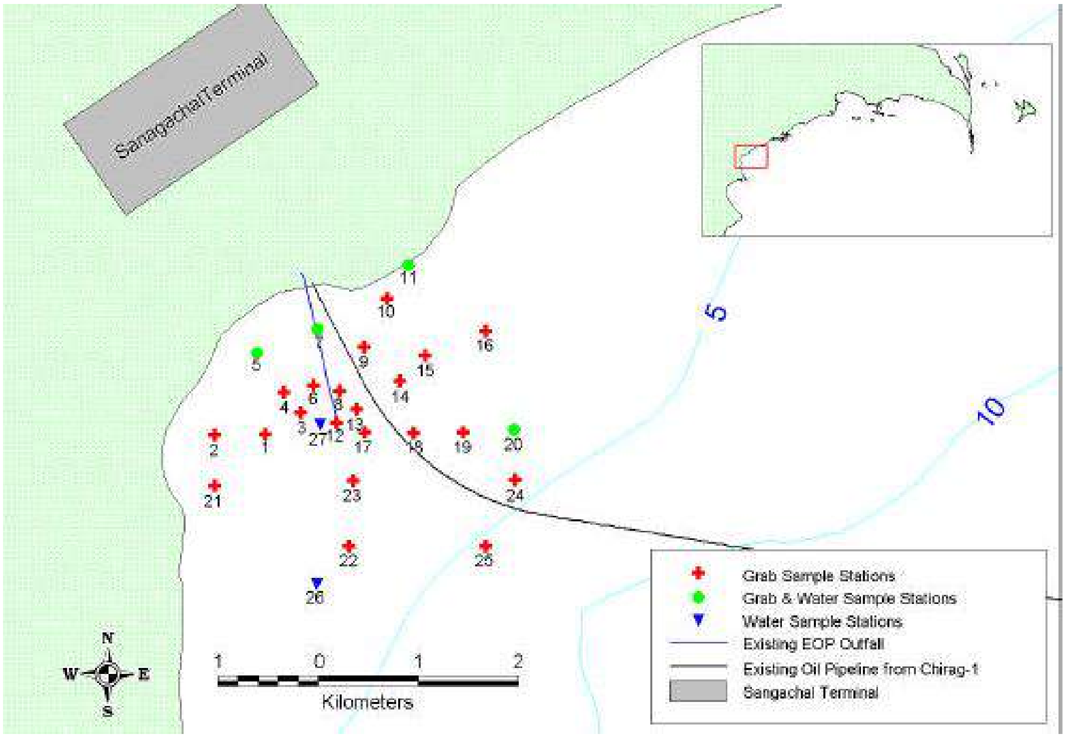
Figure 6.30 Critical velocities for quartz sediments as a function of grain size



6.3.4 Results of environmental surveys

A baseline environmental survey of the nearshore sediments and waters adjacent to the Sangachal oil reception terminal was completed in September 1996 and repeated in October 2000. Sediment and water samples were collected from a number of locations and analysed for a range of chemical and biological parameters. Sample station locations for the 2000 survey are shown in Figure 6.31. The results of these environmental surveys are summarised below.

Figure 6.31 Location of Sample Stations in Sangachal Bay



6.3.4.1 Water quality

During the 2000 baseline survey water samples were collected from the surface and near-bottom at six stations for chemical and physical analysis. Water samples were collected from a limited number of stations in 1996. The use of different analytical techniques and differences in the range of parameters analysed severely limits the comparisons that can be made.

The results (average of surface and bottom sample values) of chemical and physical analysis from the 2000 survey are summarised in Table 6.11. No significant or systematic difference between surface and bottom samples was observed in both the 2000 and 1996 surveys.

Nutrient concentrations were generally low and frequently below detection limits. Measurable concentrations were recorded in the 2000 survey only at stations 5 and 7, with higher concentrations at the former station for all parameters (nitrite, nitrate, phosphate, and ammonia).

Phenol concentrations in the 2000 survey were above the detection limit (2 µg/l) only at station 5. Surfactant concentrations were above the detection limit (100 µg/l) at stations 5, 7, 11 and 27, ranging between 110 and 170 µg/l.

Total petroleum hydrocarbon concentrations were low in all samples both in the 1996 and 2000 survey. In the 2000 survey, with the exception of station 11, average concentrations fell within a narrow range (3.5 to 4.9 µg/l). The average concentration at station 11 was approximately twice as high, at 9.1 µg/l.

Table 6.11 Summary of physical and chemical analysis of Sangachal water samples, 2000 baseline survey

Station number	**5**	**7**	**11**	**20**	**26**	**27**
Nitrite (mg/l)	0.24	0.18	0.12	0.11	0.13	0.10
Nitrate (mg/l)	4.15	3.04	<2.0	<2.0	<2.0	<2.0
Ammonia (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Phosphate (mg/l)	0.41	0.21	<0.15	<0.15	<0.15	<0.15
Phenols (mg/l)	0.0105	0.002	0.002	<0.002	0.002	<0.002
TPH (µg/l)	4.3	9.1	4.9	3.5	4.1	4.6
PAH (mg/1)	10.45	7.45	10.5	6.85	12.8	14.55
Surfactants (mg/l)	0.15	0.155	0.13	<0.10	<0.10	0.135
Chlorophyll *a* (µg/l)	8.84	9.25	6.78	6.91	8.62	10.08
pH	8.09	8.09	8.06	8.04	7.93	8.13
Dissolved oxygen (mg/l)	5.8	5.5	5.5	5.6	5.5	5.6
Temperature (C)	20.2	20.0	19.6	19.5	19.4	19.9
Salinity (%)	1.15	1.13	1.13	1.13	1.12	1.13
Depth (m)	3.7	4	3.6	5.09	5.1	5.5

Conductivity, salinity and pH varied little between samples or stations, and between the 1996 and 2000 surveys. All values were within the normal seasonal range for the Caspian Sea.

Chlorophyll *a* concentrations measured in the 2000 survey lay within a narrow range from 6.78 to 10.08 µg/l, and showed no significant variation between samples or stations. These concentrations reflect typical levels of phytoplankton biomass and production and indicate the absence of 'bloom' conditions at the time the samples were collected.

The majority of the metals analysed in the 2000 survey were below the limits of detection (cadmium, chromium, copper, mercury and lead). This was also observed during the 1996 survey.

Several stations in the 2000 survey exhibited particularly high iron concentrations, almost certainly due to the inclusion of re-suspended bottom sedimentary material in these samples. Iron concentrations of 264 µg/l at station 26 and 109 µg/l at station 5 in the near seabed samples were recorded. High iron concentrations were also recorded in 1996 survey. Zinc concentrations were around 50 to 60 µg/l in most samples; where higher concentrations were observed, these occurred in surface samples. Trace metal concentrations are based on the analysis of 'total' extracts and therefore do not necessarily represent the concentration of the dissolved ion but also include a component of particulate bound metals. Dissolved zinc at the reported concentrations would be potentially toxic to some marine species.

6.3.4.2 Plankton

Samples for phytoplankton and zooplankton identification were collected in the 2000 survey, but not in 1996. The phytoplankton community consisted entirely of endemic species commonly found in coastal waters and was reasonably diverse but also quite patchy. The zooplankton community was dominated by non-endemic species and was less diverse than the phytoplankton community. A number of endemic taxa were however, present. Most notably was a complex of cladoceran species which is characteristic of the Caspian. The non-native ctenophore Mnemiopsis leiydi was abundant at most stations, and accounted for a high proportion of the zooplankton biomass.

6.3.4.3 Phytoplankton

Samples were collected from near-surface and near-bottom at 6 stations during the 2000 baseline survey. A total of 30 taxa were recorded in the samples. Twenty-one were diatoms, six were dinophytes and three were blue-green algae. The diatoms were represented by 13 genera with *Chaetoceros* and *Nitzschia* the most diverse.

Of these 21 taxa, 15 were present at only one station each, nine were present at 2 or 3 stations, and only six were present at 5 or 6 stations. The number of taxa present at each station ranged from 9 to 15.

The most abundant taxa were the diatoms *Chaetoceros* sp., *Nitzschia tenuirostris* and *Thalassionema nitzschoides* and the dinophytes *Prorocentrum cordata* and *Prorocentrum scutellum. T. nitzschioides* and *P. cordata* were the most abundant species overall; the former represented between 20% and 35% of the community at each station while the latter represented between 29% and 47% of the community at each station (Table 6.12).

Table 6. 12 Distribution of abundance by taxon (%)

Taxon (%)	Station						Average (%)
	5	7	11	20	26	27	
Chaetoceros sp.	10	4	0	5	3	11	5
Thalassionema nitzschioides	20	31	31	35	23	30	28
Nitzschia tenuirostris	3	11	8	5	11	10	8
Prorocentrum cordata	47	40	29	40	40	34	38
Prorocentrum scutellum	9	9	4	6	13	6	8
Total	**89**	**95**	**82**	**90**	**90**	**92**	**90**

The total abundance of algae was very similar at all stations, ranging between 54,280 cells/l and 75,800 cells/l.

6.3.4.4 Zooplankton

A total of nine zooplankton taxa were recorded in surface and bottom samples collected from six stations during the Sangachal 2000 survey. These comprised five species of Cladocera, four species of copepoda, and one species of ctenophora. One species of copepod (*Eurytemora*) and all the cladocerans are endemic; the remaining taxa are invasive species having probably arrived from the Black and Azov seas.

Cladocera were present at all stations but only one species, *Pleopis polyphemoides*, was present in all samples. *Polyphemus exiguus* and *Evadne anonyx prolongata* were present at five stations. Two subspecies of *Podonevadne* were present at only three stations. Cladocera were present in low numbers at all stations. In general, diversity was greater in stations closer to shore while the highest abundances were recorded in samples from stations further from shore. *Pleopis* was the most abundant cladoceran.

Juveniles of the ctenophore *Mnemiopsis* were present in all but one sample. *Mnemiopsis* is an invasive species, probably introduced from the Black Sea, where it has caused substantial ecological damage. *Mnemiopsis* is a predator on zooplankton as well as fish eggs and larvae, and has itself no natural predators in the Black Sea. Little is known about its ecology in the Caspian and it is possible that it also has no predators here.

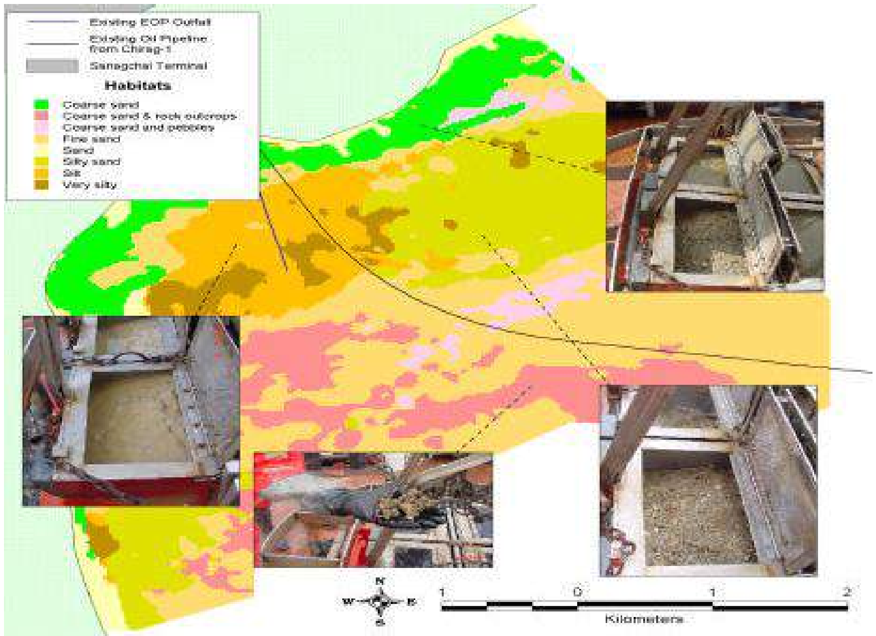
Total zooplankton biomass ranged from 277.4 mg/m^3 to 6.3 mg/m^3. *Mnemiopsis* accounted for between 71% and 91% of zooplankton biomass at all stations. The size and character of *Mnemiopsis* is such that it will inevitably be this much, or more, of the biomass.

6.3.4.5 Seabed sediments

Sangachal Bay is sedimentary in character and the predominant seabed sediment type is a poorly sorted mixture of silt, clay, sand and shell gravel. In the immediate vicinity of the existing outfall from Sangachal Terminal the seabed consists however, of soft cohesive grey clay with a smooth surface and little sand or shell content. Other similar but isolated muddy patches also occur within the Bay. Sediments in the shallows within 200 to 300 m of the shoreline tend to be less muddy and are often rippled as a result of wave action. South of the outfall, approximately 2,000 to 3,000 m offshore, sediments are coarser and are overlain to varying extents (20% to 99% cover) by a 2 to 4 cm layer of hard carbonate concretion having the appearance of a flat ‘pavement’. Figure 6.32 shows the types of seabed within Sangachal Bay surveyed during June 2000 with photographs of samples collected from various habitats.

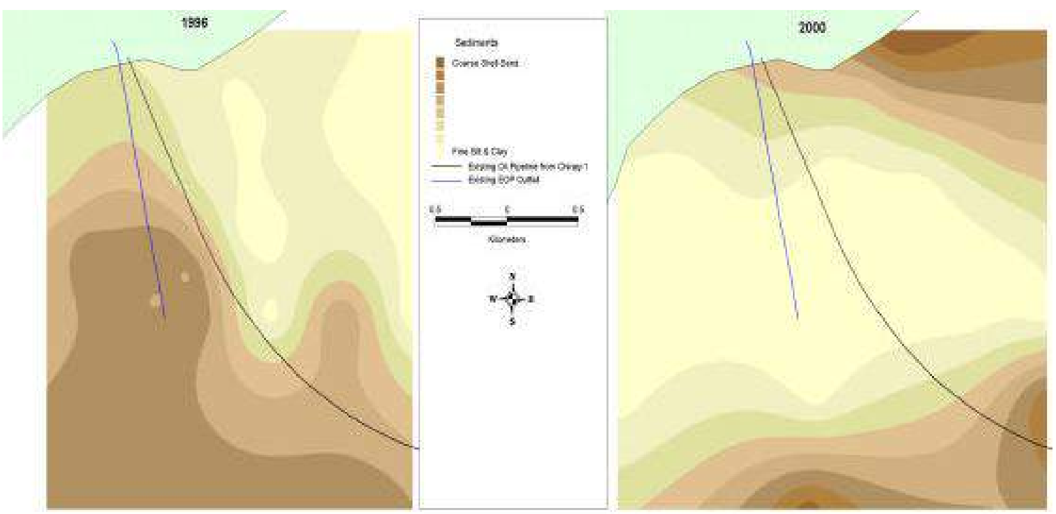
A comparison of the distribution of sediment mean particle diameter between 1996 and 2000 (Figure 6.33) indicates that there has been a substantial change during the intervening period. In the 2000 survey, there was a central band of fine sediment with coarser material nearshore and to the south. In 1996, the finest sediments were located closer to shore and there was a more consistent gradation of increasing particle size with increasing distance offshore.

Figure 6.32 Ground types in the Sangachal nearshore environment



In both surveys, however, the same relationships were observed between particle diameter, carbonate content, silt/clay content, and organic content. It is thus reasonable to conclude that the sediments of the shallow Sangachal area are highly mobile, and may regularly be re-distributed by wave action as described in Section 6.3.3.

Figure 6.33 Comparison of mean sediment particle diameter between the 1996 and 2000 Sangachal surveys



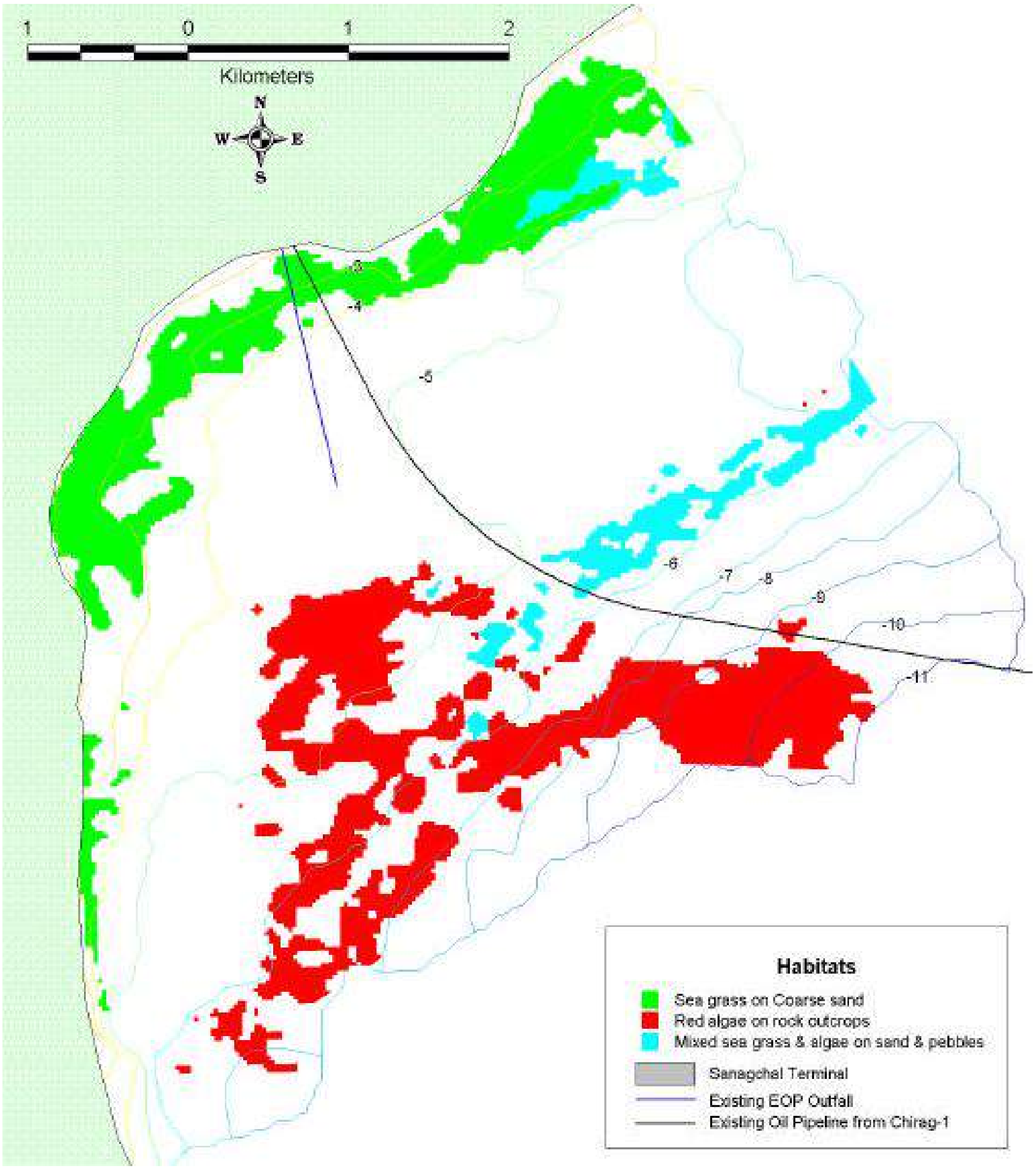
6.3.4.6 Marine flora

Algae and seagrass are important because they are one of the most productive components of the marine ecosystem, supporting a rich fauna and used as nursery areas for fish and foraging areas for birds. A seabed mapping survey was completed in June 2001 of the nearshore waters of Sangachal and samples of algae and seagrass were collected for identification. The distribution of the seagrass and algae was patchy and primarily influenced by sediment type (Figure 6.34).

The flora of the shallow water areas adjacent to the shoreline is dominated by dwarf seagrass (*Zostera noltii*). Less extensive areas of seagrass were also found a few kilometres from the shoreline. Seagrass was observed growing in areas of coarse grained sediment, coarse sand, coarse sand and mud, coarse shelly sand and areas of gravel/pebbles. Seagrass was not found growing in areas with rock outcrops or fine grained sediment composed of mud. These types of substrata do not allow the development of root networks.

Zostera species form continuous mats which extend marginally by growth of stolons. New beds and new individuals initially suffer high mortality and can take five years to establish and stabilize. *Zostera* beds area particularly sensitive to fragmentation and small patches show much higher mortalities. The majority of growth takes place in the spring and summer and established patches can enlarge at 0.5 m per year. Seeds probably do not play a major role in the life history of *Z. noltii*, although they could permit survival during extremely adverse periods.

Figure 6.34 Seagrass and Red Algae distribution in Sangachal Bay



During the recent seabed mapping survey six species of red algae, five species of green algae, and a single species of xanthophyta were identified (Table 6.13). The majority of the red algae were growing on a variety of substrata including live mussels and barnacles, and dead shells. Only a limited number of samples were retrieved from areas of rock outcrop. This is probably a function of limitations of the grab sampler in obtaining samples from these areas.

All the red algae were of a filamentous morphology and mostly members of the Ceramiales. This was possibly due to the sedimentary substratum and high natural turbidity of the water, which would select against morphologies (e.g. foliose, crustose) more likely to accumulate silt and hinder photosynthesis.

Table 6.13 Algae types identified during 2001 survey

Red Algae - Rhodophyta	*Callithamnion* sp. *cf. corymbosum* *Ceramium sp. cf. tenuicorne* *Osmundea caspica* (synonym *Laurencia caspica* *Polysiphonia denudata* *Polysiphonia stricta* *Acrochaetium/Audouinella* sp
Green algae - Chlorophyta	*Chaetomorpha* sp. *Cladophora* sp. *Enteromorpha flexuosa* *Rhizoclonium* sp. *Spongomorpha* sp
Xanthophyta	*Vaucheria* sp

The lower depth limits of the red algae may be influenced by either light penetration or substratum availability. The upper depth limit of approximately 5 m is apparently determined by the particle size of the sediments, which are too small at shallow depths to support macroalgae. The maximum depth at which red algae were recorded in the present survey was 10 to 11 m. If this depth limit is set by irradiance (typically at approx. 0.05% of surface irradiance; Dring, 1976), it is expected that smaller individuals of perennial species will grow near the lower limit (Kiirikki 1998). On the other hand, if the maximum depth limit is set by substratum availability there is not expected to be any decrease in size of individuals at the lower limit. The poor visibility within the Bay does not allow the use of the video footage to support/disprove this theory. Given the high turbidity observed during surveys, it perhaps can be assumed that algae are light-limited at depth.

The red algae observed fall into two life history categories as follows:

- Annual or ephemeral species, with one to several life histories being completed during the spring, summer and autumn. These include *Callithamnion* sp., *Ceramium* cf. *tenuicorne, Polysiphonia denudata* and *Acrochaetium* sp. Natural variations in population sizes are probably very high, as they are able to rapidly recolonise areas affected by changes in sedimentation and water turbidity.
- Perennial species include *Osmundea caspica* and *Polysiphonia stricta*, perennating as mature thalli, either entire thalli or holdfasts. Both grow fastest in the spring, occur as large thalli in the summer, and overwinter as perennating bases. The basal perennating bases of both species contain large amount of storage material, and they can safely survive very reduced light or even total darkness for several months. The largest red algae in the samples collected was an endemic species *Osmundea caspica*, and the majority of the other red algae were growing epiphytically on it.

6.3.4.7 Seabed chemistry

The heterogeneous nature of the physical sediment characteristics is also reflected in the chemical composition of the sediments. A detailed comparison between the 1996 and 2000 chemistry data can not be made due to differences in the analytical methods used between contractors and differences in the range of parameters measured.

The distribution of trace metals such as copper, iron and zinc was similar for both surveys. Higher concentrations of these metals in both surveys were associated with fine grained sediments with high levels of silt/clay and organic content, present in the central part of the survey area.

The distribution of metals suggests a variety of sources of input. As noted above several metals (zinc, copper, chromium) are closely associated with iron and with sediments containing high amounts of silt and organic matter. These metals could be of historical geological origin or could be historical anthropogenic contaminants from diffuse sources. Two metals, mercury and lead, do not fit this pattern. Although both metals will tend to adsorb to fine, organic-rich sediments, their distribution is patchier and more localised than that of the other trace metals. Isolated high levels of mercury and lead were recorded in the central part of the survey area in the vicinity of the existing terminal outfall at sample station 13, with high levels of mercury also being recorded in the western part of the survey area. Not enough data exists however, to infer a likely source of these metals as other potential sources have not been studied. With the exception of lead, the range and average values of trace metal concentrations between the 1996 and 2000 survey show little difference. Concentrations of lead in the 2000 survey had increased in comparison to 1996 at nearly all stations.

Hydrocarbons will also tend to adsorb preferentially to sediments with high silt/clay and organic content but in the sediments of Sangachal Bay there is evidence of a tendency towards higher concentrations in coarser sediments. In general, the highest total hydrocarbons concentrations are present in sediments closer to shore and in the south-east of the survey area. The lowest concentrations are observed in sediments in an east-west belt in the centre of the survey area. In the nearshore area there are distinctly higher concentrations at stations in the eastern part of the survey towards Primorsk. Concentrations of hydrocarbons in the 2000 survey had not increased in comparison to the 1996 survey. At some stations 2000 levels were reduced in comparison to 1996. A comparison of the sediment hydrocarbon concentrations is provide in Table 6.14.

Table 6.14 Comparison of sediment hydrocarbon concentrations (μg/g)

Parameter	1996	2000
Min	10	11.9
Max	280	120.2
Mean	121.6	48.9
Median	110	40.4

Analysis for phenols was also completed in the 2000 survey. The concentration of phenols in Sangachal sediments ranged from 2.05 ug/g to 26.4 ug/g. The pattern of distribution of phenol concentrations was associated with water depth; there was a gradual and quite consistent increase in phenol concentration from north to south across the survey area.

6.3.4.8 Macrobenthic biology

Benthic macrofaunal community analysis was also carried out in the nearshore Sangachal environment in 1996 and 2000. In both surveys the macrobenthic fauna retained on a 0.5 mm sieve were identified and enumerated.

The overall number of taxa in the 2000 survey was low, although not untypical of coastal communities. Thirty-one taxa were present in total, of which 20 occurred at only one or two stations and 12 occurred at only one station. Only 13 taxa could be considered widespread in the survey area: three species of mollusc, four polychaetes, five oligochaetes and one amphipod species. Introduced species such as the polychaete Nereis and bivalve mollusc Abra were frequently dominant in terms of numbers, distribution, and biomass. Crustacea (amphipods, cumaceans, barnacles, and crabs) were absent altogether from five of the six stations in the southwest sector of the survey area.

The most obvious trend is that molluscs (especially Abra) dominated the east/northeast sectors of the survey area while annelids (especially oligochaetes) dominated the west/southwest sector. Gastropods were present in the centre of the survey area, but were most diverse and abundant in the south. Oligochaetes dominated numerically at eight stations, polychaetes at two stations, and molluscs at 15 stations. This provides a general picture in which filter-feeding (Mytilaster, Cerastoderma) and selective deposit-feeding molluscs (Abra) are numerically dominant in the east and north-east of the survey area, and deposit-feeding oligochaetes are numerically dominant in the west and south-west of the survey area.

The harder substrata support species assemblages characterised by bivalve molluscs, barnacles and filamentous red algae (*Ceramium*, *Polysiphonia*, *Callithamnion*, *Laurencia*).

The numerical range of most community statistics was larger in 2000 than in 1996 (Table 6.15). Although the maximum number of species at any one station was higher in 2000, it is worth noting that the average number of species per station was lower. Average diversity was also lower in 2000 and average dominance was correspondingly higher. The differences between years are not large, however, and both surveys provide similar pictures of a community of limited diversity.

Table 6.15 Comparison of community statistics between 1996 and 2000 surveys

Parameter	No of taxa	No of individuals	Shannon-Wiener Function Hs	Pielou's evennes index	Simpson's dominance index
1996					
Min	8.00	101.00	1.65	0.50	0.18
Max	16.00	3869.00	2.63	0.82	0.48
Mean	11.25	1010.61	2.26	0.65	0.27
2000					
Min	4.00	43.00	0.74	0.31	0.22
Max	21.00	6254.00	2.93	0.82	0.82
Mean	8.56	1922.16	1.80	0.60	0.59

A common feature between the two surveys is the dominance of the communities by the same small number of taxa. In both years, *Nereis*, *Abra*, *Mytilaster* and oligochaetes were the most abundant and widespread organisms, with the first three groups more abundant in coarser sediments and the fourth more abundant in finer sediments. A brief comparison indicates a larger number of cumacean species in

1996 and a larger number of gastropod species in 2000 but some of this difference could be attributable to differences in taxonomic convention.

Biomass (measured as grams blotted wet weight per square metre) was dominated at most stations by molluscs (*Abra*, *Mytilaster*, and *Cerastoderma*). Total biomass ranged from 1 g/m^2 at station 2 to 505 g/m^2 at station 25. At eight stations annelids and crustacea represented more than 10% of the biomass with one exception where biomass was comparatively low (less than 60 g/m^2).

Annelid biomass ranged from 0.02 to 4.66 g/m^2, while the biomass of crustacea (where present) ranged from less than 0.01 g/m^2 to 98.94 g/m^2. In general the biomass of crustacea was greater than that of annelids. The highest crustacea biomass values were recorded in samples where the barnacle *Balanus* was most abundant.

6.3.4.9 Caspian Seal

No quantitative information is available on numbers and distribution of the Caspian seal (Phoca caspica) in the Sangachal Bay area. There are no reported haul sites in the immediate vicinity. Anecdotal sightings have however, been made and during the June 2001 terrestrial survey; a number of dead seals were noted on the shore. It is believed that these animals probably died due to the severe outbreak of canine distemper virus (CDV) which has been the primary cause of a massive die-off throughout the Caspian over recent months.

6.3.4.10 Marine reptiles in Sangachal Bay

No quantitative information is available on numbers and distribution of marine reptiles in Sangachal Bay. It is widely known however, that water snakes and turtles are present in the area and these species inhabit lengths of coastline where conditions are suitable for feeding and shelter. Further information can be found in Section 6.4.3 and 6.4.4. A grass snake species *(Natrix tessellata*) is often observed in the coastal waters around Sangachal, as well as in the adjacent reed beds and inland wherever marshy habitat is available. They readily take to the water being able to stay submerged for minutes at a time. This snake's main prey species include marsh frogs and small fish which often congregate in 'nurseries' close to the shore where they can avoid large predatory fish. The species is non-poisonous.

6.3.4.11 Sangachal fish population studies

A series of four seasonal surveys conducted between July 2000 and June 2001. Each survey was designed to provide a comprehensive overview of the status of resident fish populations. Fish species were selected that were most likely to be vulnerable to any impacts arising from the expansion of the Sangachal terminal. Within each survey, fish samples were collected to measure both physical and physiological characteristics of the population. In addition to these, a measure of water quality (pH, turbidity, dissolved oxygen, surface water temperature and salinity) was conducted at each sample site using a range of environmental measures.

Fish were collected using two gear types: small mesh trawl nets to sample the nearshore populations at six stations and five fixed gill nets placed further out in the bay at a depth of approximately 5 m. The location of the sampling stations is shown in Figure 6.35. A total of 17 fish categories were identified to species level or family. Of these, three species, *Atherina mochon caspia* (sandsmelt), *Rutilis rutilis kurensis* (vobla) and *Neogobius fluviatilis pallsai* (goby) were sampled in sufficient number to collect a range of physical measurements to describe demographic characteristics of each population.

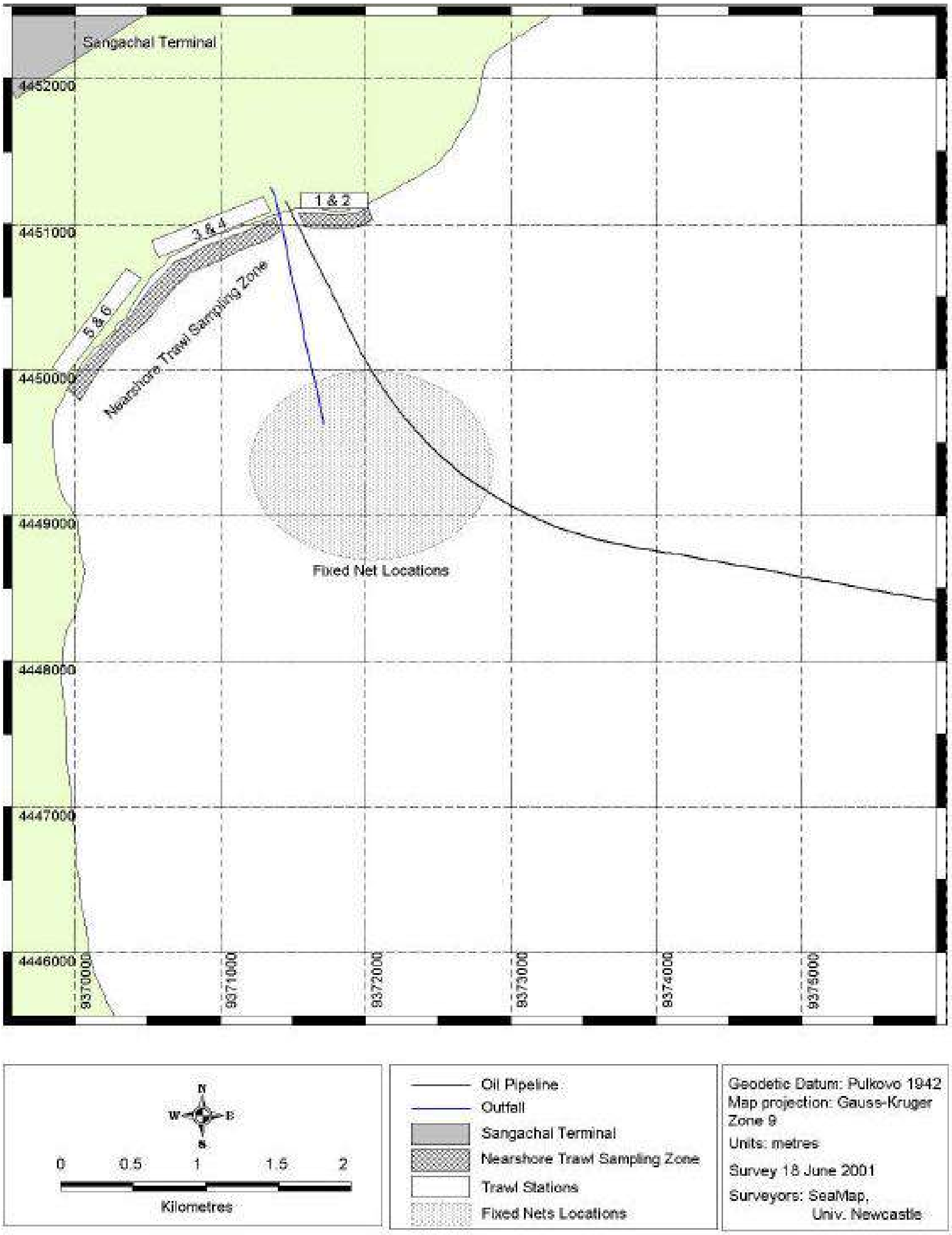
Measurements of total fish length and maturity showed that each gear type had selected a different range of the population. Trawl stations contained samples of several age classes of smaller species and juveniles of larger fish whereas the fixed nets caught only larger adult individuals.

Weak seasonal trends in overall abundance were observed with most species at minimum abundance in the March 2001 survey. Seasonal variation was greatest in those species which grow to a larger size and which range more widely as adults (e.g. roach, mullet and herring species). It is presumed that these fish use Sangachal primarily as a nursery area.

Only weak seasonal trends in length and mass were observed in the majority of fish species caught in trawl nets. This is presumed to be a reflection of the points made above; that is, the catches were of mixed age classes for some small species and/or that the area was used by specific size or age classes of larger species.

In fixed net catches, variation in average length between surveys was limited for roach and mullet but was more marked for kilka and sprat. Variation in mass was more marked in kutum and mullet and was also substantial in herring and sprat. The variations did not coincide however, indicating that there were differences between cyprinids (carp) and clupeids (herring) in migration patterns and in the timing of spawning.

Figure 6.35 Sangachal coastline and sampling locations


Sangachal Terminal
4452000
4451000
4450000
4449000
4448000
4447000
4446000
9370000
9371000
9372000
9373000
9374000
9375000
1 & 2
3 & 4
5 & 6
Nearshore Trawl Sampling Zone
Fixed Net Locations
N
W
E
S
0
0.5
1
1.5
2
Kilometres
Oil Pipeline
Outfall
Sangachal Terminal
Nearshore Trawl Sampling Zone
Trawl Stations
Fixed Nets Locations
Geodetic Datum: Pulkovo 1942
Map projection: Gauss-Kruger Zone 9
Units: metres
Survey 18 June 2001
Surveyors: SeaMap, Univ. Newcastle

A number of physiological measurements were made on larger fish caught in the fixed nets to quantify the level of toxins present. The scope of work identified roach (*Rutilis* spp.), gobies (*Neogobius* spp.) and carp (*Cyprinus* spp.) as the most appropriate resident species. During the field sampling insufficient numbers of carp were caught for further analysis. Blood samples were taken from larger specimens to analyse for total albumen content and the presence of micronuclei in red blood cells and sub-samples of fish tissue (muscle and liver) were taken to analyse heavy metal concentrations.

Large variations were observed in the total albumen content and the presence of micronuclei in blood samples. Much of the study concentrated on roach (*Rutilis* spp.) and gobies (*Neogobius* spp.) which provided only small sample sizes. The background incidence of micronuclei was estimated at approximately 1.8 per thousand cells. No data are currently available on the presence, or concentration of potential mutagens or clastogens in the marine environment at Sangachal.

The level of heavy metal concentrations in goby (*Neogobius* spp.) muscle and liver tissue exhibited some clear systematic relationships although these are not consistent between surveys. These differences could be attributed to changes in their exposure conditions between surveys but could also be strongly influenced by biological processes. Concentrations of most metals were lower in the liver of fish caught in the fixed net than in the liver of those caught in nearshore trawls. The exception to this was mercury, where concentrations were higher in the larger net-caught fish than in trawl-caught fish.

This survey was conducted to fill a recognised data gap (the lack of comprehensive recent data on Sangachal fish populations) and there is thus an inadequate basis for comparison with previous data. Nevertheless, samples caught throughout the survey period showed no external signs of stress or pathology. It is likely that the data presented in this report describe fish populations that are currently healthy.

6.3.4.12 Seabirds

Ornithological surveys in the late 1950's recorded between 160 to 180 bird species in the Apsheron peninsular area (Gambarov et al., 1958; Gambarov, 1960; Mustafaev *et al.*, 1968). Over 200 species were identified during recent surveys and the majority of these species were found in the Shahdilli-Pirallahi area (Sultanov and Kerimov, 1998, 1999).

According to these most recent surveys, the average abundance of birds along Apsheron coastline up to Pirsagat cape is 668 individuals per kilometre. The highest density of bird population occurs between Pirallahi Island - Beuk Tava - Shahdilli Cape. There is a direct relationship between the number of species and the winter conditions experienced on the Apsheron Peninsula. Every three to five and 10 to 11 years, when the coldest winters occur, the number of individuals can increase a few times, especially swans, pelicans and geese.

Table 6.16 indicates the most abundant bird species that reside within the area. Other nesting species are: moorhen (*Gallinula chloropus*), coot (*Fulica atra*), purple gallinule (*Porphyrio porphyrio*), great white egret and little egret (*Ardea alba* and, *Egretta garzetta)* purple heron (*Ardea purpurea*), shelduck (*Tadorna tadorna*), ruddy shelduck (*Tadorna ferruginea*), Caspian plover and little ringed plover (*Charadrius dubiu and C.alexandrinus*) and the black-winged stilt (*Himantopus himantopus*).

Table 6.16 Bird count data from the Apsheron peninsula

Location	Cormorant *Phalacrocorax carbo*	Herring gull *Larus argentatus*	Common tern *Sterna hirundo*	Sandwich tern** *Sterna sandvicensis*	Total
Shahdili	100	3000	6000	2000	
Garabattag Island	190	50			
Bolshaya Plita Island	60	1500			
Malaya Plita Island	30	500			
Podplitochny Island	180	1200			
Yal Island	200	3000			
Islands Koltish, Dardanell, Greben		100			
Goo Island	30	100			
Light house sign		100			
Pirallahi island* (30)	50	250			
Jilov Island		200	140		
Total	**840**	**10000**	**6350**	**2000**	**20,350**

* Nesting on oil rigs around the island.
** Endangered species.
Source: Sultanov and Kerimov, 1998, 1999

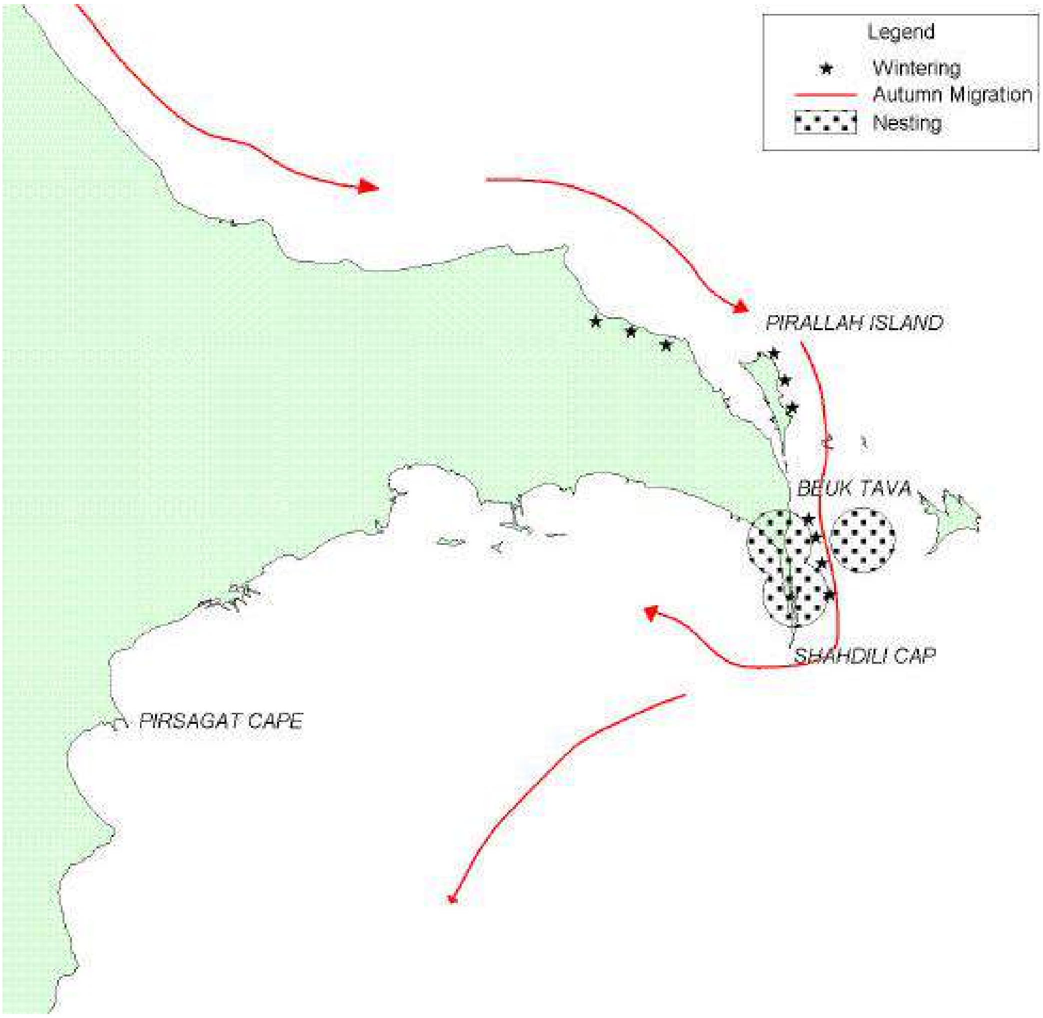
Migration, feeding and nesting patterns

The majority of the species found in the Apsheron Peninsula (41%) use the area during the migration period. Thirty-four percent are resident species whilst the remaining 25% use the area for over wintering purposes. Bird species residing in the Apsheron Peninsula can be categorised according to their feeding habits:

- birds feeding on fish including grebe, cormorant, gull, tern, egret;
- birds feeding on plants or invertebrates including grebe (partially), swan, goose, duck, coot, stint; and
- predators that feed on birds or relatively large fish including white tailed eagle and harrier.

The main breeding season is from late March until April when bird numbers are highest. Nesting gulls, terns, cormorants and stints are restricted to mainly uninhabited islands and abandoned oil rigs. Other species such as coots (*Fulica atra*), moorhen (*Gallinula chloropus*), great white, little egrets (*Ardea alba*, *Egretta garzetta)*, purple gallinules (*Porphyrio porphyrio*), shelduck and ruddy shelduck (*Tadorna tadorna*, *T. ferruginea*), prefer reeds and small water bodies whereas the Caspian plover and little ringed plover (*Charadrius dubius*, *C. alexandrinus*) favour open areas of shrub. The location of the main nesting and over-wintering areas with the main migration routes is provided in Figure 6.36.

Figure 6.36 Autumn migration, nesting and over wintering distribution of birds on the Apsheron Peninsula



Pressures and problems

Illegal hunting is a major concern in the Shahdilli area where geese, ducks and coots are regularly captured. A further concern is the historical pollution. Due to the lack of systematic and regular bird counts in recent years, it is difficult to assess whether historic pollution, illegal hunting and habitat loss has a significant impact upon local bird populations. Table 6.17 below highlights the key activities associated with bird populations over the course of the year as well as the key data gaps for these activities.

Table 6.17 Key activities of birds on the Apsheron Peninsula

Activity	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Breeding	Data Gap	Data Gap	Data Gap	Medium	High	High	High	Low	Data Gap	Data Gap	Data Gap	Data Gap
Over wintering	High	High	Low	Data Gap	Data Gap	Data Gap	Data Gap	Data Gap	Low	Low	Medium	High
Migration	Data Gap	Medium	Low	High	Medium	Low	Data Gap	Low	Low	Medium	High	High
Feeding nearshore	High	High	Medium	Medium	Low	Low	Low	Low	Low	Medium	High	High
Feeding offshore	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Medium
Numbers of species	Medium	Medium	High	High	High	Medium	Low	Low	Medium	High	High	Medium
Numbers of individuals	High	High	Medium	Medium	Medium	Medium	Low	Low	Low	Medium	Medium	High
Vulnerability to disturbance	High	High	High	Medium	Medium	Medium	Medium	Low	Low	Medium	High	High

Key (Level of Activity)	High	Medium	Low	Data Gap

6.3.5 Summary of environmental sensitivity

There are several ecological features and processes within Sangachal Bay that have different and overlapping sensitivities. These include:

- presence of seagrass mats and patchy areas of algae;
- shallow water area including areas were seagrass is found, that is used as fish spawning and nursery grounds for juvenile fish; and
- spring time increases in benthic and plankton productivity and recruitment.

Seasonal fluctuations in the environmental sensitivity occur and are illustrated in Figure 6.37. Spring is the most sensitive period of the year. As water temperatures and light intensity increase fish, plankton, seagrass, algae and benthic communities increase productivity. The majority of the annual recruitment also occurs during this period.

Figure 6.38 illustrates spatial variations in the seabed sensitivity. This has been developed using information on the distribution of seagrass and algae as well as sediment types and their mobility. Those areas which support seagrass and red algae have been considered most sensitive as well as fine grained sediments composed of silt which are highly mobile. Disturbance of highly mobile sediments will lead to increased water turbidity as well as increased sedimentation as the sediment settles.

Areas that supported sparse communities of seagrass and red algae or sandy sediments which could support seagrass mats were classified as being of medium sensitivity. Those areas where seagrass or red algae was not found during the survey, and areas composed of silty sand, were assigned the lowest sensitivity.

Figure 6.37 Seasonal changes in sensitivity

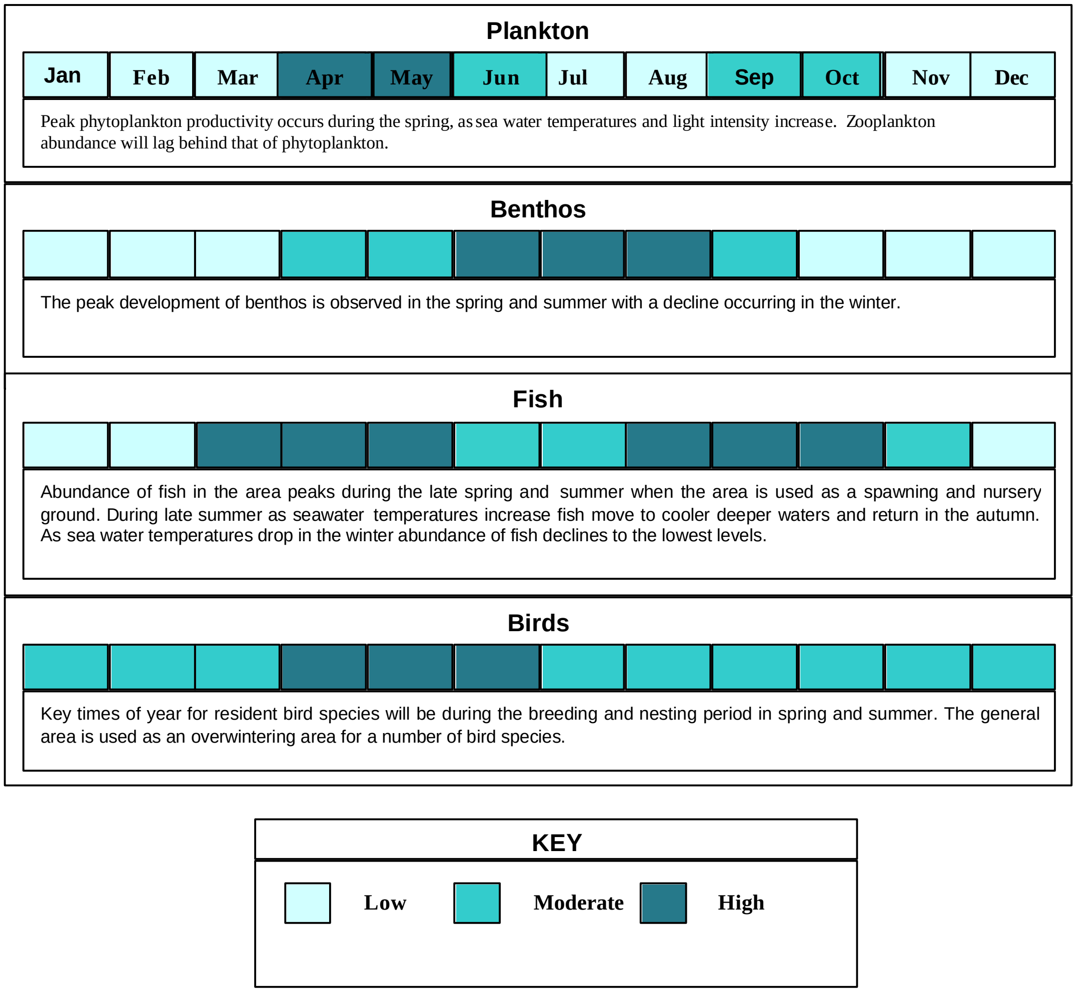
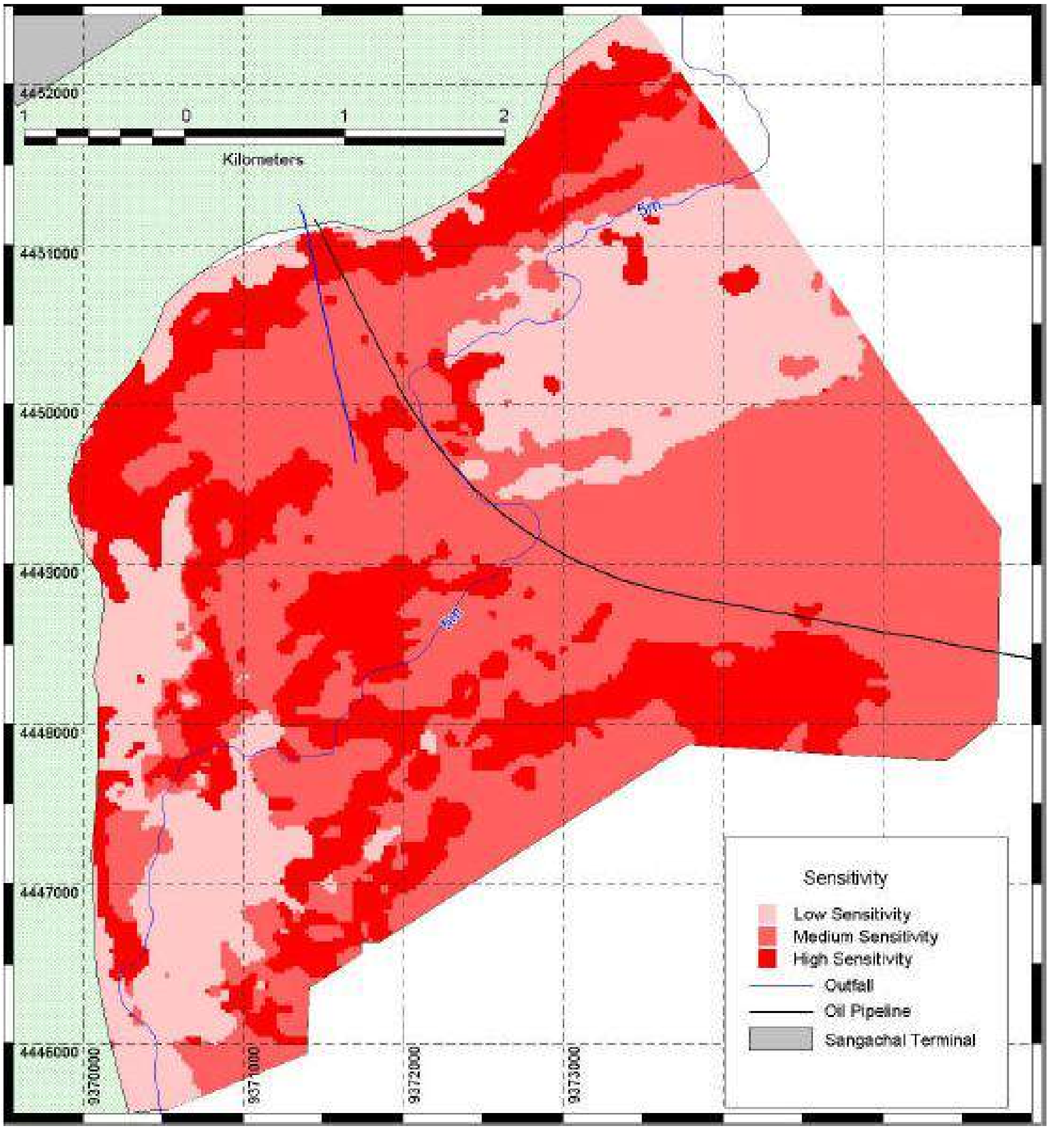


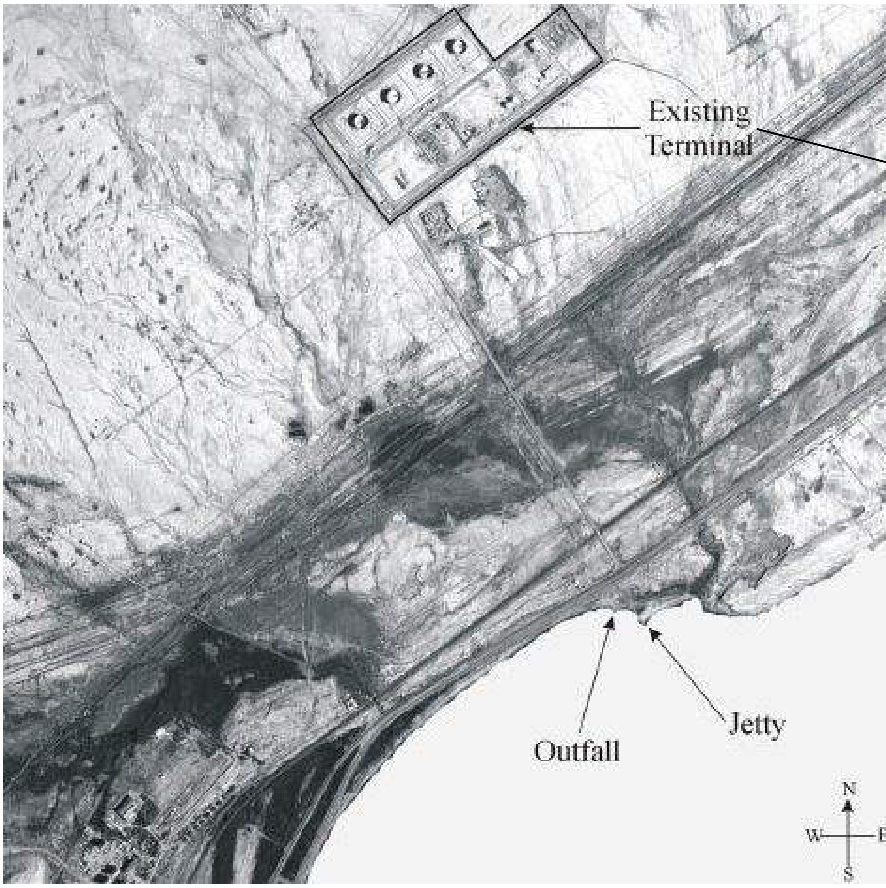
Figure 6.38 Seabed sensitivity



6.4 Coastal and terrestrial environment

This section provides a general description of the environmental conditions in the areas potentially affected by development of the Sangachal terminal and the onshore section of the pipelines delivering gas and condensate from the TPG 500 platform (Figure 6.39).

Figure 6.39 Location of the existing Sangachal te rminal



Location of Sangachal in respect to Azerbaijan and Caspian Sea.

6.4.1 Data sources

In order to describe the terrestrial environment of the Sangachal area an initial and thorough review of secondary data sources was undertaken. These included data gathered from available literature, assessment reports prepared to-date and expert assistance from Azerbaijan scientists. Key data sources reviewed included:

- AIOC 1995: Environmental Baseline Study Literature Review (Woodward Clyde International);
- AIOC 1995: AIOC Environmental Baseline Study Final report (Woodward Clyde International);
- AIOC 1995 AIOC Environmental Baseline Study (Woodward Clyde International); and
- AIOC 1996 Early Oil Production. Environmental Impact Assessment (Det Norske Veritas).

All gathered information was assessed and reviewed to identify data gaps and to scope out appropriate studies necessary to address these gaps. Much of the scientific literature reviewed regarding the ecology in the Sangachal region is dated and hence, the overall information base required updating to enhance the understanding of current environmental conditions and seasonal variability and to augment the level of detail already provided within the existing reports. Scoping workshops were also held with the Azerbaijan scientific and NGO community to identify their opinions and concerns and incorporate these in the survey programme design.

The results of this exercise led to the development and implementation of a field survey programme in May and June 2001. The programme aimed at gathering the baseline data required to enhance the understanding of the environmental conditions in the region. Local scientists were used during the survey to access and incorporate as much local knowledge and expertise as possible.

The surveys covered a 2.5 km radius around the existing Early Oil Project (EOP) terminal (Figure 6.40). This area, although considerably larger than BP's anticipated ecological 'footprint' for both construction and operation of the new terminal facilities, was chosen to account for all aspects of the local environment in consideration of the methods of construction and extent of the Shah Deniz Stage 1 and ACG Phase 1 developments. It was also selected to gain an appreciation of environmental conditions in the wider area. A number of surveys were designed and executed as follows:

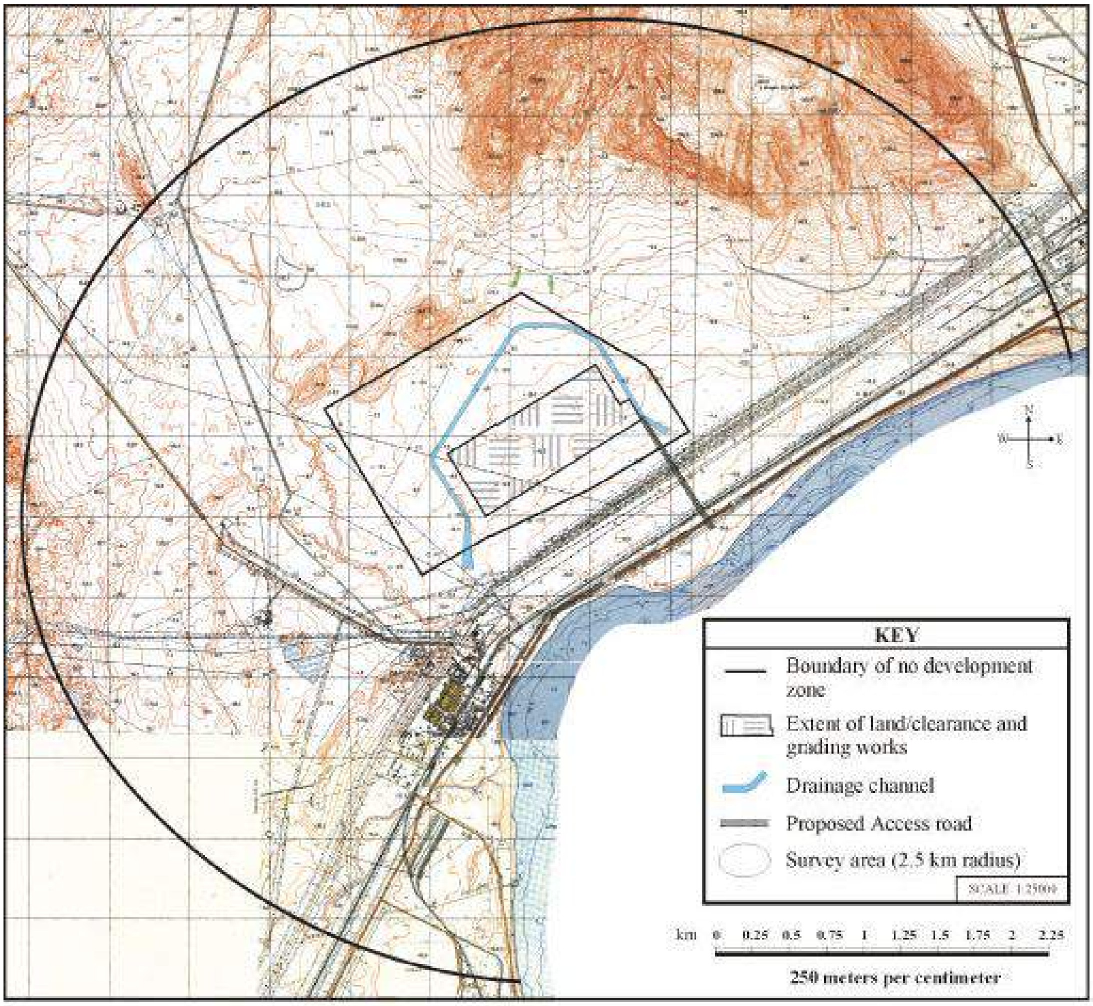
- flora;
- mammals, reptiles and amphibians;
- ornithology;
- archaeology and cultural heritage;
- soil & groundwater; and
- socio-economics.

The following description principally draws on the results of these recent surveys of the inland terrestrial environment. Full reports on each aspect are included as Technical Appendices to this ESIA document.

The environmental parameters investigated are listed below and discussed later in this section:

- meteorology;
- topography;
- soil (surface and subsurface) characteristics and groundwater properties;
- vegetation types, habitats and characteristics; and
- animal classes using various habitats for nesting, migratory passage, and feeding grounds including:
  6 mammals;
  7 reptiles and amphibians (collectively referred to as herpetofauna); and
  8 avifauna (birds).

Figure 6.40 Location and extent of survey area



6.4.2 Meteorology

The meteorology (air temperature, humidity, precipitation and wind regime) for the coastal and terrestrial Sangachal area is very similar to that presented for the nearshore environment. The reader is therefore referred to Section 6.3.1.

6.4.3 Topography and landscape of the Sangachal area

The Sangachal region, including the Sangachal terminal site, is located close to the centre of a flat, low-lying basin that occupies an area of around 32 km^2 along the margin of the Caspian Sea. Within the basin area the land surface is typically 12 to 14 m below the world ocean datum (taken to be the Baltic Sea in Former Soviet Union (FSU) countries) and is therefore approximately 10 to 12 m above the local sea level. The land rises sharply to the north of the basin to form a range of steeply sloped hills with a maximum elevation of 300 to 400 m above the world ocean datum. Ground surface elevations rise more gradually from the Sangachal terminal to the north-west.

The coastal plain gently slopes in a south easterly direction from the hills to the north and west, towards the coastline. The northern hills form part of the Greater Caucasus Mountain range and reach a maximum height of 400 m. The topography slopes steeply from these hills to the central Sangachal region. These plains are divided by the western hills, comprising a small range of mud volcanoes reaching a maximum height of 100 m. A river valley flows from the west hills across the central south area of the coastal plain towards the Caspian Sea located less than 2 km to the east. Beyond the river valley the topography rises gently to the south west to a range of hills located beyond the far western region.

Ground surface topography in the vicinity of Sangachal terminal is fairly uniform with gentle undulations of less than a metre spread over a large area. A railway and road run parallel with the coastline generally less than 100 m inland. From the road, the terrain slopes moderately down to a beach front approximately 10 m lower.

The coastline of Sangachal Bay is formed from sedimentary deposits and debris of reeds and sea grass. The seabed slopes evenly and gradually to the open sea and is comprised of poorly sorted mixtures of silt, clay, sand and shell gravel. There are also isolated patches of very soft cohesive grey clays and areas of carbonate concretions. Sea level rise within the Bay can range from +70 cm to –60 cm during storm surge conditions. The water level of the Caspian has however, fluctuated significantly over time and is currently between 27 m and 28 m below world ocean level.

6.4.4 Geology and geomorphology around Sangachal

The geological structures of this region are the result of the epeirogenic uplift and depression associated with the Caucasus orogenic belt and later marine transgressions and regressions during the Quaternary period. The landscape has been modified as a result of denudation associated with anthropogenic activities and precipitation processes.

The geology of Sangachal is illustrated in Figure 6.41. The area to the north of the Sangachal terminal is dominated by a number of complex geological structures. Most notable are the Dzheirankechmaz depression, which comprises a broad low relief bowl (8 x 10 km), the Miajik structure to the north, the Utagli anticline to the northwest, and the Yanizdag-Sangachal anticline to the southwest.

These anticlines, seen at surface, are associated with Late Pliocene compression with shortening facilitated by deep north west-south east faults. The general sense of movement may be oblique to the underlying faults resulting in right lateral offset with the magnitude of the offset unknown. The large structural features cover areas in the range 25 to 80 km^2 and are separated by faults which are illustrated in Figure 6.42 as red dotted lines.

The Miajik structure to the north of the terminal is an anticline inverted along a pre-existing northeast-southwest fault. The axis is clearly visible, plunging 5° to 9° southwest, as is part of the northern limb dipping to 40° to 45° northwest. The southern limb dips gently 5° to 8° to the south. The crest of the structure has numerous radial faults which may be associated with inversion and/or piercement by mud volcano activity. The southwestern margin of the southeastern limb is seen a major fault scarp trending northwest-southeast; exposure in these cliffs faces is of Apsheron and Akchagyl mud dominated sequences.

Figure 6.41 Surface geology of the South Gobustan region

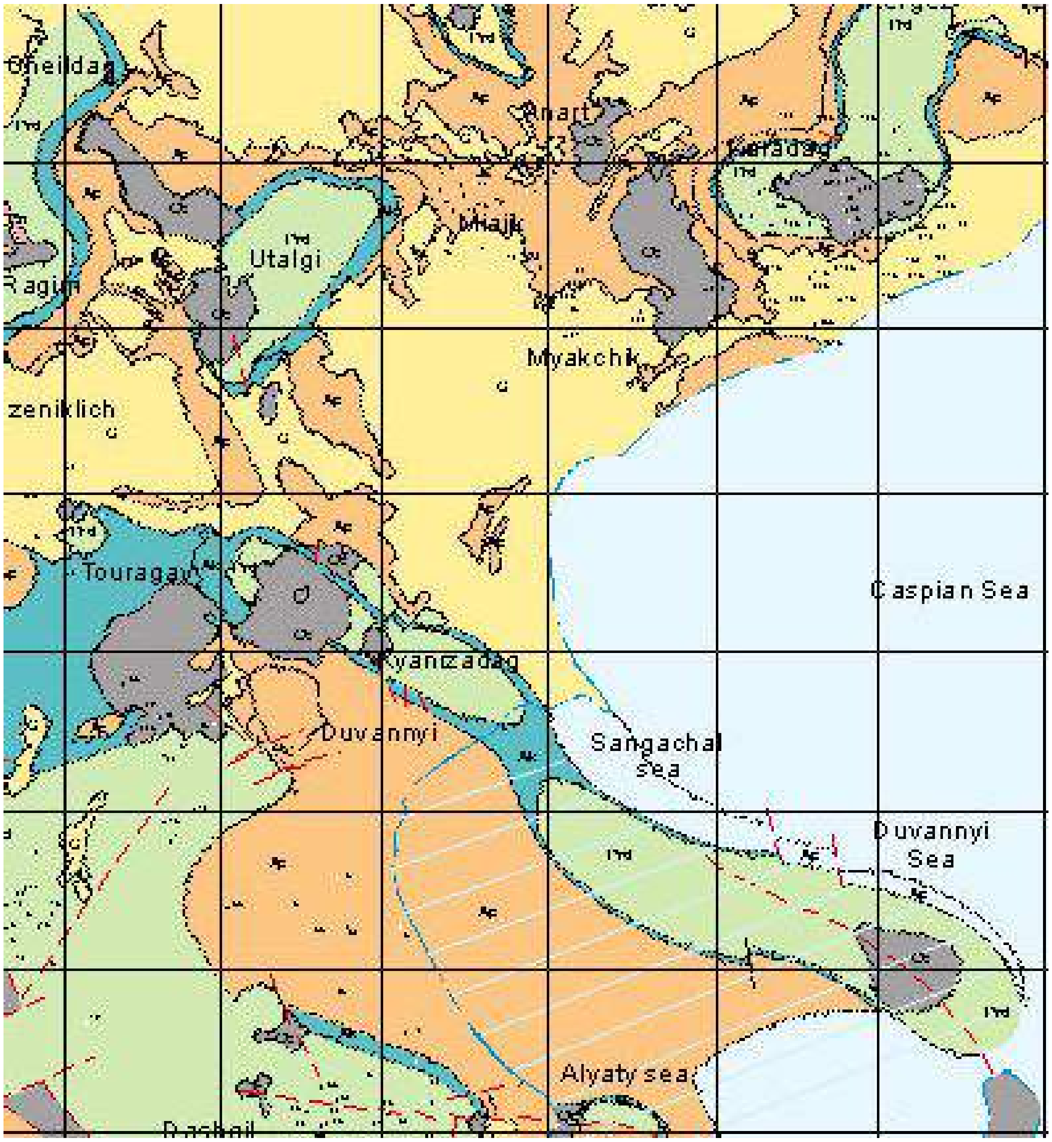
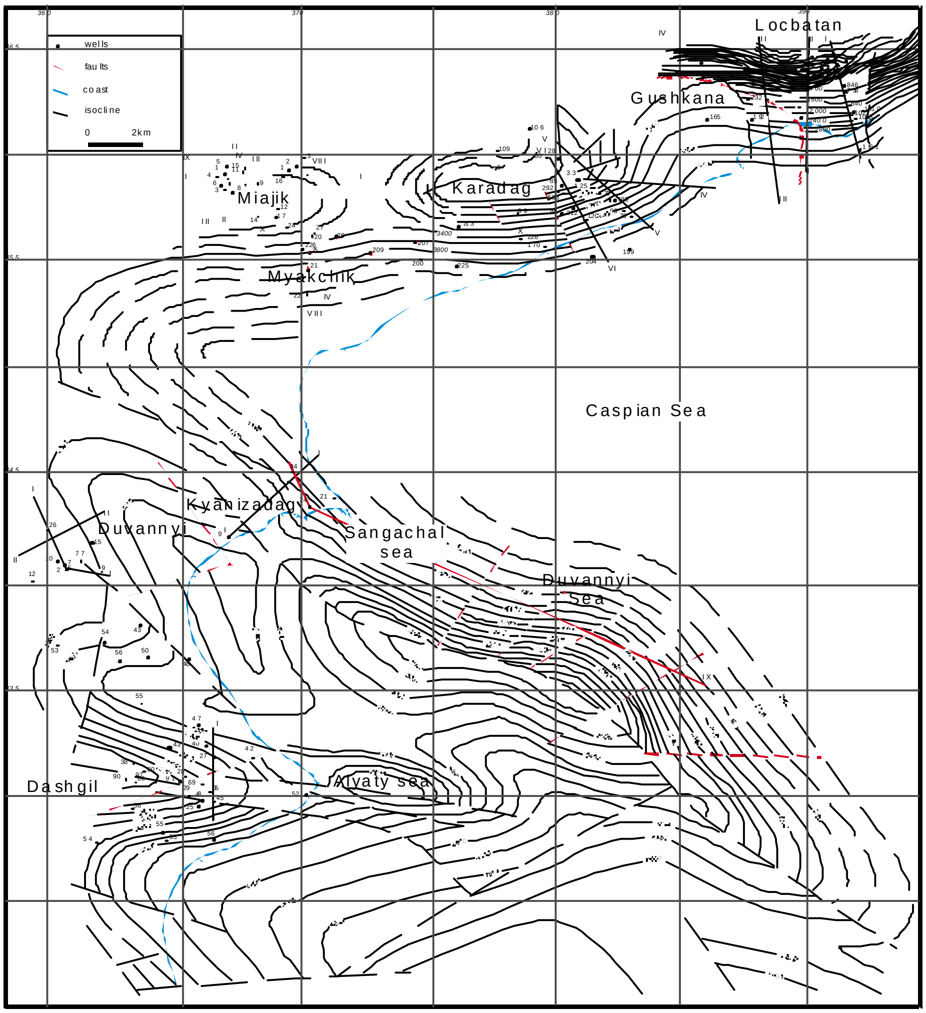


Figure 6.42 Regional geological structures in the South Gobustan region



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The Utalgli anticline to the west of the Myakchik anticline brings the Productive Series to the surface. Structural dips are consistently 25° west with good exposure of the Surakhany Series in numerous stream cuts.

The Surakhany Formation is the youngest formation of the Productive Series, being early Late Pliocene in age (c. 3.5Ma). It is overlain non-conformably by the Akchagyl Suite, a sequence of black carbonaceous mudstones and siltstones, often with thin ash layers that provide the top seal to some of the sands in the underlying Surakhany Formation.

The Surakhany Suite is a thick (c. 1,000+ m) sequence of clastics that become progressively finer grained and mud dominated moving towards the basin.

On the western flank of the Utalgi Anticline the lower part of the Upper Surakhany Formation crops out at the surface, exposed in a series of small ravines and stream cuts. In a recent field excursion the strata were seen to dip at c. 25°E thus some limited exposure is afforded down section. The section comprises c. 200 to 250 m of dominantly fine grained clastics showing a marked upward fining trend divided into two roughly equal units.

6.4.5 Seismicity and tectonics

The Apsheron Peninsula and adjacent area of the Caspian Sea are located in a zone of moderate seismic activity because of their location in the active Alpine folding zone. The abundant mud volcanoes indicate tectonic activity and the likely presence of oil and gas in the deep strata. Five earthquakes with a magnitude greater than six have taken place since 1842 with the most recent, measuring 6.5 on the Richter scale, having occurred on 25th November 2000 with an epicentre 30 km east-northeast of Baku.

6.4.6 Hydrogeology

6.4.6.1 Aquifers

In the vicinity of the Sangachal region there are no reported aquifers used to provide potable drinking water.

For the deeper sandstones hydraulic effectiveness is governed by sand body porosity, permeability, lateral extent and continuity, which in turn are governed by provenance and gross depositional environment. BP's database indicates that the deeper sand bodies such as the Surakhany are sparse, comprising raw well data from wells drilled in the ACG PSA area. There is no analysis of this data available; for example, no porosity / permeability versus depth trend data. Perhaps the closest analogue is the underlying Balakhany Formation, drilled in all of the ACG appraisal and development wells.

Average porosity and permeability data for the Productive Series of the South Caspian have been catalogued by Abasov (1997). These data indicate the Productive Series is likely to retain effective porosity/permeability characteristics to 5,500 mSCS.

The Surakhany aquifer extends down to more than 2,500 mSCS to the south of Sangachal with well data indicating that good porosity/permeability characteristics are likely. Field observations indicate that diagenesis is likely to be a major contributor to reducing rock quality. Compaction is likely to be more important which is determined by burial, clay content and type, and pressure regime. In addition tectonic modification from strike slip movement and inversion (uplift) may play a part. The maximum uplift on the Myakchik structure is perhaps 2,000 m. The effects of facies (i.e. grain size and ductile content) may mask any depth trends but grain size effect may be limited due to most of the sand bodies appearing to have consistent grain size.

Direct field observation in the Utagli area indicates that small scale faults may be common. Two vertical faults were noted 15 m apart, with fault zones up to 50 cm wide and cemented with crystalline gypsum. Crystal orientation within the faults suggests right lateral movement with no evidence seen of any vertical component of throw. Both faults were traced for over 200 m lateral extent and at least 30 m vertical extent. This should be taken as a minimum for fault dimensions in any model; such faults will be sealing. The fault model is superimposed on the depositional model of complex modest scale sand bodies comprising heterolithic facies. Faulting in the area is known from SOCAR mapping to be complex.

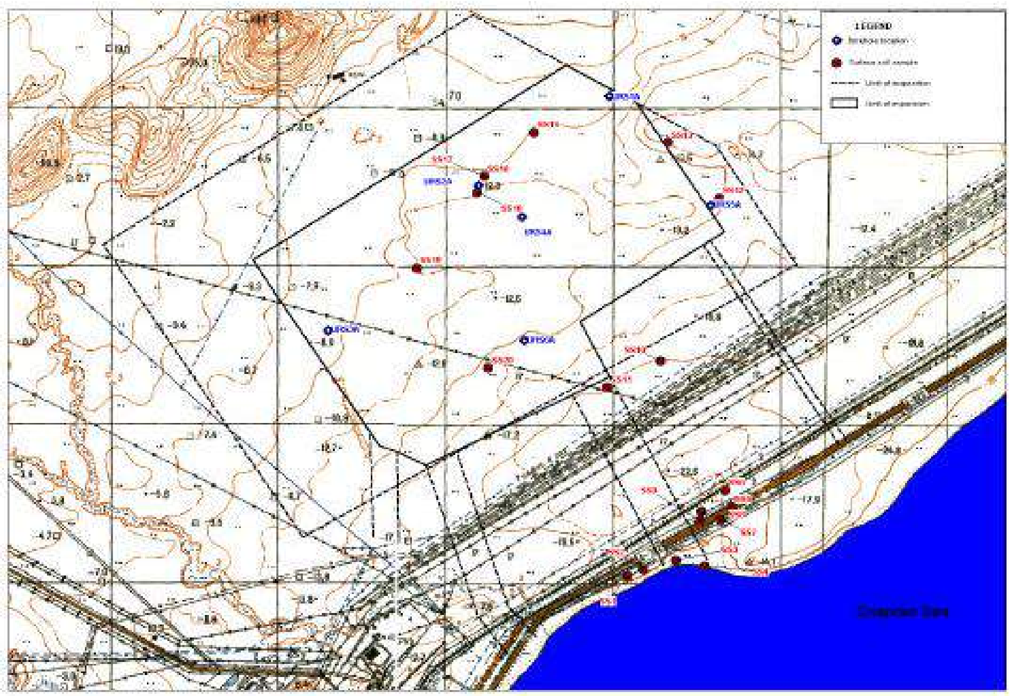
The faults seen in the field are interpreted to have acted as conduits for low temperature mineralisation and will be sealing given the pervasive gypsum cementation which is inferred to be related to the major light lateral fault movement in the Late Pliocene and Quaternary. Mineral rich fluids invaded the coarser [red] sands producing pervasive gypsum cemented layers within some of the sand bodies thus forming 'localised' sub-horizontal barriers / baffles. Thus, while permeable, many sands are likely to be networked with a series of vertical barriers (faults) and sub-horizontal barriers (cemented sands) compartmentalising the aquifers. Both barrier types may have aerial extent equivalent to the sand body size; however there are no statistics quantifying the distribution barrier sizes.

6.4.6.2 Groundwater

A limited soil and groundwater intrusive investigation of the area around the Sangachal terminal was conducted in 1996 (Fugro, 1996) prior to the construction of the EOP terminal. Groundwater was not encountered during the drilling. A previous geotechnical survey of the terminal revealed clay to a drilling depth of 50 m. Anecdotal evidence from the EOP terminal construction project indicates, however, that the groundwater table was between 10 m and 20 m below ground level around the terminal site. The absence of groundwater during drilling may indicate a low permeability with slow ingress of water into the boreholes or the presence of discontinuous bodies of perched groundwater.

An additional intrusive investigation was conducted in the terminal area during May/June 2001 (URS, 2001). The location of the borehole and sediment sampling locations are depicted in Figure 6.43. No groundwater was encountered in the boreholes during actual drilling although a slightly moist, clayey/silty fine sand unit was encountered at 8.5 m below ground level in borehole BHURS1 and after a "standing time" of a few days, a sampling event returned groundwater suggesting low permeability with slow ingress of water. Groundwater recovery was recorded as low to moderate which may indicate a fairly transmissive and productive unit. The remaining five boreholes were dry and the presence of groundwater in only one of the wells suggests that any groundwater present at the site is localised, perched and discontinuous. A general groundwater gradient across the site towards the Caspian Sea may be inferred, broadly similar to the site topography.

Figure 6.43 Environmental borehole and sampling locations



Analysis of the groundwater sample from BHURS1 detected trace concentrations of copper, zinc, lead and iron and a salinity of 15%. Total dissolved solids was recorded indicating a saline sample likely to be in hydraulic conductivity with the Caspian Sea.

6.4.7 Soils

Surface soils in the region of the Sangachal terminal have been formed in desert climate conditions with accompanying 150 mm of winter precipitation and high summer temperatures. These conditions lead to a high rate of disintegration of organic matter. Soils are sierozem with a low humus content, short soil profile and low agricultural productivity. The soils are typically fine-grained clayey silts or silty clays with a low porosity and high salt content, often to a depth of 1 m.

During the intrusive subsurface investigation six boreholes were drilled to a maximum depth of 20 m below ground level (mbgl). In addition twenty 20 soil samples were collected in and around the terminal area to a maximum depth of 0.05 mbgl to investigate ground conditions at the proposed terminal site boundaries and surrounding area.

Made ground (i.e. imported fill material) was generally absent across the site and was encountered only in one borehole, namely BHURS1, located in the vicinity of a former oil well. This borehole is located to the northwest of the existing terminal. Made ground was encountered to a depth of 0.6 mbgl.

The geology encountered in the boreholes during drilling generally comprised a stiff to very stiff, light brown to brown, laminated clayey-silty sequence with occasional seams of fine to medium grained sands varying in thickness to a maximum of 12 mm from the ground surface to approximately 13 mbgl. Gypsum (crystals and powder) was noted throughout the unit.

The underlying sequence comprises a very stiff to hard grey clay. Occasional bi-valve fossils were encountered and appeared to confirm a marine provenance of the deposits. A dry, very dense, grey brown, poorly cemented fine sandstone band was encountered in BHURS2 from 5.4 to 6.0 mbgl. Slightly moist, very dense, brown, clayey/silty fine sand unit with occasional laminations was encountered in BHURS1 from 6.0 to 10.00 mbgl.

Standard penetration tests (SPTs) were conducted in five of the boreholes in order to determine the consistency and cohesive nature of the sub soils. The number of blows ("n") indicates an approximation of the strength of the soils and is recorded on the borehole logs. The field tests indicate that the upper clay unit clay had 'n' counts of between 10 to 12 blows per 0.3 m indicating a firm consistency and an inferred cohesion value of 40 to 75 kN/m^3. The lower clay unit had "n" counts of between >50 blows per 0.3 m indicating a hard consistency and an inferred cohesion value of >200 kN/m3.

The following limited olfactory and visual observations of potential contamination were noted during this survey:

- ashy silt was noted on the ground surface near BHURS2 possibly indicating a fire in the vicinity of the former oil well (surface soil samples SS15 - SS18);
- black stained surface sediments were noted in the wadi located south of the site (surface soil samples SS5 and SS6);
- dark grey silty ash was encountered between the railway tracks and coast road (surface soil sample SS7); and
- a sulphurous odour was noted on the groundwater abstracted from BHURS1.

Thirty eight soil and surface sediment samples were submitted for chemical laboratory analysis for Total Petroleum Hydrocarbons (TPH) and metals (i.e. arsenic, barium, cadmium, chromium, copper, iron, lead, mercury and zinc).

Analytical results indicated trace concentrations of arsenic, barium, chromium, copper, iron, lead and zinc in the soil and surface sediment samples. An elevated barium concentration of 1,519.20 mg/kg was detected in SS3 at 0.05 mbgl located near the wadi.[3] Elevated concentrations of copper (578.2 mg/kg) and iron (328.45 mg/kg) were detected in SS7 at 0.03 mbgl located near the railway. Elevated iron concentrations were also detected in SS15 at 0.05 mbgl, SS16 at 0.05 mbgl, SS17 at 0.25 mbgl and SS18 at 0.05 mbgl, located in the vicinity of the former oil well near BHURS2.

In general low TPH concentrations were detected in the soil and surface sediments analysed, with slightly higher concentrations noted in surficial soils than at depth. Elevated TPH concentrations were noted in SS15 at 0.05 mbgl, SS16 at 0.05 mbgl, and SS17 at 0.25 mbgl. These sediment samples comprised ashy silts and the sampling locations were near the former oil well.

[3] Barium is constituent of drilling mud and the high concentration may indicate historic contamination.

Particle size analysis (PSA) was conducted on the twenty surface sediment samples to determine the size distribution of particles. Carbonate and organic content of these samples were determined. This analysis indicated that SS1, SS2, SS3 and SS4 located at or near the coastline comprised well sorted fine to medium sands with a high carbonate but low organic content. The remaining sediment samples from the inland area comprised fine to medium silts with a low average organic content of 3.75% and a low average carbonate content of 27.72%.

6.4.8 Noise

A noise survey was undertaken in 1996 to establish background noise levels in the vicinity of the then proposed location of the EOP terminal facility (AIOC EOP EIA, 1996). The survey results indicated that noise levels were generally high most likely due to road traffic on the Baku-Tbilisi-Iran Highway and windy conditions in the area at the time of the survey.

A more recent noise survey was completed by Acoustic Technology Limited on behalf of BP Exploration (Caspian Sea) Limited in November 2001. The survey was undertaken to establish baseline conditions post-construction and during operation of the EOP terminal and in support of the ACG Phase 1 and Shah Deniz Stage 1 ESIA processes. Recorded noise levels at the nearest sensitive receptors took account of the existing EOP terminal operations. Table 6.18 summarises the results of the 2001 survey as reported in Preliminary Noise Study ACG Full Field Development and Shah Deniz at Sangachal Terminal Sangachal, Azerbaijan (Kellogg Brown and Root, 2002).

Table 6.18 Measured maximum noise levels at nearest sensitive receptors to proposed ACG FFD and Shah Deniz FFD terminals location near Sangachal

Location	Noise Level dB(A)			
	Leq		L_{90}	
	Day Time	Night time	Day Time	Night time
Roadside Café	67	54	52	45
Umid Camp	48	45	45	40
Umbaki	48	42	41	38
Herdsman's Farmstead	48	40	41	33

Note: A night-time measurement at Herdsman's Farmstead was not possible; levels shown for night time were actually taken in the early morning.

In Table 6.18, Leq is the equivalent continuous sound pressure level; that is the time-varying sound pressure level averaged over a period of time. L_{90} is a measure of the background or residual noise level. The Leq measurements for both day-time and night-time at Roadside Café were below 70 dB(A), the World Bank Guideline for commercial properties. The day-time and night-time Leq measurements were below 55 dB(A) and were below or equal to 45 dB(A), the World Bank Guideline for residential premises, at the Umid Camp, Umbaki and the Herdsman's Farmstead. Thus, the measured existing noise levels at the nearest sensitive receptors to the proposed terminal development site are in compliance with the World Bank Guidelines.

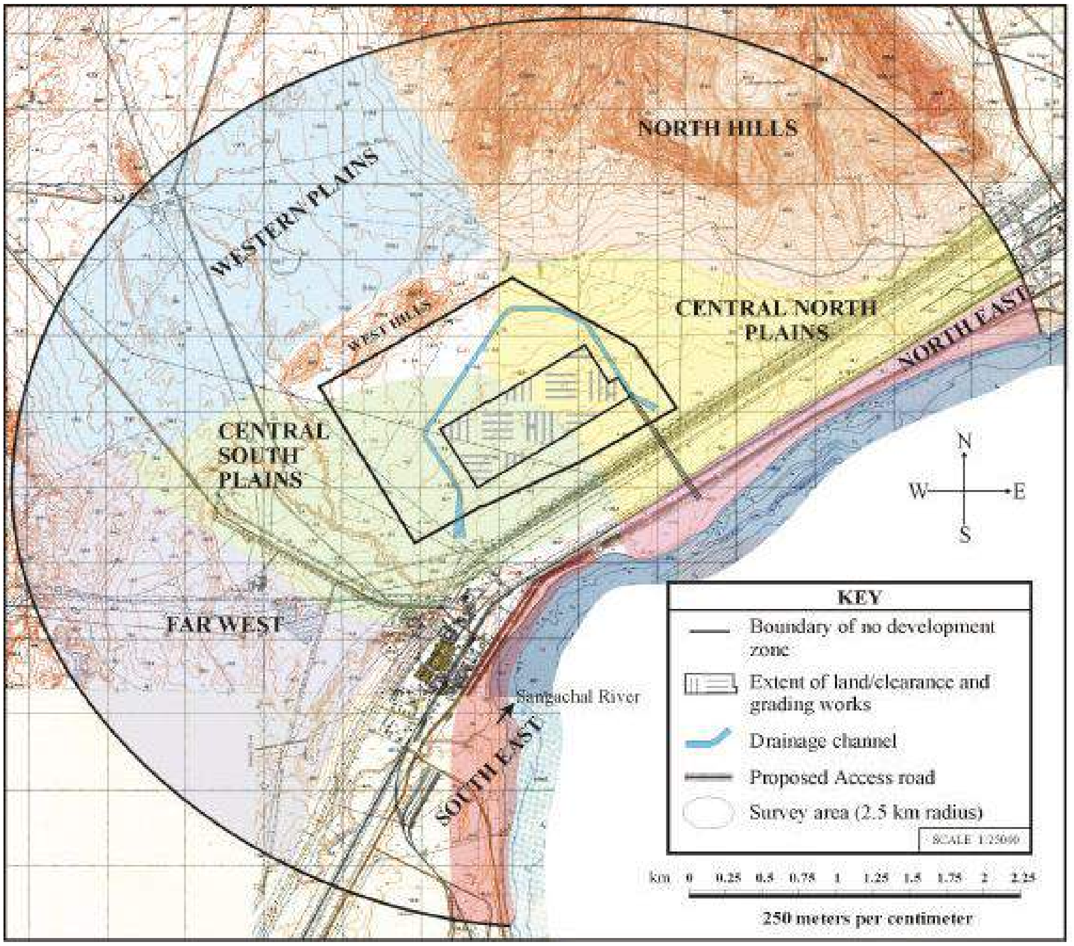
6.4.9 Habitats and characteristics

A flora and fauna field survey was conducted during May and June 2001. The survey area was defined as land within approximately a 2.5 km radius of the existing Sangachal terminal. This area was subdivided, primarily on geomorphological grounds, into eight constituent sectors including:

- Southeast (coastal).
- Northeast (coastal); and
- North Hills;
- Western Plains;
- Far West;
- Central North;
- West Hills;
- Central South;

The geographical location and extent of the each of the sectors is illustrated in Figure 6.44.

Figure 6.44 Geographic location and extent of survey sectors (defined primarily on geomorphological characteristics)



Transects were walked across the survey area to characterise resident biotopes including their composition and constituent species abundance within each sector. Representative 2 m^2 sample plots were selected for species abundance data collection in each of the identified biotope. All species of higher order plants within a plot were recorded using the Domin Scale of Cover Abundance as presented in Table 6.19.

Table 6.19 Domin Scale of Cover Abundance

Domin Scale of Cover-Abundance	For 2 m^2
+	One individual, reduced vigour
1	Rare
2	Sparse
3	<4%, frequent
4	5-10%
5	11-25%
6	26-33%
7	34-50%
8	51-75%
9	76-90%
10	91-100%

The field survey was undertaken in summer and as such, a number of ephemeral and ephemeroid species that can only be readily identified up to April, may not have been accounted for, as stems, leaves and flowers often wither in summer making identification difficult. For this reason, wherever possible, seeds, roots and other indicators of these species were noted as evidence of their presence in the survey area. Abundance and distribution could not however, be as accurately assessed using these methods.

The following sections present a discussion, in terms of their flora and fauna characteristics, on the biotopes identified within each of the eight survey area sections.

6.4.10 Coastal biotopes

Coastal habitats within the project area play a critical role in the functioning of the region's ecosystems. The habitats integrate the flows of water, nutrients, energy and biota. Within the coastal sectors ecotones (i.e. boundary or transition zones between plant communities) were observed to support a high diversity of species and individuals indicating that they are an important element in the broader ecosystem.

A detailed description of the biotopes and floristic communities identified in the coastal sectors is presented below.

6.4.10.1Southeast sector (SE)

The SE sector was observed to include and support:

- sandy beaches;
- ephemeral, shallow lagoons (i.e. usually waterlogged from September/October to March);
- a few wet (marshy) slacks with riparian vegetation; and
- an area at the southern-most section supporting a heterogeneous arrangement of coastal and semi-desert elements.

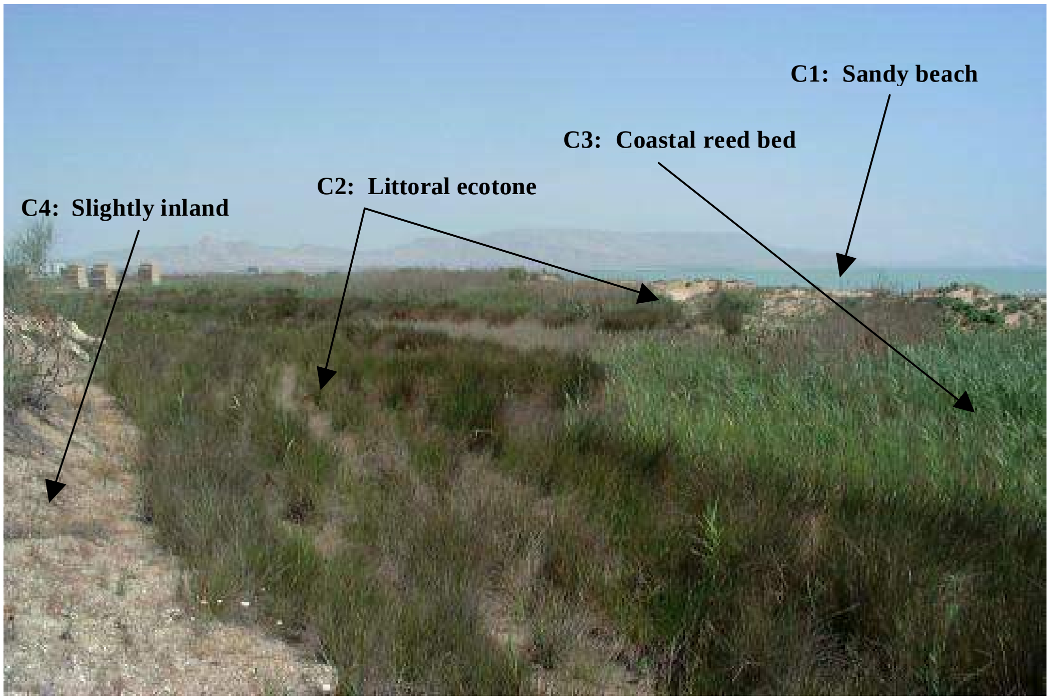
6.4.10.2Northeastern sector (NE)

The NE sector supports similar coastal biotopes to the SE sector. The following disparities were observed and noted:

- overall less wetland (both ephemeral and permanent);
- less habitat associated with more inland areas (e.g. semi-desert) due to its proximity to the Baku-Tbilisi highway (set as the easternmost boundary of the SE and NE coastal sectors); and
- numerous areas of rocky coastline with little to no vegetation.

Both coastal sectors support variable amounts of reed growth and/or tamarisk scrub and have intermittent streams that reach the shore of Sangachal Bay. Representative examples of the prevailing pattern of community sequence along the coastline are detailed below and apply to both SE and NE coastal sectors, albeit with minor differences (primarily in magnitude) as noted above. The coastal communities, referred to as C1, C2, C3, C4 and C5, are illustrated in Figures 6.45.

Figure 6.45 Coastal sector community sequence



C1: Sandy beach with the non-native association *Argusiactum siberica*

The shrub species *Argusia siberica* is a pioneer species; that is, the first to reside in an area (in this case sandy beaches) after which other species may co-reside with or replace it. *Argusia siberica* thicket cover ranged from 20% to 60% with scattered *Phragmites australis* (reed) displaying 5% to 10% coverage. A sample plot in this area yielded *Argusia siberica* as ranking eight and *Phragmites australis* as ranking four on the Domin Scale.

In the NE sector of the coastline, some areas of *Argusia sibirica* thicket is co-dominant with *Convolvulus persicus* thicket, also a pioneer species typical for the Azeri coastline.

C2: Littoral ecotone

Littoral reed beds, an ecotone or transitional zone between two communities containing species characteristic of each, occurs on the wet coastal sand (biotope C1) with *Juncusetum acutus* comprising approximately 70-80% of the ground cover. Community members and Domin Ranking for SE sector littoral ecotone are shown in Table 6.20 below.

Table 6.20 SE sector "littoral ecotone" species and Domin Scale Ranking

Species	Domin Scale Ranking
Juncus acutus	8
Tamarix meyeri	4
Phagmites australis	4
Argusa siberica	4
Alhagi pseodalhagi	4
Poa bulbosa	3
Medicago minima	3
Cynodon dactylon	3
Astragalus species	1
Allium rubellum	1

C3: Reedbeds

Reed thickets are comprised of two species, namely *Phragmites australis* (reeds) and *Juncus acutus* (spiny rush). Some of these thrive year-round and are concentrated about ephemeral streams and in topographically lower areas along the coast. Ephemeral reed beds only thrive from September/October to March/April. Community members and Domin Ranking for SE sector reedbeds are shown in Table 6.21 below.

Table 6.21 SE section "reedbeds" species and Domin Scale Ranking

Species	Domin Scale Ranking
Phragmites australis	10
Juncus acutus	2

Slightly inland from the communities described above (i.e. C1, C2, C3), and especially in the southern section of the SE sector where the Baku-Tbilisi Highway is located further from the Caspian shoreline, a more complex floral community develops consisting primarily of the *Alhagietum psedalhagi* association with a ground cover of approximately 60 to 70%. This includes some halophytic species (i.e. plant that grows in saline soil) typical for the inland semi-desert biotope. Community members and Domin Ranking are shown in Table 6.22.

Table 6.22 SE sector "slightly inland" species and Domin Scale Ranking

Species	Domin Scale Ranking
Alhagi pseudalhagi	7
Argusia siberica	5
Suaeda dendroides	4
Salsola denproides	4
Bromus japonicus	4
Medicago minima	3
Adonis australis	2
Poa bulbosa	2

Two of the three rare and endemic species, *Calligonum bakuense* and *Astragalus bacuensis*, were found in this slightly inland community. These species are listed in the 1989 Red Book of Azerbaijan and in the 1997 International Union for the Conservation of Nature (IUCN) Red List of Threatened Plants. Figure 6.46 illustrates these two rare species; the blossoming shrub *Calligonum bakuense* and the circled scrubby plant *Astragalus bacuensis*. More information regarding these species can be found later in this section.

Figure 6.46 SE sector listed species *Calligonum bakuense* and *Astragalus bacuensis*

C5: Rocky beaches

There are a number of rocky beaches along the NE coastline. The main community encountered within this sector resembles the C4 community described above although the rocky beaches are generally more sparsely vegetated. The community sequence C1, C2, C3 as described above occurs both parallel and perpendicular to the coastline (from the waterline inland) within the rocky beach biotope.

6.4.10.3Coastal flora recovery rates

The four main coastal botanic communities identified vary in time necessary to recover if they are impacted. Table 6.23 below list the communities identified during May/June 2001 field survey and by community, the normal restoration times in the absence of further anthropogenic effects. Tables 6.24 to 6.27 present a breakdown of each community with recovery time in years for each constitute species.

Succession can be inferred though focusing on the years needed to recover to pre-impact levels. Furthermore, relative percentage of each species can be inferred through the order in which they are presented in each table, with the first species rating highest on the Domin Scale of Cover Abundance and the last, the lowest. Species with the same rating are in no particular order. "E" in the restoration in years column indicates the species to be either an ephemeral or ephemeroid species.

Ephemeral species restore within one year or growing season (i.e. usually one to two months duration) and live for the same period of time. Individuals do not however, necessarily grow the following season. Ephemeroids also restore relatively quickly (e.g. one year) but are perennial (i.e. individuals grow season after season). For both types of plants, revegetation requires viable source seed that commonly abounds for these types of species.

Table 6.23 Coastal floral communities natural recovery rates

Community	Soil type	Percentage Recovery to Pre-impact Levels (Years)[4]									
		1	2	3	4	5	6	7	8	9	10
Sand beaches	Wet coastal sand	10-20	30-40	100							
Littoral ecotone	Clay/ argillaceous sand mixture	10-15	20-30	30-40	40-50	50-60	60-70	70-80	90-100	100	100
Reedbeds	Clay/ argillaceous sand mixture/ wet	60-70	100								
Slightly inland	Clay/ argillaceous sand mixture	10-15	20-30	30-40	50	60	70	80	90	100	100

Table 6.24 Sandy beach species recovery times

Species	Recovery Time in Years
Argusa siberica	2

Table 6.25 Littoral ecotone species recovery times

Species	Recovery Time in Years
Junus acutus	2
Tamarix meyeri	8-10
Phagmites australis	2
Argusa siberica	2
Alhagi pseodalhagi	1-2
Poa bulbosa	E
Medicago minima	E
Cynodon dactylon	E
Astragalus species	E
Allium rubellum	E

Table 6.26 Reedbed species recovery times

Species	Recovery Time in Years
Phagmites australis	2

Table 6.27 Slightly inland (coastal semi-desert) species recovery times

Species	Recovery Time in Years
Alhagi pseudalhagi	1-2
Argusia siberica	1-2
Suaeda dendroides	8-10
Salsola denproides	10-12
Bromus japonicus	E
Medicago minima	E
Adonis australis	E
Poa bulbosa	E

[4] Natural variation in revegetation time is signified where numbers are repeated across columns.

6.4.11 Inland biotopes

Inland from the coast semi-desert biotopes with desert elements prevail, particularly in the central (south and north) and western plains. The rocky areas at the foot of the north and west hills support similar botanic communities as found on the semi-desert plain, although the vegetation cover is sparser due to the rock substrate.

The western part of the central south and far west sectors, in addition to supporting semi-desert communities, support a number of low meadow/marshy areas and a relatively large number of tamarisk stands. The occurrence of the latter two can be attributed to the presence of the ephemeral Djeizan Kechmaz River (local translation "Jeyran Deer never crosses"), topographically lower areas and a number of small waterlogged areas, some of which are apparently due to leaky water mains and past dredging activities. Descriptions of selected resident floral communities are provided below. Photographs of the inland communities, identified as I1 to I5, are shown in Figure 6.46. Detailed descriptions of all transects surveyed and detailed taxonomic information concerning sample plots are provided in the Technical Appendices to this ESIA document.

It should be noted that large areas within the central plain sector have been heavily impacted by mudflows which occurred in late 1999 during the autumn rains. Ground cover percentage and species diversity is currently far lower than would be normally expected in these areas, although natural restoration can start within the next two to three growing seasons (*pers. comm. Hajiyev, Dr. V.; June 5, 2001*). Additionally, wind erosion has desertified large sections of the western plains.

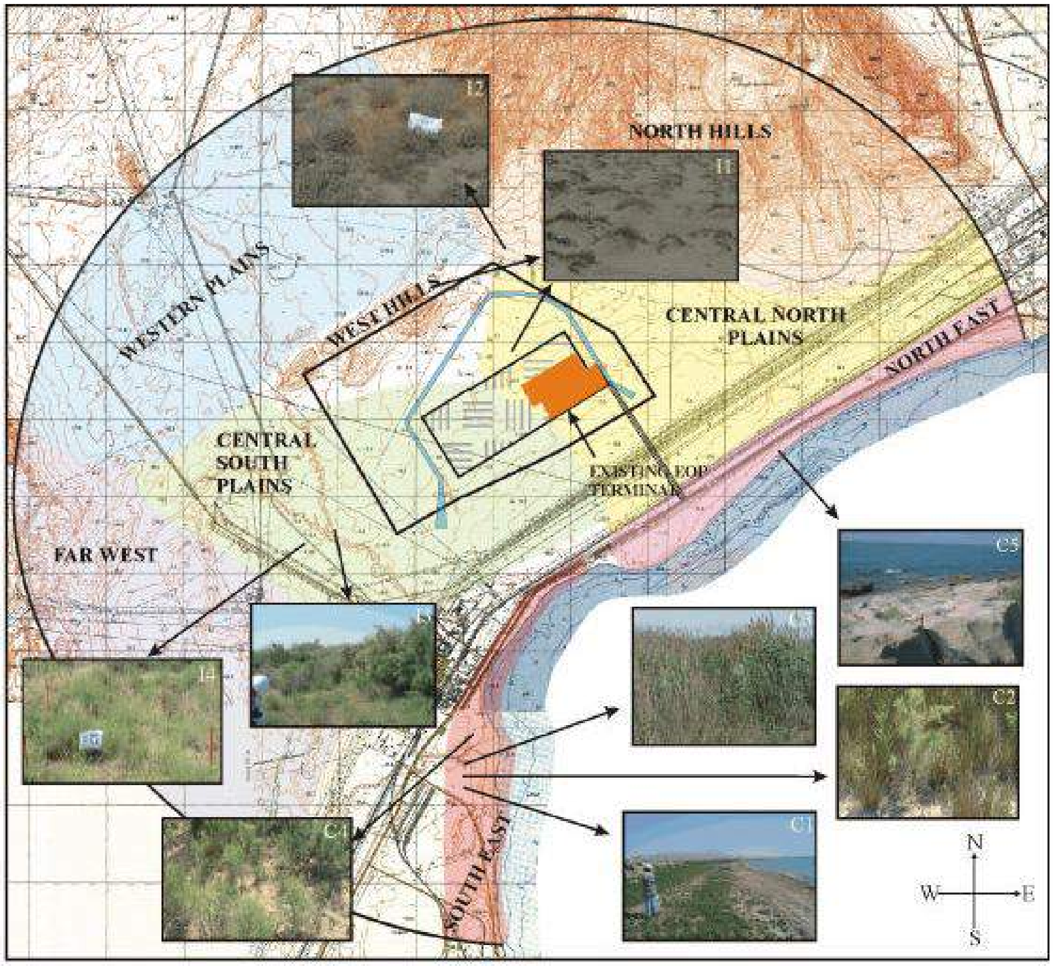
Dr. Hajiyev also made the generalization that 20% to 25% of naturally occurring semi-desert ground cover has disappeared in the majority of the central plains with productivity of valuable herbage (predominantly *Salsosa nodulosa*, described in more detail in the section below concerning *Salsoletum nodulosae* and *Suaeda dendroides* association) 30% to 40% less than expected. In addition, a number of invasive species have taken root thereby slowing and/or impeding natural revegetation.

6.4.11.1Semi-desert with desert elements

The two main components of the semi-desert flora are the low perennial bushes, such as wormwood (*Artemisia fragrans*) and saltwort species (*Salsola dendroides* and *S.nodulosa*.) and ephemeral species (e.g. *Medicago.*, *Plantago* and *Poa* spp). The perennial bushes can be observed year-round while ephemeral species flower and set seed early in Spring within 1 to 2 months, afterwards withering until the Autumn rains stimulate new growth. Although efforts were made during the June 2001 June survey to detect evidence for the presence of ephemeral species, the timing of the survey means that it is possible that these species have been underestimated in terms of their diversity and abundance.

The expanses of semi-desert communities that occur in the central and western plains, far west, and at the foot of the west hills and in the north hills vary in species composition and abundance where there are differences in soil type and salinity levels. These communities are described below.

Figure 6.47 Photographs of the inland floral communities



KEY

- Boundary of no development zone
- Extent of land/clearance and grading works
- Drainage channel
- Proposed Access road
- Survey area (2.5 km radius)

SCALE 1:25000

COMMUNITY TYPES

C1. Sandy Beach	I1. Sallsoletum nodulose + Suaeda dendroides
C2. Littoral Ecotone	I2. Artemisietum fragrans + Salsoletum nodulosae
C3. Coastal Reed beds	I3. Tamirisk thiskets
C4. Slightly Inland	I4. Meadow formation
C5. Rocky Coastline	

km 0 0.25 0.5 0.75 1 1.25 1.5 1.75 2 2.25

250 meters per centimeter

6.4.11.2Salsoletum nodulosae and Suaeda dendroides association

The *Salsoletum nodulosae* and *Suaeda dendroides* association (Figure 6.46, Photo I1) is common for this region and is characteristic of *solonchak* (i.e. soils containing relatively high levels of neutral salts) and slightly saline, clay and pale loam soils. Homogonous groupings of *S. nodulosa* and *S. dendroides* would occur where these soils types occurred discretely, with the former species showing a preference for solochak and the latter species preferring the slightly saline clay/loams. Community members and Domin Ranking for the Central plains ecotone (*Salsoletum nodulosae* and *Suaeda dendroides* association) are shown in Table 6.28.

The halophytic *S. nodulosa* is a sought after shrubby fodder species for livestock and it is estimated that 200 g per day will sustain one adult sheep (*pers. comm. Hajiyev, Dr. V.; June 4, 2001*). Dr. Hajiyev remarked that the central plains have been winter grazing ground for decades and possibly centuries due to the nutritional quality and extent of *S. nodulosa*.

Table 6.28 Central plains *Salsoletum nodulosae* and *Suaeda dendroides* association

Species	Domin Scale Ranking
Salsola nodulosa	6
Salsola ericoides	4
Holosnemum strobilacaum	4
Bromus japonicus	3
Catabrosella humilis	2
Allium rubellum	1
Sideritis montanaMontana	1
Torularia contortu pliceta	1
Anabasis aphylla	1
Nepeta sp.	+
Puccinellia bulbosa	+
Jurinea elegans	+

6.4.11.3Artemisietum fragrans and Salsoletum nodulosae association

The *Artemisietum fragrans* and *Salsoletum nodulosae* association is encountered in small areas of a few square meters, usually alternating between homogenous *Salsoletum nodulosae* and *Artemisietum fragrans* groupings. In this semi-desert biotope it represents a particularly compound community (Figure 6.46, Photo I2). Community members and Domin Ranking for the Central plains ecotone (*Artemisietum fragrans* and *Salsoletum nodulosae* association) are shown in Table 6.29.

Table 6.29 Central plains *Artemisietum fragrans* and *Salsoletum nodulosae* association

Species	Domin Scale Ranking
Artemisia fragrans	8
Salsola nodulosa	7
Salsola ericoides	5
Catabrosella humile	2
Filago arvense	2
Medicaco minima	2
Medicogo orbicelaris	1
Plantago minuta	1
Agropyrum orientale	+
Veronika amoena	+
Trigonella manspeliaca	+
Allium rubellum	1
Poa bulbosa	1
Erodium sp.	1
Brachypodium sp	1

Seeds of *Iris acutiloba*, listed in the 1989 Red Book of Azerbaijan and in the 1997 International Union for the Conservation of Nature (IUCN) Red List of Threatened Plants, were found in the semi-desert areas of the sector. More information regarding this species is presented later in this section.

6.4.11.4Other floral communities

***Tamarixetum meyeri* thickets**

Tamarix meyeri (tamarisk) thickets (Figure 6.46, Photo I3) covering approximately 75% of the ground are scattered throughout the study site in topographically lower areas, especially alongside and on the banks of the various ephemeral streams. They are also concentrated along the existing pipeline corridors through the central plains, particularly the central south plains and near anthropogenic structures in the far west. The typical community structure and Domin Scale ranking is presented in Table 6.30.

Table 6.30 Central south plains tamarisk thickets

Species	Domin Scale Ranking
Tamarix meyeri	8
Alhagi pseudalhagi	5
Allium rubellum	2
Cardus albidus	2
Afremisia canasica	2
Rhamnus pallasii	2
Lepidium resicarium	1

Marsh/meadow

In the western end of the central south and far west sectors, often at the fringe of tamarisk stands as described above, small areas of marshy meadow are encountered with the community structure detailed in Table 6.31 (Figure 6.43, Photo I4).

Table 6.31 Central South and Plains and Far West meadow community

Species	Domin Scale Ranking
Salsola nodulosa	8
Artenisia phrangrans	6
Catabrosella humilis	4
Salsola ericoides	3
Alhagi pseudoalhagi	2
Filago arvenisis	2
Trogopason sp.	2
Verinika amoena	2
Comphorosma lessingii	1

6.4.11.5Inland flora recovery rates

Identified inland botanic communities vary in the amount of time required to recover following impact. Table 6.32 below lists the communities observed during the 2001 survey and by community, the normal restoration time listed in percentage pre-impact ground cover reclaimed over time. Tables 6.33 to 6.36 present a breakdown of each community with recovery time in years for each constituent species.

Table 6.32 Inland floral communities recovery rates

Community	Soil type	Percentage Recovery to Pre-impact Levels (in years)[5]											
		1	2	3	4	5	6	7	8	9	10	11	12
Salsoletum nodulosae + Suaeda dendroides association	Argillaceous saline	0	0	5-10	10-20	20-30	30-40	40-50	50-60	60-70	80-90	90-100	90-100
Artemisietum fragrans + Salsoletum nodulosae association	Argillaceous saline	0	0	5-10	10-20	20-30	30-40	40-50	50-60	60-70	80-90	90-100	90-100
Tamarisk thickets	Relatively moist Argillaceous soil	10-30	30-50	50-55	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	95-100
Marsh / meadow	Argillaceous saline	10-30	30-40	45-55	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	95-100

[5] Natural variation in revegetation time is signified where numbers are repeated across columns.

Table 6.33 *Salsoletum nodulosae* and *Suaeda dendroides* association recovery times

Species	Recovery Time
Salsola nodulosa	10-12
Salsola ericoides	12-14
Holosnemum strobilacaum	8-10-12
Bromus japonicus	E
Catabrosella humilis	E
Allium rubellum	E
Sideritis montana	E
Torularia contortu pliceta	E
Anabasis aphylla	E
Nepeta sp.	E
Puccinellia bulbosa	E
Jurinea elegans	E

Table 6.34 *Artemisietum fragrans* and *Salsoletum nodulosae* association recovery times

Species	Recovery Time
Artemisia fragrans	10-12
Salsola nodulosa	10-12
Salsola ericoides	10-12
Catabrosella humile	E
Filago arvense	E
Medicaco minima	E
Medicogo orbicelaris	E
Plantago minuta	E
Agropyrum orientale	E
Veronika amoena	E
Trigonella manspeliaca	E
Allium rubellum	E
Poa bulbosa	E
Erodium sp.	E
Brachypodium sp	E

Table 6.35 Tamarisk thickets recovery time

Species	Recovery Time in Years
Tamarix meyeri	10-12
Alhagi pseudalhagi	1-2
Allium rubellum	E
Cardus albidus	E
Afremisia canasica	10-12
Rhamnus pallasii	8-10
Lepidium resicarium	E

Table 6.36 Meadow community recovery time

Species	Recovery Time in Years
Salsola nodulosa	10-12
Artemisia phrangrans	10-12
Catabrosella humilis	10-12
Salsola ericoides	10-12
Alhagi pseudoalhagi	1-2
Filago arvenisis	E
Trogopason sp.	E
Verinika amoena	E
Comphorosma lessingii	E

6.4.11.6 Lower plants (lichens, moss, fungi)

Samples of lichen species observed in the field were collected for laboratory identification. Lichens can be used to form the basis of a long-term air quality monitoring program. The species are reliable bio-indicators of air quality and are known to be particularly sensitive to long-term changes in SO_2 concentrations.

Lichen species encountered during the survey and brief morphological descriptions are provided in Table 6.37 below. Selected photos are presented in Figure 6.48. More detailed information regarding species location, abundance and other characteristics are provided in the Technical Appendices of this ESIA document.

Table 6.37 Collected and identified lichen species

No	Genus species	Location encountered	Substrate	Brief Description	
				Thallus[1]	***Apothecia***[2]
1	*Aspicilia contorta**	Rocky slopes, western plains	Rock surfaces	Light or grayish-orange, sometimes lemon yellow leaf-like rosettes	Bright orange-yellow or brownish orange, situated
2	*Caloplaca citrina*	Rocky slopes, western plains	Rock surfaces although can occur on bark as well	Green or egg-yellow in form of small-grained crust, often formed of separate cells divided by cracks	Disk orange or reddish yellow
3	*Caloplaca ferrugunea**	Rocky slopes, western plains	Rock surfaces	Ash or dark gray, crusty, warty and often cracked at centre	Disk flat or slightly convex - orange or brownish red
4	*Caloplaca holocarpa*	SE coast	*Lucium uuthenicum* bark	White-gray ashy thin crust	Yellow or orange-yellow - numerous, independent, or twisted
5	Caloplaca saxicola*	Rocky slopes, western plains	Rock surfaces	Yellow/reddish/orange rosettes warty or cellular in centre	Numerous
6	*Candelariella aurella*	Rocky slopes, western plains	Rock surfaces	Green or egg-yellow in form of small-grained crust	Disk slightly convex
7	*Cladonia foliaceae*	Western plains	Moss	Large and narrow or wide and irregularly divided, flat green tint on top, more pale on bottom	Single individual, on sample taken Apothecia absent
8	*Collema crispum*	Semi-desert, rocky hillsides, west hills	Clayey soil	Greenish-black/dark scaly and thin olive thallus blades, denticulated on verges	Densely crowded on surface of a dark brown Apothecian disk

No	Genus species	Location encountered	Substrate	Brief Description	
				***Thallus*[1]**	***Apothecia*[2]**
9	*Diploschistes gupsaceus**	Throughout Semi-desert areas depending on soil type	Limey soil	Ash-white thick and warty crust	Submerged in thallus, Apothecian disk (or top) black, often with whitish bloom
10	*Fulgensia fulgens*	Semi-desert, rocky hillsides, west hills	Potassium or gypsum soil & moss	Light or grayish-orange leaf-like rosettes	Bright orange-yellow or brownish orange, only in centre of thallus
11	*Lecanora atra*	Rocky slopes, western plains	Rock surfaces	Whitish ash gray thick warty crust	Round or irregular
12	*Physcia adscendens**	SE coast	*Calligonum bakiense* bark	Whitish grayish	On sample taken Apothecia absent
13	*Psora lurida*	Rocky slopes, western plains	Soil	Brown leaf-like overlapping scales	Reddish brown or almost black
14	*Squanarnaia lentigera*	Throughout Semi-desert area depending on soil type	Limey soil	Olive green with thick whitish bloom in ill defined round shape	Round or irregular secured in center of thallus
15	*Toninia coeruleonigricans*	Western plains	Soil and moss	Dark olive or gray	Either naked or completely covered with white bloom scales
16	*Xanthoria parietina**	SE coast	*Calligonum bakiense* bark	Orange-yellow	Yellow-orange-reddish short petioles

1. body.
2. disk-shaped asocarp (fruiting body).

Figure 6.48 Selected lichen species

Aspicilita contorta | ***Caloplaca saxicola*** | ***Caloplaca ferrugunea***

Figure 6.49 Selected lichen species (continued)

Diploschistes gupsaceus	***Physcia adscendens***	***Xantharia parietina***
		

6.4.11.7 Azeri Red Book / IUCN Red List species encountered

Species identified during the survey activities and listed in Table 6.38 fall into one of the following categories:

- included in the 1989 Red Data Book of the Azerbaijan Republic [6]; and/or
- included in the 1997 International Union for the Conservation of Nature (IUCN) Red List of Threatened Plants.

Calligonum bacuensis and *Astragalus bacuensis* (Figure 6.46) were found in and preferentially inhabit coastal areas in the SE coast sector of the survey area. *Calligonum bakuense* was found at numerous locations on the SE coast sector and were typically found in 'bunches' and scarcely distributed, which is characteristic of this species. Scientific articles cite distributions of both these species as being limited to the Apsheron Peninsula thereby increasing local conservation concern (Karyagin, 1952 c; Soskov, Akhmedzade, 1974; Khalilov, Djalilov, 1976; The USSR Red Data Book., 1978; Rzazade, 1954; Akhundov, 1967).

[6] The Red Data Book is currently in the process of being revised; some species included will be removed and others added.

Table 6.38 Azeri Red Book / IUCN Red List species encountered

Genus species	Biotope in	Type of evidence[1]	Endemic to	1989 ARB[2] (Y/N)	1997 IUCN Red List[3] (Y/N)	IUCN Designation
Astragalus bacuensis	Slightly inland (coastal/semi-desert)	Plant	Azerbaijan	Y	Y	Indeterminate[7]
Calligonum bacuensis	Slightly inland (coastal/semi-desert)	Plant	Azerbaijan	Y	Y	Indeterminate
Iris acutiloba	Semi-desert	Seeds	Azerbaijan	Y	Y	Endangered[8]

1. Whole plant, seeds, etc..
2. Azerbaijan Red Book.
3. 1997 International Union for the Conservation of Nature Red List of Threatened Plants.

Within the inland section of the study area, semi-desert seeds of *Iris acutiloba* were found. Scientific literature cites the Apsheron Peninsula as one of the few areas in the Caucasus where this species can still be encountered (Grossgeym, 1940; Karyagin, 1952, a,b; USSR Red Data Book, 1978; Endangered and Disappearing Species, 1981). This species usually blooms from March to April and as such, the seeds were the only evidence of this species encountered during the May-June 2001 survey. As the likelihood of finding seeds of rare plants is far less than encountering them when in bloom, no reliable statement can be made regarding its local distribution.

6.4.12 Mammals and herpetofauna (reptiles and amphibians)

For the fauna survey the study area was traversed on foot along predetermined transects. Survey team members stopped when a site of interest warranted more intrusive investigation (i.e. removal of brush or closer inspection). All direct sightings of mammals and herpetofauna species were recorded in terms of the species, time and place of observation, and transect number, and photographs were taken where possible. Indirect evidence of a species presence was recorded by place encountered and type (i.e. nest, tracks, scat, food remains, vocalization, others).

For night survey work bat detectors (i.e., devices that convert ultrasonic frequencies to those audible by humans) were used to identify bat species echolocating in the vicinity. In addition, 25 small mammal traps and two mist nets were set to capture small ground dwelling mammals and bat species respectively. Summarized results of the survey are presented in Table 6.39. A detailed description, including field data sheets, is included in the Technical Appendices accompanying this ES report.

It should be noted that only one species of amphibian, the Common Marsh Frog, was observed during the field survey. Other species (such as *Bufo viaibis*) are known to reside in the area from past surveys and research. The failure to observe these species

[7] Taxa expected to be Extinct, Endangered, Vulnerable, or Rare but where there is not enough information to determine which of the four categories is appropriate.

[8] Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating. Included are taxa whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction.

during the May/June 2001 survey may be attributed to survey activities occurring outside relevant the breeding season (April-May) thereby making it difficult to detect territorial/breeding vocalizations.

6.4.12.1 Coastal sectors (SE and NE) and littoral ecotones

The SE and NE coastal sectors support relatively high biodiversity; that is, a diverse and abundant faunal community. This is due to the habitat edges[9] it forms with the inland semi-desert and various coastal biotopes and holds particularly true for the most south-easterly heterogeneous section where a number of observed habitat edges provide animals access to the resources of different habitat types simultaneously, including those found on sandy beaches, on rocky coastlines, in wetlands and areas of semi-desert vegetation. In short, habitat complexity is a primary factor that influences the species richness of communities. When assessing the data collected (i.e. species sightings/evidence of residence and/or passage) and taking into account the amount of land each study area comprises this assumption is substantiated. Out of the 22 species (11 mammal species and 11 species of reptiles and amphibians) recorded during the survey activities, 14 (7 and 7) and 16 (8 and 8) were noted on the NE and SE sectors of the coast respectively.

Many of the foxes, hares and the various rodent species identified during the survey reside on or rely upon the resources available on the habitat edges along the coast. Although not directly encountered during the survey, conversations with residents of Sangachal indicated the presence of jackals (excrement found in numerous places) and wolves in the area. The Golden Jackal is a rather reclusive species that depends on the thick reed beds along the coast and inland along the survey area's rivers for habitation. Wolves, on the other hand, shy away from the coast for habitation due to human activity in the area and tend to utilise the nearby larger hills where ample den space is available. They are however, infrequent visitors to slightly inland areas when hunting especially when herds of sheep are present.

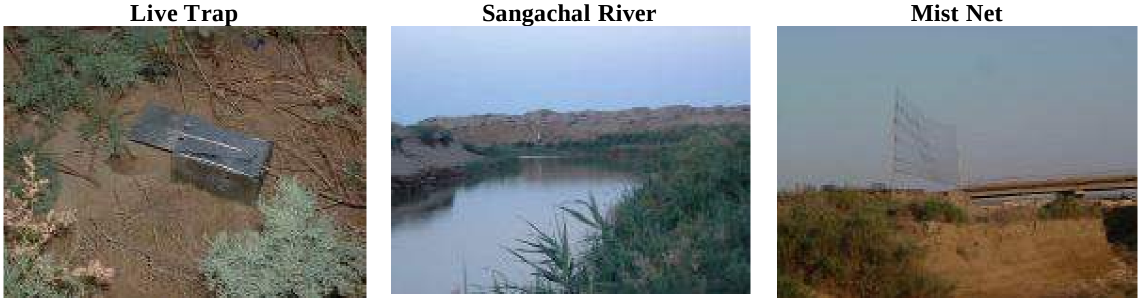
The SE coastal sector and in particular the area near the canal locally referred to as the Sangachal river (Figure 6.49) was chosen for the majority of the night time work due to the relatively high biodiversity in the area and greater chances for successful trapping. Numerous Kuhl's bats were observed and echolocations indicative of feeding activity (i.e. registered between 36 and 52 kHz) were 'heard' with the bat detectors. This occurred throughout the night but was concentrated two hours after sunset and two hours before sunrise. This insectivorous bat species is renowned for its affinity for roosting in or on anthropogenic structures such as eves of rooftops especially when near wetland biotopes, it's preferred hunting ground.

Two mist nets were set up parallel to the canal to capture bats hunting insects. Twenty-five small mammal traps were also placed near rodent burrows on the bank of the canal (17 traps) and adjacent coastal semi-desert area (eight traps). Only burrows which showed evidence of recent occupation or usage (e.g. tracks, scat, freshly excavated soil) were chosen for trap placement. Figure 6.50 shows the traps used and the area of investigation for the night work.

[9] Edges or ecotones are areas where two or more habitat types or different aged patches of the same habitat type meet. They occur naturally where there are abrupt changes in soil characteristics and are unique because they combine characteristics of two or more habitats.

Figure 6.50 Trapping area and equipment – SE coastal sector, slightly inland biotope

Live Trap **Sangachal River** **Mist Net**



During periods of peak activity for Kuhl's Bat (referred to above), 22 individuals were caught (Figure 6.51) although several escaped before subsequent data collection and 'ringing' (i.e. placing a unique identification ring on the animal prior to release) could be completed. Only two of the 25 live traps were sprung, both with House mice.

Figure 6.51 Kuhl's bat capture and release

Capture **Disentanglement** **Release**

The highest diversity of reptile and amphibian species was found on the coast. In fact, only two of the 11 herpetofauna species encountered during the survey were not encountered in the coastal sectors. The Caucasian agama, usually found inland, was encountered in the NE coastal sector where rocky beaches prevail.

The Spur-thighed tortoise (Figure 6.52) a species listed in the 1989 Red Data Book of the Azerbaijan Republic and in 1994 IUCN Red List of Threatened Animals as "vulnerable"[10], was encountered in the SE coastal sector. Of particular value to this species is the section of the coast where sandy beach gives way to semi-desert floral elements such as desert shrubs (i.e. saltwort and wormwood) atop of hillocks of light soil which present prime areas for burrowing (i.e. escaping from the summer heat or clutch laying).

[10] A taxon is "vulnerable" when it is not "critically endangered" or "endangered" but is facing a high risk of extinction in the wild in the medium-term future.

Figure 6.52 Spur-thighed Tortoise burrowing (left) and in the open (right)

6.4.12.2 Central and western plains and far west sectors

Covering more than half the study area, the central and western plains and far west sectors constitute relatively homogeneous clay/saline soil terrain and support the least diverse animal community (as measured by species encountered per unit area). Water is in short supply in these areas and there are few places suitable for habitation by some of the larger mammals. Exceptions were encountered where small 'pockets' of high biodiversity were observed in the western section of the central south plain where a mosaic of habitats of varying characteristics has been apparently formed by leaky water mains and dredging giving rise to marshy vegetation including large swathes of tamarisk stands. The only example of the Caspian turtle was found in such a marshy area, burrowing for cover after sighting the survey team (Figure 6.53).

It is noted that the proposed terminal site lies across the boundary of the central south and central north sectors. The western portion of the site lies close to the area where the Caspian Turtle was observed and recorded.

Topographically varied sections of the western plains support a number of tamarisk stands and associated fauna. This area may attract significantly different animal populations when the Djeizan Kechmaz, an ephemeral river running through the western and central south plains, is water-laden. The far west shares characteristics of the semi-desert central plains and topographically varied sections of the western plains and can be generally described as hilly semi-desert supporting both species common in the semi-desert and those concentrated in marshier areas.

Figure 6.53 Caspian turtle beginning to burrow

There is a compressor station to the west of the SE/NW road and a human settlement, Azimkend close to the road. Relatively large patches of reed beds appear in this marshy area. Frogs such as the Marsh Frog, were observed in this area and the Golden Jackal may find sufficient reed cover in these areas for habitation or hunting forays. A number of reptile species and marsh frog found on the coastline were also encountered in these areas.

During the night-time survey, two 5 km transects were driven on an access road southwest of the terminal to gain an appreciation of nocturnal animal activity in the central plains. Hares, small rodents and foxes were observed. Echolocations of Kuhl's Bat were also detected although far beneath the frequency of occurrence noted closer to the Sangachal River.

6.4.12.3North and west hills (foothills and caves)

As with the coastal areas described above, the rocky slopes at the feet of the western and northern hills support a relatively diverse faunal community and high number of individuals relative to the amount of area they comprise, again attributable to the habitat edge they form between the flat semi-desert and rocky slopes. This is particularly true for the north hills where larger mammal species can find ample space for shelter from the anthropogenic activity in the area on the hillside and above. As mentioned above, Sangachal residents noted the presence of wolves in the area. This species would shy away from the coast for habitation, instead utilizing the hills in the vicinity and most likely the larger north hills, where ample den space is available.

Numerous reptiles take advantage of the rocky feet of the hills for alternating between sun-bathing and cooling down and for hunting. The only example of Dahl's Whip snake seen during the survey was encountered at the foot of the hills. The Caucasian Agama is particularly plentiful at the feet of the north and west hills. Inhabiting colonies with adult males scattered atop the larger rocks exhibiting territorial behaviour such as head bobbing (Figure 6.54) were observed.

Two bat species, one Horseshoe bat and an Asian Barbastelle bat (Figure 6.55) were observed during excursions into the numerous caves in the north hills. These bat species, unlike Kuhl's bat which congregates on and near anthropogenic structures, are usually found far removed from human presence.

Figure 6.54 Caucasian agama

Figure 6.55 Asian barbastelle bat

Table 6.39 below summarizes the mammal and herpetile species recorded during the May/June 2001 survey activities.

Table 6.39 Recorded mammal & herpetofauna species

English Name	Genus / Species	Location (sector) Within Survey Area Where Recorded								Biotope	Evidence	Time (D/N)
		SE	NE	CS	CN	WP	FW	WH	NH			
Herpetofauna												
Marsh Frog	*Rana ridibunda*	X	X	X			X			Wetlands	Sighting	D
Spur-thighed Tortoise	*Testudo graeca*	X	X	X						Semi desert and beach side	Sighting	D
Caspian Turtle	*Mauremys caspica*			X						Wetlands	Carapace and sighting	D
Caspian Gecko	*Cyrtopodion caspius*	X	X							Semi desert and beach side	Sighting and captured	D & N
Caucasian Agama	*Stellio caucasius*		X					X	X	rocky places	Sighting	
Racerunner	*Eremias velox*	X	X	X	X	X	X	X		Semi desert and beach side	Sighting and captured	D
Eremias species	*Eremias arguta*	X		X	X						Sighting and captured	D
Snake-eyed Lizard	*Ophisops elegans*	X	X				X		X	Foothills	Sighting	D
Grass snake species	*Natrix tesellata*	X	X							Wetlands	Sighting	D
Dahl's Whipsnake	*Coluber najadum*								X	Foothills	Sighting	D
Schmidt's Whipsnake	*Coluber schmidti*	X								Beach side	Sighting	D
Mammals												
Long-eared Desert Hedgehog	*Hemiechinus auritus*								X	Open semi desert	Resident information	N
Horseshoe Bat species	*Rhinolophus genus*								X	Cave	Sighting	D
Asian Barbastelle Bat	*Barbastella leucomelas*								X	Cave	Captured	D
Kuhl's Pipistrelle Bat	*Pipistrellus kuhlii*	X	X	X	X	X	X	X	X	Numerous	Captured, audible sounds and sighting	N
Brown Hare	*Lepus europaeus*	X	X	X	X	X	X	X	X	Semi desert and beach side	Sighting, nests	D & N
Small Five-toed Jerboa	*Allactaga elater*	X	X	X	X	X	X	X	X	Semi desert and beach side	Sighting and burrows	D & N
House mouse	*Mus musculus*	X								Riverside	Captured	N

English Name	**Genus / Species**	**Location (sector) Within Survey Area Where Recorded**								**Biotope**	**Evidence**	**Time (D/N)**
		SE	**NE**	**CS**	**CN**	**WP**	**FW**	**WH**	**NH**			
Armenian (gray) Hamster	*Cricetulus migratorius*									Semi desert	Sighting	N
Libyan Jird	*Meriones lybicus*	X	X	X	X	X	X	X	X	Semi desert and beach side	Burrows	D & N
Wolf	*Canis lupus*			X		X			X	Semi desert and foothills	Resident information	D
Golden Jackal	*Canis aureus*	X	X				X			Wetlands	Excrement and resident information	D
Red Fox	*Vulpes vulpes*	X	X	X	X	X	X	X	X	Semi desert, beach side and foothills	Excrement, sighting, footprints, burrows and resident information	D & N
Caspian Seal	*Phoca caspica*	X	X							Beach side	Dead bodies	D

Sector name abbreviations:
SE = Southeast Coast.
NE = Northeast Coast.
CN = Central North Plains.
CS = Central South Plains.
WP = Western Plains.
FW = Far West.
WH = West Hills.
NH = North Hills.

6.4.13 Key sensitivities

The peak sensitive times for mammalian and herpetofauna species are during the mating season and pregnancy. High stress levels (e.g. from anthropogenic disturbances) during the former decrease the chance of successful pairing and during the latter are known to either cause spontaneous abortions or foetal re-absorbtion. In both cases reproductive success is decreased. The tables below detail the mating and pregnancy times for the mammal and herpetofauna species encountered during the survey activities as well as giving brief descriptions of the animals themselves.

6.4.13.1Class: *Mammalia*

Order: *Chiroptera*

Common name	Event	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Horseshoe bat	Breeding								■	■			
	Pregnancy*				■	■							
Asian Barbastelle bat	Breeding								■	■			
	Pregnancy*				■	■							
Kuhl's bat	Breeding												
	Pregnancy*				■	■					■		

* For many Bat species and for all those that inhabit Azerbaijan, gamete production is delayed through the female storing sperm during hibernation and ovulating towards the end of this period so that parturition (giving birth) coincides with favourable environmental conditions for rearing young.

These bats are insectivores, locating insects using echolocation. Most species feed in the air but some species (e.g. the Asian Barbastelle bat) glean insects directly from leaves or the ground. Bats are active at night and roost during the day. Rather than migrating to warmer climates, most of these bats winter in hibernation sites relatively short distances from summer ranges. Hibernation sites include caves, abandoned mines, buildings or other cavities that provide proper temperature and humidity conditions and that are free from human disturbance.

The continued viability of bats in the survey area is tied to the presence of sites that are suitable for hibernation and roosting. For Kuhl's bat these include anthropogenic structures; for the other two species identified, the presence of the caves in the surrounding hills are critical.

Order: *Lagomorpha*

The herbivorous Brown hare is the only lagomorph residing in the study area. This common species breeds year round and is an important prey species for jackals, foxes and wolves as well as a number of birds of prey. Temporal sensitivities are not considered for this species as it breeds year round.

Order: *Insectivora*

The only member of this order documented during the field investigation was the Long-eared Desert hedgehog. They are omnivorous but feed mainly on small invertebrates and insects as well as small vertebrates such as lizards and snakes. Long-eared Desert hedgehogs are nocturnal and they may wander up to 9 km a night in search of food. They commonly burrow under small bushes but may also rest by day under rocks, rock heaps or hollows. One exceptional trait is their remarkable resistance to food and water scarcity. The species have been shown in laboratory conditions, to have survived as long as ten weeks without food and water. Pregnancy and rearing times (i.e. April through July) are considered the most sensitive times for this species.

Order: *Rodentia*

The following species of rodent were found to be present in the study area:

- Libyan jird;
- Armenian (Gray) hamster;
- House mouse; and
- Small five-toed jerboa.

All these rodent species are known to breed year-round with oestrous cycles less than one week.

The Libyan jird is a diurnal (i.e. active day and night) sociable rodent often encountered living in colonies. It is primarily a vegetarian but is known to also eat insects at times. It is a significant prey species for foxes, snakes and various birds of prey. Often their burrows, once abandoned, provide refuge for snake species.

The Armenian (or Gray) hamster is a solitary, burrowing and nocturnal rodent. Its omnivorous diet includes grains, roots, green parts of plants, insect larvae and frogs. It is a valuable prey species for foxes, snakes and various birds of prey, particularly the little owl.

The House mouse lives as a human commensal, often out-competing species natural to the area they inhabit due to their prolific reproductive potential and association with humans. Its diet is varied and omnivorous and will include carrion. It is generally nocturnal although some are active during the day in human dwellings. It is interesting to note that it rarely travels more than 50 feet from their dwelling. As with the rodents above, it is a valuable prey species for foxes, snakes, and various birds of prey.

The Small five-toed jerboa is commonly found in its burrows around human settlements and occupies wormwood (one of its main fodder species) steppes and saline areas occupied by *Salsola* spp. with population densities far greater for the latter (i.e. sometimes more than two times). It is a valuable prey species for foxes, snakes, and various birds of prey.

Order: *Carnivora*

Common name	**Event**	**Month**											
		J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Wolf	Breeding	■											■
	Pregnancy		■	■									
Golden jackal	Breeding										■	■	
	Pregnancy	■	■										■

Red fox	Breeding												
	Pregnancy												

The wolf population in the Sangachal area varies across seasons with few permanent inhabitants of the region during summer months and a considerably larger population (coinciding with shepherds and their herds of sheep migrating down from the north to use the plains for winter pasturage) during the winter months. They usually travel in packs but loners are not uncommon, especially in the case of older males. Although they prefer live kills, they scavenge as well.

The Golden jackal is a rather reclusive species which shy away from intense anthropogenic activities. It finds refuge in larger reed beds and tamarisk stands within the survey area. The species is mainly a forager feeding on plants, small animals and occasionally carrion.

The Red fox select areas of greatest diversity and use edges heavily. It prefer loose soils such as those found in the SE coastal sector. Red foxes are omnivorous, eating a variety of animals and plant materials depending mainly on the availability of the food source. Small mammals, birds, fruits and insects comprise the bulk of the diet.

6.4.13.2Herpetofauna

6.4.13.3Class Amphibia and Reptilia

Order: *Anura* (Frogs)

Marsh frogs, as indicated in the table below, spawn in the spring months (April and May), when intra-specific calling can be heard day and night under suitable weather conditions. The eggs are often laid in the same water bodies where coupling occurred and subsequently the eggs incubate and undergo metamorphosis from tadpole form to young adults by September.

Common name	Event	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Marsh frog	Spawning												
	Incubation / metamorphosis												

Order: *Testudines*

Turtles

The Caspian turtle, which prefers to feed on small fish and insects, can be found throughout the study area especially in the fresh-water marshy areas.

Common name	Event	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Caspian turtle	Breeding												
	Incubation												

Tortoises

This herbivorous tortoise is found throughout the study area, especially where soft soil hummocks form on the sides of shrubbery. This habitat provides ideal places for burrowing and laying of egg clutches (three clutches per year). They are especially apparent during the first warm days of the year when they begin to pair (i.e. usually in early April).

Common name	**Event**	**Month**											
		J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Spur-thighed tortoise	Breeding				■	■	■						
	Incubation						■	■	■				

Order: *Squamata* (Snakes)

Common name	Event	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Grass snake species	Breeding				■								
	Incubation						■	■	■				

Although the survey only identified one grass snake species (*Natrix tessalata)*, from previous studies at least one more is known to inhabit the survey area (*Natrix natrix*). They are often found at water's edge including the Caspian Sea, and are able swimmers feeding on small fish. They are non-poisonous.

Common name	Event	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Whip snakes (2 species)	Breeding					■	■						
	Incubation							■	■				

Two whip snakes (*Coluber spp.)* were identified during the survey activities; Dahl's and Schmidt's whip snakes. These are long and thin, green to green-brown snakes and not poisonous.

Suborder: Sauria (lizards)

Common name	Event	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Eremias spp. Snake-eyed lizard	Breeding				■	■							
	Incubation					■	■	■					

Two *Eremias* species, *E. velox* and *E. arguta*, and a Snake-eyed lizard species (*Ophisops elegans*) were identified during the daytime survey activities. These species breed and incubate their eggs, which they bury, at the same time of the year and for the same duration, so are consolidated in the table below. The Eremias species are small (i.e. 7.6 to 15.2 cm long) insectivorous lizards common to semi-desert regions, each with a reddish-pink tinge to the tail starting at the vent. The Snake-eyed lizard, also insectivorous, is 10 to 18 cm long with characteristic stripes from head to tail, the number of which vary among closely related species.

Common name	Event	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Caspian Gecko	Breeding					■	■						
	Incubation							■	■				

The Caspian gecko, like all geckos, has padded feet covered with 'suction cups' that allow for climbing at any angle. This species can reach a length of 15.2 cm and is primarily nocturnal. They are often found on or near anthropogenic structures and especially near night lighting as they are apparently attracted to the insects that are its prey.

Common name	Event	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Caucasian Agama	Breeding					■	■	■					
	Incubation							■	■				

This species inhabits dry rocky areas with sparse vegetation and prefers vertical slopes. Its whole length (including tail) can reach 36.6 cm. It is omnivorous feeding on ephemeral flowers, insects, and small mice.

6.4.14 Azeri Red Book / IUCN Red List species encountered

Table 6.40 below lists the Azeri Red Book / IUCN Red List mammal and herpetofauna species observed during the 2001 survey activities.

Table 6.40 Azeri Red Book / IUCN Red List mammal and herpetofauna species encountered

Genus species	Biotope encountered in	1989 ARB (Y/N)	1997 IUCN Red List (Y/N)	IUCN Designation
Testudo graeca	Sandy beaches and semi-desert	Y	Y	Vulnerable [11]
Phoca capsica	Sandy beaches	N	Y	Vulnerable

Species identification was not possible for the Horseshoe bat species (*Rhinolophus sp)* as identification would have entailed capture which was not possible at the time of sighting. It should be noted however, that four of the five species belonging to this genus are included in the IUCN Red List (ranging from "lower risk" to "vulnerable"). They were not however, observed to be roosting within the proposed land take area.

During a baseline survey conducted in March 2001 for a separate project, an example of the nationally red listed Toad's Head Lizard (*Phrynocephalus helioscopus*) was observed in the central north plains. In addition, during the 1996 EOP survey, Marbled polecat (*Vormela peregusna*), a nationally red listed species was observed within the Sangachal area. The 2001 survey activities did not confirm the presence of this species although its continued presence in the project area can not be discounted.

6.4.15 Birds

6.4.15.1Introduction

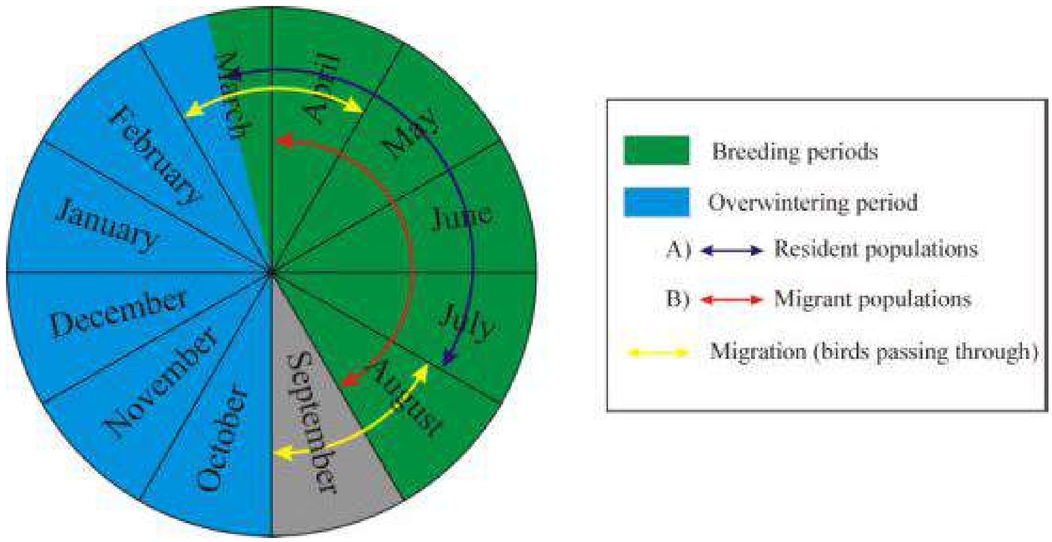
A considerable amount of ornithological data has been collected previously from coastal waters and islands (and oil platforms) from north of the Apsheron peninsula south to Kyzyl Agach. The international importance of the region for waterfowl has as a result, been firmly established. Sangachal Bay itself supports important numbers of waterfowl during migration periods and particularly during winter. These have been the subject of previous studies on behalf of AIOC.

Many migrant species including a number of Red Book and/or globally threatened species are known to pass through the area during the spring and fall migrations (i.e. March-April and August-September peak periods), respectively. Most simply fly over without stopping (e.g. Honey buzzard and Lesser kestrel) following the coastal

[11] A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

lowlands northwards to their breeding grounds. The peak period along the Azerbaijani coast for waterfowl is during the winter (i.e. October to mid-March) when thousands of individual birds over-winter where lagoons are available. Figure 6.56 illustrates key periods for birds which either visit or reside in the survey area.

Figure 6.56 Key periods for birds in the Sangachal area



Due to seasonal timing of the survey no data collection for over-wintering or migrant bird populations could be undertaken. However, a review of secondary data sources yielded a wide array of datasets. These datasets were collected during the numerous surveys of migrant and over-wintering populations as well as through literature reviews. Within the historical data abundance estimates vary widely as do methodologies for data acquisition, and some of the data appears outdated. The Technical Appendices accompanying this ESIA document includes a list of bird species found in the past in Sangachal Bay. Conservation status data is also presented.

There is little quantitative data on breeding bird populations along the coastal fringe and immediate hinterland in the survey area. The May/June 2001 survey of the area surrounding the terminal therefore concentrated on assessing the status of these resident bird populations. It consisted of single morning and afternoon visits made to each of the survey sectors. All birds whether seen or heard, were recorded. A full report is presented in the Technical Appendices to this ESIA document.

6.4.15.2Breeding populations

SE and NE coastal sectors

The coastal waters of Sangachal Bay were surveyed from onshore. The Bay is known to be of high importance for waterfowl during migration periods and in winter, but not in summer when only resident terns (*Sterna* spp) would be expected. A number of bird species were observed along the coastline in the NE and SE sectors during two survey mornings. In the SE sector an estimated five breeding pairs of Collared pratincole were observed, constituting a breeding colony for this species. Breeding colonies of Common and Little terns were also discovered with an estimated six to eight and seven pairs respectively.

Table 6.41 presents minimum population estimates as number of pairs for all possible, probable, and confirmed nesting species. All figures refer to minimum number of pairs or occupied territories.

Table 6.41 Breeding bird populations in the coastal survey area

Species (Common English Name)	Genus / Species	SE Sector 28/5 a.m.	NE Sector 29/5 a.m.
Little Bittern	*Ixobrychus minutus*	1	-
Purple Heron	*Ardea purpurea*	1	-
Kestrel	*Falco tinnunculus*	1	-
Black-winged Stilt	*Himantopus himantopus*	2	3
Collared Pratincole	*Glareola pratincola*	5	-
Kentish Plover	*Charadrius alexandrinus*	8	6
Common Tern	*Sterna hirundo*	-	6-8
Little Tern	*Sterna altifrons*	-	7
Rock Dove	*Columba livia*	1	3
Hoopoe	*Upupa epops*	1	2
Crested Lark	*Galerida cristata*	3	7
Black-headed Wagtail	*Motacilla (f.) feldegg*	2	-
Isabelline Wheatear	*Oenanthe isabellina*	1	1
Finsch's Wheatear	*Oenanthe finschii*	1	-
Reed Warbler	*Acrocephalus scirpaceus*	9	3
Great Reed Warbler	*Acrocephalus arundinaceus*	1	-
Red-backed Shrike	*Lanius collurio*	-	1
Starling	*Sturnus vulgaris*	1+	3
House Sparrow	*Passer domesticus*	1+	-

Central south and central north plain sectors

The north-western area of the central northern sector has been heavily impacted by mudflows. Heavy grazing pressure has also contributed to habitat degradation. In the central south sector are low mud cliffs suitable for burrow-nesting birds such as the European bee-eater.

The low-lying wet grazing marsh (with reeds, reedmace and rushes) and tamarisk scrubland in the central sectors support a large number of bird species. This habitat is of greater extent in the southern area of the sector where reedbed growth is also far more extensive. One notable observation in the area concerned a migrant species the Syke's booted warbler (hereafter Syke's warbler) which was found breeding in wet tamarisk scrub to the south of the access road to the existing terminal.

This observation is noteworthy as it constitutes the first confirmed breeding season presence of the species in Azerbaijan. It can thus be confirmed as nesting within the country and in the Sangachal area. Nesting habitat typical for this species is present widely over the south central survey sector.

A breeding colony of European bee-eaters was found in a depression where six nests had been burrowed in the inside walls. It is highly likely that more colonies reside in the central and western sectors (plains) in similar depressions and alongside ravines.

North hills sector

The North Hills were surveyed along the southern foot of the range. The rocky slopes run up to sheer faces in places. These are suitable nesting areas for a number of birds of prey including corvids (i.e. crows, choughs, ravens, etc.) and other species. The entire area is apparently treeless and mud volcanoes are present near the summit.

West hills sector

The isolated trio of hills lying immediately to the west of the terminal site are lower than the north hills but possess a similar rocky topography. Only low cliff faces are present and these are largely inadequate for nesting by birds of prey, with perhaps the exception of kestrels and the Little owl.

Western plains sector

The western plains sector lies to the west of the west hills and is crossed by the western route export pipeline. Wind erosion has affected part of this area and it is also crossed by at least one stream with low mud cliffs. The narrow channel sustains tamarisk stands. The area is otherwise a semi-arid steppe-like range-land. Hunting raptors were observed on a number of occasions in this area.

Table 6.42 provides minimum population estimates as number of pairs, for all possible, probable, and confirmed nesting species recorded inland. All figures refer to minimum number of pairs in occupied territories.

Table 6.42 Breeding bird populations in the inland survey area

Species (Common English Name)	Genus species	North Hill	South Central Plain	North Central Plain	West Hills	Western Plains
Date (a.m./p.m.)		**28/5 p.m.**	**30/5 a.m.**	**30/5 p.m.**	**31/5 p.m.**	**31/5 a.m.**
Purple heron	*Ardea purpurea*	-	1 (1/6)	-	-	-
Ruddy shelduck	*Tadorna ferruginea*	-	-	-	-	1
Long-legged buzzard	*Buteo rufinus*	1	-	-	-	1+
Kestrel	*Falco tinnunculus*	1	1+	1	-	1
Chukar	*Alectoris chukar*	2	-	-	1	-
Stone curlew	*Burhinus oedicnemus*	-	-	1	-	-
Black-winged stilt	*Himantopus himantopus*	-	1	2	-	-
Little Ringed plover	*Charadrius dubius*	-	-	1	-	-
Kentish plover	*Charadrius alexandrinus*	-	-	2	-	-
Black-bellied sandgrouse*	*Pterocles orientalis*	-	-	-	-	2

Species (Common English Name)	**Genus species**	**North Hill**	**South Central Plain**	**North Central Plain**	**West Hills**	**Western Plains**
Date (a.m./p.m.)		**28/5 p.m.**	**30/5 a.m.**	**30/5 p.m.**	**31/5 p.m.**	**31/5 a.m.**
Rock dove	*Columba livia*	+	-	-	-	-
Cuckoo	*Cuculus canorus*	-	1+	-	-	-
Little owl	*Athene noctua*	1	-	-	1	-
European bee-eater	*Merops apiaster*	-	6	-	-	1+
Hoopoe	*Upupa epops*	-	3	-	-	-
Short-toed lark	*Calandrella c. cinerea*	-	1	1	-	2
Crested lark	*Galerida cristata*	-	7	2	2	5
Black-headed wagtail	*Motacilla (f.) feldegg*	-	2	2	-	-
White wagtail	*Motacilla alba*	-	5	2	-	-
Rufous Bush robin	*Cercotrichas galactotes*	-	9	-	-	-
Isabelline wheatear	*Oenanthe isabellina*	-	3	-	-	7
Finsch's wheatear	*Oenanthe finschii*	5	-	-	6	1
Moustached warbler	*Acrocephalus melanopogon*	-	1	-	-	-
Reed warbler	*Acrocephalus scirpaceus*	-	7	-	-	-
Great Reed warbler	*Acrocephalus arundinaceus*	-	2	-	-	-
Syke's (Booted) warbler	*Hippolais rama*	-	14	-	-	-
Menetries' warbler	*Sylvia mystacea*	-	11	-	-	-
Rock nuthatch	*Sitta neumayer*	4	-	-	5	-
Red-backed shrike	*Lanius collurio*	-	1	-	-	-
Chough	*Pyrrhocorax pyrrhocorax*	1	-	-	-	-
Magpie	*Pica pica*	-	1	-	-	-
Hooded crow	*Corvus c. cornix*	-	2	-	-	1
Raven	*Corvus corax*	-	-	-	-	1
Starling	*Sturnus vulgaris*	-	Many	-	-	Many
House sparrow	*Passer domesticus*	-	Many	1+	-	-

1. Possible, probable and confirmed breeding records are all included.
* Signifies national Red Book species.

Swifts (*Apus apus*), swallows (*Hirundo rustica*), house martins (*Delichon urbica*) and sand martins (*Riparia riparia*) feed in large numbers over the area and are probably also breeding within the survey area.

6.4.15.3 Other bird populations

A number of sightings were made of visiting migrant species recorded in the same survey areas, some of these being late departing winter visitors or non-breeding, immature birds. These are listed in Table 6.43.

Table 6.43 Other bird species recorded in the survey area

Common Name	Genus / Species	Sector					
		SE	NE	CS	CN	WH	WP
Great crested grebe	*Podiceps cristatus*	-	4	-	-	-	-
Great cormorant	*Phalacrocorax carbo*	1	2	-	-	-	-
Glossy ibis	*Plegadis falcinellus*	-	-	1	-	-	-
Honey buzzard	*Pernis apivorus*	-	-	15	-	-	2
Egyptian vulture	*Neophron percnopterus*	-	-	-	-	1	-
Steppe buzzard	*Buteo (b.) vulpinus*	-	-	2	-	-	-
Buteo sp.		-	-	-	1	-	-
Lesser kestrel**	*Falco naumanni*	-	-	2	-	-	-
Shelduck	*Tadorna tadorna*	-	3	-	-	-	-
Wigeon	*Anas penelope*	-	1	-	-	-	-
Mallard	*Anas platyrhynchos*	-	3	-	-	-	-
Greater sand plover	*Charadrius leschenaultii*	2	18	-	-	-	-
Wood sandpiper	*Tringa glareola*	1	-	-	-	-	-
Black-headed gull	*Larus ridibundus*	-	1	-	-	-	-
Slender-billed gull	*Larus genei*	-	2	-	-	-	-
Herring gull	*Larus cachinnans*	8	6	-	-	-	-
Gull-billed tern	*Gelochelidon nilotica*	-	1	-	-	-	-
Sandwich tern	*Sterna sandvicensis*	-	15	-	-	-	-
Whiskered tern	*Chlidonias hybrida*	4	-	-	-	-	-
Red-throated pipit	*Anthus cervinus*	-	-	1-2	-	-	-
Sedge warbler	*Acrocephalus schoenobaenus*	-	-	1	-	-	-
Rosy starling	*Sturnus roseus*	-	-	1	-	-	-
Goldfinch	*Carduelis carduelis*	-	-	2	-	-	-

* Red Data species
** Globally threatened (note that Lesser kestrel is not actually a Red Book species in Azerbaijan yet it is considered globally threatened).

6.4.16 Azeri Red Book / IUCN Red List species encountered

Table 6.44 below lists the Azeri Red Book / IUCN Red List bird species observed during the 2001 survey activities

Table 6.44 Azeri Red Book / IUCN Red List species encountered

English Common Name	Genus species	Biotope encountered	1989 AZB (Y/N)	1997 IUCN Red List (Y/N)	IUCN Designation
Black-bellied sandgrouse	*Pterocles orientalis*	Semi -desert	Y	N	
Lesser kestrel	*Falco naumanni*	Mixed semi -desert/tamarisk stands	N	Y	Vulnerable*

* A taxon is "vulnerable" when it is not "critically endangered" or "endangered" but is facing a high risk of extinction in the wild in the medium-term future.

Black-bellied sandgrouse

The black-bellied sand grouse is a member of the order *Pterocliformes* with all members found only in Africa and Eurasia. Members of this order are unique in that they share aspects with both pigeons and waders. One special feature of sandgrouse is their long flights to water holes in desert and semi-desert country, where not only do they drink but, during breeding, they wet their belly feathers to carry water to their chicks.

The distribution of this species in Azerbaijan from 1977 data, is concentrated significantly southwest of Sangachal in the Kura-Araz lowlands during the breeding season (March-July) and south in Salyan and Lenkoran lowland for the winter. The recent 2001 survey sighting in the western plains may represent a widening of this species home range.

Lesser kestrel

The Lesser kestrel over-winters in Africa in large numbers and in India in smaller numbers. This gregarious species breeds in Azerbaijan among other countries. The northward passage out of Africa begins in March and is at its height in April and early May. The earliest arrivals at breeding quarters appear in late March but most breeding is in early May and the bulk of birds do not arrive at their breeding places until April. Their diet is composed of insects, caught either on the ground or taken in the air. Small mammals and lizards, and occasionally frogs, are also taken on the ground.

Although no breeding colonies of Lesser kestrels were identified during the recent May 2001 survey activities (only one individual sighted), if colonies were to exist in the study area, they would most likely reside in some of the larger ravines in the western plains, in the north hills, or in the denser tamarisk stands found throughout the study area.

7 Socio-economic Baseline

7.1 Introduction

In order to identify the project socio–economic aspects of the Stage 1 development a matrix was compiled of all project activities and socio-economic receptors. The receptors[1] were identified using the information contained in the following socio-economic baseline and through the stakeholder consultation process.

7.2 Methodology for compiling the socio-economic baseline

Full details of the approach used for compiling the socio-economic baseline are contained within the Socio-economic Baseline Data Gathering report (Appendix 12). A summary of this approach is provided below under the following key elements:

- collection and interpretation of secondary data sources;
- field visits;
- consultation with key stakeholders;
- compilation and interpretation of data collected;
- preparation of baseline report; and
- incorporation of data into the ESIA process.

7.2.1 Secondary data sources

Numerous secondary data sources were identified, reviewed and evaluated to ensure that the data are relevant and up-to-date. In this report, secondary data sources are referenced by footnote or within the text.

Individuals from two non-governmental organisations were also interviewed: ISAR and ASPA, along with the representative of the Know How Fund, Ministry of Finance, Azerbaijan. The ECEWP and the full ACG and Shah Deniz projects were not discussed at these meetings. The meetings were held to gather broad information on social issues and the role of civil society in Azerbaijan.

Information was drawn from a separate sociological survey of Umid, Primorsk and Sangachal undertaken by the Azerbaijan-Holland Friendship Society, on behalf of BP, to provide specific information for the development of BP's Social Investment Strategy.

Other secondary data sources include the minutes of meetings between BP and the garage café owner and the Director of the stone mine. Both facilities are located in the general vicinity of the existing EOP terminal.

7.2.2 Field visits[2]

Field visits were undertaken of the area in and around Sangachal. These visits provided site-specific information to augment the information collected during the secondary data search. The following representatives were consulted:

[1] A socio-economic receptor is defined as something that could be impacted upon by the proposed development that would affect the economic or social profile of the area.
[2] Various caveats apply to the reliability of the information gathered from the sources listed in this section. These caveats have been outlined in the introductions to, and footnotes for, the regional and local sections of this chapter.

- representative, Caspian Fish Company;
- representative, Socio-economic Development Department, Garadag Executive Power Office;
- Head of Garadag Executive Power Representation, Umid Settlement;
- Secretary in Charge, Garadag Executive Power;
- Sangachal District Representative, Garadag Executive Power;
- representative, Azer Fishery State Concern;
- representative, Fisheries Institute;
- railway barrier operator;
- security guard at 15th century historical restaurant (Caravansari); and
- employee, 'Firuza' stone mine.

Questionnaires were used as the basis for collecting information whilst on the field visits. These questionnaires sought to gather information on topics such as economic activity, health and education.[3] All those interviewed were made aware of the nature and purpose of the interview and questionnaire process.

In addition to the above, a number of data gathering field visits and interviews were undertaken with the local herding community. An initial field visit was undertaken by URS who spoke with male representatives of an extended family at the Central North herder settlement. This information has been included in the baseline, however the information was given by the herders without any knowledge of the nature and purpose of the researchers visit. Further information was collected from the herding supervisors responsible for the state herding activities in the Sangachal area and two of the herders and this information appears to relate to the West Hills herding settlement. This baseline information collection regarding the proposed development was carried out directly by BP, with the assistance of a local sociologist, and the information used to verify and supplement that collected earlier from the herders.

7.3 Geopolitics

With a total land area of 86,600 km^2, Azerbaijan is the largest of the three Trans-Caucasian republics of the former Soviet Union. It is located on the Caspian Sea and is bordered by the Russian Federation (specifically Dagestan) to the north, Georgia to the northwest, Armenia to the west and Iran to the south. The enclave of Nagorno-Karabakh (populated mainly by Armenians) is situated within the borders of Azerbaijan. The Autonomous Republic of Nakhchivan, located between Iran and Armenia, also belongs to Azerbaijan. The total length of Azerbaijan's frontier is 2,013 km.

Azerbaijan is a country of mountain ranges and river valleys. Most of the country is characterised by lowlands around two main rivers. The Kura river flows from the northwest into the Caspian Sea, while its tributary, the Araz, forms the border with Iran. North of the Kura lies the main axis of the Greater Caucasus mountain range. The largest city in Azerbaijan is Baku, the capital, with a population of nearly two million. Baku is situated on the Apsheron Peninsula, which juts about 40 miles out into the Caspian Sea, and is a large port. Other large towns in the republic include Ganja, Sumgait, Mingacevir and Nakhchivan. (UZ Azerbaijan, 2000).

The Caspian has traditionally been a region of strategic importance providing a direct link between Europe and Asia and a border between two world religions. With a central role in this region, Azerbaijan is surrounded by newly independent states and more established

[3] The questionnaires covered a range of socio-economic issues. The questionnaires are contained in the Technical Appendix to this document.

countries such as Turkey and Iran. The advent of independence and the economic and social transformation process has been marked by armed conflict, social unrest and ethnic tension. Tension still exists including ongoing disputes between Azerbaijan and Armenia, the Chechnyans and the Russians, Abkhazia and the South Ossetian disputes in Georgia (AIOC, 2000a).

The collapse of the former Soviet economy revealed that many Soviet enterprises were loss making and uncompetitive. This accelerated the decline in output that had begun in the Soviet Union in the late 1980s. As a result, independence left the Caspian states with the task of reforming their economies towards a market-orientated system while coping with a severe drop in output and budget revenues (AIOC, 2000a).

Much hope is placed on oil revenues as an opportunity to finance economic and social development. There are estimated reserves of 28 billion barrels in Azerbaijan and additional unconfirmed reserves estimated between 70 to 200 billion barrels in the Caspian Sea. It is possible that once the required exploration, production and transport infrastructure is in place the region could produce about 6 million barrels per day. The infrastructure investment required to achieve this is estimated at between AZM0.3-0.5 trillion (US$70-100 billion) (AIOC, 2000a).

7.4 National

7.4.1 Population and demographics

7.4.1.1 Population and migration

Since 1990 Azerbaijan has experienced a declining growth rate as a result of social and economic hardship, substantial emigration, military conflict with Armenia, a decreasing birth rate and a declining life expectancy. Despite these factors, the total population has risen from 7.1 million in 1990 to 7.6 million in 1997, 7.9 million in 1999 and to 8 million as of January 1, 2000 (UNHDR) and is expected to increase steadily by just over 1% per annum over the next 50 years. Of the total population, some 52% reside in urban areas and 48% in rural areas (AIOC, 2000b).

7.4.1.2 Religion and ethnicity

Ethnic minorities such as Russians, Armenians and Lezghins make up approximately 20% of the total population of Azerbaijan. Over 10% of the Azerbaijani population is internally displaced as a result of the continuing occupation of one-fifth of the territory of Azerbaijan by Armenia. Some 900,000 Internally Displaced People (IDP) are dispersed throughout the country. Just under half of these people live in rural areas (AIOC, 2000b).

The religious distribution in Azerbaijan is relatively homogenous with the majority of the population defined as Muslim. Other religions include Orthodox Christianity, Judaism, Catholocism and Protestantism. The Constitution of the Republic of Azerbaijan and the Law on Freedom of Religion and Religious Organisations (adopted in 1992 and amended in 1996 and 1997) grants all citizens the legal right to practice their religions, go on pilgrimage and advocate their religious values as long as these activities do not compromise national or public security (UNDP, 1999; UNHDR, 2000).

7.4.1.3 Gender distribution

In Azerbaijan women and men possess equal rights and liberties under the constitution. The country's labour law also explicitly prohibits wage discrimination on the basis of gender, however in common with many other countries, gender inequalities remain. Women's employment in Azerbaijan tends to be concentrated in lower paying sectors of the economy and women are not equally represented at the higher levels of management. For example, although women account for more than 66% of employment in health, education and cultural work, where remunerations levels are relatively low, they represent 35% of the heads of clinics and polyclinics and less than 20% of management in the educations system. The decline in light industry and food industry production over the last decade has also had an adverse affect on women who traditionally have relied upon these industries for a significant proportion of employment opportunities.

The average wages paid to women are lower than those paid to men in all sectors and unemployment is more serious among women. Government statistics show that women accounted for approximately 60% of the registered unemployed throughout the 1990s and the UNFPA puts unemployment for women at six times the number of men (ASSC, 1999; UNFPA, 2001; Azerbaijan UNHDR, 2000). From 1993 to 1997 the number of women among postgraduate students declined by one third. Azerbaijan has, however, achieved almost universal literacy among both men and women. The number of women in vulnerable groups is reported to be increasing, including the number of women-headed households. This trend is most noticeable among the one million people who were displaced during the war with Armenia.

In response to gender specific concerns, the Government of Azerbaijan has established an inter-ministerial State Committee for Women's Problems to formulate gender sensitive policies and programmes (UNFPA, 2001). Within Government, women hold 12% of the seats of Parliament (the Milli Mejlis), 9% of ministerial-level positions and 9% of regional heads of administration as well as 11% of ambassadors to foreign countries.

7.4.2 Income

The income level of most Azerbaijani households remains low though several indicators suggest that real household incomes have increased in recent years. Average monthly salaries for Azerbaijan are presented in Table 7.1 below. For the period 1998 through 2000 salaries increased by 21.8% according to government statistics.

Table 7.1 Average monthly salaries in Azerbaijan

Year	AZM	US$
1998	168,419	43
1999	184,368	47
2000	205,112	44

Source: Azerbaijan Economic Trends Oct-Dec 2000.

About 40% of this income derives from wages, 8% from social transfers and the remainder from informal employment, sales of agricultural products and other sources. The latest data shows that real wages *per capita* increased significantly during the period between 1996 and 1998, by 19% in 1996, 53% in 1997, and 20% in 1998.

Monthly pensions for elderly and disabled pensioners, which were doubled in August 1997, average around AZM56,000 (US$14.50). Pensions are however, often subject to substantial delays in payment and the amount paid varies according to the recipient's work history. Pensions are higher for women who have many children or disabled children (AET, 1999).

Changes in household consumption patterns during this decade reveal that households concentrated their expenditures on food products as their ability to pay for other categories of products (e.g. medical care, education, clothing and recreation) fell sharply after the transition period began. According to government statistics, households spent less than half of their income on food products in 1990 but have spent nearly 70% on food every year since 1994 (AET, 1999).

7.4.3 Employment profile

The unemployment rate is difficult to track in Azerbaijan due to the fact that the government only counts the number of those registered as unemployed. This is recorded as only 1% of the labour force in Azerbaijan. The registration process is complicated and the benefits of being officially unemployed not significant enough to warrant large numbers of persons applying. Consequently, people rarely register and government figures rarely change (AIOC, 2000b).

Changes in the sector profile can be tracked showing public sector employment falling steadily in the past decade but offset by increases in the private sector. Industry and agricultural sector employment rates have also fallen, although agriculture remains the largest source of employment. There is a large degree of underemployment in the public sector with posts remaining filled when there is insufficient work to justify it and with employees continuing on the workforce on reduced or even zero wages and enforced unpaid leave. The state sector also provides jobs for a large number of internal refugees from the occupied territories (AIOC, 2000b).

Unofficial labour markets are also prevalent throughout the country and primarily in the larger settlements. According to the UNDP this trend signifies that the working age population is desperate for work. In addition, skilled labour is migrating to foreign countries to seek employment thereby taking valuable resources outside the country (AIOC, 2000b).

7.4.4 Economic Activity

The information presented in this section has been sourced from the following documents:

- Government of Azerbaijan Interim Poverty Reduction Strategy Paper 2001;
- Nations in Transit 2000;
- Statistics Division ESCAP 2000; and
- Azerbaijan UNHDR 2000.

Until recently, the Azerbaijani economy was in the grip of a substantial decline that began in 1989. Gross Domestic Product (GDP) in 1995 was estimated at 34% of the 1989 level and the first positive growth (1.3%) was not recorded until 1996 (AIOC, 2000a). Whilst GDP has continued to grow since 1996, such growth has been erratic and recently it has slowed decreasing from 10% in 1998 to 7.4% in 1999. In 2000 however, there was a recorded increase in growth of 11.3%.

Table 7.2 depicts GDP trends by sector and shows the significant changes in the contribution from the construction sector between 1995 and 1998 as it increased by almost 13%. This decreased by 71% however, between 1998 and 2000. Meanwhile, trade, industry and transport and communications have continued to steadily increase year to year between 1995 and the year 2000. Agriculture has continued to decrease by almost 30% between 1995 and 2000.

Table 7.2 GDP by sector (%)

	1995	1996	1997	1998	2000
Industry	27.3	25.9	24.8	22.3	25.4
Agriculture	25.2	24.8	20.1	20.3	18.0
Construction	3.7	9.3	13.8	16.4	4.7
Transport and communications	17.4	10.2	11.9	12.9	15.5
Trade	4.8	5.2	5.5	5.7	6.6
Other	21.6	24.6	23.9	22.4	22.5
Total	100.0	100.0	100.0	100.0	100.0

Source: UNDP Human Development Report, 1999; Azerbaijan Economic Trends, Fourth Quarter 1998 p25; ASSC Statistical Yearbook of Azerbaijan 1999, p211; Azerbaijan Economic Trends October-December 2000.

Recent monetary and fiscal policies appear to be stabilising the economy and creating a platform for recovery with moderate underlying fiscal deficits at around 2.4% of GDP in 1999. These were budgeted to fall to under 1% of GDP in 2000. Whilst efforts are being made to improve the quality and transparency of public finances, predictability of fiscal policies could be assisted through greater transparency regarding changes to public sector wages, pensions, electricity and other tariffs. Persistent tax arrears by major taxpayers are also a source of concern although not currently destabilising to the overall economy (AIOC, 2000a).

Since 1995 with the gradually stabilising political situation and the cease-fire in the Armenian conflict, the Azerbaijani government has begun implementing an economic program supported by the World Bank and International Monetary Fund. Rapid progress has been made in restoring financial stability through tight fiscal and monetary policies. The consolidated budget deficit was brought down to 1.7% in 1997, and limited to about 4% in 1998 despite a fall in world oil prices. During 2000 the budget deficit fell to –1.1% or AZM239 billion (US$0.05 billion) (ASSC, 2001). This was below the government's target of 2.6% and considerably lower than the levels of 4-5% in 1998-99.

The budget is dependent on oil revenues for financial stability. Between January and September 2000 export revenue from oil and oil products was AZM6,044 billion (US$1,308.4 million), four times higher than the same period in 1999. This was a result of high oil prices (AET, 2000). The state budget revenue for 2000 was AZM3.572 trillion (US$773,160 billion) of which oil accounted for AZM 1.384 trillion (US$299,567 billion). Meanwhile, total state revenue for 2000 was AZM 4.137 trillion (US$895,454 billion) of which oil accounted for AZM 1.511 trillion (US$327,056 billion) (ASSC, 2001). In 1992, the Social Protection Fund was created as Azerbaijan's social insurance program and almost one-third of government expenditures are transfers through the fund. Pension arrears are a constant problem.

The rapid expansion of the private retail sector has, to a considerable extent, overtaken price liberalisation. While state-owned stores that sell subsidised bread and other staples remain in operation, large and vigorous markets that sell a wide variety of goods exist in almost every city and town of any size. Gasoline prices were liberalised in 1995. Power and telecommunications prices remain artificially low.

7.4.4.1 Agriculture

Agriculture is the most important sector in terms of employment with around 30% of the workforce directly engaged in agricultural production. Such production, including cotton, generates around 20% of GDP and 15% of merchandise exports. In 1999, the rate of growth for the gross agricultural output was 7%, including increases in the production of main plant based products such as cereals, potatoes, vegetables, watermelons, fruits and tea. This was however, offset by sharp falls in the production of other crops such as grapes and cotton. The output of meat and milk in 1999 exceeded 1990 levels.

Structural reform of the agricultural sector was launched in 1997. With the abolition of the state order system, liberalisation of producer prices and the ongoing process of closure and privatisation of state farms the reform has boosted agricultural and cotton production and exports. By the beginning of 2000 the number of newly established private farms had reached 36,000. The lack of a land market has however, restricted consolidation of ownership, restructuring, and the use of land as collateral. The structure of agricultural production has been stable since 1995 at 59% crop production and 41% livestock production (AIOC, 2000a).

7.4.4.2 Resource based industry

Resource based industries have developed a greater importance to the overall economy as compared with manufacturing, due principally to the development of the oil sector. Light industry remains underdeveloped due to the former reliance on Soviet markets and a general difficulty in competing with imported goods. Though privatisation efforts did yield an initial gain in output in 1996, production and yields continue to be lower than pre-1990 figures (AIOC, 2000a).

Offshore oil production accounts for the significant growth in the energy sector. In 2000 oil production grew by 2.8%. This growth has offset downward growth trends in other production sectors such as light industry and machinery. The oil and gas sector currently accounts for around 25% of GDP and almost 80% of merchandise exports.

As new oil and gas fields and pipeline routes come on stream, export of oil and gas will dwarf the export of other goods and services. The projected export boom is expected to improve Azerbaijan's economic and credit prospects. The accumulation of foreign assets through the Azerbaijan State Oil Fund, and the development of the non-oil economy will however, be vital for providing Azerbaijan with some protection against adverse oil shocks. Whilst the potential for export revenues is profound, there are issues associated with the volatility of commodity-related income streams, political threats to the various export routes and the capacity of the domestic oil and gas industry (AIOC, 2000a).

Azerbaijan's oil reserves are estimated to be in the range of 28 billion barrels and gas reserves are estimated at 100 billion cubic metres. Azerbaijan has an oil refining capacity of about 20 million metric tonnes per year but domestic oil production is approximately half this quantity with refineries operating well below capacity. In past years crude oil has been imported from Russia to make up some of the shortfall, however this practice ceased recently. Domestic consumption of oil products is 7.5 million metric tonnes per year or approximately 75% of current production. The remaining 25% is exported. Oil production has been declining for the past 15 years principally due to a sharp drop in output from onshore fields that now account for less than 20% of total production (AIOC, 2000b).

Despite gas reserves estimated at 100 billion cubic metres, domestic gas production does not currently meet Azerbaijan's needs. In 1994, the deficit of approximately 2 billion cubic metres was supplied by imported gas from Turkmenistan. A gas collection and treatment facility to recover gas from offshore oil fields, where associated gas had been previously flared, was commissioned in 1995 that should allow a reduction in gas imports. Fuel oil consumption should decrease as gas is substituted for oil in the generation of electricity (AIOC, 2000b).

Industrial production has collapsed to less than one-third of its 1991 level and the composition of industrial output has changed greatly. The production of energy including fuel and electricity, declined much less significantly than production in any other industrial sub-sector causing a substantial increase in the share of the value of industrial output that arises from energy production (from 16% in 1990 to 68% in 1998). The fuel industry alone has accounted for more than half of the total value of industrial production for the past three years. Despite the high potential that exists in Azerbaijan for development of both light and food industry, this sector of the economy has dropped from almost 20% in 1990 to less than 2% in 1999, as illustrated in Table 7.3 below. Overall, the rate of growth for gross industrial output in 1999 was 3.6% (ASY, 1999).

Table 7.3 Structure of industrial production by sectors (%)

	1990	1993	1994	1995	1996	1997	1998	1999
Overall industry	100	100	100	100	100	100	100	100
Electricity	4.0	11.0	16.7	19.2	17.9	16.7	20.3	20.6
Fuel	10.1	18.7	33.4	46.2	52.4	59.2	60.5	61.3
Ferrous metallurgy	1.5	2.4	2.7	0.3	0.1	0.3	0.1	0.0
Non-ferrous metallurgy	2.1	2.9	1.3	1.0	0.2	0.4	0.3	0.2
Chemicals and petrochemicals	6.4	7.7	5.4	5.4	4.5	4.0	3.2	4.2
Machinery and metalworking	20.3	16.0	7.3	3.6	3.6	3.9	3.5	2.4
Construction materials	3.0	5.0	3.0	1.5	1.1	1.4	1.2	1.0
Glass and ceramic industry	0.4	0.4	0.2	0.2	0.2	0.1	0.1	0.1
Woodworking industry	1.9	1.3	0.5	0.2	0.1	0.1	0.1	0.2
Light industry	19.9	14.8	11.5	9.5	8.2	5.1	2.3	2.0

Source: SCS 2000.

Shipping

The shipping activities in Azerbaijan waters include commercial trade, passenger and vehicular ferry transport, military, scientific and research operations, and service and supply operations to the offshore oil and gas industry. Merchant shipping levels have varied in the last decade, with a sharp decline in the early and mid-1990s followed by a substantial increase beginning in 1996. The majority of the increased vessel traffic over the last two years is related to new oil activities, particularly those of AIOC. Table 7.4 below summarises records from the local harbour authorities on cargo and passenger transport between 1995 and 1997.

Table 7.4 Quantities of cargo and passenger traffic in Azerbaijani waters

Cargo (million tonnes)	1995	1996	1997
Liquid (mainly oil)	3.09	3.02	4.0
Solid goods (merchant vessels)	0.19	0.26	0.24
Solid goods (ferries)	0.86	0.73	1.2
Total cargo	4.14	4.01	5.44
Total number of passengers	47,900	38,600	37,000

Source: Environmental Statement of the Azerbaijan Caspian, ERT 97/314, 1998.

Azerbaijan has eight commercial ports that are centred along the Apsheron Peninsula and Baku. The activities of these ports is summarised in Table 7.5 below.

Table 7.5 Commercial seaports in Azerbaijan

Location	Name	Activities
Apsheron	Dubendy	Bulk oil cargo
Baku	Zikh	Oil field services and construction yards
	Refinery	Crude oil and oil products
	East port	General cargo and ferries
	Military port	Military base, ship repair
	South dock	Ship repair, construction yards, oil spill response and supply base
Primorsk	SPS	Construction yard and oil field supply base
	Primorsk	Offshore oil field supply base

Source: ERT, 1998.

The Caspian shipping fleet consists of vessels operated primarily by the Caspian Shipping Company (CSC) and the Volgotanker River Shipping Company although there are a number of smaller companies. The CSC is an Azerbaijani state-owned company comprising 33 cargo tankers. In addition, the CSC operates 23 dry bulk chips, two 'roll on roll off' ships and eight railroad sea cargo/passenger ferries. The Volgotanker River Shipping Company operates in the Volga-Don system as well as throughout the Caspian Sea. In 1997, 20 vessels operated in the Caspian. The company states that its fleet comprises river craft of 250 tonnes, 200 river-sea tankers and 50 ore/oil carriers, however it is not clear how many of these vessels are actually in operation. Other vessel owners are thought to operate up to 10 vessels of 6,000 dead weight tonnes (DWT) and six small tankers totalling 3,000 DWT.

7.4.4.3 Fishing

Information in this section has been gathered from the following sources:

- Caspian Environment Programme (various sources);
- a report provided by the Caspian Fish company;
- a report provided by the Azerbalyk Fishery State Concern; and
- Fisheries Institute.

The fishing industry has represented a relatively major contribution to GDP at approximately 1%. Indeed, the Caspian is an important fishing area with commercial catches of sturgeon, sprat, carp, darters, gobs, herring, salmon and mullet. Caspian fish stocks have however, fallen substantially since the advent of independence among the littoral states. The industry today is in serious decline, not only as a result of falling stocks, but also disrupted export routes and markets, and inadequate supplies of materials for processing and packaging. It is widely believed that the primary reason for the reduction in fish stocks within the Caspian is due to a lack of regulation and control of the fishing industry, which has led to increased illegal and over-fishing in the region. Illegal fishing in the region is believed to represent in excess of 70% of officially recorded figures.

The fish resources of the Kura River have been exploited for many years; for example, in the period 1829 to 1840 some 580 tonnes of caviar were produced. Although this dropped to 510 tonnes between 1841 and 1845, the Kura River continued to be the biggest producer of caviar, and remained so between 1925 and 1930, when it accounted for, on average, 45% of all caviar in the Caspian. Statistics for the period 1996-1998 state that caviar production is between 1.5 to 3 tonnes per annum. Fish quotas have been agreed between the states of the FSU bordering the Caspian, with the exception of Iran.[4]

[4] Caspian Environmental Programme.

Table 7.6 below provides details of the fish catch in Azerbaijan between 1990 and 1997. Statistical data on fishing is annually recorded by the Catch Department of the Azerbalyk, the State Fisheries Concern, based on information from fishing areas. This information only covers however, data obtained in the Azerbaijani sector of the Caspian. In addition, the figures submitted for fish catch levels may not truly reflect the numbers of fish caught, as has been highlighted through inspection checks. It is estimated that the legally caught fish amounts to only 30% of that caught. Species such as salmon, kutum, asp and shemaia are caught solely by poachers.

Table 7.6 Fish catch in Azerbaijan 1990-1997

Year	Fish Catch	Value (billion AZM)	Value (million $)
1990	39,541	-	7.7
1991	36,932	-	7.2
1992	30,283	-	5.9
1993	21,526	-	4.2
1994	18,710	-	3.6
1995	9,509	8.4	1.9
1996	6,636	5.8	1.3
1997	5,302	4.0	1.0
% change 1990-1997	(86.6)	(86.6)	(86.6)

Note: Exchange rates for 1990-1994 inclusive were not available.

The fish caught in the Caspian is primarily for food; for example, in districts such as Neftechala and Lankaran fish is the daily, basic food. In addition to providing a basic food resource, the fish catch is also used for the production of caviar, cannery, smoking and fish flour. In the Kur Dashy contract area there are two fish factories, the Narimanov factory in Lenkoran and the Taiev factory.

The fishing sector is ranked third, after oil and gas and cotton, in terms of its contribution to the national economy. The Azerbaijan fishing industry employs nearly 4,000 people or 7.3% of the workforce in the food industry and accounts for 16.9% of fixed assets of the food industry. The main fishing ports are Hovsany, Lenkaran and Banka.

There are six species of sturgeon in the Caspian. Sturgeon is fished with sweep-net in the rivers flowing into the Caspian during the spawning migration season. In the sea, fishing of sturgeon is prohibited in order to save young and roe carrying fish, with the exception of the coastline of Iran, where they are fished with fixed nets. There has been a sharp reduction in the number of sturgeon being caught in the Caspian. Table 7.7 below illustrates that catches of sturgeon decreased by over 90% between 1990 and 2000.

Table 7.7 Sturgeon catch in the Caspian

Year	Catch ('000 tonnes)
1990	13,700
1997	1,845
2000	1,002
% change 1990 – 2000	(92.7)

Source: Azerbaijan Fisheries Institute.

It is believed the sharp reduction in sturgeon catch is connected to the destruction of spawning and breeding grounds mainly as a result of dam construction in the rivers feeding the Caspian. It is also accounted for by a sharp increase in poaching following the break up of the Soviet Union and the resulting collapse of control and monitoring of the sea, weakening of law enforcing bodies and the loss of the Government monopoly over sturgeon caviar production.

Today young and early roe carrying fish are poached in the sea, while females on their way to spawn are poached in rivers. The extent of poaching is estimated to be far greater than legal sturgeon fishing. Azerbaijan is taking steps to eliminate sturgeon poaching. Azerbaijan's parliament, the 1,125 member Milli Mejli, approved the Convention on International Trade of Endangered Species (CITES) on 23 June 1998and came into force on 21 February 1999.[5]

Since the break up of the Soviet Union, sturgeon poachers have illegally transported caviar to countries such as Turkey and the UAE, where they package the caviar in accordance with international standards and then sell it on to the world market. The best sturgeon is caught during the months of April-June and September-November. Young fish are released from the farms from May until mid July. There is a second round of breeding activity between September and October.

Quotas will be established on the amount of caviar that can be produced in Azerbaijani waters. Azerbaijani factories will then be issued certificates verifying the origin and legality of the caviar. Once the certificates have been issued, INTERPOL and other international organisations will be charged with enforcing the CITES quotas by prosecuting exporters who transport caviar lacking the obligatory certificates. Through these mechanisms, the amount and frequency of sturgeon poaching in Azerbaijani waters can be expected to diminish.

Sprats are normally fished in the Southern Caspian, mainly on the shelf grounds of Azerbaijan or Turkmenistan. According to surveys carried out by the Caspian Fisheries Institute, the sprat catch in the year 2000 amounted to some 250,000 tonnes. It is estimated that the catch for 2001 could be 300,000 tonnes however, the alien comb jellyfish (*Mnepiopsis leidyi*), believed to be introduced to the Caspian from the Azov Sea, feeds on plankton, the main food of sprats, sprat fry and also fry. As a result the volume of caught sprats has been decreasing drastically. Studies are currently being undertaken to find ways to mitigate this problem. Sprats are caught using fish pumps and cone-shaped nets and are invariably caught during the night. Sprat is fished all year round, however the best fish can be caught from September through to April, with fishing activity slowing down during the summer months.

The Caspian Salmon forms several shoals confined to the rivers feeding the Caspian: Kura, Terek, Samur, Sefidrud and others. Following construction of the Mingechaur Hydro Plant salmon resources dropped drastically. Construction of two salmon breeding farms in Chaykent and Chukhur-Gabala reduced the likelihood of extinction of the Caspian salmon population. Despite this, uncontrolled fishing and a drop in the artificial breeding rate put the Kura salmon on the brink of extinction. Salmon are confined to the western and southern coasts and never move offshore to depths in excess of 40-50 metres. They do travel however, long distances along the coastline. The salmon are attracted to the coast between November and February, this being the best fishing season for them.

Carp are concentrated in the Northern Caspian. These fish are caught between 40-60 km from the shore by boats using lights to attract the fish. The number of vessels engaged in this form of fishing activity peaked at approximately 500 vessels but numbers have dropped to around 100 vessels. Whilst wild carp are fished year round, the best months are May-April and October-December.

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[5] The process of making a declaration to be bound to the provisions of CITES is called "ratification", "acceptance", "approval" or "accession". Acceptance, approval and ratification are legally equivalent actions but are only applicable in relation to the States that signed the Convention when it was open for signature, between 3 March 1973 (when it was concluded) and 31 December 1974. (Acceptance and approval are the actions taken by certain States when, at national level, constitutional law does not require a treaty to be "ratified"). The term "accession" is used in relation to the States that did not sign the Convention.

Mullet is concentrated mainly in the Southern Caspian, with fishing in the Kur Dashy from September-November. There are five species of herring in the Caspian and they spend all winter in the Southern Caspian. Herring fishing occurs between the months of April-May.

7.4.5 Exports

The information presented in this section has been sourced from the following:

- Government of Azerbaijan Interim Poverty Reduction Strategy Paper 2001;
- Nations in Transit 2000;
- Statistics Division ESCAP 2000; and
- Azerbaijan UNHDR 2000.

For many years Azerbaijan's access to external markets has been disrupted by regional political turmoil. By January 2000 finished products valued at AZM587.1 billion (US$0.1 billion) had been accumulated as stocks with industrial enterprises. The key routes for the transport of goods including oil and gas from Azerbaijan to Western markets are through Georgia to Black Sea ports and through Russia and Iran. Baku is a major transport hub for the entire Caspian region. In recent years, restrictions on trade have virtually all been removed and the authorities plan to reduce the general import tariff rate of 15% to 10%. Azerbaijan has also applied to join the World Trade Organisation (WTO) with the intention of becoming members by the end of 2002. The country has not fully accepted all the obligations under Article VIII of the IMF's charter but in practice, the Manat is fully convertible for current account transactions (AIOC, 2000a).

In 1999, Azerbaijan's merchandise export had a growth rate of 53.2% worth AZM3,670 billion (US$929 million). Its import growth rate was -4.1% or some AZM4,080 billion (US$1,033 million). Between 1994 and 1997, on average 45% of Azerbaijan's merchandised exports were destined for CIS markets. In the aftermath of the financial crisis in Russia in 1998 however, exports to the CIS totalled AZM 820 billion (US$211million) or a little over one fifth of total exports. The decline in the value of exports to Russia and other CIS markets was more than offset by an almost doubling of oil exports to non-CIS markets in 1999 (AIOC, 2000a).

As indicated above, the geographical location of Azerbaijan creates dependence on its neighbours for the transport of imports and exports with 90% of road freight and 95% of rail freight passing through Russia. Although barriers to trade have been eased, and have allowed new trades routes to prosper in light of the collapse of the traditional Soviet distribution network, Azerbaijan may still have to wait some time before pre-Soviet volumes of trade are realised again (AIOC, 2000b).

7.4.6 Foreign investment

The information presented in this section has been sourced from the following:

- Government of Azerbaijan Interim Poverty Reduction Strategy Paper 2001;
- Nations in Transit 2000; and
- Statistics Division ESCAP 2000.

Foreign investment in Azerbaijan was AZM1,520 billion (US$342 million) in 1996 rising to AZM4,080 billion (US$1 billion) in 1997 and AZM4,468 billion (US$1.15 billion) in 1998. In 1999 foreign investment decreased by 26%, direct investments fell by 44% whilst foreign investments in the oil sector fell by 39%. In aggregate, foreign investment flows have been small outside the oil sector. Foreign investors have improved logistics facilities for the oil industry, introduced mobile telephony, begun to rehabilitate the construction materials industry and brought modern commercial property and business services to Baku. Foreign investment has however, made little impact on industry or on the agriculture/agri-business that is the heart of the Azerbaijani economy. Continued state ownership has limited direct foreign participation in improving and expanding the main utilities and infrastructure assets.

7.4.7 Privatisation

The information presented in this section has been sourced from the following:

- Government of Azerbaijan Interim Poverty Reduction Strategy Paper 2001;
- Nations in Transit 2000; and
- Statistics Division ESCAP 2000.

The Azerbaijan government passed a privatisation law in January 1993 to establish ground rules for joint-stock enterprises and the auction of small and medium-sized enterprises. In 1995, the Azerbaijani government pledged to make significant efforts to privatise the industrial and agricultural sectors. The Law on Privatisation that was approved by parliament on July 21, 1995, called for privatisation to begin on September 1, 1995. The IMF was instrumental in stimulating the government to begin a privatisation program in 1997. In February 1997, Azerbaijan launched a three-year programme to privatise 70% of enterprises by the end of 1998, dividing enterprises into small, medium and large companies.

The country's privatisation legislation divides enterprises into four categories as follows:

- non-privatisable (e.g. the national bank, railroads);
- privatisable by presidential decree (e.g. fuel, energy);
- privatisable by decree of the council of ministers (e.g. oil and oil products, construction), and;
- fully privatisable.

The IMF were instrumental in focussing efforts on privatisation but the process has moved slowly and the private sector remains small in relation to state concerns, employing only 16% of workers. There has been a significant increase in the volume of output over the last few years and the corresponding increase in the number of employees. In addition, there is a steady growth of joint venture enterprises involving foreign companies within Azerbaijan. In 1992 there were 100 joint ventures. Numbers rose to 730 by 1994. In that year, 66% of the inward investment was by Turkish companies and nearly 10% was invested by companies from the USA.

Tax system reforms began in the spring of 1995 in response to rampant national tax evasion, declining revenues and pressure from international financial institutions. The size of the tax administration was increased and tax inspectors were ordered to collect tax arrears aggressively from state and privately owned enterprises and in some instances, NGOs. Tax compliance varies among taxpayers with foreign companies being generally compliant. The Finance Ministry reported a collection rate from foreign companies as being nearly 100% in 1996.

Key tax administration measures adopted in January 1999 include stronger powers to collect tax arrears such as enforcement of notices of levy to collect from delinquent taxpayers' bank accounts and those of their debtors, liens on property and the seizure and sale of physical property. In addition, computerisation of tax collection agencies is being expanded, the Large Taxpayers Unit (LTU) is being reinforced and the audit function is being introduced.

Despite these measures taxation remains unpredictable. In January 1999, corporate profit tax rates were reduced from 32% to 30%. Due to the lack of deductibility for legitimate expenses (including interest charges) however, effective tax rates are considerably higher. Import tariffs and major taxes have increased, while the number of exemptions from profit and value-added taxes have declined.

Tax revenue, as a proportion of government revenue, remains low (e.g. tax revenues in 1999 were estimated at 19.3% of GDP). As a result the state budget is generally dependent on foreign credits and signing bonuses on oil-exploration leases.

7.4.8 Land ownership

The privatisation process in the agricultural sector began in late 1996 and has progressed rapidly. Price controls on agricultural products have been removed and trade has been liberalised. The system of state and collective farms is in the process of being dismantled and a wide variety of "small-holder" farming structures have emerged ranging from small family farms to medium companies. The privatisation of livestock is also nearing completion. It is believed that 80% of rural land titles have been issued and state-owned machinery and equipment are being distributed to private farmers. The share of households and private farms in total agricultural production rose from 67% in 1996 to 94% in 1998 (URS, 1999).

A number of structural bottlenecks continue to impede agricultural productivity. Most important among these are the lack of rural financing, the poor condition and management of the irrigation system and the absence of extension and support services (PD, 1999).

No reliable information is available to describe the current status of land reform within Azerbaijan. Most state land was transferred to regional administrations and since then land has been allocated to the population. This allocation has been undertaken to the extent that approximately 60-70% of land has now been allocated. (ERM, in press).

7.4.9 Infrastructure

Most of Azerbaijan's infrastructure was built during the Soviet period and is in a generally poor condition. There has been inadequate public investment and maintenance of the country's infrastructure since independence. The power generation and distribution system is deteriorating and gas, water, electricity and oil product shortages are common in Baku. In 2000, Azerbaijan switched its power-generating facilities from fuel oil to gas in an effort to free up more oil for export, but problems with gas supplies to power plants at the beginning of 2001 caused electricity shortages, forcing the state oil company SOCAR to increase domestic oil use again. In an effort to boost foreign investment in the energy sector, Azerbaijan established the Fuel and Energy Ministry in April 2001 to oversee the country's fuel and energy sector (Energy Information Administration, 2001).

7.4.10 Water

Clean water resources are scarce in Azerbaijan. More than 80% of the population are living in areas without modern water or sewage networks. The Kura and Araz rivers, which provide most of Azerbaijan's fresh water, are both contaminated with industrial, agricultural and domestic wastes generated both inside and outside Azerbaijan (UNDP, 1999).

The problem of clean water scarcity is compounded by inefficient water use. For example approximately half the drinking water distributed to the Apsheron peninsula is lost in the distribution pipeline system. The degraded and poorly managed irrigation system is responsible for agricultural water losses of about 50%. Within industry recycling of water is virtually non-existent (UNDP, 1999).

7.4.11 Health

The quality of health care in Azerbaijan is compromised by structural characteristics inherited from the Soviet years[6] [7]. The system consists of a complex, hierarchical network of medical structures that remain almost completely within the public sector. The lack of public attention to the health sector has resulted in deteriorating medical buildings and shortages of up-to-date medical equipment. This has been compounded by the near collapse of emergency services and primary care in most rural areas. A number of modern health facilities have recently become operational, within Baku the capital, however the majority of the population is unable to afford or access these services.

Health receives 4.5% of the state budget. In circumstances of economic crisis and inflation these allocations do not meet the minimal requirements. In addition, current facilities cannot be maintained or improved and there are key medicine and equipment shortages. As a whole, specialists consider health care in Azerbaijan to be in a critical state. Programs are being elaborated on several health care fronts including immunisation, anti-TB campaigns, drug addiction treatment, family planning and measures against infectious diseases amongst others. UNICEF, UNFPA and the WHO are all active in Azerbaijan. Almost 95% of medicine, medical equipment and supplies are provided through international humanitarian assistance.

There are currently 755 health centres, 1,624 ambulances and polyclinics including 757 medical laboratories and 2,288 maternity centres in Azerbaijan. There are 39.2 physicians and 9.5 auxiliary medical workers per 10,000 people. Male life expectancy in 1997 was 66.5 years and female life expectancy 74 years. The birth rate was 17.4 per thousand (a drop from 26.4 per thousand in 1989) and deaths 6.2 per 1,000 people. According to statistics listed with the WHO, the suicide rate in Azerbaijan was 0.7 per 100,000 people in 1995 and 0.9 per 100,000 people in 1996. The number of hospital beds totalled 76,900 or 104.4 per 10,000, a ratio well above European Community levels.

The leading causes of mortality in Azerbaijan, in order of magnitude, includes:

- cardiovascular disease;
- cancer;
- respiratory infections; and
- accidents.

The incidence of communicable diseases is increasing having been successfully reduced during Soviet times. The steep decline in attention given to preventive care and the impossibility of carrying out therapeutic and public health and epidemic prevention measures at an appropriate level, results in epidemics of polio, diphtheria, and malaria and there has been an increase in the incidence of rabies, brucellosis, anthrax, tuberculosis (TB) and other infectious diseases (GOA IPRSP, 2001). HIV/AIDS, hepatitis A, diarrhoeal, sexually transmitted diseases and acute respiratory infections are all important public health problems, along with reported instances of botulism, tetanus and malaria (ERM, undated). TB is seen as particularly serious in Azerbaijan. Mortality from TB has risen from 4.6 per 100,000 in 1990 to 10.4 per 100,000 in 1993. Poor water quality has exacerbated problems and unsanitary conditions have led to outbreaks of acute intestinal diseases.

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[6] Dr Vladimir Verbitski, WHO Regional Office for Europe in Azerbaijan and Dr Richard Zalesky, Head of the Chair of Tuberculosis of the Latvian Medical Academy. Article published in Azerbaijan International (3.4); Winter 1995.

[7] Dr Irada Yusifli, The Return of Infections and Contagious Diseases, published in Azerbaijan International, (3.4); Winter 1995.

HIV/AIDS and STD incidences are increasing in Azerbaijan. Only seven cases were registered between 1987 and 1992 but 164 HIV cases were confirmed by January 2000 (UN, 2000). Actual statistics may also be much higher as many cases may go unreported. Due to changes in testing policy and economic constraints, the number of HIV tests performed has decreased from more than 300,000 per year (excluding blood donations) in the early 1990s to 12,000 in 1998. HIV cases are reported nationally without names. One of the drivers of an increasing HIV/AIDS infection rate is labour migration and mobility with workforces being disconnected from their families (UNAIDS, 2001).

The number of health cases connected with drug addiction and alcoholism has also increased since the late 1980s.

7.4.12 Education

Azerbaijan inherited a strong and comprehensive system of education from the Soviet Union, a system characterised by total centralisation and standardisation in approaches to education. The law of the Azerbaijan Republic “On Education” guarantees the right to education for all its citizens irrespective of race, nationality or sex.

Azerbaijan has a long history and tradition of learning. The system encompasses 1,814 pre-school institutions serving 112,000 children, 4,561 general education schools (with 1.6 million students), 110 vocational schools and academic preparatory schools (with 24,000 students), 25 public and 18 private universities (with 113,000 students), and 70 colleges (with 35,000 students). Thus, there are more than 2.2 million people studying at all of these institutions (27.5 percent of the total population) and they are being taught by over 400,000 instructors, teachers, on-the-job training supervisors and other workers (GOA IPRSP, 2001).

A system of private educational institutions is being developed. Specialised secondary schools play an important role in training more than 70,000 pupils for specific jobs. Today about 86% of the workers in the national economy have an education to the level of higher, secondary or incomplete secondary education and there is almost universal literacy. Many foreign students, particularly from Turkey, Iran, India, Arab countries and others attend special institutes in Azerbaijan.

Azerbaijan’s educational progress is jeopardised however, by current funding problems and structural weaknesses within the education system (UNDP, 1999) that needs fundamental improvement and to be brought closer in line with progressive world standards. This applies not only to improving the quality of the educational and instructional process and the qualifications of teaching personnel but also to improving the administrative structure in the educational sphere. Moreover, the current status of the material and technical base of educational and training institutions and especially general education schools lags significantly behind what is needed.

Over the past ten years almost no schools have been built in Azerbaijan and due to the limited budget resources that have been allocated it is not possible to purchase up-to-date equipment, supplies, electronic and other technical equipment. As a result, it is not possible to incorporate new technologies into the learning process at many educational institutions, especially in rural areas and the absence of adequate computer equipment prevents students and teachers from obtaining the necessary information and organising the educational process on a contemporary level (GOA IPRSP, 2001). Additional problems include low salaries for teachers and the shortage of suitable buildings, textbooks and furniture. In 1997 approximately 5% of GDP was spent on education.

7.4.13 Poverty, refugees and internally displaced persons

Statistical information on poverty is emerging as Azerbaijan upgrades surveys of standards of living and introduces new survey methodologies. Considerable discrepancy exists among various sources concerning the scale of poverty in Azerbaijan. Informal sources, such as NGOs and the media, put the current number of people living below the poverty line at 80%, according to the World Bank this figure is 60% and UZ Azerbaijan estimates that more than 1 million people continue to live below the poverty level. Government sources maintain that only 20% of citizens live in poverty. There appears to have been a sharp deterioration in virtually all measures of human welfare and health since 1990 (Nations in Transit, 2000).

According to World Bank experts, approximately 20% of families can be classified as severely vulnerable. Over 500,000 people are unemployed. The lowest average salaries are found in the agriculture and education sectors as well as the wood industry. The cost of the minimum consumer basket[8] in Baku currently exceeds the average Azerbaijani salary by 3-4 times. It should be noted, however, that the actual overall income per capita considerably exceeds the official salary level. This means that unofficial or “grey area” financial turnovers (non-controlled by the Government) have become the main source of income for a large percentage of the population (UZ Azerbaijan, 2000).

The major causes of increasing poverty could be perceived as the general economic decline and the fragmentation of the social welfare systems which, in Soviet times, provided a minimum standard of living for all. Support services appear to have collapsed, wages and pensions frequently go unpaid or are severely delayed, unemployment has risen and the real value of social support payments has fallen. Poverty, especially for women and children, appears to be more widespread amongst the rural population.

This poverty is intensified by the reduction of access to social services such as health care and education. Many of the people of Azerbaijan continue to live without access to safe water, sewage systems or energy. Social inequality is also a rising problem. Market reforms are very focussed on Baku, the capital city, leading to an increasing stratification between the population of Baku and the rest of the country. There is also a tendency towards migration out of Azerbaijan, the consequence being that the proportion of young people, especially males, is decreasing and the proportion of elderly citizens is increasing. This points to a ‘brain drain’ taking place within Azerbaijan, particularly in scientific fields (UNHDR, 2000).

The situation is made more complex by the ongoing economic crises, the uneasy peace with Armenia and the problem of accommodating over half a million people displaced from territories now occupied by Armenia (the occupied sections covering approximately 20% of Azerbaijan). There are currently about 1 million Azeri refugees and internally displaced persons (IDPs) in Azerbaijan, accounting for approximately one-seventh of the country's total population. The refugee population is composed of some 230,000 Azerbaijanis who fled Armenia after 1988 and approximately 50,000 Meshetian Turks who fled Uzbekistan in 1989.

The IDPs come from the various regions around Nagorno-Karabakh that are now occupied by Armenian forces. Some live in prefabricated houses, railway wagons and tent camps managed and assisted by international humanitarian organisations. The major camps are located in Sabirabad, Saatly, Bilasuvar, Agdam, Barda, Agjabadi, Sumgait, Goranboy, Yevlax, Seki, Deveci, Imisli and Mingacevir. Other groups of refugees and IDPs reside in rehabilitated public buildings such as university hostels, administrative buildings, schools or sanatoriums. Most of these buildings are overcrowded and in severe disrepair. Many IDPs have been residing in these buildings for four years or more (UZ Azerbaijan, 2000).

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[8] A consumer basket is a ‘basket’ of the essentials needed by a family - the cost of this basket allows an assessment of whether income levels are adequate.

7.4.14 Civil society

There are approximately 950 NGOs officially registered in Azerbaijan. Of these only approximately 90 to 110 are active according to a January 1998 report by the United States NGO, ISAR-Azerbaijan. The various NGOs include women's groups, charitable organisations, environmental associations and public policy institutes. The strongest national NGOs are those that work on refugee issues and that have contacts with international organisations such as the United Nations High Commission for Refugees. There are also well-established groups working on health and children's issues. Several NGOs deal with charitable work although the exact number is unavailable.

Environmental NGOs on the whole are non-controversial and are concerned with conservation, animal welfare and environmental education. Some of the stronger of these NGOs include the Azerbaijan Society for the Protection of Animals and Azerbaijan Green Movement. A lack of established philanthropic organisations in Azerbaijan has meant NGOs are heavily reliant on oil industry funding and volunteers.

The 1995 constitution and a 1992 press law ostensibly guarantee free media. The print media in Azerbaijan are however, subject to various restrictions. Most popular newspapers, magazines and journals are published in Baku and are privately owned. Private newspapers include *Ayna/Zerkalo*, *Avrasiya*, *Gunay*, and *Press-Fakt*. Party-financed papers include the opposition *Azadliq*, *Yeni Musavat*, *Istigal* and *Millat*. Government-supported newspapers include *Azerbaijan*, *Bakinskiy Rabochiy* and *Yeni Azerbaijan*. The two state-owned television stations, AzTV-1 and AzTV-2, dominate the electronic media and provide the population with most of its news. Several independent stations exist, a number of private and two Russian TV channels although a tightening of private broadcast regulations has forced them to narrow their coverage to a range of subjects acceptable to local authorities (Nations in Transit, 2000). Recent reports suggest a lifting of these restrictions (Baku Sun, 2002).

Azerbaijan's telephone system is a combination of old Soviet era technology, used by Azerbaijani citizens and small- to medium-size commercial establishments, and modern cellular telephones used by an increasing middle class, large commercial ventures, international companies and most government officials. Internet and e-mail services are available in Baku (Nations in Transit, 2000).

Satellite service between Baku and Turkey provides access to 200 countries. Additional satellite providers supply services between Baku and specific countries. Azerbaijan is a signatory of the Trans-Asia-Europe Fibre-Optic Line (TAE). Although TAE lines are not laid a Turkish satellite and a microwave link between Azerbaijan and Iran could provide Azerbaijan with worldwide access in the future.

7.4.15 Cultural heritage

Azerbaijan is a country of ancient history and culture. Several states existed on the territory of the present Azerbaijan in ancient times. In the 3rd century B.C. the territory of historic Azerbaijan was under the dominion of the Sassanid dynasty of the Persian Empire. In the Middle Ages Azerbaijan was divided into separate khanates. Several attempts were made to unite them; the most successful was by Shah Ismayil, founder of the Safevid dynasty.

Situated between the southeastern slope -of the Greater Caucasian Range and the Caspian Sea, lies the plain broken with ravines, called Gobustan (the territory of Gobu). In the mountains of Gobustan there is a concentration of rock carvings, settlements and tombstones recording the history of the Azerbaijani people from the Stone Age onwards. Ancient rock carvings are of a particular prominence. These prehistoric art monuments reflect the culture, economy, world outlook, customs and traditions of ancient Azerbaijan people (Azerbaijan Ministry of Culture, 2001).

The Azerbaijani language is a member of the south Turkic group of languages, originally written in Arabic script. The Latin alphabet was introduced in 1929; ten years later the use of Cyrillic script was made compulsory. Following independence the Government began to phase out the use of Russian, which was widely spoken during Soviet times and is still in use, and the Latin alphabet was reintroduced in the spring of 1992. Russian is often spoken in urban areas (especially Baku and Sumgait) and understood throughout most of Azerbaijan.

7.5 Regional

It should be noted that there is a lack of formal, consistent and comprehensive data collecting and recording processes at a regional and local level. For example the data on age split in the Garadag region (along with data on population figures, split by male/female, labour force, religious mix, and employment by sector) is only collected every 10 years. As the data were not freely available, and collection and recording methods considered unreliable, a number of key individuals were consulted to gather data at a regional and local level (Section 7.2.2).

The data gathered was based on conversations and some of the data offered was opinion rather than based on official figures. Without having this verified by a household baseline survey and/or 'knowledge, attitudes and practices' (KAP) survey, the data cannot be completely relied upon for accuracy and any views expressed would need to be corroborated by members of the community as a whole. These factors may have affected the completeness and reliability of the information at regional and local level and this needs to be borne in mind when reading these sections.[9]

Some data has also been included from a sociological survey undertaken of the settlements of Umid, Sangachal and Primorsk (AHFS, 2001). The interpretation of this survey data however, has been hampered by the methodological approach to design and collection (as outlined in the Socio-economic Data Gathering Technical Appendix) and so can be taken to be indicative only until it can be verified at a future date.

The terminal site at Sangachal is located in the Garadag District, part of the Baku Administrative Region extending from just south of Baku to Gobustan. Population figures indicate that almost 94,300 people are resident in the District, a 2.3% increase over 1995 figures.

[9] In addition, three other factors have affected the reliability of the data at regional and local level: time constraints placed on the data gathering process, constraints placed on who could be interviewed for the data collection process as a result of a parallel process taking place around land acquisition (for instance URS were unable to speak with the cafe/garage owner in Sangachal due to this process), and the cultural sensitivity to providing outsiders with information, oral or written combined with the sensitivity of individuals to being identified as information givers.

Figure 7.1 Garadag District

7.5.1 Population and demographics

The key settlements within Garadag District are outlined in Table 7.8 along with the estimated population numbers in each of these settlements and the split between male and female. The data indicate slightly more females in the district than males. In addition to these key settlements there are also a further three small villages, namely Umid, Shikhlar and Kotel. Figures for the overall population of Umid were obtained by consulting community leaders or from official statistics. As far as can be ascertained, no population figures exist for Shikhlar or Kotel and no age or gender distribution details exist for any of the three villages. The age profile of the population in Garadag District for 2001 is outlined in Table 7.9.

Table 7.8 Population figures Garadag District (2001)

Settlement	Male		Female		Total
	Number	%	Number	%	
Lokbatan	14,118	48	15,164	52	29,282
Sahil (previously Primorsk)	10,345	49	10,655	51	21,000
Gobustan	6,249	49	6,387	51	12,636
Elet	5,723	49	5,951	51	11,674
Gizildash	1,929	50	1,927	50	3,856
Mushfigabad	3,942	50	3,972	50	7,914
Sangachal	1,702	49	1,773	51	3,475
Buta	509	50	499	50	1,008
Cheyildag (previously Umbaku)	489	49	504	51	993
Korgoz	948	50	957	50	1,905
Shangar	274	50	269	50	543
Total:	46,228	49	48,058	51	94,286

Source: Garadag Executive Power Office.

Table 7.9 Age profile Garadag District (2001)

Age Bracket	Population	
	Number	%
<4	7,987	8.5
5-9	11,678	12.4
10-14	12,750	13.5
15-19	9,382	10.0
20-24	6,890	7.3
25-29	6,432	6.8
30-34	8,176	8.7
35-39	9,676	10.3
40-44	7,520	8.0
45-49	4,104	4.4
50-54	2,009	2.1
55-59	1,942	2.0
60-64	2,272	2.4
65-69	1,565	1.7
70<	1,903	2.0
Total:	94,286	100.0

Source: Garadag Executive Power Office.

Table 7.10 below details the ethnic origin of those within the district. The majority of the population in the District is of Muslim religion, with only a small minority, approximately 7.4%, being Christian.

Table 7.10 Ethnic origin Garadag (2001)

Ethnic Origin	People	
	Number	%
Azeri	76,000	90.0
Ukrainian	1,100	1.3
Russian	2,970	3.5
Turkish	32	0.03
Tatar	1,250	1.5
Lezghin	2,660	3.1
Talish	55	0.07
Kurd	230	0.27
Armenian	16	0.02

Ethnic Origin	People	
	Number	%
Jewish	23	0.03
Avar	15	0.02
Georgian	19	0.02
Sakhur	6	0.007
Tat	7	0.008
Others	93	0.11

Source: Garadag Executive Power Office.

7.5.2 Livelihoods

Income levels in Garadag District for the year 2001 are detailed in Table 7.11. The average monthly salary column illustrates the average salary received during one month by a resident of Garadag District between 1996 and 2001. The population income column illustrates the total income received by all of those resident in Garadag District. As illustrated, income levels were steadily increasing to a peak in 2000 at which time a decline through 2001 set in.[10]

Table 7.11 Income levels Garadag District (1996-2001)

Year	Average Monthly Salary		Population Income	
	AZM	(US$)	AZM million	(US$ million)
1996	184,800	42	8,316	1.87
1997	231,000	57	9,702	2.38
1998	272,580	70	12,012	3.09
1999	332,640	84	14,322	3.63
2000	388,080	83	16,170	3.49
2001	346,500	76	16,170	3.5

Source: Garadag Executive Power Office.

7.5.3 Employment profile

Employment in Garadag district is dominated by its proximity to the industrial and economic centre of Baku and also by industry in Primorsk (e.g. the Shelprojecstroy (SPS) rig fabrication yard and the nearby Garadag Cement Plant (GCP)), Gobustan and Lokbatan (AIOC, 2000a). The oil and gas industries support large numbers of workers, relative to the employment base in the area, and have traditionally contributed significantly to productivity (Table 7.12). Agriculture is less important in this area although the desert and semi-desert areas provide important winter pasture for stock (AIOC, 2000a). There is very little arable farming due to the poor climatic and soil conditions (AIOC, 2000a). Some small market gardens are evident around settlements but no intensive farming activities are present (AIOC, 2000a).

[10] It should be noted that the AHFS survey of the residents of Sangachal, Primorsk and Umid found that approximately 35% of those surveyed receive no income at all. Only around 24% receive an income of between AZM200.000 and AZM500.000 (US$43-US$108).

Table 7.12 Employment by industry sector Garadag District (2001)

Industry Sector	People	
	Number	%
All production industries	23,000	72.3
Education, art and culture	4,000	12.6
Health, physical training and social service	1,500	4.7
Government managerial	700	2.2
Public utility service	500	1.6
NGO and private commercial	2,100	6.6
Agriculture	3	0.0
Total:	31,803	100.0

Source: Garadag Executive Power Office.

No official information is available regarding the total number of people employed in the fishing sector in the District (Garadag Executive Power; 23/7/01). It is understood that fishing activities in the District are largely recreational and subsistence in nature, and are concentrated around Elet, Sangachal and Lokbatan.

Table 7.13 details the available labour force in Garadag District between 1996 and 2001. The table indicates that there has been a continuing increase in the available labour force in the District over the last six years amounting to almost 28% between 1996 and 2001. This equates to almost 5% growth per annum. The available figures suggest that the total employable population, if it is assumed to be those aged between 20 and 59 inclusive, is 46,749 for 2001. The figures in the two tables do not balance as the total employable population by age is less than the available labour force for the same year possibly illustrating the lack of reliability in data collection in the District.

Table 7.13 Labour force Garadag District (1996-2001)

Year	Labour Force
1996	42,500
1997	43,500
1998	48,000
1999	51,500
2000	54,200
2001	54,186
% change 1996-2001	27.5

Source: Garadag Executive Power Office.

Official figures provided by the Garadag Executive Power indicate that unemployment for the Garadag region was 5% in 1998. However, given the general collapse of industrial activity, lack of local agriculture and few new employment opportunities, it is expected that real unemployment is closer to 40%, which more accurately mirrors the national estimate. It is estimated that in the last five years unemployment has increased by between 3% and 5% within the Garadag region (Garadag Executive Power; 23/07/01).

7.5.4 Economic Activity

Table 7.14 below details Gross Domestic product (GDP) for Garadag District, in addition to illustrating the contribution of the two main sectors of the local economy. On average the oil and associated industries sector accounts for 50% of GDP. The construction industry accounts for approximately 30%.

Table 7.14 Gross domestic production Garadag District (2001)

Year	Total GDP		Of which: Oil and associated industries GDP[1]		Of which: Construction Industry GDP[1]	
	AZM billion	US$ million	AZM billion	US$ million	AZM billion	US$ million
1997	653	160	335	82	196	48
1998	629	162	322	83	190	49
1999	668	169	340	86	201	51
2000	736	159	375	81	218	47
2001[2]	376	82	193	42	115	25

1. Approximate.
2. First 6 months.

Source: Garadag Executive Power Office.

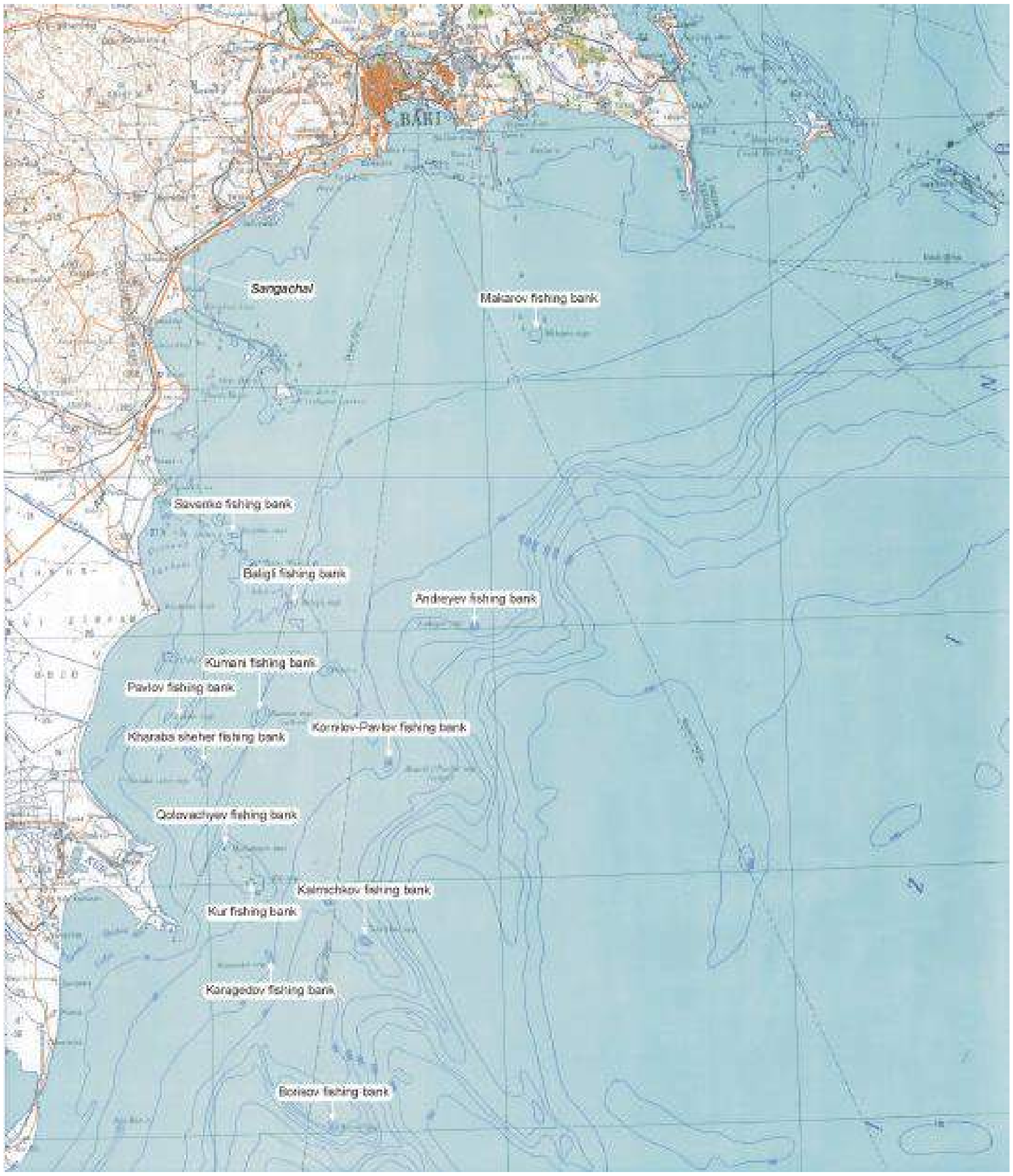
Azerbalyk, the State Fisheries Concern, have a hatchery located near Primorsk in Garadag District. The hatchery was built in 1976 and breeds salmon and white sturgeon fry. Before the fall of the Soviet Union, the fish farm was used to raise fish brought from lake Mengichevir for later release into the Caspian. The fish farm is also involved in salmon and white sturgeon fishing along the coastline up to the town of Alyat. Most fishing is undertaken using nets spaced every few hundred metres although occasionally boats and fishing platforms are used. The fish found in this area include sturgeon, salmon, herring, carp and mullet.

The area used to be a significant source for sanders, with between seven and 10 tonnes of sanders being produced annually. However in recent years the catch of sanders has drastically declined to zero. Whilst offshore developments have been a perceived cause for this decline, the role of uncontrolled fishing and the use of banned fishing equipment, such as keep nets and self fishing tackles, is recognised as having contributed to the decline.

Figure 7.2 illustrates the location of the fishing grounds within the region. The majority of the fishing grounds are based in and around the coastal area of Neftcala.

It is estimated that approximately 70 people are employed in the local fishing industry between Baku and Gobustan although the majority are employed at the fish farm in Primorsk. Some 380 kg of fish were caught in the District in 1997 (AIOC, 2002). This is not however, consistent with data from the national office of Azerbalyk that suggest two tonnes were actually caught. . In 1995 the District's fish catch was 780 kg (i.e. declined by more than 50% over two years). The trend of drastically reducing fish catches has extended over the past five years and across all fish species; for example, between the 1996/1997 and the 1997/1998 fishing season two species of fish fell from 76 to five specimens and 49 to zero specimens respectively.

Figure 7.2 Fishing grounds



7.5.5 Infrastructure

The Baku-Alyaty highway routed along the coastline passes to the south of the Sangachal terminal location. This section of road is a main highway in Azerbaijan. It is part of the main transportation route from Kesik at the Georgian border to Baku (a total of 510 km) and south from Baku to Astara to the Iranian border (a total length of 313 km). Both routes accommodate two-thirds of all road freight through Azerbaijan.

Data from the TACIS TRACECA Programme in 1999 (TACIS TRACECA Programme; Azeravtoyol and Azerbaijan State Department of Railways, 2001) indicate that 9,581 vehicles passed along the Baku-Alyaty highway during this year, an increase on the 1998 figure of 4,763 vehicles. The breakdown of vehicle types in 1999 included:

- <3 tonnes: 986 units;
- 3.5-5 tonnes: 1,211 units ;

- 5-8 tonnes: 1,444 units ;
- >8 tonnes: 1,150 units;
- trailers: 1,093 units;
- caterpillars: 56 units;
- light cars: 2,991 (in 1998 - 1,496 units); and
- bus: 650 units (in 1998- 325 units).

The passenger flow along the Baku-Alyaty highway section amounted to 40,000 persons travelling from Baku and 35,000 going to Baku in 1999.

The Baku-Alyaty electric railway, owned and operated by Azerbaijan Railways, runs parallel to the highway through the Garadag District and is part of the main transportation route for Azerbaijan in terms of its capacity. This section of the railroad is part of three main rail routes as follows:

- **Baku-Boyuk-Kesik railroad:** This route is used for carrying passengers and cargo through Boyuk-Kesik on the Georgian border. This railroad continues into Georgia to the ports in the Black Sea, in particular the port of Batumi.
- **Baku-Agbend/Ordubad/Velidag railroad:** This route was used to carry passengers and cargo to Agbend (a settlement of the Zengilin Administrative District of Azerbaijan) onto Oruband in Armenia, through Armenia to Velidag in Natchivan. The route has not been working since 1993 due to the occupation of Zengilan and part of the Jebrayil Administrative Districts by Armenia.
- **Baku-Astara railroad:** Runs from Baku to Iran.

The maximum carrying capacity[11] of the Baku-Alyaty railroad amounts to 109 million tonnes per annum or up to 180 trains in each direction every day. The railroad is however, significantly under utilised. Figures from 1997 recorded the actual transportation along the Baku-Boyuk-Kesik route amounted to 2.19 million tonnes and along the Baku-Astara route amounted to 0.227 million tonnes. In total, the Baku-Alyaty section of the railroad transportation load in 1997 was approximately 4 million tonnes or nine trains in each direction daily.

A number of utility lines and pipelines are also routed along the coast parallel to the highway and railway line. These utility lines provide electricity, communications, oil, gas and water as detailed in Table 7.15.

Table 7.15 Utility lines Garadag District

Description	Owner/User
Communication Cable (flooded)	SOCAR Onshore Oil &Gas Production Association's Communication Department
Communication Cable (destroyed)	Baku Telephone Network Production Association
Communication Cable	SOCAR MOLPA
Communication Cable	Unidentified
Communication Cable (2 cables)	Technical Unit of Cable Trunks
Gas pipeline (5 lines, 1 cut)	CJSS AZERIGAS
Gas pipeline	SOCAR BULA OFFSHORE
Oil pipeline (2 lines)	SOCAR MOLPA
Condensate Line	SOCAR BULA OFFSHORE
Water Pipeline (5 lines, 1 abandoned)	Apsheron Water Company
Water Pipeline	SOCAR Amirov O&GPD

[11] The maximum carrying capacity is taken and recognised as the line's project capacity.

Description	Owner/User
High Voltage Overhead Line (HOVHL)	Azerbaijan Railways
High Voltage Overhead Line (HOVHL) (4 lines)	JSC AZENERGI
Unidentified pipelines (3 lines)	Unidentified

Source: Shah Deniz and ACG Third Party Pipelines, Road and Rail Crossings: Information Pack; Shah Deniz Gas Export Project (Doc. BRCDZZZZCMGUI0006 Rev A1).

There are a number of beaches around the Shykhov and Primorsk seashore that are popular with visitors in the summer. Recreational fishing is also a popular pastime (AIOC, 2000b).

7.5.6 Health

Each settlement detailed in Table 7.3 has a medical-ambulance station. These stations together are able to serve some 3,400 people during one shift (i.e. 3.5% of the total population for Garadag District). There are two hospitals in the District, one of which is in Primorsk, with 1,450 beds in total. There are no major health problems although in 1989 there was a typhus epidemic (Garadag Executive Power; 23/7/01). In addition, those employed in the opencast 'Firuza' stone mine near Sangachal tend to be affected by respiratory problems (Garadag Executive Power; 23/7/01). Respiratory problems are also caused by the burning of wood for indoor fires and increasing road traffic pollution and are the third highest cause of mortality in Azerbaijan (UNHDR AZERBAIJAN, 2000). Figures show that up until August 2001 between 700-750 people had been injured in the workplace in the Garadag region.

7.5.7 Education

There are 22 secondary schools and four colleges in the Garadag District, with a capacity for 13,736 students at any one time (Garadag Executive Power; 23/7/01). In total however, between 25,000 and 27,000 children study in these schools (Garadag Executive Power; 23/7/01) indicating a problem with overcrowding. This is consistent with data at a national level that indicates a lack of available buildings and equipment within the education system.

Some 1,260 students graduated from secondary school in Garadag District in 2000 (Garadag Executive Power; 23/7/01). Although no figures are available on the percentage of graduates from the total school population, a rough estimate would be that 5.7% of school age (rather than school attending) children graduate from secondary school.[12] Of these, 460 (36.5%) are continuing their education in colleges and other higher schools (Garadag Executive Power; 23/7/01).

The colleges offer qualifications relating to the oil and construction industries, as well as driving, welding, painting and carpentry. This year some 1,355 pupils applied to professional technical and higher schools. The results, as to who has been accepted for further education, are revealed in September each year. (Garadag Executive Power; 23/7/01).

7.5.8 Poverty, refugees and internally displaced peoples

The total number of Internally Displaced Peoples (IDP) within Garadag District is provided in Table 7.16. The IDPs in the District are primarily located in Lokbatan, Sahil, Gizildash and Sangachal Settlements. There are a few in Elet and Gobustan but none in Shangar, Cheyildag and Korgoz (Garadag Executive Power; 23/7/01). Just over 20% of the IDPs in the District are from Armenia and arrived in the area between 1988 and 1989. The remaining 80% are IDPs from Fizuli, Agdam, Zengilan, Gubadli, Kelbejer, Jebrayil, Lachin districts and Shusa,

[12] This figure is the sum of the total population for the district between 10-14 and 15-19 and calculating 1,260 as a percentage of this.

Khojavend, Khojali city and villages of the Nagarno Karabakh region. They have been arriving since 1992 (Garadag Executive Power; 23/7/01).

Table 7.16 IDP gender distribution Garadag District (2001)

IDPs	People	
	Number	%
Male	4,704	48.0
Female	5,096	52.0
Total	9,800	100.0

Source: Garadag Executive Power Office.

7.6 Local

7.6.1 Methodology for data collection

The following section, which outlines the socio-economic profile of the area local to the Shah Deniz Stage 1 onshore facilities, has been compiled from a number of sources as described below, as outlined in Section 7.2 and also detailed in the Socio-economic Baseline Data Gathering report in Appendix. A number of meetings and sites visits were undertaken with relevant stakeholders and those resident in the area.[13] During these visits, both quantitative and qualitative data was collected using questionnaires.[14] In addition some information has been included from the sociological survey undertaken by the Azerbaijan-Holland Friendship Society on behalf of BP. Information on the Central North and West Hills herding settlements has been gathered from a variety of sources and these are listed in the relevant section.

The information sourced illustrated the following socio-economic receptors[15] within the local area[16] around the proposed Shah Deniz Stage 1 Project onshore developments:

- Sangachal town limit;
- Umid IDP / cement Camp;
- West Hills herding settlement;
- Central North herding settlement;
- Railway barrier operator;
- Roadside café & garage;
- Caravanserai (15th century historic restaurant);
- Fishing nets (beach landing); and
- 'Firuza' stone mine.

Each of these is discussed below and illustrated in Figure 7.3. For Sangachal and Umid Camp much of the information on health, education and infrastructure is similar to that discussed in Section 7.6 given their geographical proximity. The information in the following section has however, been divided for Sangachal and Umid Camp as they have been identified as two separate socio-economic receptors. In addition, although the Umid Camp consists of both the IDP camp and the cement workers camp the information relating to Umid is in some

[13] Details of individuals interviewed, sites visited are presented in Section 7.2.

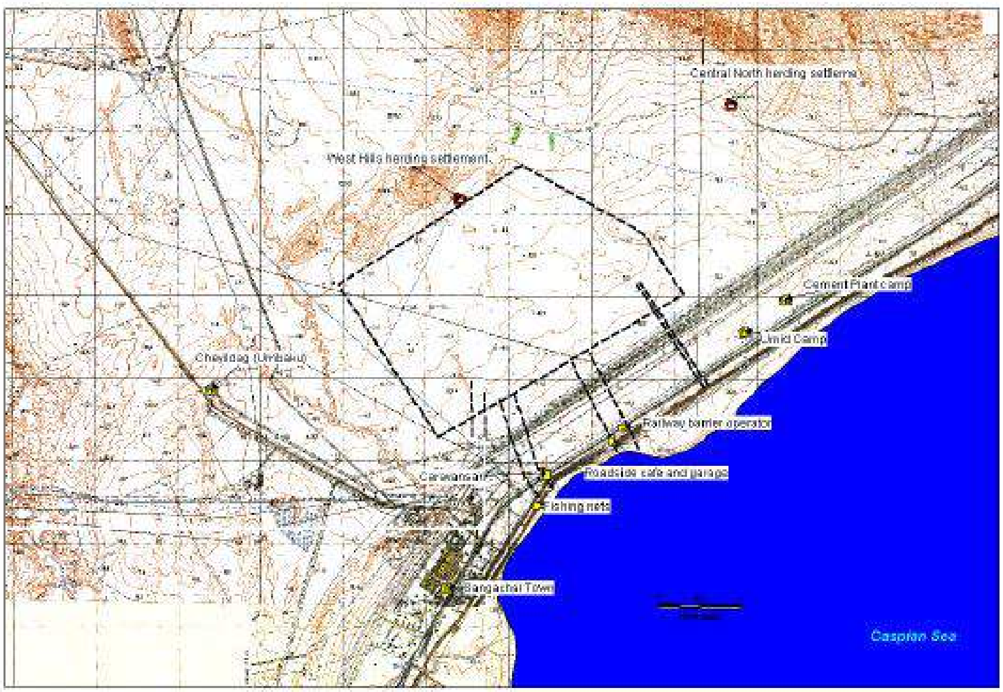
[14] The questionnaires covered a range of socio-economic issues. The questionnaires are contained in the Technical Appendix to this document.

[15] A socio-economic receptor is defined as something that could be impacted upon by the proposed development that would affect the economic or social profile of the area.

16 Local is classed as 2-5km around the various facilities, whilst regional is taken as the wider surrounding area and in this instance, the Garadag District area as illustrated in Figure 7.1.

instances, specific to the IDP population and is not inclusive of the cement camp workers. This is indicated in the text where necessary.

Figure 7.3 Sangachal town and surrounding area



7.6.2 Sangachal Town

The information presented in the following sections is based on data gathered during discussions with representatives of the Garadag Executive Power Office with specific responsibility for Sangachal Town and the findings of a sociological survey undertaken by the Azerbaijan-Holland Friendship Society in August 2001. All responses were recorded and collated although it should be noted that individuals who provided information requested that their identities be kept confidential.

7.6.2.1 Population and demographics

There are approximately 4,000 residents in Sangachal Town. This figure includes more than 500 IDPs from all of the 10 different districts within Azerbaijan that are currently occupied by Armenia. The total population of Sangachal Settlement has been increasing every year for the past 5 years by between 4 and 5% per annum.

Some 97% of the residents are Muslim (*pers. comm.*, Garadag Executive Power representative; 23/7/01) with the remaining 3% Christian. In a community survey residents identified themselves as the following nationalities:

- Azeri Turk (95.2%);
- Russian and Slav (2.9%); and
- other 1%.[17]

[17] 1% of respondents gave no answer to this question.

Approximately 62.5% of the population is male and 37.5% female (AHFS, 2001).

Table 7.17 Age data for Sangachal residents

Age Range	%
18-30 years old	26
31-50 years old	61.5
51-70 years old	12.5
Over 70 years old	

Source: Azerbaijan-Holland Friendship Society, Sociological Survey, Baku 2001.

7.6.2.2 Income

As noted in 7.6.2 above, the average income level for the Garadag region as a whole in 2001 was US$75 or AZM346,500[18]. The AHFS survey gathered a range of data on Sangachal residents' perception of family welfare and on income levels. This is presented in Tables 7.18 and 7.19. As illustrated, almost 36% of those interviewed and resident in Sangachal earn no income, with a further 11.5% earning up to AZM100,000 (US$22) a month only. As a result, 68% of those interviewed believe their standard of welfare is either poor or almost poor.

Table 7.18 How would you estimate your family's welfare standard?

Rating	%
High	1
Good	1
Average	29.8
Almost poor	16.3
Poor	51.9

Source: Azerbaijan-Holland Friendship Society, Sociological Survey, Baku 2001.

Table 7.19 Family's monthly earnings

Income Level		%
AZM	US$	
No reply	No reply	1.9
0	0	35.6
1 to 100, 000	1 to 22	11.5
100,001 to 200, 000	23 to 43	23.1
200,001 to 500, 000	44 to 108	26.9
500,001 to 1, 000, 000	109 to 216	1
1, 000, 001+	217+	0

Source: Azerbaijan-Holland Friendship Society, Sociological Survey, Baku 2001.

7.6.2.3 Employment profile

Officially, between 250 and 300 people are employed although this excludes those normally involved in agriculture, which is thought to be a further 5-10% (Garadag Executive Power; 05/07/01). Approximately 50% of people in employment work in a number of State run enterprises in the town, namely:

- Narimov Oil and Gas Production Office;

[18] US$1 = AZM4,620.

- Water and Pipe Station;
- Oil pipeline office; and
- Railway office.

Unemployment is a key problem in Sangachal with official figures showing between 30-50% of people unemployed. The figures on unemployment and employment profile tally roughly with the figures supplied from the survey undertaken by Azerbaijan-Holland Friendly Society (AHFS, 2001), as illustrated in Table 7.20 below.

Although figures were provided for overall population within Sangachal and those employed, no figure was available giving the available labour force for the settlement. It is also understood from consultations with the Garadag Executive Power that a percentage of illegal work is undertaken in the area and few people sign up for unemployment benefits due to the complexity of the process and the paucity of benefits actually provided.[19] Data illustrates however, that of those who are unemployed some 70% are men and 30% are women. These figures may not be reliable due to lack of reporting and varying data collection methods. These figures are also inconsistent with the national figure showing that for the registered unemployed 60% are women.[20]

Although there are no figures available detailing the skills base of the available labour force the Garadag Executive Power was able to identify some of the skills that are available from those currently unemployed. These skills include manual workers, drivers, cleaners and a number of welding specialists who previously worked in Primorsk. All of these skills may be relevant to the Shah Deniz Stage 1 Project developments.

Table 7.20 Employment profile of Sangachal residents

Type of employment	%
Unemployed	53,8
In oil, gas industry	13.5
Other industrial fields	2.9
In the field of economy	3.8
Public utilities	9.6
Transport	1.9
Education, culture	4.8
Public health	1
Domestic services, catering, trade	1
Other	7.7

Source: Azerbaijan-Holland Friendship Society, Sociological Survey, Baku 2001.

Information was also gathered on Sangachal residents' satisfaction with their current employment and this is illustrated in Table 7.21. Almost 41% did not reply and it is believed that this reflects those that are unemployed and roughly equates to known unemployment levels in the area. The question does however illustrate that almost 40% of residents interviewed state their unhappiness or indifference with respect to job satisfaction.

[19] See the National section of this chapter for a discussion on social security conditions within Azerbaijan.
[20] See the National section of this chapter for a discussion on gender distribution.

Table 7.21 Sangachal residents job satisfaction rating

How satisfied are you with your job?	%
No reply	40.9
Fully satisfied	19.4
Not bad	19.4
Unhappy	20.4

Source: Azerbaijan-Holland Friendship Society, Sociological Survey, Baku 2001.

7.6.2.4 Economic activity

Only a few residents (i.e. less than 10 according to the Garadag Executive Power) are involved in agriculture within Sangachal. Associated with this activity are approximately 140 cows and 500 sheep (Garadag Executive Power; 05/07/01). According to the Garadag Executive Power there are no key problems or concerns with regards to agriculture although, as noted above, due to poor soil and climatic conditions agriculture is not a preferred, or possibly even viable, livelihood for local residents (excluding the trans-human herder population; see below). It seems that for those few residents within Sangachal who are practising some form of agriculture, it forms a subsistence livelihood.

Less than 1% (i.e. approximately 40 people) of the Sangachal population is involved in fishing in the nearby Sangachal Bay (Garadag Executive Power; 05/07/01).[21] The Bay is under the jurisdiction of the Azerbalyk State Fisheries Concern (ASFC). The ASFC does not allow the wider community to fish commercially. They are however, allowed to fish with rods for subsistence and recreational purposes. According to the Garadag Executive Power the fish caught either supplement the families diet or are sold to other Sangachal residents. The fishing season varies depending on the species although it is largely in the spring (February-April) and autumn (August-October).

7.6.2.5 Land ownership

The population is housed in a total of 346 apartments of which 220 are state-owned, 24 private, 2 are "sleeping houses"[22] and 94 are illegally built. No information was available on whether there was a shortage of housing stock within the town. The town consists of four apartment blocks and a number of older single storey houses along with an army barracks (AIOC, 1996; p. 251). The area has many summer homes owned by families normally resident in Baku (*ibid*).

7.6.2.6 Infrastructure

There are very few roads in and around Sangachal and most of these are covered in gravel. It takes approximately one hour to travel by bus to Baku and costs AZM1,000 (US$0.22)for a one-way trip.

According to official sources all houses in the town have electricity and gas and supplies are regular, reliable and sufficient. Wood is not used for heating or cooking. The cold water supply is piped into the town. There is no hot water supply to Sangachal and this is normal for the area. Bottled water is not used for drinking, washing or cooking (Garadag Executive Power; 05/07/01).

[21] As there is some confusion over the legality of various types of fishing in the area it may be that greater numbers of local residents are involved in fishing and that numbers of those involved are misreported.

[22] Shelter to temporarily house local residents.

The sewage system is basic. Enclosed canals are utilized to take sewage out of the town to where it is collected near the sea. These canals are open between the town and the collection point. From the collection point, sewage is transported out to sea without any treatment. To date, according to the Garadag Executive Power, there have been no health issues associated with the current sewage disposal system.

There are five garbage disposal sites in the town and they are emptied once or twice a week, depending on the site, and taken to the main landfill disposal site near Sangachal. The material is either burnt or simply covered.

7.6.2.7 Health

Based on discussions with the Garadag Executive Power, it appears there are no major health problems in Sangachal settlement. The issue of health was discussed as part of the AHFS survey undertaken in Sangachal and Table 7.22 summarises the results. Over 50% of the population assess their health as poor although there are no official figures available to support this assertion. It should also be noted that the information from the AHFS sociological survey would need to be verified by a "Knowledge, Attitudes, Perceptions" (KAP) survey before it could be relied upon. It does however, tally with figures and assertions at the national level showing health issues to be of major concern within Azerbaijan.

Table 7.22 How do you assess your health?

Response	%
No reply	1.9
Absolutely healthy	41.3
Not very healthy	35.6
Sick	21.1

Source: Azerbaijan-Holland Friendship Society, Sociological Survey, Baku 2001.

An immunisation campaign is being undertaken within the town, administered by the doctors from the United Hospital in Primorsk (Garadag Executive Power; 5/7/01). Given the rising incidences of communicable diseases recorded at national level in Azerbaijan, the immunisation programme would appear to be an important component in maintaining public health in Sangachal.

There is no hospital or pharmacy within Sangachal. There is however, an ambulance station that provides basic first aid. From discussions with Garadag Executive Power it was ascertained that the station apparently provides a very good service. Although Primorsk is not far away in terms of distance (about 15 minutes by bus) with few cars in Sangachal and unreliable public transport, the United Hospital is not ideally positioned to serve the Sangachal community.

Even though the health services are limited, the Garadag Executive Power is of the opinion that existing services are good and improving. The AHFS survey ascertained that the state of health services is viewed as a problem area although not one requiring urgent or immediate attention. Given the statistics at national level, which show that the health service within Azerbaijan as a whole is in crisis, such a view would need to be verified by the above-mentioned KAP survey.

7.6.2.8 Education

There is one school in Sangachal illustrated in Figure 7.4. Several children travel to the school in Primorsk. These children attend school in Primorsk in order to participate in extra curricular activities (e.g. sports and music); such activities are not available in Sangachal (Garadag Executive Power; 5/7/01). All children between the ages of six and 17 attend school. This year there are some 724 children at Sangachal school and 63 teachers.

In the year 2000 approximately 10 children went onto university education, with half of them being young women. The number of students who go on to higher education varies from year to year (Garadag Executive Power; 5/7/01) and they can experience attendance difficulties as some universities charge an attendance fee and public transport to Baku is not reliable.

According to the Garadag Executive Power, Sangachal School faces a number of key problems including necessary and ongoing building maintenance and lack of computer equipment for pupils. The computers that the school has do not work and can only be used as a visual aid for the children. Such assertions are consistent with data at a national level stating that Azerbaijanis educational progress is jeopardised by lack of funding and structural weaknesses such as lack of materials and equipment.[23]

Table 7.23 Level of education reached by Sangachal residents

Level of education reached	%
Incomplete secondary education	11.5
Secondary education	51.9
Secondary-professional education	26.9
Higher education	9.6

Source: Azerbaijan-Holland Friendship Society, Sociological Survey, Baku 2001.

Figure 7.4 Sangachal School

[23] See the Section 7.4.11.

7.6.2.9 Poverty, refugees and IDP

Almost 13% (i.e. approximately 520) of Sangachal residents are classified as IDP. Most of these residents arrived in Sangachal in 1992 although people continued to arrive throughout 1993 and 1994. IDP within Sangachal do not live in permanent accommodation and are housed in either public buildings or abandoned homes.

Whilst IDP receive free medical services and education, they do have to pay for medication. The receipt of foreign aid for IDP in both Sangachal and Umid is limited and very infrequent and no figures were available on amounts, frequency or purpose. According to the Garadag Executive Power approximately three or four (or approximately 0.5%) of the IDP living in Sangachal are employed, specifically by the Narimanov Gas and Oil Production Office and in Sangachal School (Garadag Executive Power; 05/07/01).

7.6.2.10 Civil society

About 100 households (i.e. approximately 30% of all households) within Sangachal have telephones. According to the Garadag Executive Power the majority of people have access to televisions although exact figures are unavailable and it is unclear whether “access” means a television in the home or within a communal area. Sangachal community receives most of its information from the television and the most frequently watched channels are ANS, SPACE and AZ.TV. There is no special shop selling newspapers within Sangachal. Those who subscribe to newspapers, which tend to be the state run organisations, have them delivered to the local post office. Radio is accessible to all.

Officials within the government, at the national and regional level, undertake decisions affecting the community, such as those connected with investment and events. These decisions are then fed down to the local executive power. According to the Garadag Executive Power, in addition to this formal process, Sangachal has a group of elders[24] who bring forward issues and concerns from the residents to the local executive power. This process was also evident from the results of the AHFS survey where residents identified the elders as the most influential people in the settlements, followed by government officials and politicians.

The role of the elders appears to be the preferred community method for raising concerns however, before such an assumption could be made further investigation would be required in order to understand how the individuals are chosen for this task, by whom and exactly how this interacts with the more formal decision making processes.

The residents of Sangachal are also very sensitive to the opinion of their family members, with 28.9% of those in Sangachal discussing the settlements problems with family members. In addition, many accept and follow the guidance provided by those family members, illustrating the presence of traditional features in the family system in Sangachal (AHFS 2001).

[24] A direct translation of the name or responsibilities of this group was difficult to ascertain and “group of elders” appears to be the most appropriate description.

Figure 7.5 Sangachal Settlement

7.6.3 Umid Camp

Umid Camp is essentially two camps within one settlement, with one camp housing IDP and another camp for workers at the Garadag Cement Plant at Primorsk. The camp has been given permanent status in that it is now recognised as a formal settlement. Where the information in this section applies only to the IDP this has been indicated within the text.

7.6.3.1 Population and demographics

In total there are more than 1,000 people living in the Umid Camp divided between 130 households in the IDP camp and a further 50 households in the cement camp. There is no official register so more specific details cannot be provided.

It is estimated that 48.3% of the population is male and 51.7% female. This illustrates a far greater percentage of females within Umid than resident at Sangachal, whose population figures illustrate that 37.5% of residents are female. Table 7.24 below illustrates the age profile of those resident within Umid Camp and interviewed for the AHFS survey.

Table 7.24 Age data for Umid Camp residents

Age range	%
18-30 years old	15.0
31-50 years old	68.3
51-70 years old	11.7
Over 70 years old	5.0

Source: Azerbaijan-Holland Friendship Society, Sociological Survey, Baku 2001.

Figure 7.6 Umid Camp house

The IDP camp at Umid has been in existence for almost two years and is populated by IDP from the presently occupied territories. The IDP would return to their homes if their land were released (Head of Garadag Executive Power Representation, Umid Settlement; 05/07/01). The cement camp at Umid has been in existence for about three years and was previously under the administration of Primorsk. Recently it, along with the IDP camp, was granted the status of a town in its own right. All the residents of Umid are Muslim and a mosque, illustrated in Figure 7.7, has recently been built at the camp (Head of Garadag Executive Power Representation, Umid Settlement; 05/07/01).

Figure 7.7 Umid Camp mosque

7.6.3.2 Income

Table 7.25 below provides an estimate of the income levels within IDP Umid Camp for those interviewed for the AHFS survey. Almost 37% of families interviewed earn nothing and a further 33% earn up to AZM100,000 (US$22). Generally income levels are estimated to be low and this is consistent with other data such as the low level of employment, the apparent unreliability of foreign aid and the relatively low level of national aid, along with the injuries to male members of some of the households. No data was available for income levels in the cement camp.

Table 7.25 Family's monthly earnings IDP Umid Camp (2001)

Income level		%
AZM	US$	
No reply	No reply	0
0	0	36.7
1-to 100,000	1 to 22	33.3
100,001 to 200,000	23 to 43	23.3
200,001 to 500,000	44 to 108	6.7
500,001 to 1,000,000	109 to 216	0
1,000,001+	217+	0

Source: Azerbaijan-Holland Friendship Society, Sociological Survey, Baku 2001.

7.6.3.3 Employment profile and economic activity

The AHFS survey undertaken of IDP Umid Camp sought to ascertain where IDP residents of the camp work and the results are contained in Table 7.21 below. Unemployment among those interviewed appears to be very high at 78%. Where there is employment it is focused in education, cultural activities and industry. Table 7.26 provides an indication of the potential source of this employment.

Table 7.26 Employment profile of IDP Umid Camp residents

Type of employment	%
Unemployed	78.0
Oil and gas industry	1.7
Other industrial fields	5.1
Economic fields	1.7
Public utilities	1.7
Transport	0
Education and culture	6.8
Public health	0
Domestic services, catering, trade	1.7
Other	3.4

Source: Azerbaijan-Holland Friendship Society, Sociological Survey, Baku 2001.

Table 7.27 provides the key employment sources within Umid Camp. There are no figures available specifying the available labour numbers as a percentage of the total population of the camp. The total population is however, 1,000 and approximately 70 employed from this total equates to 7%. Although the two tables are from different sources the figures generally tally and can be read as indicative of the true employment profile of the camp population.

Table 7.27 Employment sources in Umid Camp (IDP and cement camp)

Employment Source	Number of Employees
School	14
Bakery	15
Camp administration	5
Cement plant	30-35
Primorsk	Temporary employment No specific number
Total	64-69

Source: Consultations with Head of Garadag Executive Power Representation, Umid Settlement (5/7/01).

All of the employment sources within IDP Umid Camp are state run enterprises. There are no private businesses. A few residents are involved in fishing for subsistence purposes to supplement diet. Such fishing is by rod from the shores nearest to the camp, including from the jetty built for the Early Oil Project (EOP).

Many of the IDP families have been affected by the war and specifically the men who were injured which further limits their job opportunities. Information given indicates that 10 households within the IDP population of the camp have war veterans as a member of the household and 14 households have officially injured (i.e. at war) people as members of the household. No information was available as to whether the injured members of the household were the main income earners however the status of "war veteran" indicates that the individuals would be the main male income earner.

This information indicates that it is often women within the household who work and not the men, as would normally be the case. No information was available on how this gender change in the main income earner might affect family income. Employment, where it occurs, is focussed on low skilled jobs and is not regular and/or long-term.

It is considered that the key concerns of the war veterans in Umid Camp are the perceived lack of government support for such affected groups and also the small amount of pension received (Head of Garadag Executive Power Representation, Umid Settlement; 05/07/01).

7.6.3.4 Infrastructure

Both the IDP and the cement camp have been growing in size since their inception. The IDP camp started with 30 households and has increased threefold in 2 years (Head of Garadag Executive Power Representation, Umid Settlement; 05/07/01). There are now 130 households. There are no plans for further expansion of the IDP camp through new residents joining, although some increase in population can be expected as a result of births and marriages. The cement camp is currently being extended, with a further 10 new houses being built.

The IDP camp and the cement camp were originally two separate settlements. Their expansion in the last few years has meant that they are now virtually one settlement. Expansion can only occur in areas where such expansion has received permission and as a result the camps cannot currently expand further towards the proposed terminal site. The new houses being built in the cement camp are being built on the opposite side of the camp to the proposed terminal expansion site.

Figure 7.8 Umid Camp housing

There is a school, medical office, bakery and post office within Umid Camp. The sewage system is a simple open drainage ditch around the camp. There are telephones in every house in the IDP camp but only one phone in the cement camp.

The roads in and around the camps are gravel based. The main road to Baku from the camp is covered in asphalt. It takes approximately 40 minutes to get to Baku by public transport and a similar time by car.

All households have access to electricity and gas within their homes. Wood is not used for heating nor cooking purposes. Sufficient quantities of water are piped to households and the supply is regular. The water supply is cold water only, which is normal for the area. No use is made of bottled water for drinking, washing or cooking.

There are three waste disposal points in the IDP Umid Camp and one in the Cement Camp (Figure 7.9). The waste points consist of bins that allow for segregation of the different types of waste. The waste is collected every week and then transported to a landfill disposal site at the Garadag Cement Works.

Figure 7.9 Umid Camp waste disposal

Sewage waste is transported via a simple open drainage ditch as illustrated in Figure 7.10.

Figure 7.10 Umid Camp sewage system

7.6.3.5 Health

According to the Garadag Executive Power, Umid Camp has not experienced any specific health problems to date.

Medical services within the camp are limited and the existing medical facility is a basic first aid post capable of providing limited services. For more serious health problems, residents must use the hospitals at either Primorsk or Baku. Again, given the unreliable public transport system this is not ideal as a health service option. There is an ambulance in Sangachal.

All of the children from the IDP Umid Camp are immunised by doctors from Primorsk hospital who visit the location during vaccination times. Whilst the medical facilities are free of charge, there is a limited supply of medicine and often one can only get access to what is available, rather than what is required. There is however, a general belief that the health services are getting better. Assistance from international organisations is on a very infrequent and ad hoc basis and so it cannot be replied upon (Head of Garadag Executive Power Representation, Umid Settlement; 05/07/01).

7.6.3.6 Education

The Umid School is the only school in the Umid Camp (Figure 7.11). It is attended by approximately 120 children that represents all the children of school age in the Camp (Head of Garadag Executive Power Representation, Umid Settlement; 05/07/01). The Ministry of Education undertook repairs and maintenance at the school in 2001. In 1999, one person continued their education at university and in 2000 one person continued their education at a secondary technical school. Both of these individuals were women.

Figure 7.11 Umid Camp school

7.6.3.7 Poverty, refugees and IDPs

The IDP population is housed independently in normal houses and flats. The IDP receive free medical services, free education and assistance with securing employment. All the houses within the camp are full and at present no more people are arriving at the camp. This is expected to remain the situation for the foreseeable future.

The IDP receive an allowance of AZM23,100 US$5) per month per person. There is some international assistance given to IDP. This is however, ad hoc and inconsistent.[25]

[25] Information sourced from Garadag Executive Power.

7.6.3.8 Civil society

All of the households have telephones, televisions and radios but they do not have access to newspapers. The Umid community receives most of its information from television, particularly the channels ANS, SPACE and AZ.TV. The elders in the camp are not viewed as quite so influential as in Sangachal with 36.7% of community people interviewed considering the elders the most influential, compared to 46.2% in Sangachal (AHFS 2001).

Any decisions about the community are undertaken by either Garadag district or Baku region. There is however, also a committee of elders consisting of those from the Camp who discuss issues, make decisions, resolve disputes and take the ideas/concerns to the head of the camp.[26] As for Sangachal, without undertaking a household survey and/or specific stakeholder consultation it is unclear whether this is the preferred method for decision making within the camp. The AHFS survey however, concluded that the residents of Umid are sensitive to the progress of the political processes and as a result place more trust in the hands of politicians than do the residents of Sangachal or Primorsk. The residents of Umid are also sensitive to the opinion and advice of their family members and as a result are seen to reflect traditional features within the family system.

The view of the Garadag Executive Power is that the IDP camp residents live together without conflict and tend to be bonded by a common background of war experience. There was no conflict between IDP and those who have work perceived by the field survey team. Further research would be needed to ascertain if there are underlying tensions.

7.6.4 Herding settlements – Central North and West Hills

The area surrounding the existing Sangachal Terminal is winter grazing land for a number of pastoralists (trans-humans), their families and their animals. There are two herding settlements within the vicinity of the terminal. One is in the central north area (Central North herding settlement) and another is situated at the foot of the west hills (West Hills herding settlement). The West Hills herding settlement lies just on the boundary of the "no development zone" for the proposed Shah Deniz Stage 1 terminal expansion.

The information collected on the herding settlements, herding practices and population numbers has been obtained from various conversations that took place with different individuals during the data gathering process as follows:

- data gathering interview conducted by URS Dames & Moore in June 2001;
- data gathering meetings between BP representatives, herding supervisors, a herder and a veterinarian in September and October 2001;
- conversations between BP and one of the herder supervisors in October 2001; and
- background research by URS Dames & Moore.

The information gathered from these meetings and interviews has been consolidated however the following limitations on the data should be noted:

- the initial URS interview was undertaken without herder knowledge of the purpose of the interview; and
- some of the information collected to date is conflicting.

[26] Although a similar process exists in Sangachal town the groups of elders are different for Sangachal and for Umid Camp.

Further information on the herders, the herder supervisors and current herding practices will be gathered using a census survey in October 2001 in order to clarify outstanding issues and verify existing information.

Allowing for the limitations on existing data, the following information provides a general indication of the socio-economic parameters of the local herding population.

7.6.4.1 Population and demographics

The Central North herding settlement, as illustrated in Figures 7.12 and 7.13, is used by herders during both the winter and summer seasons[27] and is currently thought to report to the Guzdek cattle breeding enterprise.

The West Hills herding settlement is also used by herders during the winter months and reports to the Qobu cattle breeding enterprise. There are approximately five to six herders who, together with their families, would number approximately 31 people. All the herders are related to each other. During the summer the majority of the herders travel to Kuba in the north whilst one family, consisting of between four to five people, remains at the settlement for security reasons.

7.6.4.2 Figure 7.12 Herding settlement - Central North

Infrastructure and utilities

The Central North herding settlement consists of two main buildings and a number of out houses, including converted shipping containers.

There are approximately 10 buildings in total in the West Hills herding settlement, some of which are used for housing animals, whilst others are for living purposes (Figure 7.15).

There are no water, gas or electricity services supplied to either of the herding settlements. Kerosene lamps are used as a source of light. Water is sourced elsewhere at both settlements

[27] The information on the Central North herding settlement was gathered from conversation during a site visit to the settlement on 24/04/01 with the male representatives of an extended family.

although exact details of water sources were unavailable. It is carried back to the camp. When water is unavailable for the animals at the West Hills herding settlement it is carried in by truck.[28]

The herders from the West Hills herding settlement come over the hills beyond the proposed terminal site to access the grazing land and do not travel via the coast where the terminal will be situated. The herders use two routes in moving to and from their summer pastures, namely Sangachal-Shemakha-Kuna and Sangachal-Kilazi-Siyazan-Galaalti-Kuba. The West Hills herding community does not use the area southeast of the proposed terminal site, where new pipelines and the access road will be built. The herders spend around eight months a year at the settlements from approximately mid-August to mid-May each year. The rest of the year is spent at the summer pastures.

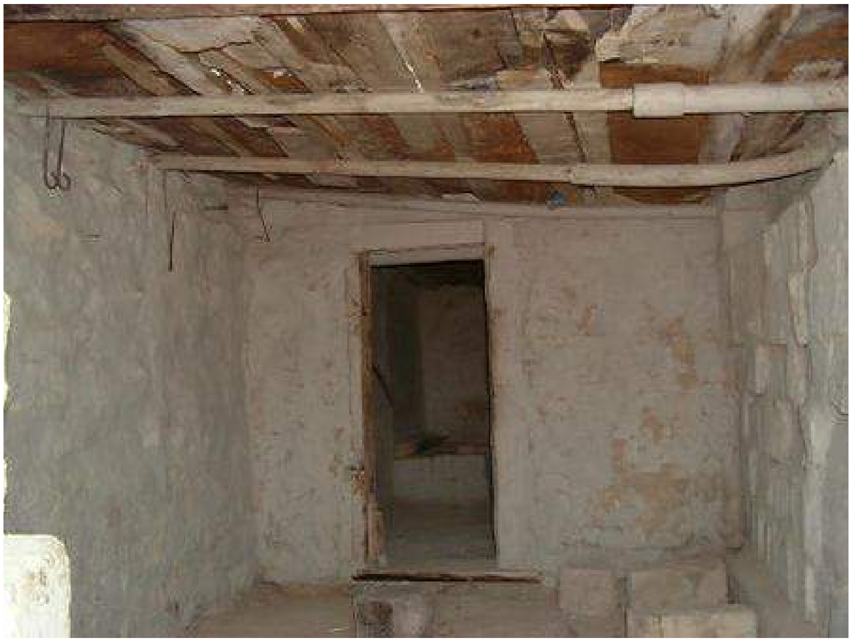
No information has been obtained to date on the routes used by the Central North herders.

7.6.4.3 Figure 7.13 Herding settlement - Central North

[28] The herders at the West Hills settlement stated that water was sourced from Sangachal by truck whereas the herding supervisors for the West Hills settlement stated that water was trucked in from Lokbatan. Both Sangachal and Lokbatan are near the West Hills settlement.

Figure 7.14 Herding settlement – West Hills external photo

Figure 7.15 Herding settlement – West Hills internal photo



7.6.4.4 Economic activity and income[29]

Those living in the Central North herding settlement sustain a living through grazing sheep and cattle and this has been their livelihood for several generations. Adult members of the settlement are not in paid employment. Their nutritional needs are primarily met from their dairy products and meats from the animals they keep. Wool from the sheep is also used to meet personal needs.

[29] Although the West Hills herding settlement has 'herding supervisors' no information was available on whether there are herder supervisors at the Central North herding settlement. In addition, the role of the herding supervisors in unclear as is the activity of their company. Secondary data sources indicate that there are no herder supervisors acting as intermediaries between the Regional Executive Powers and the Grazing Office.

According to the herder supervisors of the West Hills herding settlement, the herders are paid a wage for looking after sheep that are owned by the state. There are approximately 500 state-owned and 500 privately owned sheep kept in the area. The herders also keep their own sheep. In addition it is estimated that there are 90 cattle, between five to ten horses, up to 50 donkeys and between eight and 15 dogs. The land around the terminal is very nutritious according to both the herders and the herding supervisors, and is good grazing with the area between the settlement and the terminal being the most nutritious and the hills being the least used area.

The West Hills herders generally earn a living from their own produce, such as cheese and wool and this is sometimes sold in Sangachal. They earn around AZM0.28-0.3 million per month (US$60-65 per month) per herder from this, although other figures of around AZM4.6-9.2 million (US$,1000-$2,000 a year) have also been quoted.

According to the West Hills herding settlement herder supervisors the West Hills herders do not pay anyone for grazing rights. The herder supervisors do not receive a wage from the state, their enterprise is privately run. The West Hills herders are paid by the herder supervisors' company.

Land ownership

Grazing areas are distributed by the Grazing Office that is under the jurisdiction of the Agricultural Ministry of Azerbaijan. The Grazing Office controls and approves the routes used for cattle and sheep movement and approves contracts between the various Regional Executive Power Offices for rights to grazing land. An Executive Power can control rights to grazing land located in the region of another Executive Power. The grazing area around Sangachal, although physically located within the Garadag Executive Power District, is mainly controlled by the Apsheron Executive Power based in Baku.

The total area of the farm associated with the West Hills herding settlement is 1,636 ha of which 1,500 ha is suitable for grazing and 256 ha of this has been lost to the existing EOP terminal.

7.6.4.5 Health

Overall, those living in the Central North settlement appeared to be in a poor nutritional state[30] with signs of malnutrition in the younger children. No accurate health data has however, been obtained to date. Health needs are generally not attended to and if there is a need for medical assistance the herders generally attempt to seek help from the Sangachal terminal site.

The children of the West Hills herding settlement are not usually vaccinated. When a medical necessity arises, children are taken to hospital by car. No other health information on the West Hills settlement was available at time of writing.

Due to the lack of utility services at both settlements, such as piped water and sewage systems, sanitation is poor and may be a cause of health problems.[31]

[30] Assessment based on general observations when on site visit to Central North herder settlement on 24/04/01.
[31] These observations were made of the extended family at the Central North herding settlement during the site visit of 24/04/01.

7.6.4.6 Education

The children of the Central North herding settlement attend the school at the IDP Umid Camp. The children of the West Hills herding settlement attend the Sangachal School. The children walk to school but the exact routes taken could not be accurately ascertained.

7.6.5 Railway barrier operator

On the access road into the terminal site there is a railway barrier that is manually operated 24 hours a day. Four people share the job as railway barrier operator, with each working a 24 hours shift and then three days off. The railway company employs them. All four employees are residents of Sangachal town and the income from employment at the railway barrier is their only source of income. The hut at the barrier provides shelter with basic facilities.[32]

7.6.6 Historical restaurant (Caravansari)

Near Sangachal town sits a 15th century historical restaurant that was a “caravanserai” (i.e. a camel resting place) (Figure 7.16). The building is now a protected state monument (Registration # 170) and is currently only used for private parties which take place approximately once or twice a month. There is security patrol 24 hours a day.[33]

Figure 7.16 Historical Restaurant

7.6.7 Roadside cafe/garage owner

There is a small cafe/garage beside the main road to Baku near to the existing entrance to the terminal site as shown in Figure 7.2. The café/garage has been in existence for seven years and has mains electricity, although the supply is unreliable and was not working during the

[32] This information was taken from an interview with one of the railway barrier operators who was on duty at the time of the data collection process. For details see the methodology section at the beginning of this chapter.

[33] This information was sourced from an interview with the security guard at the historical restaurant that took place during the data collection process.

data gathering field visit. The café/garage is owned and run by two Sangachal residents. The garage is used by people to repair their vehicles or, if they wish, mechanics are brought in to carry out repairs.[34]

7.6.8 Fishing

Sangachal Bay attracts a large quantity of commercial fish and their fry (e.g. sturgeon, salmon, carp, grey mullet) for spawning and wintering. The only commercial fishing authorised by Azerbalyk State Fisheries Concern in Sangachal Bay is fishing to support the Fish Hatchery Plant nearby (Figure 7.17). The Fish Hatchery Plant supports the salmon population numbers in the Caspian Sea that require constant stock supplementation.

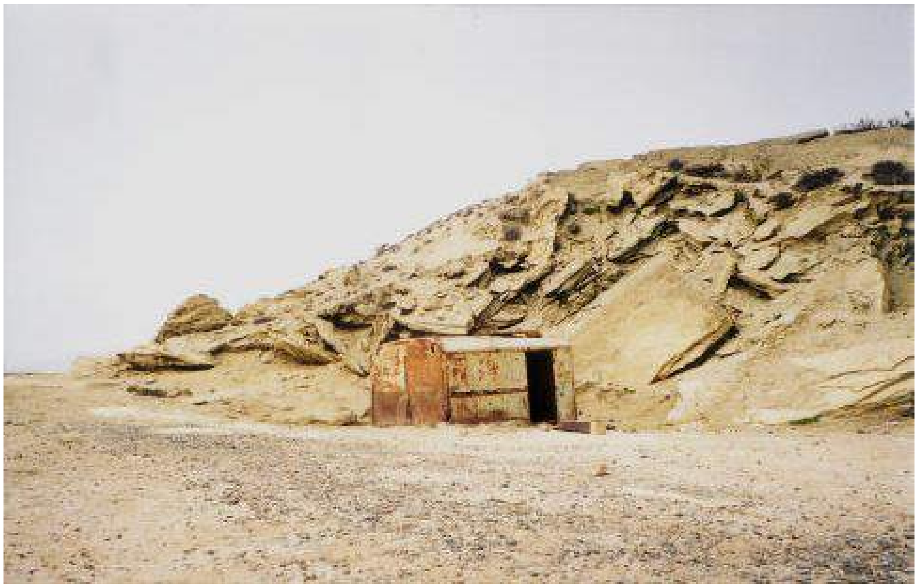
Figure 7.17 Sangachal Bay

Azerbalyk State Fisheries Concern has two fishing nets positioned in Sangachal Bay, running out into the sea for some 500-600 m. The nets are 1,000 m apart and go straight to the sea floor. The nets are weighted and positioned with posts. They are put into position by boat and checked twice a day for fish (morning and evening). The nets are never changed, only maintained. The nets remain there all year although fishing is only undertaken during the months of January-May and September-December. In addition, Azerbalyk has cages in the bay for catching fish, one of which lies within the ACG Phase 1 pipeline corridor.[35]

There are some three or four fishermen employed to work these nets and cages. There is a temporary building near the shore where the fishermen can shelter (Figure 7.18). The number of fish required per year to support the fish hatchery is a small percentage of the total fish catch. The remainder of the catch is divided with 30-40% being given to the fishermen in lieu of wages and the rest sold with revenues going to the fish hatchery.[36]

[34] This information was sourced from an interview with the person who runs the café/garage that took place as part of the ESIA process and was undertaken by BP.
[35] Information provided by BP and gathered as part of the Resettlement Action Plan process, 2002.
[36] Information provided by BP and gathered as part of the Resettlement Action Plan process, 2002.

Figure 7.18 Fisherman's shelter



The numbers of salmon in Sangachal Bay have been dwindling in recent years. In 1997 approximately 110 salmon were caught in the Bay all of which were given to the Fish Hatchery Plant. There is now no salmon. Salaries in the fishing sector are determined on a quota basis and in 1997 the monthly salary of a fisherman was AZM23,000 (US$5). This salary is recognised as very low and is one of the main drivers of illegal fishing activity.

The only other authorised fishing undertaken within Sangachal Bay is for leisure purposes. Rod fishing is the only type of fishing allowed for leisure and nets are not allowed. Fishing takes place primarily at weekends either from the jetty built for the Early Oil Project in Sangachal Bay or from the fishing platforms that are situated slightly further out into the sea. There are six platforms, which are in a state of disrepair but provide a useful position from which to fish (Figure 7.19).

Figure 7.19 Fishing platforms

In addition to the fishing undertaken near shore, fishing is also undertaken some 1-2 km from the coast, whereby nets are thrown into the sea. The fish is not however, of a very high quality and as a result is not sold commercially but used for subsistence purposes.

Fishing vessels also catch sprats further out to sea approximately 40-60 km from shore. The fish are caught using a combination of lights and nets to attract the sprats. Each vessel catches between 10-20 t per night. There used to be between 140-150 boats active in fishing for sprats in these areas. It has now decreased however, to approximately 100 boats.

7.6.9 'Firuza' stone mine

A stone mine is currently operational some 10 km from Sangachal town behind the terminal site. It is an open cast mine and stone is cut out in blocks using electrical equipment. The materials are used for construction (e.g. houses) in the local area. The mine has been in operation for between eight and nine years. It is estimated that there is enough material still left in the mine to continue working it for a further 20 or 30 years. Production is approximately one to two vehicle loads a day. The mine is in production 24 hours a day with employees working in shifts. Production is constrained by a lack of infrastructure such as spare parts and an adequate access road.

The mine owner does not own the lorries that pick up the material. Purchasers of materials pick up the product. Some 25 people work at the stone mine and the employees come from the Gobustan and Duranley settlements.

The electricity line running through the proposed terminal site supplies the mine.[37]

7.6.10 Cultural heritage

Individuals from the National Academy of Sciences of Azerbaijan, Institute of Archaeology and URS undertook a non-intrusive field survey on May 23, 2001 and from June 4-7, 2001 to document features of archaeological significance in the Sangachal area. The initial walkover (May 23) served to focus the survey areas for the subsequent survey. For this survey, the team walked a number of transects across the study area which were documented via Geographical Positioning System (GPS). The team stopped when an item of interest was observed. Photos were taken along with GPS coordinates for features identified. The Institute members performed visual dating while smaller items (pottery shards, etc.) were collected and taken to the Institute of Archaeology for dating by comparative analysis. Numerous items of proposed significance were discovered, the most significant of which are summarised below. For a more detailed report regarding the survey undertaken refer to the Socio-economic Data Gathering Technical Appendix.

Although items of significance were spread out widely on the terrain assessed, some of the most significant items were concentrated north west of the existing terminal in the West Hills (Figure 6.35 depicts this area). On the sides and top of these hills archaeological features indicative of human settlement were discovered. Many of them resembled those already documented in the Gobustan Protected Area, which is approximately 15 km south west of the survey location. These included:

- artificial grooves laid in stone slabs apparently used for building;
- a triangular cove (three stone slabs together forming an upright triangle);
- stone carvings resembling goats on the inside walls of the cove; and

[37] The information on the 'Firuza' stone mine was sourced from an interview with an employee of the stone mine conducted by URS Dames & Moore and an interview with the Director of the stone mine conducted by BP. Both took place during the ESIA process.

- stone carving resembling a schematic image of a human (an image previously found only in Gobustan on "Yazili Tepe", the drawing hill, which is dated to the 2nd Century B.C.).

Figure 6.50 identifies the features described above. Note that the last feature, a schematic of a human, has been electronically enhanced for the purpose of this illustration.

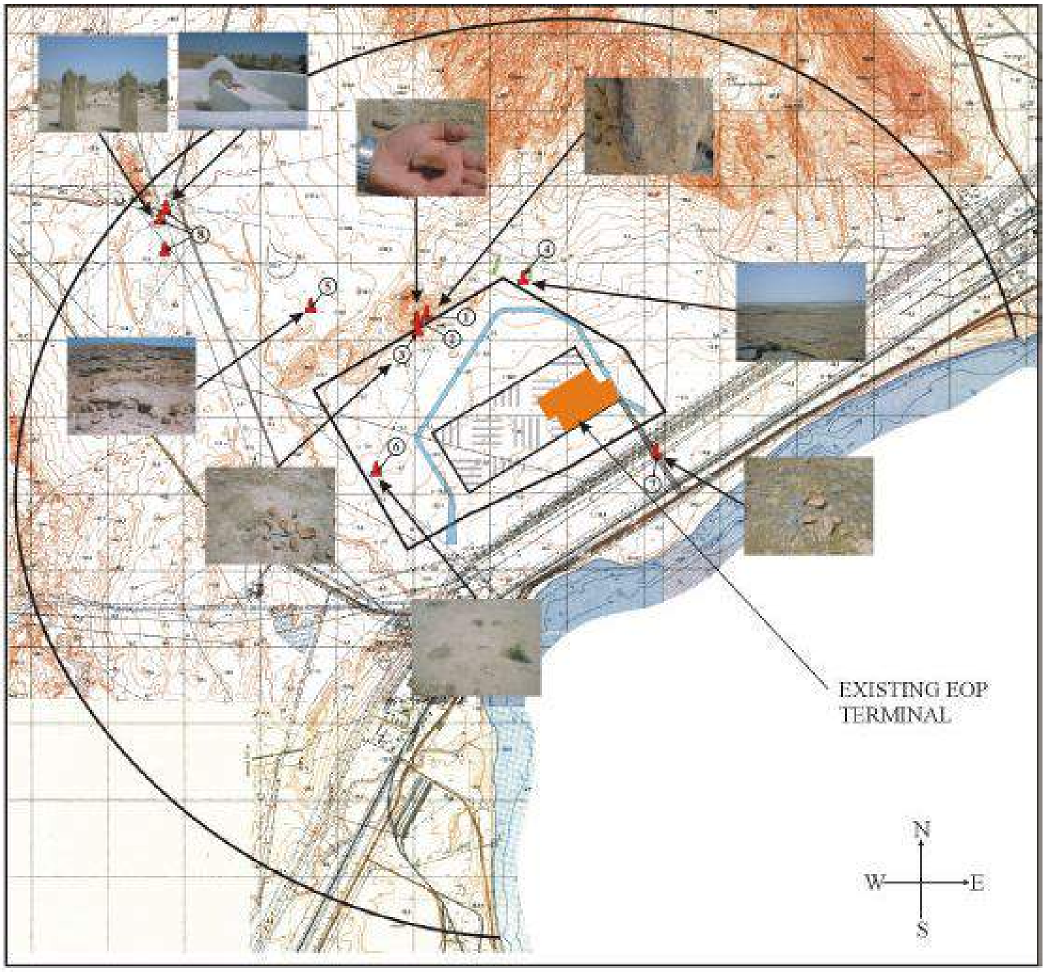
From the apparent level of pre-conception[38], artistry, and likeness to the carving found in Gobustan as mentioned above, it is estimated that these images might have been carved in the same period (i.e. 2nd Century B.C.). The rest of the features discovered on and around the West Hills have been dated by the Azeri archaeologists as being from the Middle Ages, approximately 1st Century A.D.

Another archeologically 'rich' area noted during the survey was concentrated in the cemetery to the NW of the terminal. The area of the cemetery is about 20 hectares. The eastern section of the cemetery is comparatively new. The northern section of the cemetery is reported as being centuries old. Hajji Elmira, a caretaker of the cemetery reported that the cemetery dates back to the XII century, with Christian graves pre-dating those of Muslim origin. In addition the cemetery is and has historically been a place of worship, as one of the relatives of Muhammad is believed to be buried within. Hajji Elmira showed the team graves dating back to 1204 A.D. Figures decorating the tombstones include camels, rams' heads and crescent moon shapes.

Surface debris and residual signs of buildings identified a number of other sites in the study area showing signs of human settlement. Figure 7.19 shows the areas associated with each of the 'sites' listed below in Table 7.28 along with selected photographs. Figure 7.21 shows the stone carvings at West Hills.

[38] 'Pre-conception' refers to the thought put into the drawing before making it i.e. the more an artist has thought about the details and artistry of the picture the higher the level of pre-conception.

Figure 7.20 Location of identified archaeological features



KEY
Boundary of no development zone
Extent of land clearance and grading works
Proposed drainage channel
Proposed access road
Survey area (2.5 km radius)
SCALE 1:25000

ARCHAEOLOGICAL FINDINGS	
1. Drawing in cove	5. Three room building
2. Ancient pipe bowl.	6. Jug or plate debris
3. Jug and plate debris.	7. Plate debris
4.XI century settlement	8. XII century cemetery

km 0 0.25 0.5 0.75 1 1.25 1.5 1.75 2 2.25

250 meters per centimeter

Figure 7.21 Cave with stone carvings at West Hills

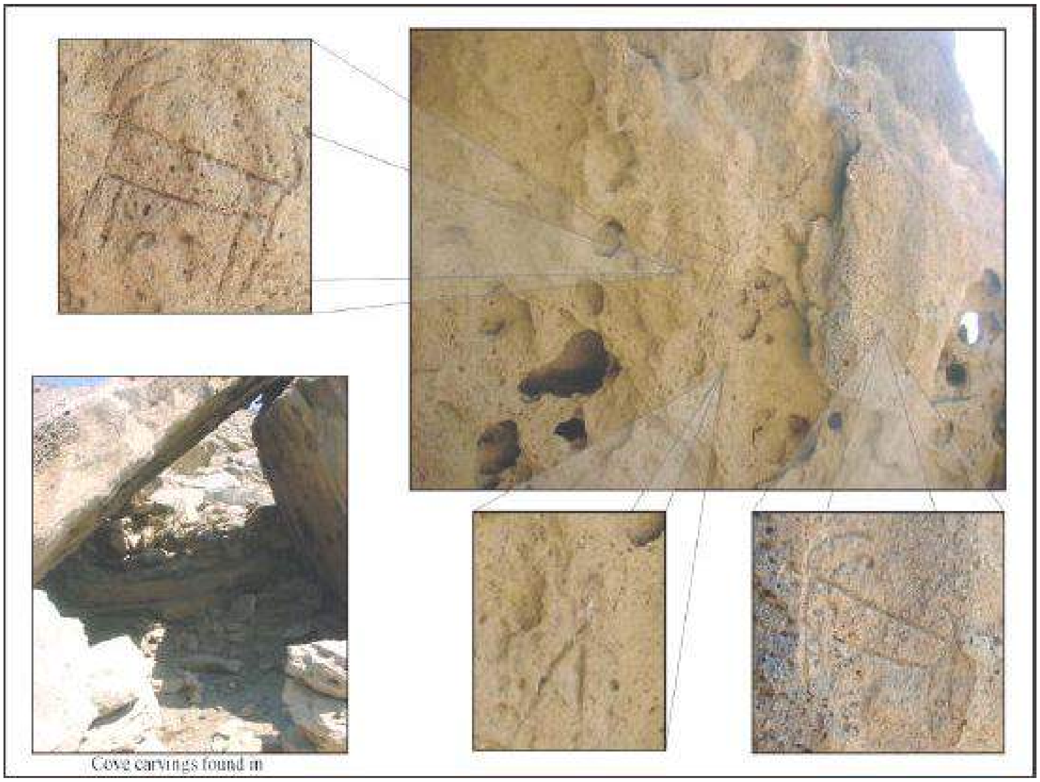


Table 7.28 Identified items of cultural heritage interest

Name	Map Reference Number	Artefact(s)	Cultural Identity	Site area[39]
Settlement #1 (Rocky dwellings)	1	remains of fireplace, earthenware debris	Medieval	Few hectares
Settlement #2 (Stone carvings inside rocky dwellings)	1	figure of goat carved on rocky dwelling interior, pottery made on potter's wheel	Medieval	Few hectares
Settlement#3	2	burnt bricks, collapsed building ,fireplace - artificial fire grooved found on large rocks	Medieval	Few hectares
Settlement#4	3	unglazed earthenware debris, jug and pitcher parts	Medieval	Few hectares
Settlement#5	4	earthenware debris - one fragment decorated with geometrical figures and spots, stone slab with grooves	Medieval	Several hectares
Settlement#5	5	collapsed 3-room building, earthenware debris	Medieval	Several hectares
Settlement#6	6	earthenware debris	Medieval	Few hectares

[39] Due to the irregularity of shape and time constraints, the scientists were unable to exactly define the areas comprising the features without considerable more field time and accompanying GIS work. Simple terms were used therefore, to generalize the size of the finds. The finds were only defined in terms of the space on the surface of easily seen features. More intrusive investigation may change size estimates accordingly.

Name	Map Reference Number	Artefact(s)	Cultural Identity	Site area[39]
Gochdash Settlement	7	earthenware debris	Medieval	Several hectares
Sangachal Cemetery - Sophi-Hamid Worship Area	8	Tombstones, various earthenware debris	Medieval	Approx. 20 hectares

8 Consultation

8.1 Introduction

Communication with stakeholders is an important part of the way that BP conducts its business and communication with the project stakeholders is an essential component of any environmental and socio-economic assessment process (Figure 3.1). BP is committed to active and ongoing communication with all organisations and individuals with an interest in the proposed Shah Deniz Stage 1 development. The consultation and disclosure programme for Shah Deniz Stage 1 is ongoing and will continue throughout the life of the project.

8.2 Public consultation and disclosure

The following sections outline the public consultation and disclosure process undertaken for the Shah Deniz Stage 1 ESIA, including the Early Civil Engineering Work Programme (ECEWP). The process was designed to meet the requirements of the Azerbaijan government and International Finance Institutions (IFI). Additional and important environmental and social drivers of the BP consultation process are:

?? understanding the environmental and socio-economic impacts of the Shah Deniz Stage 1 project including the Early Civil Engineering Work Programme (ECEWP);
?? understanding the concerns of those directly and indirectly affected;
?? influencing the detailed project planning process to mitigate impacts and concerns;
?? contributing positively to socio-economic developments and environmental protection in Azerbaijan;
?? engaging proactively with national and international NGOs; and
?? complying with the requirements of the PSA, relevant laws and decrees, the regulatory authorities and international finance institutions.

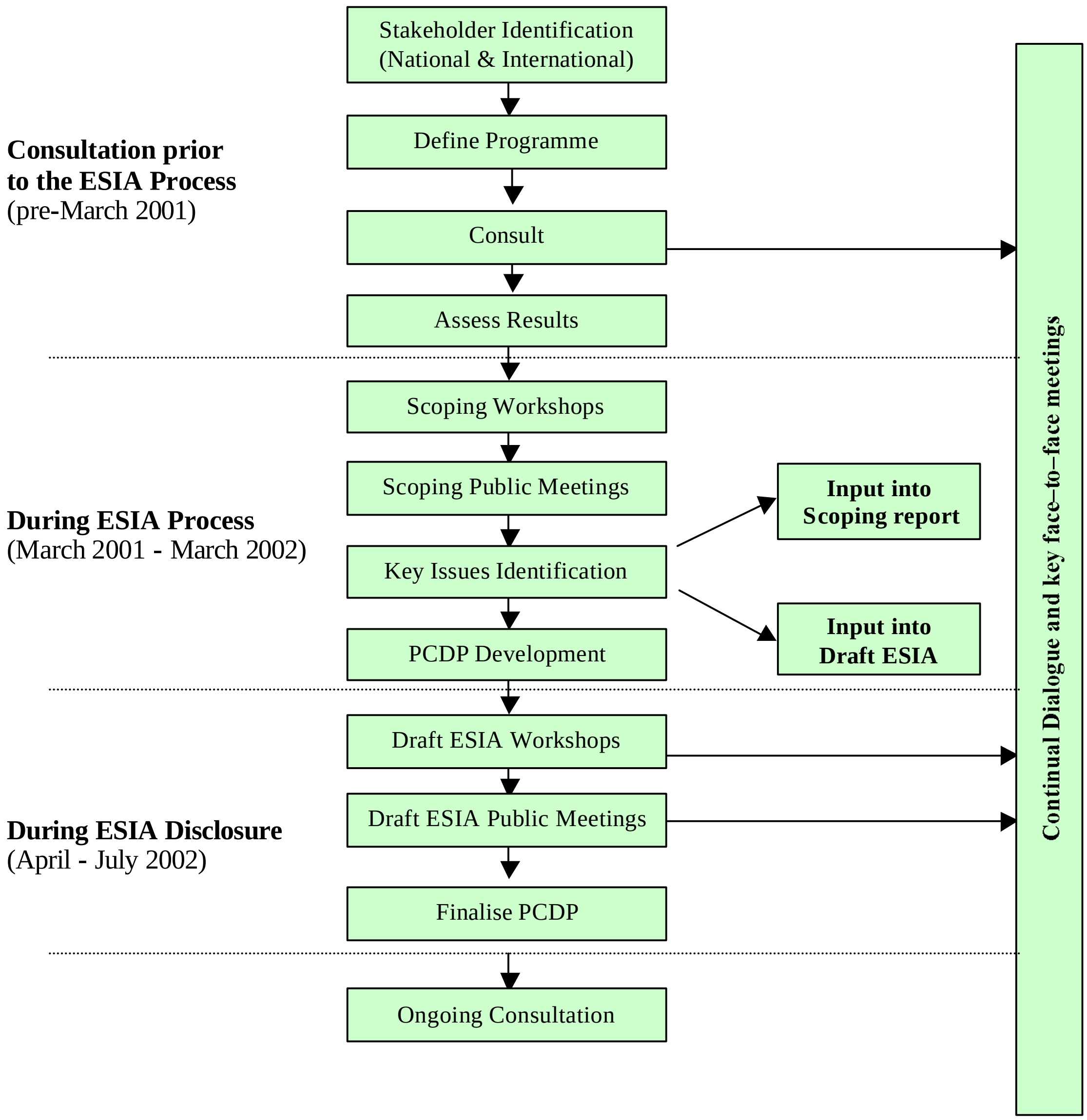
Figure 8.1 illustrates the Shah Deniz Stage 1 consultation and disclosure process. The key phases of the consultation process are:

?? project stakeholder identification;
?? pre-ESIA consultation;
?? ESIA scoping consultation;
?? ESIA land acquisition and resettlement consultation; and
?? ESIA draft document disclosure consultation.

There are three concurrent and related public consultation and disclosure processes:

?? the ECEWP ESIA process;
?? the full Shah Deniz Stage 1 ESIA process; and
?? consultation relating to the full ACG Phase 1 ESIA process.

Figure 8.1 Shah Deniz Stage 1 consultation and disclosure programme



These processes will result in three separate but inter-related ESIA documents, particularly with respect to the nearshore and onshore environments. The phases of the consultation process in relation to each of these ESIAs is illustrated in Table 8.1. The ECEWP is preparatory work for both the ACG Phase 1 and Shah Deniz Stage 1 projects.

Table 8.1 Concurrent and related consultation and disclosure

Phases of Consultation Process	Project
Stakeholder identification	Applied to both ACG Phase 1 and Shah Deniz Stage 1.
Pre-ESIA consultation	Separate meetings were held for ACG Phase 1 and Shah Deniz Stage 1.
ESIA scoping consultation	One set of scoping workshops and meetings was held where both ACG Phase 1 and Shah Deniz Stage 1 were addressed.
ESIA land acquisition and resettlement consultation	Various meetings focused on ACG Phase 1 and Shah Deniz Stage 1 land acquisition and resettlement issues.
ESIA draft document disclosure consultation	Separate draft disclosure consultation processes have been, and will be, held for ECEWP, ACG Phase 1 and Shah Deniz Stage 1.

Consultation with stakeholders to date has consisted of public meetings and workshops held within Azerbaijan. In addition, ongoing dialogue with regulatory agencies and stakeholder groups has been completed by means of key face-to-face meetings. These elements of the consultation programme are discussed below.

The objective of these consultations has been to:

?? present general project descriptions;
?? present the BP environmental and social programme approach;
?? present the schedule for draft ESIA reporting;
?? identify and present initial issues arising from scoping consultation efforts completed to date, identify and present issues arising from draft ESIA document disclosure meetings; and
?? listen and respond to stakeholder concerns.

The public consultation and disclosure process will be recorded in a formal Public Consultation and Disclosure Plan (PCDP). The full Shah Deniz Stage 1 PCDP document will be made publicly available on the internet as a stand-alone report. The final version of the ECEWP ESIA document contains a summary of the ECEWP consultation process and the minutes of ECEWP specific consultation meetings. The full Shah Deniz Stage 1 PCDP will contain:

?? the methodology used to identify and consult with the stakeholders;
?? a list of the stakeholders consulted;
?? the locations and dates of the meetings and workshops;
?? a full description of the results of the workshops including a record of all issues raised by the project stakeholders; and
?? details on how BP has responded to the issues raised and how the responses were conveyed back to the stakeholders.

8.2.1 Stakeholder identification

Stakeholder identification is undertaken to determine all of the organisations and individuals who may be directly or indirectly affected (positively or negatively) by the developments proposed and who may be able to contribute to the programme of work due to their expert knowledge of and/or experience in the region.

BP has been working in a public participatory manner in Azerbaijan for a number of years and over this time has developed a strong working partnership with many of the regional stakeholders. Relevant project stakeholders were identified on the basis of this local knowledge to ensure as wide a public involvement as possible in the consultation and disclosure programme. The BP commitment to the involvement of stakeholders in the project definition process is encapsulated in its Business Policies, Commitments and Expectations as follows:

> *"We will build relationships on the basis of mutual advantage – alive to the needs of all those with whom we do business and the needs of each community in which we operate."*

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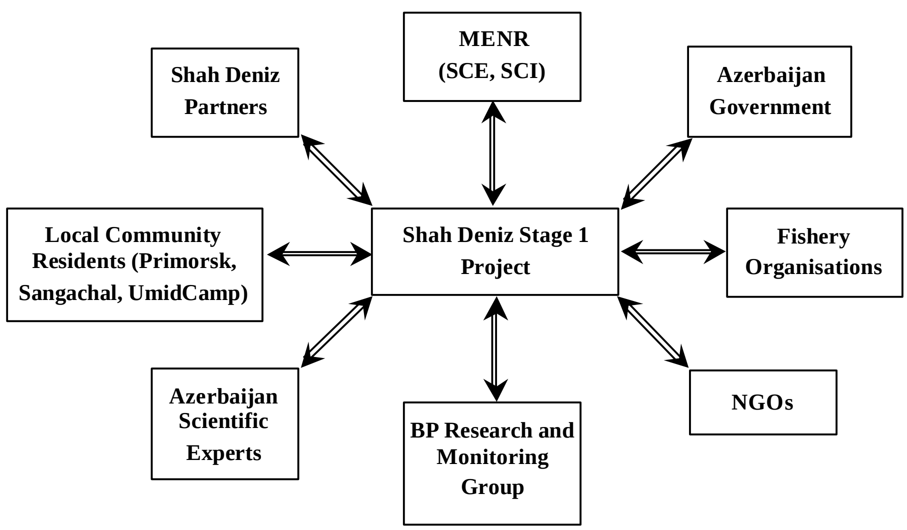
Caspian Oil & Gas Developments and Associated Pipelines
April 2001

The organisations and groups consulted are shown in Figure 8.2.

Figure 8.2 Consulted stakeholder groups



8.2.2 ESIA consultation and disclosure methods and key issues raised

Three key consultation methods were used during the ESIA consultation and disclosure process:

?? workshops;
?? public meetings; and
?? face-to-face meetings with particular individuals and groups.

The workshops and public meetings are explained in more detail below. The face-to-face meeting process is detailed in Sections 8.3 and 8.4.

The key disclosure methods included:

?? summary briefings of the Shah Deniz Stage 1 project;
?? presentations at workshops and meetings; and
?? disclosure of draft ESIA documents.

All issues raised by stakeholders were recorded in the minutes to each workshop and meeting. Table 8.2 below records the key issues raised during the scoping workshops and consultation meetings for the Shah Deniz Stage 1 project.

8.2.2.1 Consultation methods

Workshops

A number of workshops with both the Azerbaijan scientific communities and Non-Governmental Organisations (NGOs) were organised and convened at the scoping stage of the ESIA process. These sessions were designed to include national scientists and NGOs that have a particular interest in the regional environment. In particular, many of the scientists have a number of years experience in environmental studies and research in the project region and their inclusion in the ESIA process was, and continues to be, important to BP's understanding of the environment in which the project is to be developed. The NGOs in many cases also have considerable experience and understanding of the regional environment and hence are similarly important. Indeed many of the NGO groups are led by local academics with environmental research interests.

The objectives of the workshops included:

?? to provide information on all stages of the proposed development to the participants;
?? to listen to and respond to concerns; and
?? to describe the proposed ESIA strategy for these developments.

A description of the proposed development, development programme and ESIA strategy was provided by senior project managers and the ESIA team and subsequently, workshop participants were invited to ask questions thus allowing them direct access to the project decision-makers. Delegates were then invited to provide the project proponent and ESIA team with a list of key issues of concern including why the issues were of concern and at what stage of the development programme they were of most concern.

To facilitate the process of workshop input, participants were divided up into a number of working groups each with a project facilitator. The facilitators encouraged and assisted each group to expand on the issues raised and also answered questions with respect to the project design and proposed development programme. At the conclusion of the group sessions, a nominated spokesperson from each working group was invited to provide a summary of the issues and concerns raised by their group. The workshops were fully minuted.

Public meetings

Pubic meetings were convened with the public, private and civil society stakeholders in the areas close to where project activities are proposed to take place. In addition, the Azerbaijan media were invited to attend and record the proceedings. The date and venue of the meetings were advertised. The public meetings were held during the scoping stage for the local affected communities and during draft disclosure for academics, NGOs and the affected community.

As with the workshops, the public meetings were attended by senior Shah Deniz Project Managers so that they could provide information on the proposed developments and ESIA strategy, outline findings, describe process for consultee involvement in the proposed projects, listen to concerns, and answer questions raised by those attending the meetings. The meetings were fully minuted.

8.3 Pre-ESIA consultation process

A series of preliminary consultation meetings were held with the principle aim of giving attendees an early summary of the proposed Shah Deniz field development and the proposed ESIA strategy for the Shah Deniz Stage 1 project. The key activities included meetings with the following regulatory bodies and organisations:

?? Azerbaijan State Committee for Ecology - Chairman and Department of Expertise, now part of the MENR;
?? Cabinet of Ministers (HSE Sector);
?? State Caspian Inspectorate (part of former Azerbaijan State Committee for Ecology);
?? Academy of Sciences;
?? BP Research and Monitoring Group, and
?? State Oil Company of the Azerbaijan Republic (SOCAR).

In addition a workshop was held in November 2000 with the Azerbaijan environmental NGOs to focus specifically on the Shah Deniz Stage 1 project.

8.4 ESIA scoping consultation

A number of consultation meetings were held during the Shah Deniz Stage 1 ESIA scoping consultation process, including continual and ongoing dialogue with the Chairman of the HSE Commission of the Azerbaijan Parliament, the Minister of the Environment, and with the Acting President of the Azerbaijan Academy of Sciences. These meetings sought to provide regular up-dates on the status of the projects.

In addition two key workshops took place:

?? **March 2001:** Shah Deniz Stage 1 ESIA scoping workshop with Azerbaijan scientists so that BP could provide more defined information on the proposed project, the ESIA process underway, and receive feedback and information from the scientific community; and
?? **March 2001:** Shah Deniz Stage 1 ESIA scoping workshop with the Azerbaijan NGOs (with the same objectives as the scoping workshop with the Azerbaijan scientists).

Following these workshops the issues raised were considered, and in some cases further face-to-face meetings were convened so that issues could be discussed in more detail with representatives from the:

- ?? Institute of Fisheries;
- ?? Institute of Botany;
- ?? Institute of Geology;
- ?? Caspian Environmental Programme;
- ?? Environmental Protection Society;
- ?? Society for Protection of Animals, and
- ?? Institute of Physiology.

These workshops were followed by two public meetings as follows:

- ?? **June 2001:** scoping public meeting at Primorsk (also known as Sahil) to inform the local community of current and proposed development activities, including the ESIA process, and seek input from the participants. Held in the Palace of Culture, this meeting was particularly important for informing many of the local residents who may be potentially affected by the developments and receiving their comments. As the fishing community for the region nearest to the proposed development activities are particularly well represented in Primorsk therefore fishing interest groups were specifically invited to attend.
- ?? **June 2001:** scoping public meeting at Sangachal to inform the local residents of the proposed developments and the ESIA process underway. This meeting was held at the Sangachal school and was particularly important in allowing the local residents who live nearest to the proposed terminal development to hear about the proposed developments directly from the Project Managers and to raise their issues and concerns in a public forum.

A number of additional face-to-face meetings have been ongoing with the regulatory bodies and other organisations during the Shah Deniz Stage 1 ESIA process. These have included meetings to discuss proposed mitigation measures for certain project activities in order to obtain agreement on the measures proposed, and to seek further recommendations on additional appropriate measures. The following regulatory bodies and organisations were consulted in this respect:

- ?? Ministry of Environment and Natural Resources (MENR);
- ?? State Caspian Inspectorate, now part of MENR
- ?? Cabinet of Ministers (HSE Sector);
- ?? SOCAR; and
- ?? The BP Research and Monitoring Group.

Table 8.2 below identifies all of the key issues raised during the scoping consultation process for the full Shah Deniz Stage 1 and ACG Phase 1 developments.

8.5 Land acquisition and resettlement consultation

As part of the land acquisition process, and in preparation for the early civil engineering work programme (ECEWP) at the terminal site, a number of utility providers were met with to discuss procedures for crossing existing pipelines, railways and other utilities in the corridor to the south of the terminal location, and for the re-routing of a small section of an overhead power line which crosses the western section of the land acquisition area. These utility companies included:

?? Azerbaijan Railway Department;
?? AZERAVTODOR;
?? Apsheron Regional Stock Water Company;
?? ? ? ? ? (Technical Unit of Main Cable Lines);
?? BAGES;
?? SOCAR;
?? CJSS AZERIGAZ;
?? Central Power Network;
?? JSC AZENERGI; and
?? Sm. Enterprise "Yigun".

Most of these utility providers worked with AIOC/BP during the ACG Early Oil Project (EOP) construction when there was minimal or no disruption to the utility companies or their customers and a relationship of goodwill has already been established with these organisations.

In addition, the Director of a stone mine that is understood to use the power line as a back-up electricity supply was consulted about the programme of work to relocate the line.

The local herding community use the area upon which the expanded ACG and Shah Deniz Full Field Development terminals will be built, for grazing their livestock. It forms part of a wider area used by the herders for grazing their livestock during the winter months of the year. Consultation is ongoing with the herding community as part of the development of a Resettlement Action Plan (RAP). The RAP process has included consultation regarding the impacts of the projects on their grazing lands and their options for compensation. The consultation process will be described and documented in the final RAP document.

Consultation has also been undertaken to understand the impacts of the ACG Phase 1 and Shah Deniz Stage 1 projects on the local fishing community. The results of this consultation, and any agreed mitigation measures, will also form part of the RAP. The consultation process is ongoing and will also be described and documented in the RAP.

8.6 ESIA draft disclosure consultation

As outlined in Section 8.2, two sets of ESIA documents have been produced for the Shah Deniz Stage 1 Project. The first was the Early Civil Engineering Work Programme (ECEWP) draft ESIA completed in September 2001. The ECEWP applies to both the ACG Phase 1 and Shah Deniz Stage 1 developments. The second is this document, the final draft of the full ESIA for the Shah Deniz Stage 1 project, which incorporates the ECEWP as the initial part of the development.

8.6.1 ECEWP draft ESIA

The ECEWP draft ESIA document was disclosed and made freely available to the public in Azerbaijan for comment. Following this, the final version of the document was published at the end of November 2001.

In addition a series of public meetings were held in October 2001 to present the findings of the draft ECEWP ESIA, enabling stakeholders to voice views and concerns in a public forum. All comments have been recorded. Issues and comments raised were incorporated into the final full ECEWP ESIA where appropriate.

8.6.2 Shah Deniz Stage 1 project draft ESIA

The draft Shah Deniz Stage 1 Project ESIA was disclosed and made available to the public for comment for a period of 60 days from the mid April 2002. Copies of the document were made freely available and were distributed widely for easy access by interested and affected stakeholders, including the general public.

A similar series of workshops and public meetings as those held during the ECEWP draft disclosure period were conducted in order to present the findings of the Shah Deniz Stage 1 ESIA process and all comments were recorded. Issues and comments raised have been incorporated into this final Shah Deniz Stage 1 ESIA document where appropriate.

8.7 Forward consultation plan

Consultation throughout the construction and operation phases of the project will be ongoing. BP will assign responsibility for liaison with relevant stakeholders throughout the construction phase of Shah Deniz Stage 1 to a Community Liaison Officer (CLO) (Chapter 14).

During operations, BP will ensure that all stakeholders are provided with ready access to the Community Liaison officer. The project is fully committed to a continued dialogue with stakeholders. Some of the issues raised during consultation will be worked through as the project evolves through detailed design, construction, installation and into operation.

Table 8.2 Key issues raised during Shah Deniz Stage 1 ESIA scoping consultation process

Issue	Concern	Issues Raised By				Section Addressed
		Regulator	Academics/ Scientists	NGOs	Individuals	
Triggering of seismic events	Fear that increased operations will increase the number of seismic events, in particular drilling activity, cuttings re-injection, and deep well disposal of produced water.	?	?	?		6.4.5 10.6.2.1 10.6.2.2
Seismic/tectonic activity	Ability of the facilities to withstand seismic event (earthquake or mud volcano activity).		?	?		10.6.2
Oil/condensate spills	Potential oiling of marine life and impact on the environment from an offshore spill. Potential for oil/condensate spills during storage at the terminal. Measures to eliminate the consequences of oil spills. Oil spill contingency planning. Wildlife response.		?	?		10.6.1 13.4 14.2.2 Technical Appendix 7
Pipeline	Ensure pipeline integrity, particularly at the landfall.	?				5.4.1 10.4.2.2
Discharge of produced water to the sea	Volumes to be discharged. Produced water discharge specification. Produced water monitoring.	?	?	?		5.4.6 5.3.6.2 5.3.6.5
Injection of excess produced water into disposal wells	Potential contamination of underground water. Potential for radioactivity of the produced water. Produced water treatment prior to injection. Over pressuring of the sub-surface geology. Integrity of the disposal well. Containment of injected wastes in the event of an earthquake.		?	?		10.4.6 10.6.1.6
Discharge of cuttings and water based muds to the sea.	Concern over the environmental impact to the Caspian Sea environment.	?		?	?	5.2.1.3 10.3.3

Issue	Concern	Issues Raised By				Section Addressed
		Regulator	Academics/ Scientists	NGOs	Individuals	
Chemical use offshore	Can a Caspian specific protocol for selection of chemicals be used?			?		5.2.13 10.3.2.2 10.3.3.1
Discharge of sewage	Discharge of sewage offshore and its impact on the sea.	?		?		5.2.2.2 5.3.7.9 10.3.2.2
Impacts on water quality	Impacts from construction and operations on sea water quality.	?	?			10.3.2
Air quality	Terminal operations impact on air quality. Impacts on air quality in the event of an emergency.		?	?	?	10.4.1
Flaring	Potential to flare associated gas and its contribution to the 'greenhouse effect'. Impact on birds offshore and onshore.		?	?	?	5.2.2.2 5.3.4.1 10.3.1 10.4.1 13.3.1
Noise and vibration	Effects of noise and vibration at the platform and terminal, particularly on people and the environment during construction and operation. Effects of noise and vibration on fish migration.		?	?		5.5.4.1 5.5.4.5 10.3.1.6 10.3.2.1 10.4.9 11.4.4
Biodiversity	Potential reduction in biodiversity as a result of the project implementation.		?			10.3.2 10.3.3 10.4.8 10.4.9 14.2.1.3

Issue	Concern	Issues Raised By				Section Addressed
		Regulator	Academics/ Scientists	NGOs	Individuals	
Terrestrial ecology	Potential effects of the terminal, onshore pipeline, access roads on the flora and fauna in the Sangachal area. Changes to nesting and resting grounds for migratory birds. Require a baseline study. Requests to monitor the impacts (including soils). To include local scientists/NGOs. Publish results.		?	?		6.4 10.4.8 10.4.9 14.4 Technical Appendix 11
Marine environment	Potential impacts on marine biology resources, in particular fish and the fishing industry, from the construction, installation and operation of the developments. Accurate baseline studies. Requests to monitor the impacts on marine microorganisms and benthos in the vicinity of the operations. Publish results. Studies should be seasonal.		?	?	?	10.3.2 10.3.3 14.4
Interference with fishing activities	When and how will the activities be organised?				?	5.1.5 11.4.2.2 11.4.3
Seal mortality and extinction	Impact of oil production (and seismic survey) on the seal death rate.		?			6.2.7.2
Gas production	Why can the gas from the developments not be provided to the Azerbaijan national grid, rather than sold overseas (or injected offshore)?		?	?		5.1.
Landscape and visual impact	Effects on the landscape from the terminal and wind dynamics.		?		?	10.4.7
Archaeology	That the proposed terminal expansion works would impact on (known) sites of archaeological / cultural significance and the measures that will be taken to protect previously unidentified sites should they be found within the proposed terminal area.		?			7.6.10 11.4.8 15.11
Waste Management	Groundwater contamination from waste landfill. Lack of waste management infrastructure in Azerbaijan. Concern about radioactive wastes and radioactive hazards.		?	?		10.5 14.3.2
Cumulative impacts.	Cumulative impacts from other activities should be included in the ESIA.			?		Chapter 12

Issue	Concern	Issues Raised By				Section Addressed
		Regulator	Academics/ Scientists	NGOs	Individuals	
Health and Safety on the platform	Distance on the platform between the living quarters and the drilling/production ops and safety to personnel.		?	?		5.3.6 5.3.7
Health and Safety at the terminal	Ensure risks to the health and safety of people are properly addressed. Ensure the correct separation distances between the oil and gas facilities at the terminal. Emergency plans and evacuation of personnel and training of the local population on what to do in the event of an emergency. Insurance arrangements following an accidental event.	?		?	?	5.4.4
Benefits to Azerbaijan	How will the population benefit? Will a refining industry be developed in Azerbaijan for the produced oil and gas?		?	?		Executive Summary 11.4.9 Chapter 16
Access to Information	Ensure easy access to information with respect to the activities and to monitoring of the activities.		?	?	?	Chapter 8
Public participation	Ensure that all stakeholders are able to participate in the project decision-making process.		?	?	?	Chapter 8
Resettlement at Sangachal	Potential to resettle Sangachal village due to the number (and size) of projects planned. Level of compensation		?			11.4.2 11.4.3 11.4.4 15.4
Sustainable development	More attention to be paid to Social aspects.		?			15.1.1 15.10
Fishing	Disruption and possible pollution.		?	?	?	10.3.2 11.4.2 11.4.3 15.4
Compensation	Will BP/AIOC compensate fishermen for losses incurred due to the project, similar to the situation in the North Sea and other regions?			?	?	11.4.2 15.4
Azeri translation of the ESIA	Request to submit the ESIA in English, Russian and Azeri languages			?		N/A

Issue	Concern	Issues Raised By				Section Addressed
		Regulator	Academics/ Scientists	NGOs	Individuals	
Employment	What percentage of the local population is currently working for BP and what percentage is manual workers as opposed to professional staff? When and how will people be provided with employment on these developments? Will there be an employment centre? Pay and conditions.				?	11.4.9 15.1.1 15.6
Training	Concern over the skills base required to get a job. There is a need to train local people in Azerbaijan.				?	11.4.9 15.6
Social investment	Investment in the Sangachal area required. What social investment plans does BP/AIOC have?				?	15.10

9 Environmental and Socio-economic Aspects

9.1 Preamble

Section 3.6 presents the definition of environmental aspects adopted for this project namely that defined by ISO 14001:1996 Environmental Management Systems - Specification with Guidance for Use (ISO, 1996). An environmental aspect is denoted where an activity has the potential to interact with the environment. A socio-economic aspect can be considered to occur when an activity has the potential to interact with the social or economic environments.

9.2 Identifying project activities, environmental and socio-economic receptors

In order to identify environmental and socio-economic aspects for this project, it was necessary to first identify all project activities. To achieve this, several key inputs were used including:

- project design documentation;
- consultation with design engineers; and
- the results of the Environmental Hazard and Risk Assessment (EHRA) workshops.

Routine activities, non-routine but planned activities and non-routine activities (accidents) were identified for the following three main project elements:

- offshore development;
- subsea pipelines; and
- the onshore terminal.

Following identification of all project activities, legal, environmental and socio-economic receptors were identified. The key input for the identification of receptors included:

- the legislative review (see Chapter 2);
- the environmental baseline (see Chapter 6);
- the socio-economic baseline (see Chapter 7); and
- stakeholder consultation.

As previously described, the environmental and socio-economic baselines were compiled using a combination of existing data and the results of a number of data acquisition focused baseline survey and stakeholder consultation programmes.

In total, 38 receptors have been identified and have been grouped under the following categories:

- **Marine environment:**
  - physical: 4 receptors.
  - biological: 6 receptors.
- **Coastal / terrestrial environment:**
  - physical: 8 receptors.
  - biological: 5 receptors.
- **Socio-economic:** 11 receptors.
- **Other (including legal):** 4 receptors.

All key issues that were raised by members of the community or by a stakeholder group during the consultation programme to date, were recorded and included as a legal, environmental or socio-economic aspect regardless of the scientific, commercial or factual validity of the claim. In this way it is assured that the ESIA process has addressed all the community and/or stakeholder concerns raised during consultations.

Table 9.1 lists the identified project environmental and socio-economic receptors. A brief explanatory comment on each is also provided.

Table 9.1 Identified project environmental and socio-economic receptors

Environmental Receptor	Comment
Marine Environment	
Physical	
Atmosphere	The atmosphere (air) at and around the proposed project offshore development sites.
Seawater	Waters of the Caspian Sea and other waterways (e.g. Bosporus, Volga Don) in which project activities are proposed to occur.
Seabed	The seabed of the Caspian Sea and other waterways (e.g. Bosporus, Volga Don) in which project activities are proposed to occur.
Subsurface Geology	The subsurface structures and rock strata of offshore areas in which project activities are proposed to occur.
Biological	
Plankton	Plankton living in the water column of the Caspian Sea and other waterways (e.g. Bosporus, Volga Don) in which project activities are proposed to occur.
Fish	Fish living in the water column of the Caspian Sea and other waterways (e.g. Bosporus, Volga Don) in which project activities are proposed to occur.
Flora	Marine flora living in the water column of the Caspian Sea and other waterways (e.g. Bosporus, Volga Don) in which project activities are proposed to occur.
Benthos	Organisms living in and/or on the benthic sediments of the Caspian Sea and other waterways (e.g. Bosporus, Volga Don) in which project activities are proposed to occur.
Mammals (Caspian Seal)	The Caspian Seal.
Seabirds	Birds that rely on the sea as a habitat and/or food source. Seabirds may also be found in coastal areas. Seabirds are often migratory and therefore, may not be present within the project areas all year round.
Coastal / Terrestrial Environment	
Physical	
Atmosphere	The atmosphere at and around the proposed project onshore development sites.
Coastline	The terrestrial part of the Caspian Sea's and other waterways' coastlines where project activities are proposed to occur.

Environmental Receptor	Comment
Soil	The soils of areas in which project activities are proposed to occur.
Groundwater / Aquifers	The groundwater resources and aquifers of areas in which project activities are proposed to occur.
Surface Water	The surface waters in creeks, streams, rivers and wadis in areas in which project activities are proposed to occur.
Hydrological Systems	The terrestrial physical systems of creeks, streams rivers and wadis in areas in which project activities are proposed to occur.
Subsurface Geology	The subsurface structures and rock strata of terrestrial areas in which project activities are proposed to occur.
Landscape / Topography	The geomorphological land forms and terrain of areas in which project activities are proposed to occur.
Biological	
Coastal Flora	Plant species that occur in the coastal zone areas in which where project activities are proposed to occur.
Terrestrial Flora	Plant species that occur in the inland areas in which project activities are proposed to occur.
Terrestrial / Coastal Birds	Birds that rely on inland and/or coastal areas as a habitat and/or food source. Some terrestrial / coastal seabirds of the area are migratory and therefore, may not be present all year round.
Reptiles / Amphibians	Reptiles (e.g. snakes) and amphibians (e.g. tortoise) that occur in coastal and/or inland environments in which project activities are proposed to occur.
Mammals	Mammals that occur in coastal and inland environments in which project activities are proposed to occur.
Socio-economic Environment	
Archaeology / Cultural Property	Archaeological sites and artefacts that have cultural significance to Azeri and other people. It is also possible that cultural significance may be attributed to a place (i.e. sense of a place being important) but this concept is not generally as important factor as actual physical items.
Fishing	The activity of fishing for subsistence and economic reasons. Fishing can occur both in nearshore and offshore areas as well as within terrestrial hydrological systems.
Shipping	The activity of shipping for recreational and/or commercial purposes.
Land Use	Existing uses (e.g. herding/grazing, farming, industrial) of the land areas in which project activities are proposed to occur.
Population in the Vicinity of Activity	The populations (people) that live in the areas in which project activities are proposed to occur.
National Employment Base	The total number of jobs (temporary, part-time, full-time) within Azerbaijan.
Utilities	The utilities (e.g. power supply, water, sewerage services) of areas in which project activities are proposed to occur.

Environmental Receptor	**Comment**
Community Infrastructure	The buildings and infrastructure (e.g. schools, hospitals, community halls) provided by government for use by the local community.
Transport	The road, rail, waterway and air transport systems (i.e. physical network and vehicles that use them) of the areas in which project activities are proposed to occur.
Oil and Gas Infrastructure	Existing oil/gas infrastructure in the areas in which project activities are proposed to occur.
National Industrial Base	The totality of the industrial and business supply network within Azerbaijan.
Other	
Government Revenue	Economic revenue that will be generated by the project and that will go to the government of Azerbaijan.
Transboundary	Areas outside of Azerbaijan.
International Procurement	International economies that benefit from project related expenditure through the procurement of goods and services outside of Azerbaijan.
Liability / Reputation	The legal liability and the reputation of the PSA partners responsible for development and implementation of the project.

9.3 Identifying project environmental and socio-economic aspects

Identified project activities and legal, environmental and socio-economic receptors were integrated into matrices with the activities on the y-axis and receptors on the x-axis, and a matrix was compiled for each of the project elements. Each matrix was subsequently assessed to identify every possible case of potential activity-receptor interaction. Where it was considered that an activity-receptor interaction was possible, the cell was marked denoting an identified environmental and/or socio-economic aspect.

The completed environmental and socio-economic aspect matrices are presented as Tables 9.2 through 9.5.

Following the completion of the environmental and socio-economic aspect identification process, a process of impact assessment was completed. Every identified aspect was assessed and ranked in terms of its consequence and likelihood thus enabling the determination of the overall significance of the aspect. The methodology for the impact assessment is presented in Chapter 3. The results of the impact assessment process are presented in Chapters 10 and 11.

Table 9.2 Environmental and socio-economic aspects – offshore

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Fabrication, Construction and Assembly in Azerbaijan	TPG500 (existing) assembly yard upgrade and preparation	●	●								●	●		●		●	●		●		●	●	●	●					●	●	●		●	●	●	●		●	
	Mobilisation of TPG500 assembly workforce											●																	●	●		●	●	●	●	●		●	
	TPG500 assembly yard facilities, services and utilities operations										●	●				●						●							●		●			●	●			●	
	TPG500 assembly yard power generation										●	●										●																	
	Assembly of TPG500 (hull; legs)										●	●										●							●	●				●	●	●		●	
	Construction of drilling template										●	●										●							●	●				●	●	●		●	

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	Testing and commissioning of assembled TPG500 at assembly yard	●									●	●										●							●	●					●			●	
Istiglal MODU Installation and Drilling	Mobilisation of the Istiglal (including vessel operations)	●	●	●		●	●	●	●	●	●	●										●				●	●			●								●	
	Positioning and anchoring of Istiglal	●	●	●		●	●	●	●	●	●	●														●	●			●								●	
	Float-out, positioning and installation of drilling template (including vessel operations)	●	●	●		●	●	●	●	●	●	●														●	●			●								●	
	Istiglal drilling surface (28”) section; discharge cuttings and drilling fluids/WBM to seabed	●	●	●	●	●	●	●	●	●																●	●			●								●	

RECEPTORS / ACTIVITY	Marine										Coastal / Terrestrial													Socio-Economic											Other			
	Physical				Biological						Physical								Biological																			
	Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Istiglal drilling of lower-hole sections; cuttings transfer and ship-to-shore	●	●	●	●					●		●														●	●			●			●					●	
Cement pump / cementing	●	●	●																										●								●	
Istiglal utilities operation (sewage, drainage fire water, potable water)	●	●			●	●																																
Istiglal power generation	●																																					
Istiglal cooling water uptake and discharge	●	●			●	●			●																													
MODU #3 DST fluid disposal to flare (if required)	●	●			●	●			●	●																			●								●	
Helicopter operations	●									●	●										●							●	●								●	

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	Vessel supply and back load (including waste transfer)	●	●								●	●										●				●	●			●									
	Presence of Istiglal offshore		●	●		●	●	●	●	●	●															●	●												
TPG500 Drilling and Production	TPG500 float-out and positioning (including vessel operations)	●	●	●		●	●	●	●	●		●														●	●			●								●	
	TPG500 seabed fluidisation for suction anchors and jack-up (including vessel operations)	●	●	●		●	●	●	●	●																●	●			●								●	
	TPG500 / pipeline tie-in and commissioning (including vessel operations)	●	●	●		●	●	●	●	●																●	●			●								●	
	TPG500 well commissioning	●	●																											●								●	

RECEPTORS / ACTIVITY	Marine										Coastal / Terrestrial													Socio-Economic											Other			
	Physical				Biological						Physical								Biological																			
	Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
TPG500 drilling of surface (28") section; discharge drilling fluids (WBM) and cuttings	●	●	●	●	●	●	●	●	●																				●								●	
TPG500 drilling of lower hole sections; cuttings transfer and ship-to-shore	●	●	●	●					●		●														●	●			●			●					●	
TPG500 cement pump / cementing	●	●	●								●														●	●			●								●	
TPG500 utilities operation (sewage, fire water / testing, potable water)	●	●			●	●																															●	
TPG500 power generation	●																																					
TPG500 cooling water uptake and discharge	●	●			●	●			●																													

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	TPG500 drainage		●			●																																	
	TPG500 corrosion protection		●	●					●					●	●	●																							
	Helicopter operations	●									●	●										●							●	●								●	
	Vessel supply and back load (including waste transfer)	●	●							●		●														●	●			●					●				
	Presence of TPG500 facility offshore		●	●		●	●	●	●	●	●															●	●			●				●		●			
Potential Accidental Events	Loss of facilities during transfer to offshore location	●	●	●				●	●																	●	●							●	●	●			●
	Vessel collision (resulting in a spill)	●	●	●		●	●	●	●	●	●	●	●							●		●	●			●	●		●					●					●

RECEPTORS / ACTIVITY	Marine										Coastal / Terrestrial													Socio-Economic											Other			
	Physical				Biological						Physical								Biological																			
	Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Encounter shallow gas during drilling TPG500 or Istiglal	●	●	●																																			
Blow-out at well-head during drilling operations TPG500 or Istiglal	●	●	●		●	●	●	●	●	●	●	●							●		●	●			●	●							●		●	●		●
TPG500 venting (planned non-routine)	●																																					
Loss of NWBM over-board from TPG500 or Istiglal		●	●		●	●		●																														●
Loss of condensate over-board from TPG500	●	●	●		●	●													●																			●
Chemical spill at/from TPG500 or Istiglal	●	●			●	●																																●
Loss of fuel inventory (diesel spill) or spill during fuel transfer	●	●			●	●				●									●																			●

RECEPTORS / ACTIVITY	Marine										Coastal / Terrestrial													Socio-Economic											Other			
	Physical				Biological						Physical								Biological																			
	Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Loss of containment (fire, explosion) TPG500 or Istiglal	●	●	●		●	●	●	●		●									●						●	●									●			●
Earthquake/other tectonic event resulting in loss of offshore facilities	●	●	●	●	●	●	●	●		●									●						●	●							●		●	●		●

Table 9.3 Environmental and socio-economic aspects – subsea pipelines

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oils and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Pipe lay-down area in Azerbaijan	Transportation to / from lay-down area					●	●			●	●	●										●							●	●					●			●	
	Lay-down area facilities/services/utilities operations										●	●										●							●	●					●			●	
Installation onshore (landfall to Sangachal)	Onshore works preparation										●	●	●	●		●	●		●	●	●	●	●	●	●			●	●	●			●		●			●	
	Pipelines trench construction										●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●			●		●			●	
	Pipe-laying onshore										●	●		●		●				●	●	●	●	●				●	●	●			●		●			●	
	Pipeline crossings of existing onshore services											●																●	●	●	●		●		●			●	

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oils and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Installation Coastal / Nearshore	Site works preparation for beach pulls (onshore)	●									●	●	●	●		●	●		●	●	●	●	●	●	●	●		●	●	●					●			●	
	Construction of landfalls	●	●	●		●	●	●	●		●	●	●	●		●	●		●	●	●	●	●	●	●	●		●	●	●					●			●	
	Construction of finger piers	●	●	●		●	●	●	●	●	●	●	●	●		●	●		●	●		●	●	●	●	●		●	●	●					●			●	
	Construction of nearshore trenches	●	●	●		●	●	●	●	●	●	●	●					●								●				●					●			●	
	Pipe-laying in the nearshore (including vessel operations)	●	●	●		●	●	●	●	●	●	●	●													●	●		●	●					●			●	
Installation Offshore	Preparation for mud volcano crossing (offshore trenching)	●	●	●				●	●																	●	●			●					●			●	
	Pipe-laying (including vessel operations; anchor drag)	●	●	●		●	●	●	●	●																●	●			●					●			●	

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oils and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	Rectification of freespans (installation of grout bags)	●	●	●		●	●	●	●	●																●	●			●					●			●	
	Helicopter operations	●									●	●										●							●	●								●	
	Material and equipment supply (including vessel operations)	●	●	●		●	●			●		●														●	●			●					●			●	
Hook-up and Commissioning	Tie in of pipelines to TPG500	●	●	●		●	●			●																●	●											●	
	Diving operations (DSV on site)	●	●	●		●	●			●																●	●			●					●			●	
	Dewatering of pipelines																	●																					
Operations and Maintenance	Pipelines operation (presence)		●	●			●	●	●	●			●	●			●													●					●	●		●	

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oils and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	ROV check (including vessel operations)	●	●			●	●			●		●														●	●			●					●			●	
	Corrosion protection		●											●																●									
Potential Accidental Events	Vessel collision (resulting in a spill)	●	●	●		●	●	●		●	●	●	●									●	●			●	●		●								●		●
	Hydrate formation in pipelines	●										●																											
	Condensate pipeline leak (>100 but <1,000 tonnes)	●	●			●	●					●								●		●				●	●									●			●
	Gas pipeline leak	●	●			●	●					●								●		●				●	●									●			●
	Loss of entire pipeline(s) inventories	●	●	●		●	●	●	●	●	●	●	●			●				●		●				●	●									●			●

Table 9.4 Environmental and socio-economic aspects – terminal

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Civil Engineering and Construction and Commissioning	Land acquisition and tenure																											●	●		●	●							
	Ground clearance and grading - terminal site											●		●		●	●		●		●	●	●	●	●			●	●	●	●		●		●			●	
	Modification of existing services											●																●	●	●			●	●	●			●	
	Excavation of drainage channel; construction of bund wall and security dyke											●		●	●	●	●		●		●	●	●	●				●	●	●					●			●	
	Construction of fencing and perimeter lighting											●							●									●	●	●					●			●	
	Construction of access road and railway crossing											●		●		●	●		●	●	●	●	●	●				●	●	●			●		●			●	

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	Mobilisation of workforce											●																	●	●		●	●		●			●	
	Construction site facilities/services/utilities /operations											●																	●	●	●				●			●	
	Terminal construction (including underground, foundations, buildings)											●		●	●													●	●	●			●		●			●	
	Demobilisation											●																	●	●			●						
	Commissioning											●										●								●								●	
Operations and Maintenance	Process facilities (physical presence)											●							●			●	●	●						●					●	●		●	
	Produced water treatment, storage and disposal (injection)											●						●																					

RECEPTORS / ACTIVITY	Marine										Coastal / Terrestrial													Socio-Economic											Other			
	Physical				Biological						Physical								Biological																			
	Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Gas dehydration and conditioning (expansion and re-compression)											●																											
Condensate stabilisation											●																											
Flash gas recovery and compression											●																											
Condensate main tank storage											●																											
Chemical injection											●																											
Utilities operation (sewage, drainage fire water, potable water)											●																											
Power and heat generation											●																											

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	Fire system tests											●				●																							
Waste	Produced water (and hydrotest water) disposal via deep well injection onshore											●			●			●											●	●					●			●	
Potential Accidental Events	Planned non-routine flaring (auto ignition)											●										●							●										
	Flare failure to ignite											●																	●										●
	Loss of integrity of water disposal well														●			●											●					●					●
	Fire / explosion											●		●					●		●	●	●	●					●		●			●	●	●	●		●

RECEPTORS / ACTIVITY	Marine – Physical: Atmosphere	Marine – Physical: Seawater	Marine – Physical: Seabed	Marine – Physical: Subsurface Geology	Marine – Biological: Plankton	Marine – Biological: Fish	Marine – Biological: Marine Habitat / Flora	Marine – Biological: Benthos	Marine – Biological: Mammals (Caspian Seal)	Marine – Biological: Sea Birds
Loss of hydrocarbon storage inventory										
Earthquake resulting in loss of inventory										

RECEPTORS / ACTIVITY	Coastal / Terrestrial – Physical: Atmosphere	Coastal / Terrestrial – Physical: Coastline	Coastal / Terrestrial – Physical: Soil	Coastal / Terrestrial – Physical: Groundwater / Aquifers	Coastal / Terrestrial – Physical: Surface Water	Coastal / Terrestrial – Physical: Hydrological Systems	Coastal / Terrestrial – Physical: Subsurface Geology	Coastal / Terrestrial – Physical: Landscape / Topography	Coastal / Terrestrial – Biological: Coastal Habitat / Flora	Coastal / Terrestrial – Biological: Terrestrial Habitat / Flora	Coastal / Terrestrial – Biological: Terrestrial / Coastal Birds	Coastal / Terrestrial – Biological: Reptiles / Amphibians	Coastal / Terrestrial – Biological: Mammals
Loss of hydrocarbon storage inventory	●		●	●	●					●	●	●	●
Earthquake resulting in loss of inventory	●		●	●	●	●				●	●	●	●

RECEPTORS / ACTIVITY	Socio-Economic: Archaeology / Cultural Property	Socio-Economic: Fishing	Socio-Economic: Shipping	Socio-Economic: Land Use	Socio-Economic: Population in the vicinity of activity	Socio-Economic: National Employment Base	Socio-Economic: Utilities	Socio-Economic: Community Infrastructure	Socio-Economic: Transport	Socio-Economic: Oil and Gas Infrastructure	Socio-Economic: National Industrial Base
Loss of hydrocarbon storage inventory					●		●			●	●
Earthquake resulting in loss of inventory					●					●	

RECEPTORS / ACTIVITY	Other: Government Revenue	Other: Transboundary	Other: International Procurement	Other: Liability / Reputation
Loss of hydrocarbon storage inventory	●			●
Earthquake resulting in loss of inventory	●			●

Table 9.5 Environmental and socio-economic aspects – transport

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Transportation of modules and materials to Azerbaijan	Vessel operations and utilities	●	●	●			●					●														●	●		●	●			●		●	●		●	
	Rail Transport											●																	●	●			●			●		●	
	Road Freight											●																	●	●			●			●		●	
Accidental Events	Introduction of exotic marine organisms		●	●		●	●	●	●	●	●															●											●		●

10 Environmental Impact Assessment

10.1 Introduction

Chapter 3 discusses the approach and methodology developed for the impact assessment process. An environmental impact is defined as:

> *"Any change to the biophysical environment, positive or negative, that wholly or partially results from a project activity or associated process"*

ISO 14001: Environmental Management Systems - Specification with Guidance for Use (ISO, 1996)

Compliance with environmental legislation, regulations, standards and policies is considered within the environmental impact assessment.

The potential for an environmental impact exists where an environmental aspect has been identified (Chapter 9); that is, where a project activity has been determined to have the potential to interact with the biophysical environment. The significance of each aspect was then determined. Impacts can be either negative or positive.

The primary objectives of the impact assessment are to:

?? establish the significance of identified potential impacts that may occur as a result of a project activity being undertaken; and
?? differentiate between those impacts that are insignificant (i.e. can be sustained by natural systems) and those that are significant (i.e. cannot be sustained by natural systems).

Unacceptable impacts will require examination of alternative and/or additional mitigation measures above and beyond those already incorporated in the base design for the project/activity. It should be noted that there is also the potential for cumulative impacts to occur. These are discussed in Chapter 12.

As for environmental aspects (Chapter 9), environmental impacts have been identified and assessed for routine activities, non-routine but planned activities and potential accidental events under the three main project elements namely:

?? offshore development;
?? subsea pipelines; and
?? the onshore terminal.

As discussed in Chapter 3, the significance of an impact is identified by:

?? determining the environmental consequence of the activity;
?? determining the likelihood of occurrence of the activity; and
?? subsequently, calculating the product of these two parameters.

The consequence and likelihood of environmental impacts are further discussed below.

10.1.1 Consequence

Table 10.1 presents the criteria for the level of consequence of an impact. The level of consequence for each identified impact is determined by examining a number of factors relating to the activity including:

- ?? level of non-compliance with legislation, policy and/or adopted project standards;
- ?? community and stakeholder issues and concerns raised (Chapter 8); and
- ?? the ability of the natural environment to absorb the impact based on its natural dynamics and resilience.

Table 10.1 Categories and definition of consequence levels for natural environment impacts

Category	Ranking	Definition
Catastrophic	**5**	✍ Transboundary and/or national scale impact resulting in: ?? long term and profound change and/or damage to the natural environment and its ecological processes; and/or ?? increase in threat category for rare and endangered species of fauna and flora identified in national and global listings. ✍ Natural habitat restoration time greater than 10 years and requiring large-scale and long-term intervention. ✍ Breach of environmental regulations and/or company policy and/or greater than 200% exceedance of international, national, industry and/or operator standard for an emission parameter. ✍ Negative widespread national and international media coverage. ✍ Significant long-term financial loss.
Major	**4**	✍ Regional to national scale impact resulting in: ?? medium term change and/or damage to the natural environment and its ecological processes; ?? reduction in regional habitat and species diversity; and/or ?? direct loss of habitat for endemic, rare and endangered species of fauna and/or flora and for species' continued persistence and viability (i.e. availability of necessary resources) nationally and regionally (for species unable to disperse). ✍ Natural habitat restoration time 5 to 10 years and requiring substantial intervention. ✍ Breach of environmental regulations and company policy and/or 100% to 200% exceedance of international, national, industry and/or operator standard for an emission parameter. ✍ Sustained adverse national media attention. ✍ Significant medium term financial loss.

Category	Ranking	Definition
Moderate	**3**	✍ Local to regional scale impact resulting in: ?? short term change and/or damage to the natural environment and it ecological processes; ?? direct loss of habitat crucial for species' (including listed species) continued persistence and viability (i.e. availability of necessary resources) in the project area (for species unable to disperse); ?? introduction of exotic species of fauna and invasive floral species replacing resident 'natural communities' within the project area; and ?? environmental stress lowering reproductive rates of species within the project area. ✍ Natural restoration time 2 to 5 years and requiring intervention. ✍ Potential breach of environmental regulations and company policy and/or 50% to 100% exceedance of international, national, industry and/or operator standard for an emission parameter. ✍ Complaints from the public, authorities and possible local media attention. ✍ Medium term financial loss.
Minor	**2**	✍ Local scale impact resulting in: ?? short term change and/or damage to the local natural environment and its ecological processes; ?? short-term decrease in species diversity in selected biotopes/areas within the project area; and/or ?? increased mortality of fauna species due to direct impact from project activities. ✍ Natural restoration within 2 years requiring minimal or no intervention. ✍ 10% to 50% exceedance of international, national, industry and/or operator standard for an emission parameter. ✍ Public perception / concern. ✍ Short term financial loss.
Negligible	**1**	✍ Impact largely not discernable on a local scale being absorbed by the natural environment; areas adjacent to disturbed areas absorb exodus of species able to disperse. ✍ Restoration within 6 months without intervention. ✍ Up to 10% exceedance of international, national, industry and/or operator standard for an emission parameter. ✍ Public perception/concern. ✍ Minimal financial loss.
None	**0**	✍ Impact absorbed by local natural environment with no discernable effects. ✍ No restoration or intervention required. ✍ No exceedance of international, national, industry and/or operator standard for an emission parameter. ✍ No financial loss.

Category	Ranking	Definition
Positive	+	?? Activity has net positive and beneficial affect resulting in environmental improvement for example: ?? ecosystem health; ?? increase in magnitude or quality of habitat for rare and endangered species of fauna and flora as well as for those species known to naturally occur in the area; and ?? growth of 'naturally occurring' populations of flora and fauna. ?? Positive feedback from stakeholders. ?? Potential financial gains.

10.1.2 Likelihood

Likelihood in this assessment is the likelihood of an activity occurring. Table 10.2 presents the criteria for the level of likelihood of the occurrence of an activity. Probability can be determined using statistical methods where good historical data exists upon which to perform the analyses but in the case of the Stage 1 development, little data pertaining to the Caspian and broader Azerbaijani environments is available and hence a statistical approach could not be confidently adopted. For this impact assessment the likelihood of an activity occurring has been taken as "certain" (i.e. ranking level 5) for all planned activities.

Table 10.2 Likelihood categories and rankings

Category	Ranking	Definition
Certain	5	The activity will occur under normal operating conditions.
Very Likely	4	The activity is very likely to occur under normal operational conditions.
Likely	3	The activity is likely to occur at some time under normal operating conditions.
Unlikely	2	The activity is unlikely to but may occur at some time under normal operating conditions.
Very Unlikely	1	The activity is very unlikely to occur under normal operating conditions but may occur in exceptional circumstances.

10.1.3 Significance

As discussed in Section 3.6.4, the significance of an impact is determined by calculating the product of an environmental aspect's consequence and likelihood of occurrence. The possible significance rankings are presented in Table 10.3 below.

Table 10.3 Environmental impact significance rankings

Ranking (Consequence x Likelihood)	Significance
>16	Critical
9-16	High
6-8	Medium
2-5	Low
<2	Negligible

As discussed in Chapter 3, impacts that have been determined to have a significance ranking of ">9" are considered to be significant and hence require examination in terms of alternative and/or required additional mitigation to reduce the level of the potential impact. Approaches and techniques for mitigation are discussed in Environmental Mitigation, Management and Monitoring (Chapter 14).

An environmental receptor might be impacted by more than one project activity. Where this has been found to be the case, the higher impact significance ranking is taken as the significance ranking for the subject receptor.

It should be noted that it is often difficult to compare environmental impacts consistently across different natural and socio-economic environments. In evaluating the environmental and socio-economic aspects, emphasis is placed on specific cause and effect relationships.

Scientific evidence as well as predictions based on observation of previous similar activities can and have been used in the impact assessment process. Where it has not been possible to fully quantify the effect that an activity may have on the environment or a component of the environment, or where there is a lack of scientific knowledge, qualitative judgment can and has been used. Such judgments have been based on a full understanding of the proposed development, the impact assessment team's extensive experience in assessing oil and gas production activities and the team's knowledge of the environment of the region in which the project's activities will occur. In addition, the inter-connectedness of various environmental or socio-economic receptors has also been considered in the assessment of impacts. In this way, it has been assured that systemic nature of both natural and socio-economic environments has been considered.

10.2 Impact assessment results

10.2.1 Impact assessment tables

Tables 10.4 through 10.8 present the full results of the impact assessment as follows:

?? Table 10.4: Environmental impact significance – offshore;
?? Table 10.5: Environmental impact significance – subsea pipelines;
?? Table 10.6: Environmental impact significance – terminal; and
?? Table 10.7: Environmental impact significance – transportation.

In the tables, project activities and potential accidental events are listed down the left-hand column (i.e. as rows) and environmental receptors are listed as columns in two main groups namely, marine and terrestrial.

The environmental impact assessment has addressed all the environmental aspects identified in Chapter 9 and has been completed using the approach and methodology presented in Chapter 3 and summarised above. Socio-economic impacts are addressed in Chapter 11.

Table 10.4 Environmental impact significance – offshore

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial												
		Physical				Biological						Physical								Biological				
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
Fabrication, Construction and Assembly in Azerbaijan	TPG500 (existing) assembly yard upgrade and preparation	5	5								5	5		5		5	5		5		5	5	5	5
	Mobilisation of TPG500 assembly workforce											5												
	TPG500 assembly yard facilities, services and utilities operations										5	5				5						5		
	TPG500 assembly yard power generation										5	5										5		
	Assembly of TPG500 (hull; legs)										5	5										5		
	Construction of drilling template										5	5										5		
	Testing and commissioning of assembled TPG500 at assembly yard	5									5	5										5		
Istiglal MODU Installation and Drilling	Mobilisation of the Istiglal (including vessel operations)	5	5	5		5	5	5	5	5	5	5										5		
	Positioning and anchoring of Istiglal	5	5	5		5	5	5	5	5	5	5												

RECEPTORS / ACTIVITY	Marine										Coastal / Terrestrial												
	Physical				Biological						Physical								Biological				
	Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
Float-out, positioning and installation of drilling template (including vessel operations)	5	5	5		5	5	5	5	5	5	5												
Istiglal drilling surface (28”) section; discharge cuttings and drilling fluids/WBM to seabed	5	5	5	5	5	5	5	5	5														
Istiglal drilling of lower-hole sections; cuttings transfer and ship-to-shore	5	5	5	5					5		5												
Cement pump / cementing	5	5	5																				
Istiglal utilities operation (sewage, drainage fire water, potable water)	5	5			5	5																	
Istiglal power generation	5																						
Istiglal cooling water uptake and discharge	5	5			5	5			5														
MODU #3 DST fluid disposal to flare (if required)	5	5			5	5			5	5													
Helicopter operations	5									5	5										5		
Vessel supply and back load (including waste transfer)	5	5								5	5										5		

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial												
		Physical				Biological						Physical								Biological				
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
	Presence of Istiglal offshore		5	5		5	5	5	5	5	5													
TPG500 Drilling and Production	TPG500 float-out and positioning (including vessel operations)	5	5	5		5	5	5	5	5		5												
	TPG500 seabed fluidisation for suction anchors and jack-up (including vessel operations)	5	5	5		5	5	5	5	5														
	TPG500 / pipeline tie -in and commissioning (including vessel operations)	5	5	5		5	5	5	5	5														
	TPG500 well commissioning	5	5																					
	TPG500 drilling of surface (28") section; discharge drilling fluids (WBM) and cuttings	5	5	5	5	5	5	5	5	5														
	TPG500 drilling of lower hole sections; cuttings transfer and ship-to-shore	5	5	5	5					5		5												
	TPG500 cement pump / cementing	5	5	5								5												
	TPG500 utilities operation (sewage, fire water / testing, potable water)	5	5			5	5																	
	TPG500 power generation	5																						

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial												
		Physical				Biological						Physical								Biological				
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
	TPG500 cooling water uptake and discharge	5	5			5	5			5														
	TPG500 drainage		5			5																		
	TPG500 corrosion protection		5	5					5					5	5	5								
	Helicopter operations	5									5	5										5		
	Vessel supply and back load (including waste transfer)	5	5							5		5												
	Presence of TPG500 facility offshore		5	5		5	5	5	5	5	5													
Potential Accidental Events	Loss of facilities during transfer to offshore location	2	2	3				3	3															
	Vessel collision (resulting in a spill)	4	4	4		4	4	4	4	4	4	4	4							4		4	4	
	Encounter shallow gas during drilling TPG500 or Istiglal	3	3	3																				
	Blow-out at well-head during drilling operations TPG500 or Istiglal	6	6	6		8	8	8	6	2	6	4								10		6	6	

RECEPTORS / ACTIVITY	Marine										Coastal / Terrestrial												
	Physical				Biological						Physical								Biological				
	Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
TPG500 venting (planned non-routine)	5																						
Loss of NWBM over-board from TPG500 or Istiglal		2	2		2	2		2															
Loss of condensate over-board from TPG500	2	2	2		2	2													2				
Chemical spill at/from TPG500 or Istiglal	2	2			2	2																	
Loss of fuel inventory (diesel spill) or spill during fuel transfer	4	4			4	4				4									4				
Loss of containment (fire, explosion) TPG500 or Istiglal	4	4	3		3	3	2	2		2									3				
Earthquake/other tectonic event resulting in loss of offshore facilities	4	4	4	4	4	4	4	4		4									3				

Table 10.5 Environmental impact significance – subsea pipelines

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial												
		Physical				Biological						Physical								Biological				
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
Pipe lay-down area in Azerbaijan	Transportation to / from lay-down area					5	5			5	5	5										5		
	Lay-down area facilities/services/utilities operations										5	5										5		
Installation onshore (landfall to Sangachal)	Onshore works preparation										5	5	5	5		5	5		5	5	5	5	5	5
	Pipelines trench construction										5	5	5	5	5	5	5	5	5	10	10	5	15	5
	Pipe-laying onshore										5	5		5		5				5	5	5	5	5
	Pipeline crossings of existing onshore services											5												
Installation Coastal / Nearshore	Site works preparation for beach pulls (onshore)	5									5	5	5	5		5	5		5	5	5	5	5	5
	Construction of landfalls	5	5	5		5	5	5	5		5	5	10	5		5	5		5	5	5	5	5	5
	Construction of finger piers	5	5	5		5	5	10	10	5	5	5	10	5		5	5		5	5		5	5	5

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial												
		Physical				Biological						Physical								Biological				
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
	Construction of nearshore trenches	5	5	10		5	5	10	10	5	5	5	5					5						
	Pipe-laying in the nearshore (including vessel operations)	5	5	5		5	5	5	5	5	5	5	5											
Installation Offshore	Preparation for mud volcano crossing (offshore trenching)	5	5	5				5	5															
Installation Offshore	Pipe-laying (including vessel operations; anchor drag)	5	5	5		5	5	5	5	5														
Installation Offshore	Rectification of freespans (installation of grout bags)	5	5	5		5	5	5	5	5														
Installation Offshore	Helicopter operations	5									5	5										5		
Installation Offshore	Material and equipment supply (including vessel operations)	5	5	5		5	5			5		5												
Hook-up and Commissioning	Tie in of pipelines to TPG500	5	5	5		5	5			5														
Hook-up and Commissioning	Diving operations (DSV on site)	5	5	5		5	5			5														
Hook-up and Commissioning	Dewatering of pipelines																	5						

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial												
		Physical				Biological						Physical								Biological				
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
Operations and Maintenance	Pipelines operation (presence)		5	5			5	5	5	5			5	5										
	ROV check (including vessel operations)	5	5			5	5			5		5												
	Corrosion protection		5											5										
Potential Accidental Events	Vessel collision (resulting in a spill)	4	4	4		4	4	4		4	4	4	4									4	4	
	Hydrate formation in pipelines	3										3												
	Condensate pipeline leak (>100 but <1,000 tonnes)	4	6			6	6					2								4		2		
	Gas pipeline leak	4	4			4	4					4								2		2		
	Loss of entire pipeline(s) inventories	3	3	2		3	3	3	3	3	3	3	3			3				3		3		

Table 10.6 Environmental impact significance – onshore terminal

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial												
		Physical				Biological						Physical								Biological				
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
Civil Engineering and Construction and Commissioning	Land acquisition and tenure																							
	Ground clearance and grading - terminal site											5		10		5	5		5		15	10	15	5
	Modification of existing services											5												
	Excavation of drainage channel; construction of bund wall and security dyke											5		10	5	10	10		5		10	5	5	5
	Construction of fencing and perimeter lighting											5							5					
	Construction of access road and railway crossing											5		5		5	5		5	5	10	5	5	5
	Mobilisation of workforce											5												
	Construction site facilities/services/utilities/operations											5												

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial												
		Physical				Biological						Physical								Biological				
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
	Power generation											5												
	Terminal construction (including underground, foundations, buildings)											5		5	5									
	Demobilisation											5												
	Commissioning											5										5		
Operations and Maintenance	Process facilities (physical presence)											5							5			5	5	5
	Produced water treatment, storage and disposal (injection)											5						5						
	Gas dehydration and conditioning (expansion and re-compression)											5												
	Condensate stabilisation											5												
	Flash gas recovery and compression											5												

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial												
		Physical				Biological						Physical								Biological				
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
	Condensate main tank storage											5												
	Off-spec condensate storage											5												
	MEG regeneration and storage (as required)											5												
	Chemical injection											5												
	Utilities operation (sewage, drainage fire water, potable water)											5												
	Power and heat generation											10												
	Fire system tests											5				5								
Waste	Produced water (and hydrotest water) disposal via deep well injection onshore											5			5			5						
Potential Accidental Events	Unplanned non-routine flaring (auto ignition)											5										5		

RECEPTORS / ACTIVITY	Marine										Coastal / Terrestrial												
	Physical				Biological						Physical								Biological				
	Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
Flare failure to ignite											4												
Loss of integrity of water disposal well														4			4						
Fire / explosion											3		3					2		3	3	3	2
Loss of hydrocarbon storage inventory											4		6	6	6					4	4	4	4
Earthquake resulting in loss of inventory											6		4	4	4	6				6	6	6	6

Table 10.7 Environmental impact significance – transportation

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial												
		Physical				Biological						Physical								Biological				
		Atmosphere	Seawater	Seabed	Subsurface Geology	Plankton	Fish	Marine Habitat / Flora	Benthos	Mammals (Caspian Seal)	Sea Birds	Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
Transportation of modules and materials to Azerbaijan	Vessel operations and utilities	5	5	5			5					5												
	Rail Transport											5												
	Road Freight											5												
Accidental Events	Introduction of exotic marine organisms		2	3		3	5	5	5	3														

10.2.2 Summary of impact assessment results

Shah Deniz Stage 1 development activities have been assessed as having the potential to cause 21 impacts of "high" significance on 10 different environmental receptors. The impacts result from seven planned routine activities and one accidental event. These are summarised in Table 10.8. It is noted that no impacts have been assessed to be of "critical" significance.

Table 10.8 Summary of "high" significance impacts

Activity Group	"High" Significance Impacts	Environmental Receptors	Contributing Activities
Offshore:	1	1	1 accidental event
Subsea Pipelines:	10	7	4 planned routine
Terminal:	10	7	4 planned routine
Transportation:	0	0	0

10.2.3 Structure of impact assessment chapter and discussion

Identified environmental impacts are discussed in Sections 10.3 through 10.6. The discussion focuses on those impacts that have been determined to be significant. As noted above (Section 10.1.3), impacts that have been identified as being of "high" or greater significance will require mitigation additional to that incorporated in the project's base case design. Recommended additional mitigation measures are presented in the Environmental Mitigation, Monitoring and Management (Chapter 14).

The environmental assessment discussion is receptor based; that is, identified receptors (Tables 10.4 through 10.7) are discussed in terms of the impacts they may sustain as a result of project activities. Figure 10.1 illustrates the structure of the impact assessment discussion as presented in this Chapter.

Figure 10.1 Structure of environmental impact assessment discussion

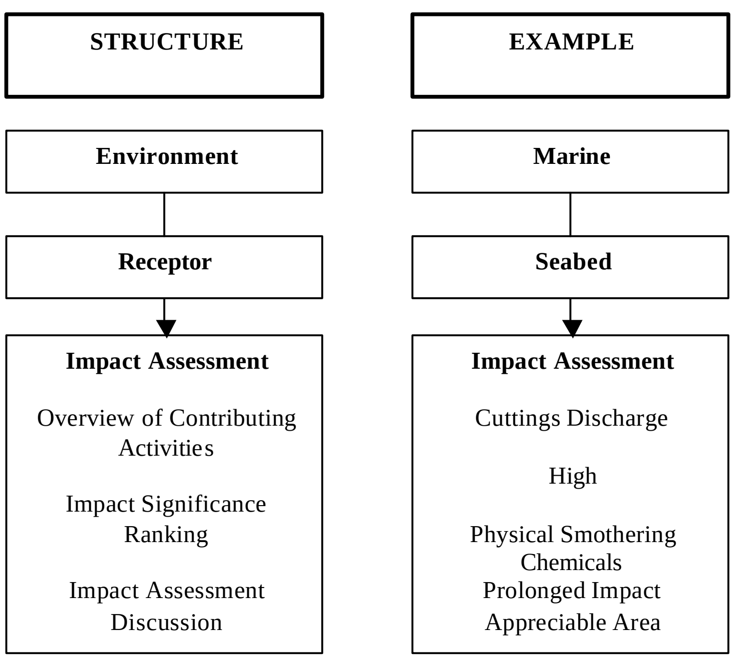
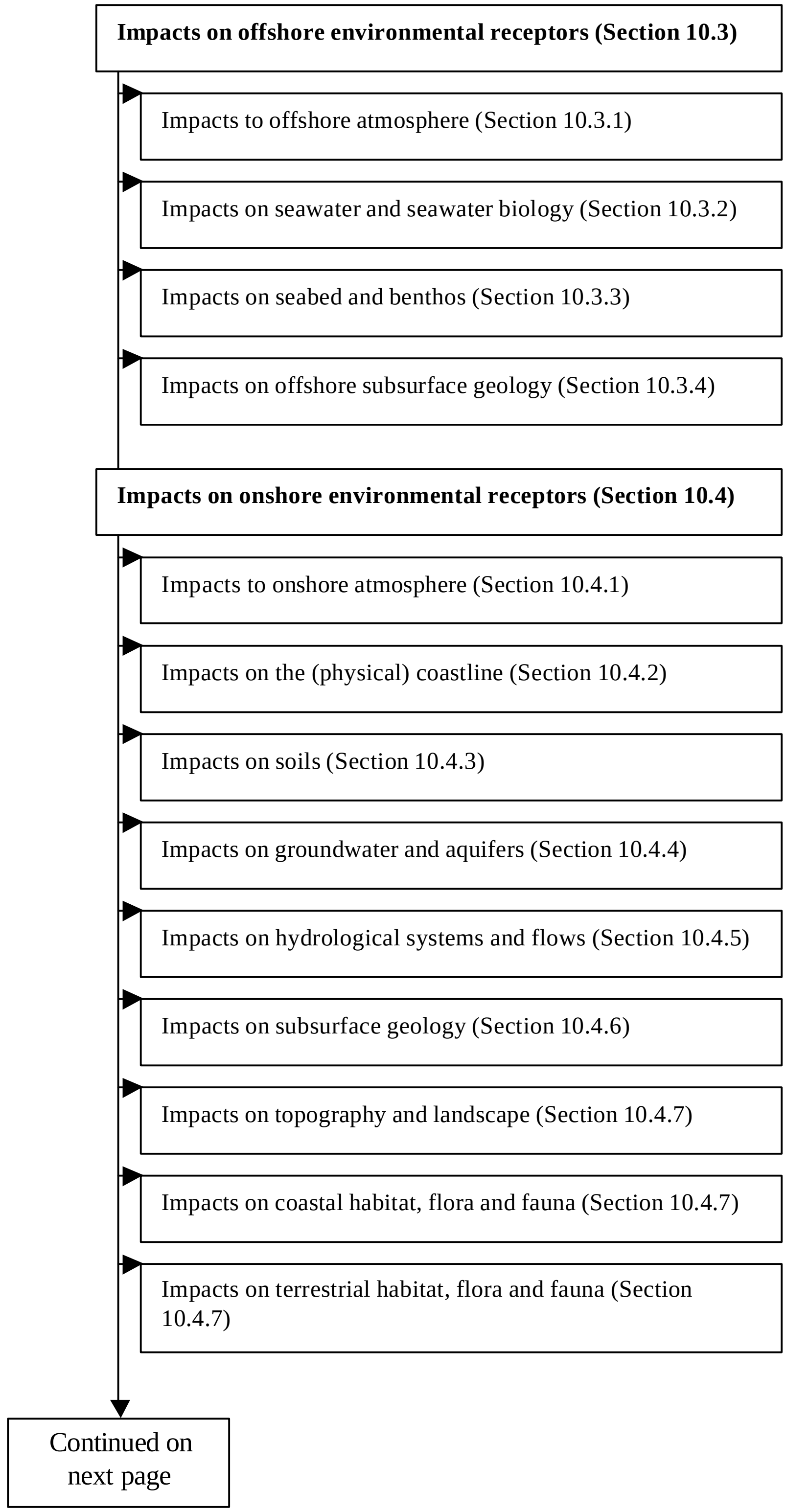
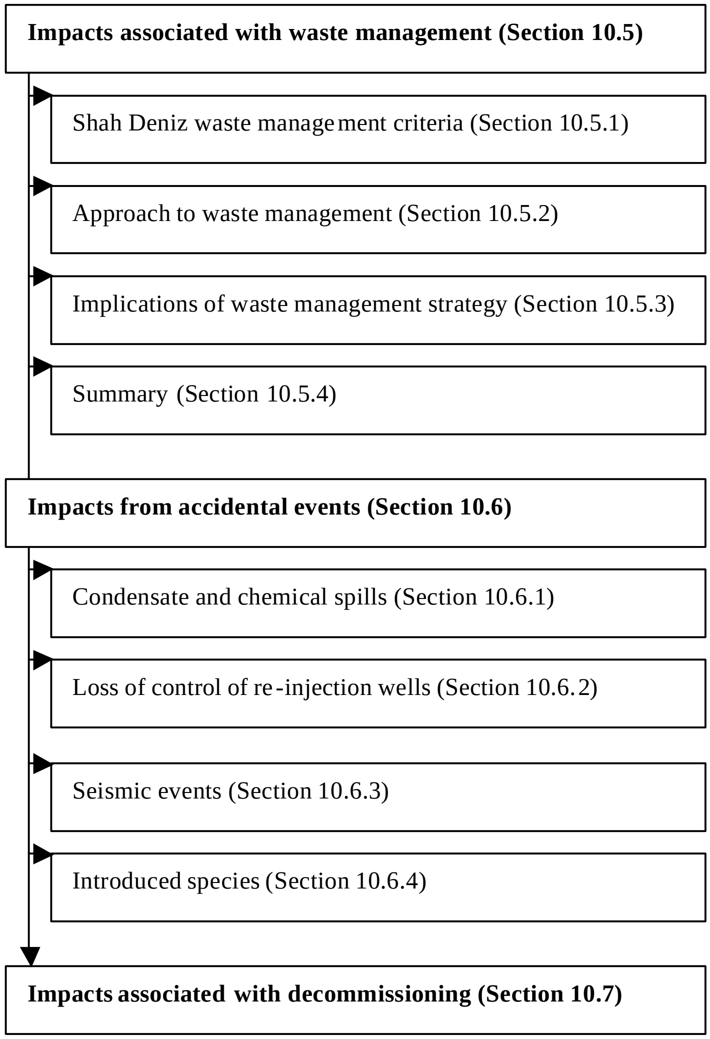


Figure 10.2 illustrates the structure of this Chapter.

Figure 10.2 Structure of environmental impact assessment chapter





10.3 Impacts on offshore environmental receptors

This section presents a discussion on potential impacts to offshore environmental receptors that would occur as a result of Shah Deniz Stage 1 development activities. The offshore environment includes the nearshore zone in which subsea pipelines installation activities would be undertaken. The following sections are presented:

?? impacts on the offshore atmosphere;
?? impacts on seawater and seawater biology;
?? impacts on the seabed and benthos;
?? impacts on hydrological systems and flows (associated with pipeline installation); and
?? impacts on offshore subsurface geology.

10.3.1 Impacts on offshore atmosphere

A number of Stage 1 project activities will generate atmospheric emissions. Principal contributing activities include:

?? transportation of project equipment and materials into Azerbaijan;
?? Istiglal MODU installation and drilling operations;

?? TPG500 installation and drilling and production operations; and
?? installation of the subsea pipelines offshore.

Atmospheric emissions from these activities comprise carbon dioxide (CO_2), methane (CH_4), oxides of nitrogen (NO_X), carbon monoxide (CO), oxides of sulphur (SO_X) and volatile organic compounds (VOCs). Operational noise emissions are discussed below in Section 10.3.1.6 and 10.3.2.1.

Public attention on atmospheric pollution has increased in recent years with concerns being focussed on local and regional pollution (i.e. human health issues) and global warming. It has been generally acknowledged that emissions of the so-called "greenhouse gases" (primarily CO_2 and CH_4) in excessive quantities contributes to global warming with the potential for consequent climate change. At an international level, efforts are being made to get individual countries to reduce their emissions of these greenhouse gas species. This effort is embodied in the recent Kyoto Agreement.

Potential environmental and human health effects of atmospheric emissions including greenhouse gases that would be generated by Stage 1 activities are presented in Table 10.9.

Table 10.9 Environmental and human health effects of atmospheric releases

Emission Species	Human Health / Environmental Impact
Carbon dioxide (CO_2)	A greenhouse gas that contributes to climate change.
Methane (CH_4)	Contributes indirectly to climate change by enhancing low-level ozone production. Poisonous at high concentrations and can potentially enhance photochemical smog formation.
Carbon monoxide (CO)	Contributes indirectly to climate change by enhancing low-level ozone production. Highly toxic to human health at concentrations of several percent (by volume) and can augment photochemical smog formation
Oxides of nitrogen (NO_X, including predominantly NO and NO_2)	NO_2 is a toxic gas, even at relatively low concentrations. NO_X also contributes to the formation of acidic species that can be deposited by wet and dry processes. Acidic species may impact both freshwater and terrestrial ecosystems. NO_X can also augment the formation of ozone at ground level when mixed with VOCs in a sunlit atmosphere. NO is a relatively innocuous species but is of interest as a pre-cursor to NO_2.
Sulphur dioxide (SO_2)	SO_2 is a toxic gas, and is known to contribute to acid deposition (wet and dry). This acid deposition may impact both freshwater and terrestrial ecosystems as well as buildings. Direct health effects potentially causing respiratory illness.
Volatile organic compounds (VOC)	Non-methane VOCs associated with the proposed development are anticipated to be predominately hydrocarbons, which play an important role in the formation of 'photochemical oxidants', such as tropospheric ozone. Many are also known or suspected carcinogens.

The following sections present assessments of the potential local environmental and human health effects of atmospheric emissions generated by the specific project activities listed above.

10.3.1.1 Transportation activities

Emissions to the atmosphere would be released during the transportation of equipment and materials into Azerbaijan. Likely transport routes and methods are discussed in the Project Description (Chapter 5; Sections 5.6.2 and 5.6.3). The emissions would principally result from vessel power generation and vehicle (road and rail) exhaust. Sources would be mobile and the overall period of release, relatively short.

Impact Significance

At the time of writing this ES, final details regarding the proposed transportation methods, routes and total number of trips for the importation of project equipment and materials were not available. As such, it is not possible to quantify the atmospheric emissions that would be generated during these activities. As stated above however, emission sources during transportation would be mobile and the duration of the activities relatively short. As such, emissions would be limited and readily dispersed over a wide geographic area and therefore, the significance of impacts on the air quality are considered to be "low" as follows:

Likelihood of occurrence = 5 - certain to occur. Consequence = 1 - impact largely not discernible on a local scale. Significance = 5 - low.

10.3.1.2 MODU installation and drilling programme

As discussed in the Project Description (Chapter 5; Section 5.2) it is proposed to drill three wells at the E2 location using the Istiglal MODU prior to installation of the fixed TPG500 facility. Emissions to atmosphere would be generated as a result of:

?? vessel engine exhausts during transfer of the Istiglal to the drilling site;
?? power generation exhausts from the Istiglal during drilling activities;
?? support and supply vessel engine and power generation exhausts during drilling activities;
?? helicopter exhaust emissions during the transport of personnel to and from the shore during drilling activities;
?? flaring of hydrocarbon product during well clean-up operations and potentially, during a drill stem test (DST) should it be decided that one is required (see below); and
?? fugitive emissions from MODU and vessel facilities such as fuel storage tanks and bulk materials transfer operations.

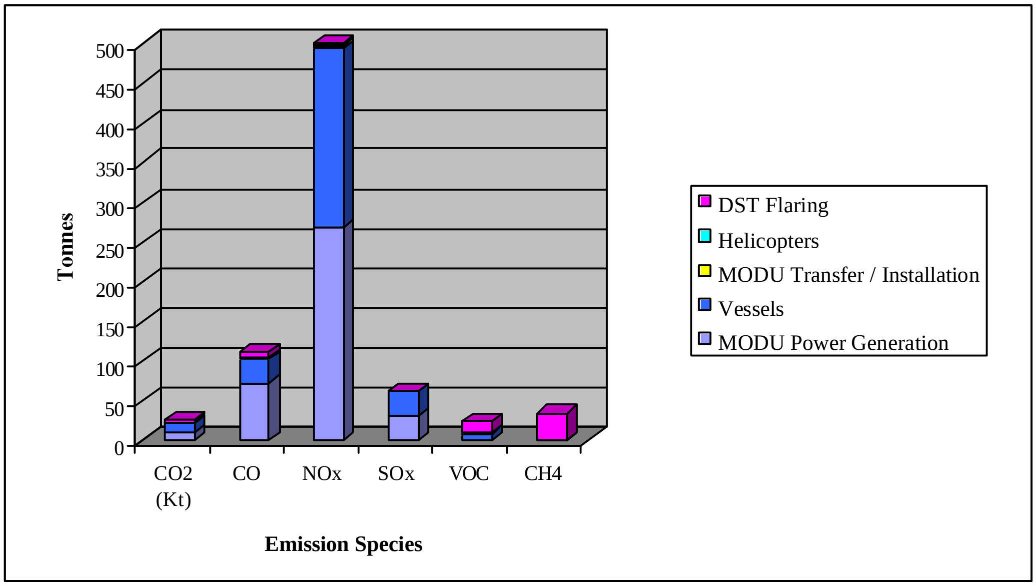
Transfer of the Istiglal MODU would take four days and would require two vessels. Emissions resulting from this activity would be very small, would be released over a wide geographic area and would be readily dispersed.

MODU power generation and support and supply vessel exhaust emissions would be the main sources of atmospheric emissions during the MODU drilling programme and these would remain relatively constant throughout the programme.

A drill stem test (DST) may be completed during the MODU drilling programme should drilling continue into a deeper reservoir and then, only if a discovery is made and testing is deemed appropriate. It is anticipated that one DST only would be completed on the third MODU well. In the event that a DST is completed, hydrocarbon product would be flared at a rate of 100 MMscfd for a maximum period of 12 hours (i.e. total 50 MMscf).

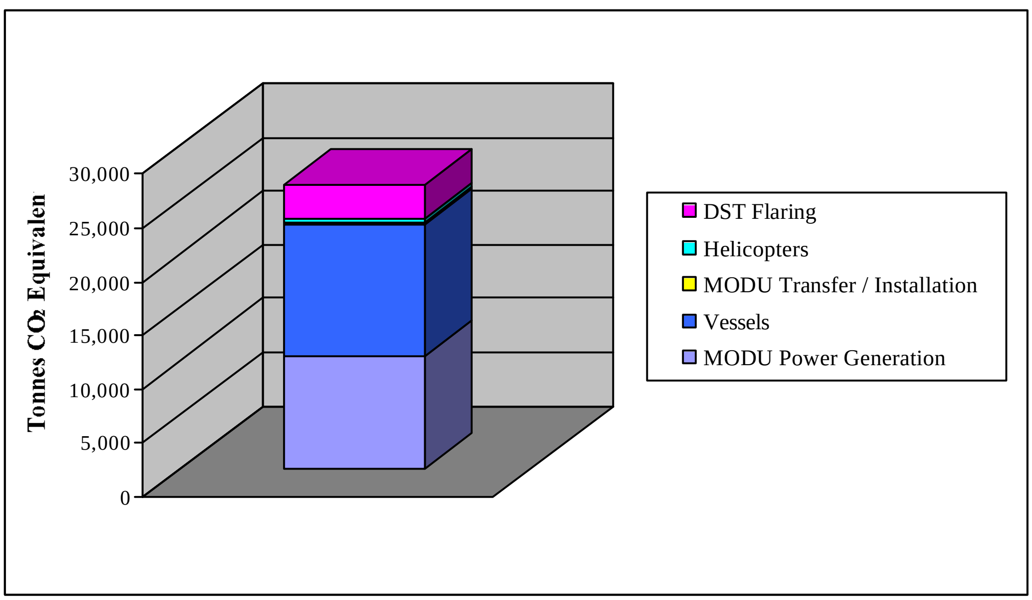
Figure 10.3 presents the combined emissions estimates for the MODU installation and drilling programme including one DST. Figure 10.4 presents the total GHG emissions (CO_2 and CH_4) for the same suite of activities.

Figure 10.3 Estimated maximum atmospheric emissions by species during the MODU drilling programme including one DST



Note: Units of CO_2 emissions are kilotonnes.

Figure 10.4 Estimated maximum GHG emissions during the MODU drilling programme including one DST



Impact significance

The predominant emission species (excluding GHG) arising from MODU installation and drilling activities would be oxides of nitrogen, typical from the combustion of diesel fuel. As indicated in Table 10.9 above, while NO is a relatively innocuous species, it is of concern as a pre-cursor to NO_2, a toxic gas that contributes to the formation of acid species and the formation of ozone when mixed with VOC in a sunlit environment.

Apart from personnel onboard the Istiglal and support vessels, there would be no sensitive human receptors in the vicinity of the MODU drilling location that could be potentially adversely affected by atmospheric emissions. Wind and natural atmospheric circulation would be expected to readily disperse the small amount of emissions generated over the course of the MODU drilling programme and it is considered therefore, that there would be limited if any discernable impact on local (offshore) air quality and there would be no adverse effect on human health.

Similarly, marine fauna would not be expected to be adversely effected by the release of atmospheric emissions during the MODU drilling programme. Due to the elevated release point (i.e. several tens of meters above the sea surface) and effective dispersion of emission concentrations of emissions at the sea surface at the drilling site would be negligible.

Overall, the significance of impacts on local offshore air quality resulting from the release of emissions during the MODU installation and drilling programmes is considered to be "low" as follows:

Likelihood of occurrence = 5 - certain to occur.
Consequence = 1 - impact largely not discernible on a local scale.
Significance = 5 - low.

Adverse effects on human health and on marine fauna would not be anticipated.

CO_2 has a long residence time in the atmosphere and, being an acknowledged GHG, has potential global consequences. While an insignificant quantity on their own, the release of GHG (CO_2 and CH_4) during the MODU drilling programme would constitute a contribution to the Stage 1 project's overall GHG emissions. Project emissions of GHG is considered to be a transboundary issue and as is further discussed in Transboundary Impacts (Chapter 13).

10.3.1.3 TPG500 assembly

As discussed in the Project Description (Chapter 5; Section 5.3.2.3) the TPG500 will be transported into Azerbaijan in sections and assembled at a yard (to be selected) near Baku. Assembly is estimated to take 10 months.

The main emission species arising from TPG500 assembly would be oxides of nitrogen as is the case with MODU related activities and as would be expected from the combustion of diesel fuel. As noted in Table 10.9 and above, NO is of concern as it is a pre-cursor to NO_2 a toxic gas with human health and environmental implications.

Impact significance

The estimated quantity of atmospheric emissions released during the TPG500 assembly programme is not considered to be significant (e.g. approximately 200 t of NO_X over 10 months). Given this and the fact that emissions would be readily dispersed, the significance of impacts on local air quality is considered to be "negligible". Adverse effects on human health or on resident fauna would therefore, not be expected.

10.3.1.4 TPG500 float-out and installation

As discussed in the Project Description (Chapter 5; Section 5.3.3) the TPG500 will be floated-out to and installed at the E2 drilling location with the assistance of four support vessels (barges). Float-out and installation activities will be completed within approximately 10 days.

The key source of atmospheric emissions during float-out and installation would be exhaust emissions from the four support vessels. Power generation (2 MW) on the TPG500 during float-out would also result in the release of emissions. The main emission species would be oxides of nitrogen resulting from the combustion of diesel fuel.

Impact significance

The quantity of atmospheric emissions released during the TPG500 float-out would be very minor (i.e. approximately 50 t of NO_X over 10 days). Rapid and effective dispersion over a relatively wide geographic area (i.e. between the shoreline and E2 drilling site) would mean that these emissions would have a "negligible" impact on local air quality. Adverse effects on human health or on resident marine fauna along the transport route would therefore, not be expected.

10.3.1.5 TPG500 operations including well clean-up

TPG500 operations would include drilling and production. Drilling activities would be undertaken over the first three and a half years after installation of the facility. Thereafter, operations would be restricted to production operations. It is possible that some time after completion of drilling at the E2 site, the TPG500 may be used to drill the E3 site using "extended reach drilling" techniques if these are technically feasible.

The principal sources of atmospheric emissions on the TPG500 would include:

?? TPG500 power generation;
?? other diesel engines (emergency generator, platform cranes, etc);
?? support and supply vessels and helicopters exhaust emissions;
?? fugitive emissions; and
?? non-routine venting.

Power on the TPG500 will be supplied by four to five dual-fuel reciprocating engines running on natural gas although for the first three months, when gas fuel will not be available, the generators will be run on diesel. Power generation would be the main source of offshore atmospheric emissions over the life of the project.

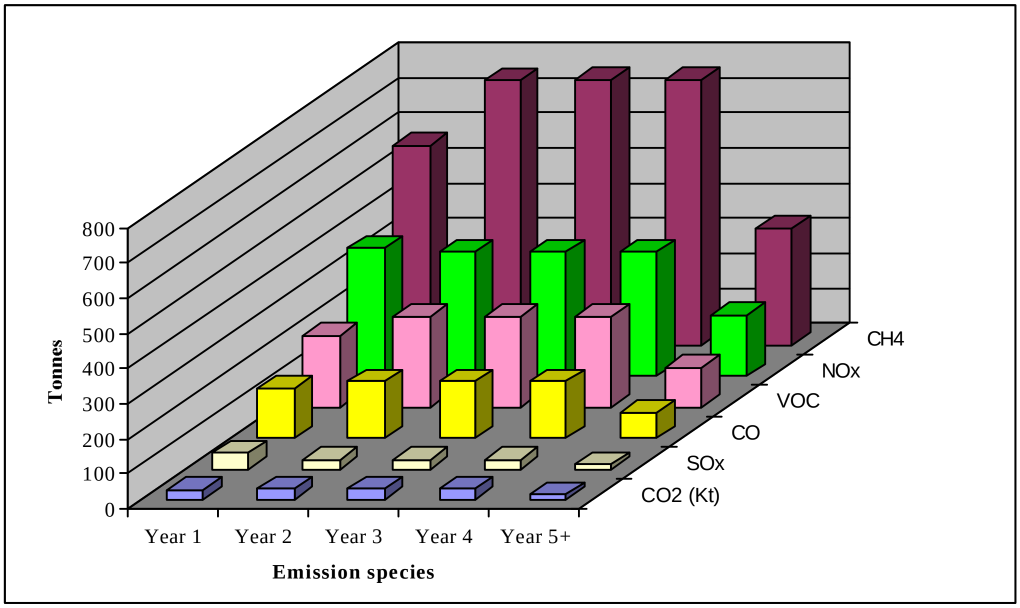
Combustion emissions from moving sources such as the support and supply vessels and helicopters would also contribute to the overall emissions to the atmosphere from the Stage 1 project. As with the MODU drilling programme, emissions from supply vessels and helicopters, although adding to the overall emission totals for the development would be transient in nature and would be readily dispersed over a wide geographic area. Combustion emissions from the support vessel are relatively low in comparison to full offshore Stage 1 operations.

Fugitive losses to the atmosphere of volatile hydrocarbons from process equipment connections represent a relatively minor source of emissions from the offshore facilities. Fugitive emissions would be controlled through the designation of appropriate specifications for storage tank seals, valves, flanges and seals during detailed engineering design. These design specifications would be incorporated during construction of the equipment.

Venting of gases on the TPG500 will occur during maintenance activities and during emergency shutdown conditions only. There will be no continuous venting on the platform. Other sources of vented emissions include condensate pig launching (20 depressurisation/year), gas pig launching (four depressurisation/year), three (maximum) depressurisations per year for the separator vessels and one gas depressurisation every five years for the production / test headers.

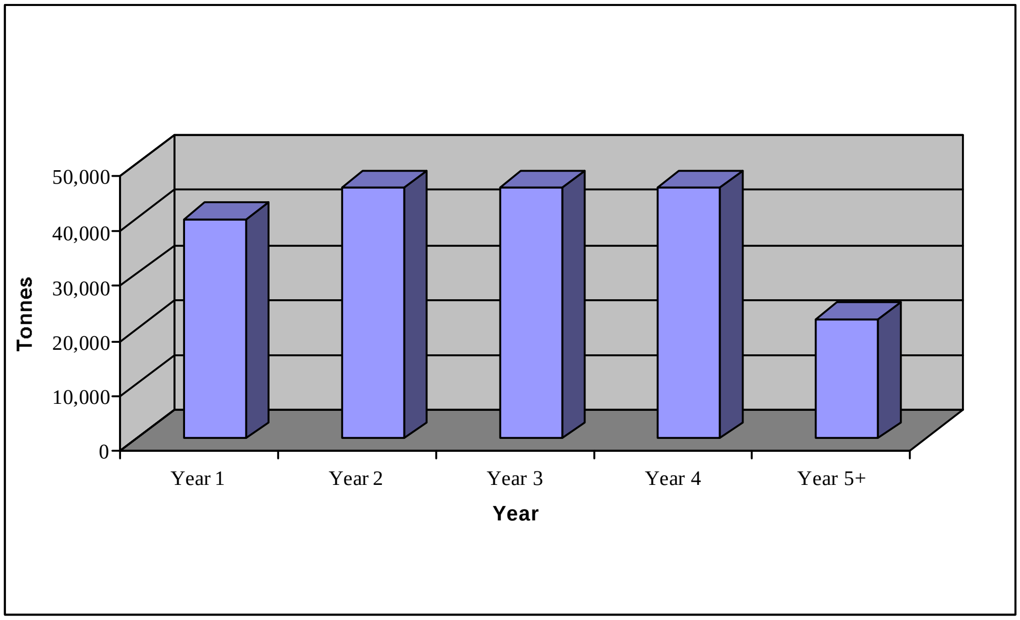
The estimated emission quantities by species during TPG500 operations are shown in Figure 10.5. Figure 10.60 illustrates the estimated total GHG emissions. Drilling and production activities would occur during years one to four and thereafter, only production activities (including production processing, platform utilities operations, etc.). The main contributor to the atmospheric emissions would be power generation. Power requirements would be largest during the first four years when drilling activities are being undertaken and thereafter decreasing and remaining effectively constant.

Figure 10.5 Estimated atmospheric emissions by species during TPG500 operations



Note: Units of CO_2 emissions are kilotonnes.

Figure 10.6 Estimated GHG emissions during TPG500 operations



After the TPG 500 has been installed at the E2 location and the pre-drilled wells tied-back, it will be necessary to cleanup drilling debris from inside the wells to allow efficient production to occur. This requires that one or two wells be flowed to a temporary burner boom at a maximum flow-rate of 100 MMscfd (2.8 million m^3/day) for one day in order to avoid damaging the reservoir (e.g. restricted flow rates and excessive sand production). This will only be required for the first and possibly second well. A maximum of 5,800 bbls (i.e. ~920 m^3) of condensate could be flared together with 100 MMscfd of gas. Depending on the performance of the first well cleanup and the availability of commissioned process and pipeline equipment, hydrocarbons from subsequent well cleanups will be routed to the process to prevent the generation of atmospheric emissions as a result of flaring. The volumes of emissions per well clean-up have been estimated (Chapter 5; Section 5.3.4.1) and are small. While larger than for some other activities, GHG emissions from well clean-up are also considered to be small at approximately 8,000tonnes CO_2 equivalent.

Impact significance

Significant polluting gases such as NO_X and SO_X have limited lifetimes in the atmosphere (1.5 days and 16 days respectively). Approximately 375 and 100 tonnes of NO_X and SO_X respectively would be released to the atmosphere annually during TPG500 drilling operations. The annual tonnage released during production operations would be approximately 50% less for both species.

A number of initiatives have been implemented in the design of the TPG500 that have resulted in a significant reduction of the amount of emissions that would be generated. Such initiatives include the export or use of all reservoir gas resulting in zero venting during normal operations and use of fuel gas for power generation in preference to diesel fuel.. The tonnages of species that would be released during TPG500 drilling and production operations are not considered to be significant and, with expected rapid dispersion, would not be expected to result in appreciable deterioration of local air quality. As such, adverse effects on human health are not anticipated.

Concentrations of emission species at sea level would also be expected to be very low and therefore, any marine fauna that may be in the vicinity of the TPG500 and support/supply vessels would not be expected to be adversely effected.

Impacts associated with atmospheric emissions released during TPG500 operations are considered to be of "low" significance in terms of adverse effects on the offshore atmosphere and sensitive receptors as follows:

Likelihood of occurrence = 5 - certain to occur.
Consequence = 1 - impact largely not discernible on a local scale.
Significance = 5 - low.

GHG (CO_2 and CH_4) emissions from the TPG500 are small but nonetheless constitute the major portion of the project's contribution of these releases to the offshore atmosphere. The release of GHG remains a concern to BP and total GHG releases throughout the life of the project will be monitored. This is further discussed in Transboundary Impacts (Chapter 13).

10.3.1.6 Airborne noise

Airborne noise would be generated during the Shah Deniz Stage 1 development as a result of:

?? support and supply vessel activity;
?? helicopter operations;
?? installation of the drilling template;
?? mobilisation, anchoring and installation of the Istiglal MODU and subsequently the TPG500;
?? Istiglal drilling activities;
?? TPG500 drilling and production operations (including power generation, gas compression and venting); and
?? installation of subsea and inter-field pipelines (including vessel operations).

Noise sources during the Stage 1 development would be both stationary and mobile.

Impact significance

Airborne noise may disturb birds (shorebirds and seabirds) and the Caspian Seal with resultant behavioural changes such as avoidance. The effects of noise could be expected to be more prevalent in coastal areas where vessel operations potentially would be closer to larger numbers of birds than are observed offshore although any piling operations undertaken during TPG500 installation may also have discernable effects on birds at sea.

Where surface noise is continuous (e.g. offshore installations), international experience suggests that birds and marine fauna (including seals) become accustomed to the noise and return to the area if avoidance was the initial response. There is also anecdotal evidence of this in the Caspian Sea insofar as sightings of the Caspian Seal and birds around the Chirag-1 platform have been noted. In the North Sea, many seabirds are seen around offshore installations and many actually stop to rest on offshore facilities. The number of birds and frequency with which they 'visit' the installations has prompted personnel to form ornithological clubs onboard offshore drilling and production platforms so that bird sightings and distributions around these installations can be recorded. This provides a valuable input to long-term environmental monitoring.

Based on the limited number of noise sources, the intermittent and transient nature of many of these sources and the generally low level of emitted noise, impacts on animals resulting from the range of Stage 1 offshore activities (including vessel operations in the nearshore area) are considered to be of "low" significance as follows:

Likelihood of occurrence = 5 - certain to occur.
Consequence = 1 - impact largely not discernible on a local scale.
Significance = 5 - low.

10.3.2 Impacts on seawater and seawater biology

A number of project activities have been assessed as having the potential to result in environmental impacts on seawater and seawater biology (i.e. plankton, fish, marine flora, marine mammals and seabirds). Impacts are associated with activities that would generate noise and would result in discharges to the water column.

10.3.2.1 Underwater noise

A number of Stage 1 activities would result in the generation of underwater noise. These principally include:

?? transport, support and supply vessel operations;
?? offshore installation operations in relation to:
  ?? the Istiglal;
  ?? the TPG500;
  ?? subsea and inter-field pipelines;
?? offshore drilling and production operations; and
?? operation of subsea and inter-field pipelines.

Underwater noise can cause direct and indirect effects on seabirds, fish and marine mammals. The data upon which to evaluate the significance of acoustic disturbance is however, limited primarily because of:

?? the complex behaviour of sound and pressure waves in water;
?? the restricted availability of the effects of noise on specific species and especially in regards to Caspian species; and
?? the effect that environmental conditions play on the behaviour of noise emissions.

Seabirds and especially those diving through or sitting on the surface of the sea in close proximity to the noise source may be disturbed. If disturbed, the typical response is avoidance. Similarly, the Caspian Seal being a highly mobile animal would be expected to avoid noise sources if they were found to be disturbing.

Fish are able to detect low-level noise at considerable distance (i.e. up to several kilometres away) from the source. As with birds and marine mammals, the typical response is avoidance. Continual high level noise may however, result in more pronounced changes to normal behavioural patterns and in extreme cases, could lead to pathological effects. The key threshold sound values for certain types of behavioural responses in and damage to fish are shown in Table 10.10.

Table 10.10 Key threshold values for response and certain types of damage to fish

Decibels	Response/damage levels
>230	Pathological damage
220	Startle response in fish
200	General repulsion of fish
180-160	Auditory damage to some fish Avoidance behavioural changes in fish

Source: McCauley, 1994.

Table 10.11 Sound sources from various maritime activities

	Frequency Range	Average Source Level	Estimated Received Level at Different Ranges (km) by Spherical Spreading			
Activity	**(kHz)**	**(dB/1 µPa/1 m)**	**0.1**	**1.0**	**10.0**	**100**
Low resolution sound:						
- explosives (TNT)	-	270	230	210	189	168
Drilling activity:						
- jack-up	0.005-1.2	85-127	45-87	25-67	4-46	<25
- semi-submersible	0.016-0.2	167-171	127-131	107-111	86-90	65-69
Drilling production:	0.25	163	123	103	82	61
Dredging:						
- gravel works	-	130	90	70	49	28
- suction dredge	0.38	160	120	100	79	58
Vessel activity:						
- 6 hp outboard small craft	0.8-20.0	105-130	65-90	45-70	24-49	<25
- 90 hp outboard speedboat	0.8-20.0	110-130	70-90	50-70	29-49	<25
- 240 hp inboard fishing boat	0.1-20.0	110-135	70-95	50-75	29-54	<25
- large merchant vessel	0.05-0.9	160-190	120-150	100-130	79-109	58-88
- supertanker	0.02-0.1	187-232	147-192	127-172	106-151	85-130
- oceanographic vessel	<0.1	170-230	130-190	110-170	89-149	68-128
- military vessel	-	190-203	150-163	130-143	109-122	88-101

Source: Evans and Nice, 1996.
Notes:
1 Beaufort Sea, Canada, early 1980's.
2 St George's Channel, Irish Sea, 1993.
* Actual measurements.
† Extrapolated.

From Table 10.10, it can be seen that avoidance behaviour in fish is induced at around 160 to 180 dB. Auditory damage can be incurred at 180 dB and more severe injuries, above 230 dB. The distance at which these thresholds are reached away from the sound source is dependant on operational and environmental parameters.

Table 10.11 lists the sound source levels and estimated sound levels at different distances from the source from various maritime activities. It can be seen from the table that the Shah Deniz activities (i.e. drilling; vessel operations) would produce noise levels typically less than 180dB and therefore, auditory damage to fish would not be expected.

Impact significance

Noise impacts on seawater biology are considered to be of "low" significance as follows:

Likelihood = 5 - certain to occur. Consequence = 1 - impact largely not discernable on a local scale. Significance = 5 - low.

Increased vessel activity

Marine animals in the Caspian Sea are accustomed to the noise generated from passing vessels and although the vessel activity along the shipping route between the shore and the offshore Stage 1 development would increase, it is expected that if animals initially displayed avoidance behaviour, they would eventually return once they become accustomed to the increased noise levels or once the noise source had moved or ceased.

A number of vessels would be on site during offshore facility and pipeline installation and commissioning activities. Again this would be expected to result in a degree of avoidance behaviour when activities are ongoing but that individuals would be expected to return once these relatively short-term activities have been completed.

Overall, impacts resulting from noise emissions from vessel activities are considered to be of "low" significance.

Offshore platform and pipeline installation

Noise emissions during TPG500 installation would primarily result from engine noise on the platform and the support vessels. There would be additional minor noise as the TPG500 legs were jacked-down to the seabed. None of these noise levels would be high and therefore, the significance of impacts on seawater biology would be "negligible".

Noise emissions associated with the installation subsea and inter-field pipelines would arise from pipeline laying operations including trenching activities in the nearshore. As the operation is a progressive one, the noise source would be mobile and hence the exposure time at any one location would be limited.

Overall impacts from noise generated by the offshore installation activities are considered to be "negligible" for those species that can readily move away from the noise source and due to limited total number of affected individuals, of "low" significance for those that cannot.

Drilling and production operations

Fish are known to congregate around offshore installations and it is considered that they become accustomed to predictable noise from sources such as stationary offshore sites and ships that follow a constant course (Norris & Reeves, 1978).

MODU drilling creates relatively lower noise levels than many large ships (Richardson *et al*, 1989) but levels (Table 10.15) may result in avoidance behaviour by some fish.

Underwater noise levels generated by drilling from the TPG500 would be similar to that emitted by the MODU Istiglal. Once commenced, production operations at the TPG500 would, for a period of approximately three and a half years, be concurrent with drilling activities on the facility. Underwater noise levels generated by combined platform drilling and production are anticipated to be similar to drilling alone as noise resulting from production activities (e.g. power generation) would primarily be generated on the platform topside and not underwater. It is considered that fish may avoid the platform during drilling operations due to slightly higher underwater noise levels but once drilling ceased, they would return. In fact, based on observations at offshore platforms around the world, fish may even favour the artificial reef environment created by the long terms presence of the TPG500. Impacts associated with noise emissions on this receptor are therefore, considered to be of "low" significance.

The Caspian seal is frequently observed close to the operational Chirag-1 platform indicating that they are largely undisturbed by drilling and production operations noise. Evidence of similar behaviour by marine mammals is available for other oil and gas production operations in other regions, where seals and dolphins are regularly observed close to offshore installations and around support vessels. Noise impacts on this receptor are therefore, considered to be of "negligible" significance.

Subsea pipelines can create low frequency noise and vibration emissions due to the flow of fluids inside them. Noise emissions may travel through the water column and disturb marine organisms and in particular, fish that typically have good low frequency hearing. While pipeline noise may be audible to fish, the sound pressure level (dB) would be significantly less in magnitude than that which would physically harm the species sensory organs (i.e. >230 dB; Table 10.10). At the most, it is considered that pipeline noise may cause some fish to display avoidance behaviour but, given the constant nature of the noise and the observed behavioural pattern of fish congregating around offshore installations, this behavioural response may not occur. The significance of noise impacts on this receptor is therefore, considered to be "negligible".

10.3.2.2 Aqueous discharges to sea

A number of project activities would result in the release of aqueous discharges to the sea. These are summarised in Table 10.12.

Table 10.12 Stage 1 activities resulting in aqueous discharges to sea

Activity	Discharges
Transportation vessels	Sewage, bilge waters, ballast waters
Installation and commissioning vessels (drilling rig, drilling template, TPG500, pipelines)	Sewage, bilge waters
Supply and support vessels	Sewage, bilge waters
Drilling	Sewage, bilge waters, drainage, food waste, WBM cuttings, cooling water including system filter backwash, potable water maker brine discharge and filter backwash/pressure relief, potable water maker off-specification bypass, seawater filter backwash, firewater pump test line and firewater pressure control lines, seawater pressure control line and helideck drains.
Production	Sewage, bilge waters, drainage, food waste, cooling water including system filter backwash, potable water maker brine discharge and filter backwash/pressure relief, potable water maker off-specification bypass, seawater filter backwash, firewater pump test line and firewater pressure control lines, seawater pressure control line and helideck drains.

Impact significance

Aqueous discharges from MODU and TPG500 float-out and installation activities (Sections 5.2.2.2 and 5.3.3.1) are very small especially when compared to later operational discharges. The total amounts are considered to be insignificant leading to no discernable adverse effect on the marine environment and therefore, are not discussed further.

The principal Stage 1 discharges of sewage, bilge water, drainage and food waste to sea would occur during drilling (MODU and TPG500) and production operations (TPG500) and during pipeline installation. Discharge volumes would be largest during the drilling phase of activity as this is when the most number of people would be on board the facilities. During production operations (i.e. approximately four years after installation), the number of people on board would reduce significantly with a proportionate significant reduction in discharge volumes.

Sewage discharges

Discharge of sewage effluent can result in localised organic enrichment in the vicinity of the discharge point. The level of organic enrichment that would be observed is dependent on the total volumes of effluent discharged and the degree of mixing and dispersion the discharge plume is subject to over a period of time. Greater and quicker mixing and dilution will minimise the likelihood of organic enrichment and hence impacts on the marine ecosystem close to the discharge point.

MODU drilling programme

The MODU drilling programme is planned to run for 425 days. During the programme up to 120 people will be on board the facility. It is estimated that approximately 12,000 m^3 of grey water and 6,000 m^3 of black water will be discharged to sea during the programme.

Sanitary wastes generated on the Istiglal will be treated to United States Coastguard Standards, using Type II IMO (International Maritime Organisation) certified equipment. Sanitary wastes, including all black (sewage) and grey water (water from shower and washing facilities) will be combined and processed in a treatment system which utilises an extended aeration process to produce a final effluent treated to a BOD (Biological Oxygen Demand) of less than 40 mg/l, suspended solids 40 mg/l and coliforms 200 MPN[1] per 100 ml prior to discharge. Chlorine levels in the discharge stream are checked on a weekly basis and recent results show that levels are in the order of 1.5 mg/l (i.e. 1.5 ppm).

The comparatively small amounts of treated effluent from the Istiglal (and associated vessels) would be expected to disperse readily and therefore, impacts associated with these discharges are considered to be of “low” significance. In addition, it is noted that the MODU drilling programme will only be of 426 days duration and therefore, the discharges will also be finite in duration.

TPG500 drilling and production programme

As discussed in Project Description (Section 5.3.7.9), the TPG500 sewerage treatment will include a customised treatment plant down-stream of the maceration unit. The system will be designed to meet US Coastguard Type II Marine Sanitation Device specifications. Discharges of sewerage waters will be via a submerged caisson and the discharge stream will have the following chemical parameters:

[1] MPN = Most Probable Number.

?? faecal coliform bacterial count of less than 200 per 100 ml;
?? suspended solids less than 150 mg/l; and
?? BOD_5 of 50mg/l.

The TPG500 drilling programme is planned to run for 980 days. During drilling (i.e. years one to four after installation) up to 110 people will be on board. Approximately 26,000 m3 of grey water and 11,000 m3 of black water will be discharged to sea.

The post-drilling Stage 1 TPG500 production operations are planned to continue to run until 2035. The number of people on board will decrease from 110 during drilling operations to approximately 18 during production operations. During well work-overs, the total number would increase to approximately 102 for short periods of time (Section 5.3.7.10). It is estimated that annually, approximately 6,500 m3 of grey water and 2,750 m3 of black water will be discharged during TPG500 production operations.

Marine dispersion modelling of the proposed sewerage discharge volumes and types has been completed. The purpose of modelling the discharge was to confirm the predicted ready dispersion of the sewage.

Table 10.13 shows the estimated quantities and properties of various constituents (BOD_5, suspended solids and total coliform) assumed to be within the sewage plume.

Table 10.13 Settings used to model the sewage plume from Shah Deniz

Discharge Parameter	**Value**
Discharge rate:	33 m^3/day
Discharge duration:	29 days
Duration of simulations:	29 days
Pipe diameter:	500 mm
Pipe orientation:	Vertical – facing down
Pipe release depth:	20 m below sea level
Sewage release amount:	957 m^3
Density of sewage:	1000 kg/m^3
Constituent	**Concentration**
BOD_5:	40 mg/L (1.32 kg/day)
Suspended solids:	50 mg/L (1.65 kg/day)
Total coliform:	200 counts/100ml (6.6 x 107/day)

The size of the suspended solids was based on Kiely (1995). The grain size, distribution and the equivalent fall velocity are presented in Table 10.14. Fall velocities for these Settling velocities were derived from empirical data provided by Dyer (1986).

Table 10.14 Particle size distribution of the suspended solids

Nominal Grain Size (mm)	Percentage of Total Mass	Fall Velocity (cm/sec)
0.1	10	0.8
0.08	5	0.5
0.07	20	0.4
0.06	30	0.3
0.04	25	0.13
0.02	10	0.03

Each constituent was modelled as a conservative tracer (no reaction or decay) constituting a "worst case" scenario. The density for both BOD_5 and total coliform were assumed to be equal to the treated sewage plume (1000 kg/m^3). BOD_5 was assumed to remain suspended within the water column (zero fall velocity) while total coliform was assumed to have a fall velocity of 1 m/day based on literature (Thomann and Mueller, 1987).

Predicted patchy concentrations of all three constituents resulted from oscillations in wind forcing and resulting oscillations in the water flowing past the discharge point. Some patches of water were dosed twice from the continuing discharge of materials. The highest concentrations for any time step were found in the vicinity of the discharge point (Table 10.15).

Table 10.15 Predicted concentrations for each of the constituents of sewage discharge during summer and winter

Constituent	Initial Concentration	Predicted Concentrations in the 12.5 m - 25 m Layer	
		Maximum	At 75 m
Summer:			
BOD_5 (g/m^3)	40	0.0224	0.01
Suspended solids (g/m^3)	50	0.00619	0.00008
Total Coliform (#/100 ml)	200	13	1.1
Winter:			
BOD_5 (g/m^3)	40	0.0225	0.011
Suspended solids (g/m^3)	50	0.00616	0.0011
Total coliform (#/100 ml)	200	15	2.9

Graphical representation of the dispersion of BOD_5, suspended solids and total coliform are shown in Figures 10.7 through 10.12.

Figure 10.7 Highest BOD5 concentrations predicted for the 12.5 - 25 m layer during summer over the 29 day simulation

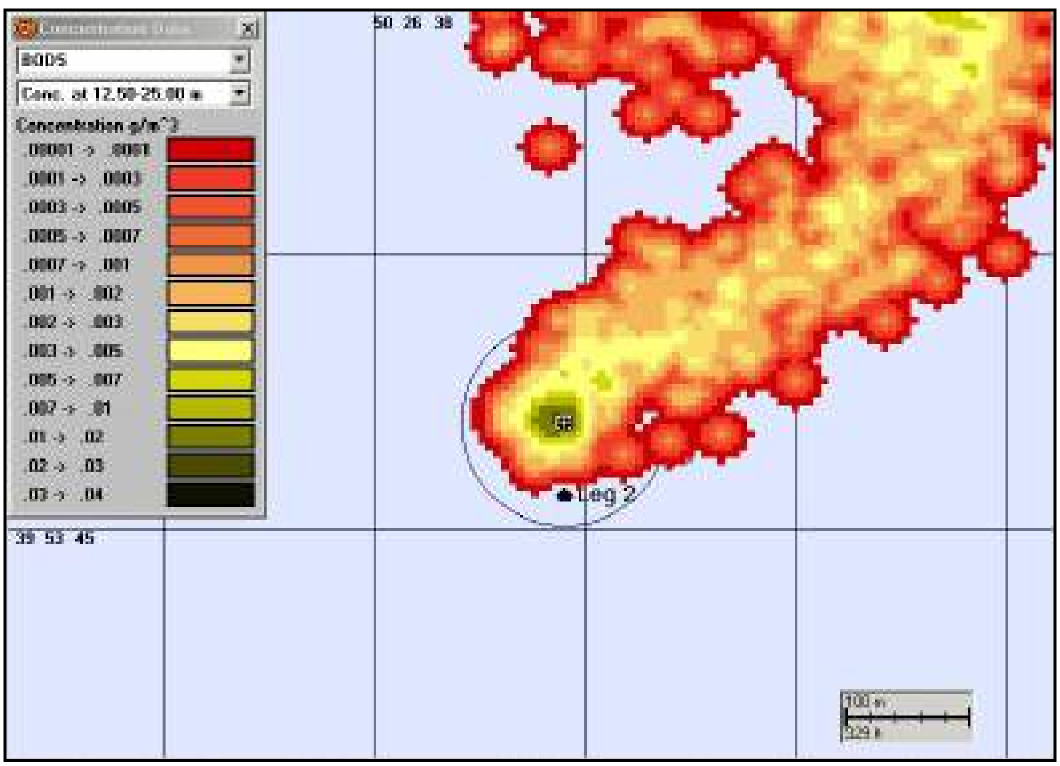


Figure 10.8 Highest BOD5 concentrations predicted for the 12.5 - 25 m layer during winter over the 29 day simulation

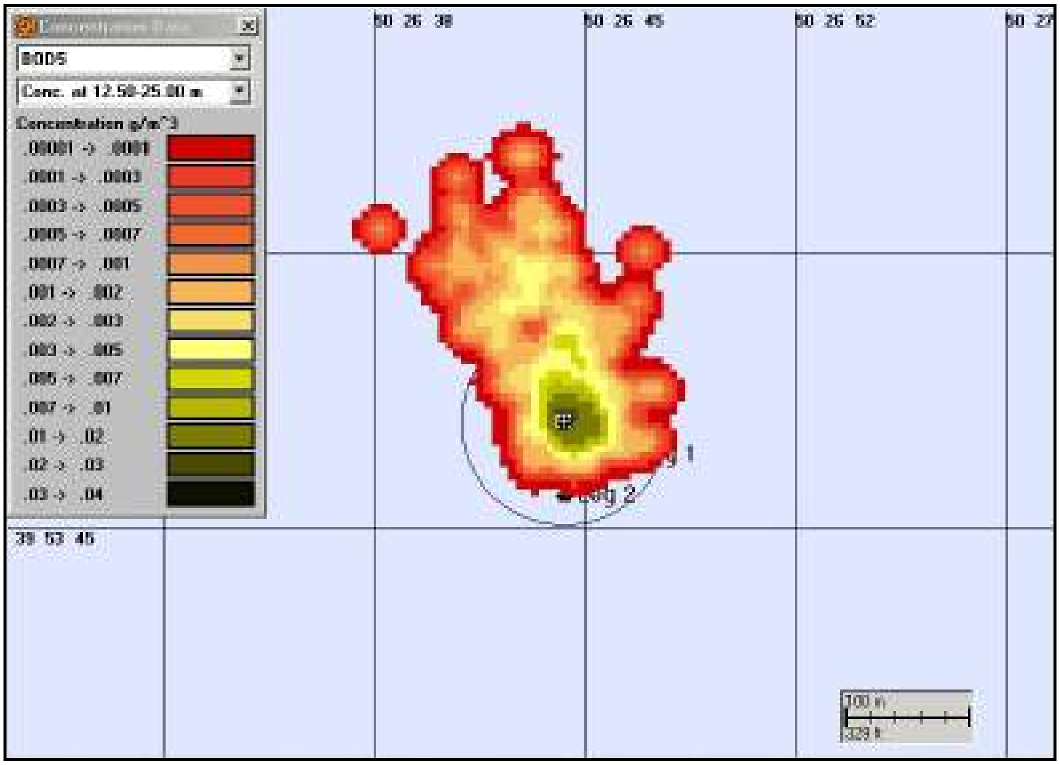


Figure 10.9 Highest suspended solids concentrations predicted for the 12.5 - 25 m layer during summer over the 29 day simulation

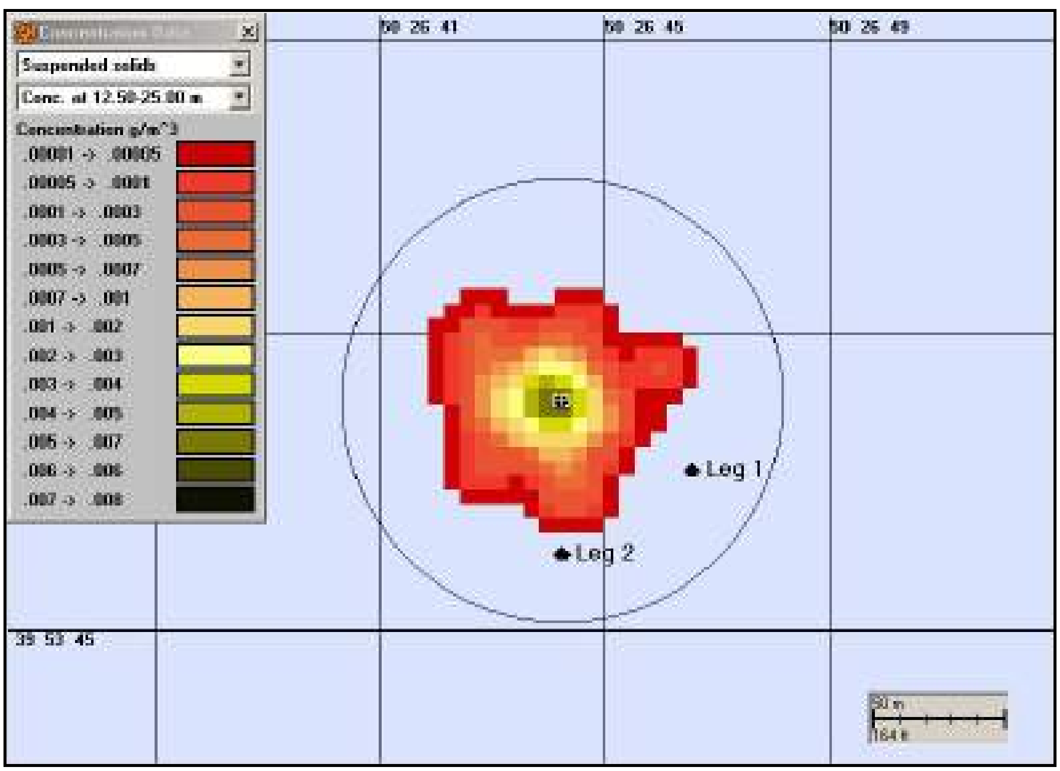


Figure 10.10 Highest suspended solids concentrations predicted for the 12.5 - 25 m layer during winter over the 29 day simulation

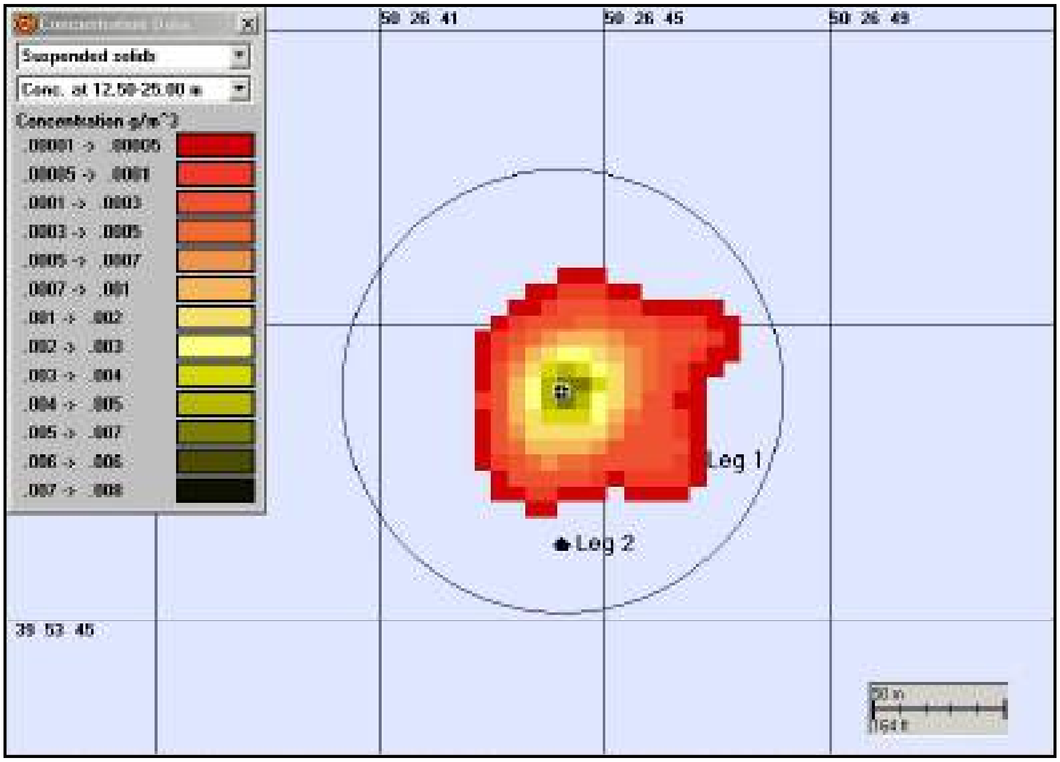


Figure 10.11 Highest total coliform concentrations predicted for the 12.5 - 25 m layer during summer over the 29 day simulation

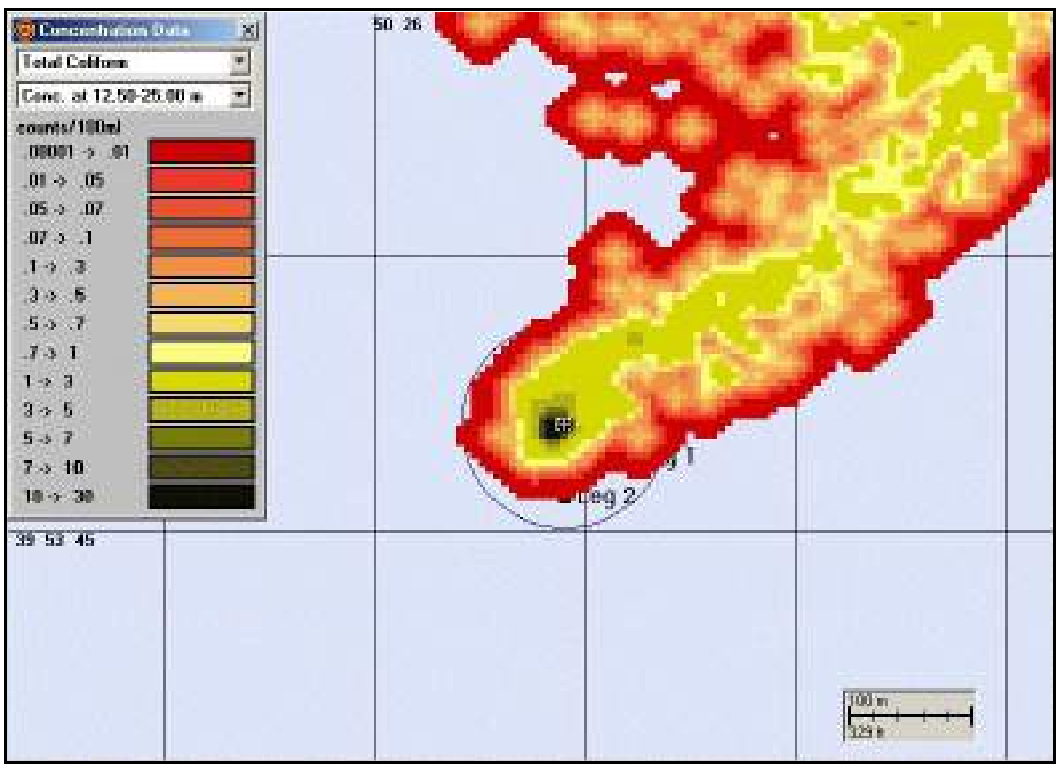
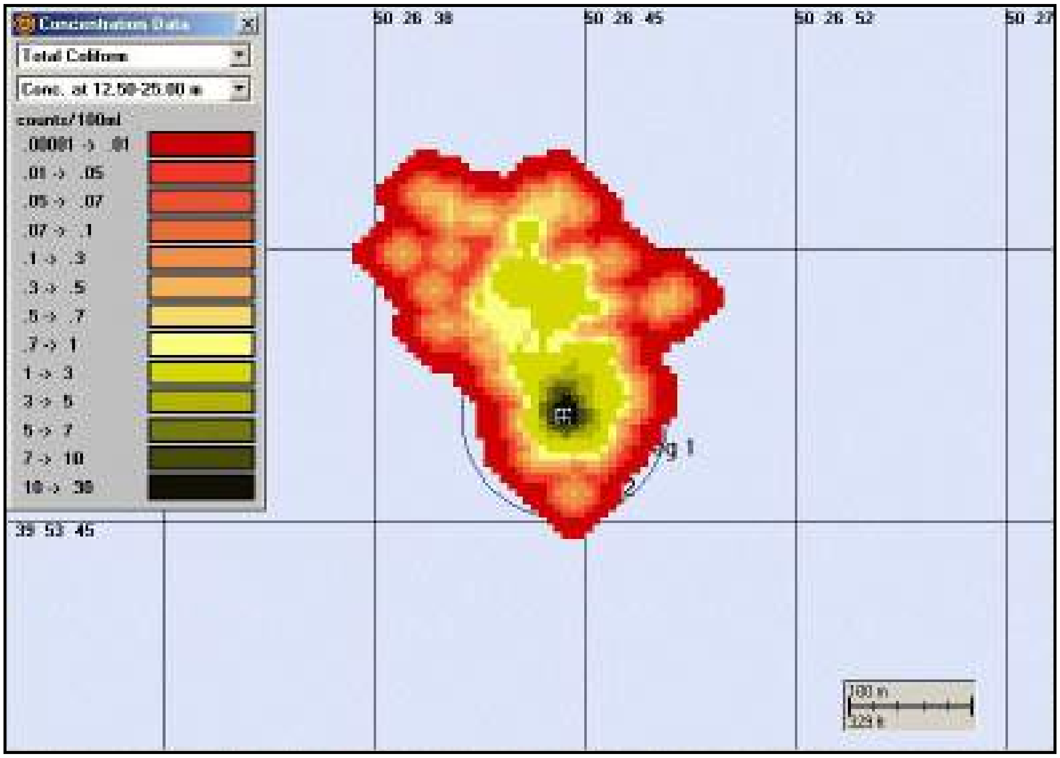


Figure 10.12 Highest total coliform concentrations predicted for the 12.5 - 25 m layer during winter over the 29 day simulation



As can be seen from Table 10.15 and Figures 10.7 through 10.12, sewerage discharges are readily dispersed and the concentrations of all modelled constituents are several orders of magnitude lower than the target US Coastguard Type II Marine Sanitation Device specifications. Water currents assist the dilution and dispersion of discharged material and would also be expected to eventually restore oxygen and nutrient levels to background conditions. Impacts on marine water quality and marine organisms are therefore, considered to be of "low" significance.

Overall impacts on seawater quality and seawater biology resulting from the discharge of sewage from the Istiglal and TPG500 are considered to be of "low" significance as follows:

Likelihood = 5 - certain to occur.
Consequence = 1 - impact largely not discernable on a local scale.
Significance = 5 - low.

Food wastes

Food waste would be generated on board all operational vessels and offshore facilities. Such wastes would be macerated to <25 mm and discharged directly to the water column. Given the limited number of personnel that would be onboard offshore installations (i.e. a maximum of 110 to 120 during drilling programmes (MODU and TPG500) and only 18 during production operations (TPG500)) and vessels (i.e. typically 10 to 20 each) combined with the anticipated level of dispersion and mixing of wastes in the water column, it is considered that impacts on marine water quality from the discharge of galley wastes would be of "negligible" significance.

Bilge, ballast and drainage water

Bilge and drainage waters may be contaminated with oily wastes. All drains on vessels and offshore installations would collect any hydrocarbon contaminated water and would direct these fluids for oil removal treatment prior to discharge to sea. Maximum allowable oil-in-water concentrations for drainage water discharges would be 15 ppm for ships and 30 ppm for the TPG500 in accordance with international standards. All discharges would be expected to readily disperse after discharge.

Ballast waters from transportation vessels would be expected to be segregated and would not be in contact with oil or chemicals. The possibility of introduction of alien species from transportation vessels entering the Caspian waters cannot however, be discounted. This event is considered an accidental event and is discussed in Section 10.7.

10.3.3 Impacts on the seabed and seabed biology

10.3.3.1 Discharge of drilled cuttings and WBM

As discussed in the Project Description (Chapter 5; Section 5.2) the Stage 1 drilling programme would consist of the development of up to 14 wells as follows:

- ?? the drilling of three wells from the Istiglal MODU prior to the installation of the TPG500;
- ?? the drilling of six wells from the TPG500; and
- ?? the drilling of an additional five wells for the subsea completion at the E3 site from a MODU but possibly from the TPG500 if extended reach drilling technology permits.

The development of the E3 subsea completion would occur several years after the installation of the TPG500. The designs for these wells are not finalised and therefore, it is not possible, at the time of writing this ES, to assess the fate and effect of any cuttings that may be discharged to the seabed. An impact assessment of cuttings discharges will be completed at a later date and prior to commencement of drilling at the E3 site.

The project has considered several options to minimise discharges of mud and cuttings to the marine environment and, as a result, all cuttings generated from lower-hole sections that will be drilled with SOBM will be recovered and contained for treatment and disposal onshore.

A Best Practicable Environmental Option (BPEO) study was completed to determine the most viable and appropriate disposal method for drilled cuttings from the top-hole sections WBM. Three disposal options were considered as follows:

- ?? discharge to sea;
- ?? re-injection offshore; and
- ?? ship-to-shore for disposal.

In the assessment of the three options, the BPEO considered the following five factors:

- ?? environmental risk;
- ?? risk to personnel;
- ?? compliance with legislation, international best practice and AIOC/BP standards;
- ?? cost of alternatives; and
- ?? technology and track record.

The BPEO study concluded that, on balance, the best disposal method for WBM/cuttings generated from the top-hole section is discharge to the marine environment. The key factors leading to this conclusion were:

?? the drilling mud to be used for the sections would be either be WBM or seawater systems that have been carefully formulated to ensure that they contain no toxic components;
?? the bulk of discharged cuttings are predicted to be deposited within a few hundred metres of the discharge point;
?? the energy consumption and therefore atmospheric emissions, would be less for discharge overboard compared to ship-to-shore;
?? ship-to-shore requires considerably more handling of cuttings and mud, with attendant safety risks; and
?? the unsuitability of the geotechnical environment in the Shah Deniz Contract Area for cuttings re-injection.

The base-case for the disposal of drilled cuttings generated from the Shah Deniz 28"sections for the MODU and platform (TPG500) wells is therefore, to discharge to directly to the seabed. The total volume of cuttings and WBM to be discharged would be approximately 268 m^3 per well. For nine wells, the total volume of cuttings would therefore, be 2,412 m^3.

While, at the time of writing, the precise formulation of the WBM to be used for the drilling programmes had not been finalised, it will be one which has been and is widely used and that has been subject to thorough environmental testing. Table 10.16 identifies typical WBM components, their characteristics and environmental fate.

Table 10.16 Chemistry and fate of typical WBM components

Chemical	Composition	Environmental Fate	HOCNS Category[1]
Barite	Barium sulphate ore.	Inert and dense material that is deposited on the seabed. Primary seabed effect would be due to physical smothering.	E
Bentonite	Clay ore.	Eventually deposited on the seabed but suspended in water column for some time (e.g. hours depending on local water circulation). Inert material but may cause some physical effects (e.g. light attenuation; clogging) in main part of turbid plume but would rapidly disperse and settle such that background turbidity levels are restored.	E
Commercial chemicals	Soda ash / Sodium carbonate.	Simple, biodegradable compound of very low toxicity that dissolves in the water column.	E
Polymers	Guar Gum.	Natural substance that readily biodegrades.	E
Salts	Potassium chloride.	Naturally occurring substance in seawater. Highly soluble salt and readily dispersed.	E

HOCNS: Harmonised Offshore Chemical Notification Scheme - a system used in the North Sea that classifies all chemicals used offshore into Groups (A to E) based on their bio-degradation, bio-availability and toxicity to a range of taxonomic groups. Group A chemicals represent the greatest potential hazard and Group E the least.

Impact significance

The main physical impacts on seawater from the discharge of cuttings and WBM are associated with a localised increase in water turbidity in the vicinity of the discharge point and subsequent minor changes in local water quality. Turbidity in the water column may increase the reflection and scattering of light thus reducing light penetration and subsequent biological activity. In addition, organic material in the discharge may contain an associated increased oxygen demand. Significant changes in seawater quality would have flow-on effects on marine biology.

The main factors that influence phytoplankton production are light and nutrient availability. The presence of a turbid plume that reduces light penetration into the primary production zone (i.e. upper portion of the water column) could result in a reduction in phytoplankton production that in turn, would lead to a reduction in nutrient uptake. Reductions in phytoplankton production rates would only persist for as long as a turbid plume was present and would only be observable where turbidity was greatest; that is, close to the point of cuttings discharge. As unused nutrients would remain in the water column and would still be available after plume dilution, production rates would be expected to eventually return to normal.

Experimental studies on spent and discharged WBM have shown that some physical damage in zooplankton can occur at total suspended solids (TSS) concentrations in excess of 30 g/l. TSS concentrations in excess of 30 g/l are only expected to occur in the most turbid part of the plume close to the point of discharge during calm weather periods when plume dispersion is limited.

Fish could potentially be affected in the vicinity of the plume by the large quantities of fine-grained sediments such as those at the Shah Deniz E2 site. Fine-grained particles may cause irritation by abrading protective mucous coatings and thereby increasing susceptibility to parasites, bacteria and fungal infections. Suspended sediment may also reduce visual acuity and hence feeding behaviour and may reduce respiration efficiency due to blocking of gills. Fish species such as sturgeon that normally inhabit turbid waters and species that use their sense of smell for feeding may be less affected by high levels of suspended sediment than visual feeders. Fish would, however, generally be expected to exhibit avoidance behaviour in response to increases in turbidity.

Any Caspian Seals in the vicinity of the drilling site during drilling activities may experience similar effects as fish from the cuttings discharge. They are also however, likely to demonstrate avoidance behaviour if the waters are found to be unfavourable. Further, it is considered unlikely that seals would be present at the depths (i.e. approximately -100 m) that cuttings and WBM would be discharged.

Cuttings generated during MODU and platform (TPG500) drilling would be discharged at the seabed. Overall therefore, impacts on seawater quality and seawater biology resulting from the discharge of drilled cuttings and WBM are considered to be of "low" significance as follows:

Likelihood = 5 - certain to occur.
Consequence = 1 - impact largely not discernable on a local scale.
Significance = 5 - low.

Impacts of the deposition of the drilled cuttings and WBM on the seabed are discussed in Section 10.3.3.3.

10.3.3.2 Cooling water uptake and discharge

Cooling water requirements for the Stage 1 development are described in the Project Description (Chapter 5; Section 5.3.7.3). There would be three sources of cooling water uptake and discharges to the sea as follows:

- from the Istiglal during the MODU drilling programme:
  - cooling water uptake at -50 m discharge at -13.5 m at a rate of 230 m^3/hr;
  - discharge temperature of $30^{O}C$; and
  - cooling system not treated with antifouling agents.
- from the TPG500 during platform drilling:
  - cooling water uptake at -50 m and discharge at -20 m at a maximum rate of 700 m^3/hr;
  - discharge at $35^{O}C$; and
  - cooling system treated with an antifouling agent.

On the TPG500, uplifted seawater will be subject to a copper-chlorine antifouling treatment. This system[2] will result in a maximum copper concentration of 5 ppb and a maximum chlorine concentration 50 ppb throughout the seawater distribution network.

Impact significance

The potential environmental effects of cooling water uptake and discharge would be:

- entrainment of phytoplankton/zooplankton and (juvenile) fish;
- effects on seawater biology due to the temperature differential between discharged and receiving waters; and
- effects on seawater biology due to antifouling chemical additives in the discharged cooling water.

The key issue associated with cooling water uptake is entrainment of marine organisms (resulting in mortality). In respect to cooling water discharge, issues relate to the environmental effects of a thermal and chemical plume (the antifoulant treated cooling water discharge plume) on the receiving environment.

Entrainment

Phytoplankton and zooplankton

Surveys undertaken in 2000 and 2001 indicated that, in the Shah Deniz Contract Area, phytoplankton biomass ranges from 0.003 mg/l to 0.09 mg/l and from 0.13 mg/l to 0.45 mg/l, respectively. Zooplankton biomass ranged from 10 mg/m^3 to 800 mg/m^3 and from 8 mg/m^3 to 540 mg/m^3 in 2000 and 2001 respectively (Chapter 6; Section 6.2.6).

Typical warm-water phytoplankton production rates are in the range of 40 g to 120 g carbon/m^2/year. Organic carbon is about 10% of wet weight. To make this comparable to biomass data, a production rate of 1 g to 3 g biomass/m^2/day is applied.

Assuming a thermocline depth of -30 m at the Shah Deniz drilling site (typical summer conditions), phytoplankton production would translate to approximately 30 mg/m^3 to 100 mg/m^3/day or on average, say 70 mg/m^3/day. Phytoplankton and zooplankton at the seawater intake depths on the Istiglal and TPG500 would be entrained in the uptake stream with consequent mortality due to the rapid increase in ambient temperatures and highly disturbed water flow.

The Istiglal would draw seawater for cooling from -50 m below the sea surface. Using a biomass value for the Shah Deniz Contract Areas of 170 mg/m^3 (average of the above

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[2] The copper-chlorine system is the BFCC system, a proprietary design manufactured by Baker Hughes.

surveyed biomass ranges) and a seawater uptake rate of 230 m^3/hr (i.e. 5,520 m^3/day), approximately 0.9 kg/day of biomass would be lost (assuming total mortality of entrained organisms).

The cooling water intake on the TPG500 is also planned to be at a depth of -50 m. Assuming the same standing biomass value of 170 mg/m^3 and a seawater uptake of 700m^3/hr (i.e. 16,800 m^3/dy) a loss of approximately 2.9 kg/day of biomass could be expected (assuming total mortality of entrained organisms).

Assuming an average biomass production rate of 70 mg/m^3/day, a volume of water equal to approximately two and a half times the volume of TPG500 daily seawater uptake (i.e. approximately 40,800 m^3) would replenish the predicted biomass loss.

It is concluded that local production of phytoplankton is more than sufficient to compensate for the estimated daily losses resulting from seawater uptake and therefore, the consequence of loss of phytoplankton due to entrainment is considered "negligible".

Larvae and juvenile fish

As discussed in the Environmental Description (Chapter 6; Section 6.2.6), the Middle Caspian, including the Shah Deniz Contract Area, is a known fish spawning area and includes spawning grounds for Anchovy and Big-eyed Kilka[3]. Spawning occurs below the sea surface and embryo rise to the surface where they hatch.

The volumes of cooling water that would be used by the Istiglal and latter by the TPG500 in comparison to the whole of the Middle Caspian would be insignificant. Impacts to the Caspian Kilka populations through the entrainment of juveniles and embryos in the cooling water uptake would therefore, be unlikely to cause any long-term or significant damage to this population and hence the consequence of this impact is considered "negligible".

Adult fish

It is considered that the majority of adult Anchovy and Kilka would avoid the Istiglal and TPG500 seawater intakes but smaller individuals could be entrained if velocity gradients at the intake rates are sufficiently high. The number of individuals that may be entrained and hence lost would not be significant in terms of total population numbers and hence, the consequence of the loss due to entrainment is considered to be "negligible".

Thermal plume discharge

The primary concern associated with the discharge of heated water is the potential for direct effects on the physiology of individual marine organisms within the area of the discharge plume. Metabolic rates increase by approximately a factor of two for each 10?C increase in temperature. Behavioural considerations with respect to thermal inputs effectively apply primarily to fish that have the capacity to mitigate exposure by means of behavioural responses. In steady-state conditions, the thermal gradient between receiving waters and the plume would be relatively constant and gradual thus allowing fish to detect the plume and avoid it. In large waters bodies such as the Caspian Sea where emigration is possible in any direction from the area of elevated temperature, mortalities would not be expected to occur.

The International Financial Institution (IFI)[4] guidelines for cooling water discharges recommend that a temperature increase of no more than 3^{O}C above ambient seawater

[3] "Kilka" is a term that collectively refers to several species of herring.
[4] . Offshore Oil and Gas Development Guidelines, International Financial Corporation Offshore, 2001.

temperatures should be maintained at the edge of the zone where initial mixing and dilution takes place. Where the zone is not defined, a distance of 100 m from the point of discharge is used.

Thermal discharge plumes were modelled for the TPG500 platform (worst case scenario) at release depths of -10 m, -30 m and -50 musing a flow rate of 1,000 m^3/hr. The modelling determined that under all meteorological conditions, thermal plume dispersion occurs rapidly and that the required IFI guidelines recommendation is readily met for both discharge depths. A base-case discharge depth of -20 m has been chosen. Discharges at this depth meet the IFI guidelines and provide a suitable arrangement in regards to the total weight of the caisson facility and hence the total topside weight on the TPG500, a key consideration from an engineering perspective.

Tables 10.17 and 10.18 present the results for +3^{O}C above ambient for modelled summer and winter scenarios (assuming a vertical port orientation) for -10 m and -30 m discharges respectively.

Table 10.17 Thermal dispersion simulations for +3OC above ambient for a -10 m discharge depth

Season	Plume Travel (m)	Minimum Plume Depth (m)	Plume Radius (m)	Plume Area (m^2)
Summer	2.7 south	9.1	1.8	10.1
Winter	2.9 north	11.8	2.4	18.4

Table 10.18 Thermal dispersion simulations for +3OC above ambient for a -30 m discharge depth

Season	Plume Travel (m)	Minimum Plume Depth (m)	Plume Radius (m)	Plume Area (m^2)
Summer	6.3 south	30.5	1.8	10.1
Winter	2.6 north	31.8	2.3	16.8

Even allowing for some uncertainties in the model simulations, the thermal discharge is expected to readily meet the IFI guidelines for cooling water; that is, to return to within 3^{O}C of ambient temperature within 100 m from the discharge point. The total volume of water that would have an elevated temperature to that of the receiving waters is very small. Impacts on the seawater biology receptor as a result of thermal plume effects are therefore, considered to be of "low" significance as follows:

Likelihood = 5 - certain to occur.
Consequence = 1 - impact largely not discernable on a local scale.
Significance = 5 - low.

Chemical plume discharge

Two options were considered for antifouling treatment of the cooling water on the TPG500. These were:

?? **BFCC? [5]:** pulsed dosing with a copper-chlorine solution with concentrations of 5 ppb copper and 50 ppb chlorine; and

5 The BFCC? copper-chlorine system is a proprietary system produced by Baker Hughes Process Systems in the UK.

?? **electro-chlorination:** dosing with a chlorine only solution at a concentration of 2,000 ppb.

After initial consideration of the electro-chlorination system, the Shah Deniz project design team elected to adopt the BFCC? copper-chlorine system as the base-case for the project. The primary drivers to this decision were:

?? the considerably lower concentrations of chlorine in the discharge stream;
?? less space requirement on the TPG500 topside;
?? less weight associated with the BFCC? system;
?? lower energy requirements resulting in less atmospheric emissions; and
?? lower overall (purchase and running) costs.

Cooling water chemical plume dispersion modelling will be undertaken for the Shah Deniz TPG500 facility in the third quarter of 2002. The results of this modelling will be reported as an Addendum to this ES report.

In order to complete a preliminary environmental impact assessment of the Shah Deniz discharge plume, the results of the BFCC? antifouling treatment system modelling undertaken for the ACG Full Field Development Phase 1 ESIA have been used. Results of the ACG simulations were presented in the Technical Appendices to the ACG Full Field Development Phase 1 Environment Statement (AIOC, 2002).

The BFCC? copper-chlorine antifouling system doses the seawater uptake with copper and chlorine at 5 ppb and 50 ppb respectively. Dosing occurs at the seawater intake point for one minute in every five minutes (i.e. 20% of the time). Given this intermittent dosing regime and assuming total mixing in the cooling system, the 'end-of-pipe' discharge concentrations would be 1 ppb copper and 10 ppb chlorine.

Discharged chemical plumes would be continually subject to dispersion and dilution once discharged from the caisson. Some time after initial release, an equilibrium or "steady state" is reached between the discharge plume and dilution in the receiving waters; that is, there is point in time where the plume does not get any larger.

Table 10.19 shows the results of modelling completed for the ACG PDQ[6] facility for a continuous discharge of 1,700m^3/hr at -67 m with release concentrations of copper and chlorine of 1 ppb and 10 ppb respectively.

Table 10.19 Steady state antifoulant chemical concentrations (ppb) in the cooling water dispersion plume for the ACG PDQ

Season/Period	BFCC? Antifouling System	
	Copper (Cu) (ppb)	Chlorine (Cl) (ppb)
Winter:		
01 Jan – 15 Jan	0.0008	0.007
15 Jan – 31 Jan	0.0008	0.006
Summer:		
13 Jul – 28 Jul	0.0009	0.008
02 Aug – 17 Aug	0.0008	0.007

In this steady state, maximum chemical concentrations would be found at water depths of between -14 m and -22 m in the winter months and between -41 m and -49 m in the summer;

[6] PDQ = Production and Drilling Quarters.

that is, constituent chemicals are never carried to the surface of the water column rather spread around the release site below the sea surface. In a steady state, the maximum concentration portion of the plume would cover an area of diameter of up to 5 km around the PDQ facility.

As shown in Table 10.19, the maximum predicted steady state concentrations of copper and chlorine in the PDQ dispersion plume are 0.0009 ppb (parts per billion or ? g/l) and 0.008 ppb respectively. The predicted concentration of copper is in the order of four orders of magnitude below the Maximum Allowable Concentration (MAC) limit for Azerbaijan (i.e. 5 ppb).

The proposed discharge rate for the single Shah Deniz TPG500 installation is 700 m^3/hr (at -20 m). This rate is approximately two and a half time less than that of the ACG PDQ facility. As such, it can reasonably be predicted that the resultant steady state plume will be substantially smaller in size. Maximum copper and chlorine concentrations would be expected to be similar.

A key assumption made in the dispersion modelling is that copper would remain in solution (i.e. dissolved) and that it is eventually more or less infinitely diluted. Metals do however tend to interact with components present in the receiving water and form insoluble inorganic precipitates which ultimately settle onto the seabed. It is considered therefore, that a proportion of the copper in the cooling water discharge may form copper compounds and precipitate out around the platforms. If this occurs, concerns could be raised in regards to potential increases in copper concentration in the seabed sediments and its subsequent bio-availability.

There is no data available for the acute toxicity levels of copper for Caspian-specific species. International studies have shown however, that metal compounds formed in the water column are virtually non bio-available to marine organisms that come into contact with them (Neff *et al.*, 1989a). These studies have principally concentrated on the uptake of metal contaminants associated with drilling mud and additives. Slight accumulations of copper as well as cadmium, mercury and lead have been however, detected in marine invertebrates in barite-contaminated sediments (Neff *et al.*, 1989b).

Copper is found at low concentrations in marine waters as it is an essential trace element required by most aquatic organisms. At higher concentrations copper and some of its compounds are however, toxic to marine flora and fauna. Plants and animals readily accumulate copper with bio-concentration factors ranging from 100 to 26,000 being recorded for various species of phytoplankton, zooplankton, macrophytes, macro-invertebrates and fish (Spear & Pierce 1979). Ahsanullah and Williams (1991) reported that the marine amphipod *Allorchestes compressa* exposed to 10 ppb of copper for 28 days accumulated 100 mg/kg body weight and experienced reduced growth.

US EPA studies showed that the acute toxicity of copper to saltwater animals ranged from 5.8 ppb for Blue Mullet to 600 ppb for the Green Crab. Invertebrates and particularly marine crustaceans, corals and sea anemones are sensitive to copper with concentrations as low as 10 ppb causing sub-lethal effects. Acute LC_{50} values for prawns, crabs and amphipods ranged from 100 to 1,000 ppb with chronic values from 1 to 300 ppb (Arnott and Ahsanullah, 1979; Ahsanullah and Florence; 1984). Gastropods are more tolerant to copper and can accumulate quite high concentrations without toxic effects. Typical 96-hour LC_{50} values for snails are 8 to 12 ppb. Marine bivalves including the mussel *Mytilus edulis* are more sensitive to copper with a 96-hour LC_{50} values of 480 ppb (Amiard-Triquet *et al.*, 1986).

The maximum concentration of copper that would result from the cooling water discharge from the Shah Deniz TPG500 is estimated to be similar to that of the ACG PDQ facility; that is, 0.0009 ppb. This is a very low concentration and hence, the significance of impacts on seawater and seawater biology are considered to be “low”.

As there is a potential for the metal to precipitate out of solution some time after discharge, it is very important that copper concentrations in the seabed sediments around the TPG500 be monitored. Such monitoring would form part of a programme of benthic surveys that would be conducted at the offshore locations as discussed in Environmental Mitigation and Monitoring chapter (Chapter 14).

Chlorine cannot be considered a persistent pollutant as its eventual fate is as the chloride ion. Dosing concentrations of 2,000 - 5,000 ppb residual chlorine are used to disinfect sewage and it is considered that at these concentrations, acute lethal effects on marine organisms would occur. A dilution factor of 10 to 100 times would mitigate acute lethal effects.

The ACG PDQ modelling predicted maximum chlorine concentrations of 0.008 ppb. It is considered that similar concentrations would occur in the Shah Deniz TPG500 plume. These chlorine levels are approximately six orders of magnitude less than those at which acute lethal effects on marine organisms are observed. At these very low discharge concentrations, no significant adverse effects on marine biology would be observed.

Overall, the predicted low concentrations of antifouling chemicals present in the Shah Deniz offshore cooling water discharge plume combined with the rapid dilution of these chemicals through dispersion, suggests that the impacts on sweater and seawater biology would be of “low” significance as follows:

Likelihood = 5 - certain to occur.
Consequence = 1 - impact largely not discernable on a local scale.
Significance = 5 - low.

10.3.3.3 Corrosion protection of TPG500 and pipelines

The Shah Deniz Stage 1 pipelines and TPG500 would be fitted with sacrificial anodes as a form of corrosion protection. The degradation of these anodes would result in the slow release of metals to the sea. Accurate prediction of the potential effects of anodes in the marine environment requires an estimate of the rate at which the materials may go into solution and the rate at which these materials would be diluted and the degree to which they would be bio-available.

Table 10.20 presents the make-up of aluminium-zinc-indium type alloy anodes that are proven for long-term continuous service in seawater, saline mud or alternating seawater and saline environments. This form of anode would be used for the cathodic protection of the Stage 1 offshore facilities, the TPG500 and subsea export and inter-field pipelines.

Table 10.20 Chemical composition of Shah Deniz offshore facility aluminium-zinc-indium type alloy active anodes

Element	Composition Range (%)
Zinc	4.00 – 5.50
Indium	0.020 – 0.040
Iron	0.090 max.
Silicon	0.20 max
Copper	0.040 max.
Others (each)	0.020 max
Others (total)	0.050 max.
Aluminium	Balance

Impact significance

According to the UK Offshore Operators Association (UKOOA), sacrificial anodes typically dissolve over a 40-200 year period (UKOOA, 1993). North Sea experience suggests that decay of anodes does not result in a significant environmental impact.

Analysis of seabed sediment samples taken along the existing EOP subsea pipeline from Chirag-1 to shore indicated no apparent significant contribution to metal levels in benthic sediments as a result of decay of the pipeline active anodes over approximately the last five years. It is considered therefore, that the Shah Deniz facility anodes would similarly not have a significant impact on ambient water quality or seabed sediments. The level of metal contamination from sacrificial anodes is not expected to reach a level that significantly influences the health of the biology found in the vicinity of the pipeline corridor although very small increases in some of these metals in the very close vicinity of the anodes would be expected.

Impacts on seawater and seawater biology associated with the slow decay of active anodes are considered to be of “low” significance as follows:

Likelihood = 5 - certain to occur.
Consequence = 1 - impact largely not discernable on a local scale.
Significance = 5 - low.

10.3.3.4 Well clean-up and drill stem testing

As discussed in the Project Description (Chapter 5), a drill stem test (DST) may be conducted on the third MODU well. In addition, it is expected that once the TPG500 has been installed, wells would be cleaned to achieve optimum flow conditions. During drill stem testing and well clean-ups, any hydrocarbon product received at the surface will be flared.

Impact significance

The flare systems used to burn gas/condensate product during MODU drill stem tests and TPG500 well clean-ups would use high efficiency burners to minimise condensate drop-out. Impacts on seawater and seawater biology as a result of well clean-up and drill stem testing are therefore considered to be of “negligible” significance.

10.3.4 Impacts on seabed and benthos

A number of Stage 1 project activities have been assessed as having the potential to result in environmental impacts on the seabed and the marine organisms living on or in it. The impacts are associated with:

?? installation activities resulting in a physical disturbance of the seabed causing an alteration to local seabed topography and the destruction of benthos;
?? WBM and drilled cuttings deposition resulting in smothering of benthos and interference with marine organism physiological processes; and
?? physical presence of the offshore structures resulting in the creation of an artificial reef environment on and around the TPG500 and subsea pipelines.

These impacts and the contributing activities are discussed in the following sections.

10.3.4.1 Offshore installation activities

Stage 1 installation activities offshore that would result in a degree of physical disturbance to the seabed and associated benthos include:

?? installation of the drilling template;
?? positioning and anchoring of the Istiglal for MODU drilling;
?? installation of the TPG500; and
?? installation of the subsea export and future inter-field (E2 to E3 site) pipelines.

Impact significance

Impact resulting from installation activities that disturb the seabed can be considered in both absolute and relative terms. The absolute impact is the total loss of biomass and/or production in the benthic communities present in disturbed areas. The relative impact of this depends on the fraction of local or regional communities of a particular type that are affected by the installation activities.

There is often concern that the loss of biomass translates into a measurable loss of biomass at higher trophic levels and particularly in fish populations. Only in cases where a significant percentage of a habitat is lost or where specific locations are of high importance (e.g. fish spawning, breeding and feeding grounds) will trophic level effects be observed. Most often, the only effect is likely to be a small change in the pattern of grazing and predation and in most instances, it is not ecologically correct to translate absolute biomass lost at the benthic level into estimated biomass lost at higher trophic levels.

As discussed in the Environment Description (Chapter 6; Section 6.2.8.1), available data indicates that the macrobenthic communities along the proposed Shah Deniz pipelines' route are heavily influenced by the sediment composition. Macrobenthic communities are dominated by amphipods, bivalve and polychaete worms. At the platform location a much greater diversity of amphipods and gastropods than along the proposed pipeline route has been observed. In the middle portion of the pipeline route, large numbers of the barnacle *Balanus* where recorded. Biological communities in the shallower sediments (i.e. where the Shah Deniz and ACG pipeline corridors would be common) are increasingly dominated by the alien bivalve Abra and polychaete Nereis. Amphipods were absent at these locations.

After seabed disturbance and subsequent loss of benthos, restoration of natural community structure would be expected to gradually take place. The offshore portion of the pipelines would not be buried and as a result, its surface would provide an additional substrate for colonisation by populations of barnacles and bivalve molluscs in areas where they may otherwise be unlikely to occur and become established. This implies that in the offshore environment through which the pipeline passes, a localised and slight change in structure of marine faunal community may be incurred.

Positioning and anchoring of the Istiglal and installation of drilling template

The Istiglal MODU is a semi-submersible facility and is secured in place during drilling activities via anchors. The anchors are positioned by support vessels during facility installation. The rig itself does not come into contact with the seabed.

Localised disturbance of the seabed during installation of the Istiglal would result from the use of anchors and anchor chains. The preparation of seabed areas for installation of the drilling template would also cause some disturbance of the seabed. The total area affected by these activities would however, be small and would occur within an estimated area of approximately 1 ha. The physical disturbance of the seabed would result in the destruction of sessile or non-moving benthic organisms including those living on (epifauna) and within (infauna) the sediment. Mortality of benthic fauna would be restricted to the area of activity. Due to the limited spatial extent of disturbance, impacts are considered to be of "low" significance as follows:

Likelihood = 5 - certain to occur.
Consequence = 1 - impact largely not discernable on a local scale.
Significance = 5 - low.

It should be noted that the area would be re-disturbed as a result of drilled cuttings deposition from MODU drilling and the later installation of the TPG500 including drilled cuttings deposition from platform drilling (Section 10.3.4.3).

Installation of the TPG500

The installation of the TPG500 including fluidisation of the seabed for the facility's leg suction cans would result in physical disturbance to the seabed. Each spudcan has a 30 m diameter and therefore, the total area of seabed that would be effected by seabed fluidisation under the three TPG500 spudcans would be approximately 2,200 m^2 (i.e. 0.2 ha).

As with the Istiglal MODU installation activities, physical disturbance of the seabed during TPG500 installation would result in the destruction of sessile or non-moving benthic organisms. The total area that would be impacted by TPG500 installation is very small in comparison to the total area of the Shah Deniz Contract Area. The amount of biota that would be lost is not considered to be significant in the context of that present in the whole Shah Deniz Contract Area. Impacts on the seabed and seabed biology are therefore, considered to be of "low" significance as follows:

Likelihood = 5 - certain to occur.
Consequence = 1 - impact largely not discernable on a local scale.
Significance = 5 - low.

Installation of subsea export pipelines and potential future inter-field pipelines offshore

The subsea gas and condensate export pipelines would be installed by the pipe-lay vessel the "Israfil Guseinov". A number of smaller support vessels would also be required. The pipeline sections are joined (welded) together on the pipe-lay vessel and are progressively laid on the seabed as a continuous length in an "S-lay" configuration (Chapter 5; Section 5.4.4.4). The gas and condensate pipelines would be spaced approximately 16 m apart in the nearshore zone and 50 m apart in the offshore zone.

The pipe-lay vessel "Israfil Guseinov" would drag its anchors during all pipeline installation activities offshore as it progressively moves forward. This would result in the mounding of soft sediments and the potential smothering of benthos. In addition the installation of grout bags for freespan correction and to build crossing points for existing subsea services as well as the actual laying of the pipeline would all result in a degree of physical disturbance of the seabed.

The offshore component of the planned 26" gas and 12" condensate pipelines is taken as being the section between the TPG500 and the 8 m depth contour (i.e. the shallowest depth in which the pipeline lay-barge can operate). It is noted that the 4" Mono-Ethylene Glycol (MEG) line will be piggybacked on the condensate line. The section from the 8 m contour and the shoreline is taken as the nearshore pipeline and is discussed in Section 10.3.4.2.

The offshore section of the pipelines amounts to a length of 90 km each. Inter-field lines between the E2 and E3 drilling sites would be, if required, approximately 5 km in length. If the E3 site is drilled from the TPG500 using extended reach drilling, there would be no requirement for the inter-field lines.

If it is assumed that pipeline installation activities would disturb the seabed over a 100 m wide corridor along the pipeline routes then the total area that would be disturbed as a result of subsea and inter-field pipeline installation and associated activities would be approximately 950 ha. Benthic communities in this area would be directly impacted most likely resulting in their loss.

While the total area that would be impacted as a result of pipeline installation is appreciable, the fact that the installation activities would be relatively short-term and that the disturbed areas would be free to rehabilitate without further and subsequent disturbance, the overall impact on the seabed and benthos is considered to be of "low" significance as follows:

Likelihood = 5 - certain to occur.
Consequence = 1 - impact largely not discernable on a local scale.
Significance = 5 - low.

As noted above, the offshore sections of the pipelines will not be buried and hence, the exposed hard surface will provide a substrate that organisms (e.g. barnacles and molluscs) can attach to. Colonisation by these species in areas where they previously didn't occur (due to no hard substrate being present) would represent a shift in community structure.

10.3.4.2 Nearshore installation activities

Installation of the marine pipelines in Sangachal Bay would result in the disturbance of seagrass beds and habitats of medium and high sensitivity (Chapter 6; Section 6.3.5). Installation activities would result in direct physical disturbance of the seabed, some localised loss of rocky outcrop (which green and red-algae species colonise[7]) and seagrass habitats. A number of activities would contribute to the impacts and these include:

?? construction of finger-pier to enable installation of the Stage 1 pipelines in the nearshore area;
?? trenching of the pipelines out to the 5 m depth contour including:
  ?? mechanical excavation of the trench from 0 m to 2 m water depth;
  ?? burial of the pipelines into the seabed between 2 m to 5 m water depths; and
?? pipeline installation.

The 0 m to 2 m section of the pipeline trenches (i.e. that mechanically excavated from the finger-pier) would be approximately 100 m long and up to 8 m wide. The 2 m to 5 m contour section would be approximately 1,900 m long and approximately 3 m wide. The entire trench length would approximately 2 km long

Impact significance

Seagrass habitat in Sangachal Bay

As discussed in the Environment Description (Chapter 6; Section 6.3.4.6) algae and seagrass are important because they are one of the most productive components of the marine

[7] Some red-algae species present in Sangachal Bay are red-listed.

ecosystem, supporting a rich fauna and used as nursery areas for fish and foraging areas for birds. The stabilising effect of seagrass is an important characteristic in Sangachal Bay.

A seabed mapping survey was completed in June 2001 of the nearshore waters of Sangachal indicated that distribution of the seagrass and algae in Sangachal Bay is patchy and primarily influenced by sediment type (Chapter 6; Figure 6.34).

The flora of the shallow water areas (i.e. up to 4m deep) adjacent to the shoreline is dominated by dwarf seagrass (*Zostera noltii*). Less extensive areas of seagrass were also found a few kilometres from the shoreline. Seagrass was observed growing in areas of coarse grained sediment, coarse sand, coarse sand and mud, coarse shelly sand and areas of gravel/pebbles. Seagrass was not found growing in areas with rock outcrops or fine-grained sediment composed of mud as these types of substrata do not allow the development of seagrass root networks.

Zostera species form continuous mats which extend laterally by growth of stolons. New beds and new individuals often initially suffer high mortality and can take five years to establish and stabilize. *Zostera* beds are particularly sensitive to fragmentation (i.e. division of larger continuous areas into a number of smaller areas) and small patches show much higher mortalities. The majority of growth takes place in the spring and summer and established patches can enlarge at 0.5 m per year.

A summary table of the functions and values of seagrass habitat *per se*, is presented in Table 10.21.

Table 10.21 Functions and values of seagrass (as applicable to Sangachal Bay)

Major Category	Functions (F) and Values (V)
Productivity	**F:** Primary production. **F:** O_2 production. **F:** Organic matter accumulation. **F:** Support of benthic and epibenthic secondary production and nearshore and offshore food webs. **F:** Habitat, refuge, and nursery for fish and invertebrates. **V:** Support of nearshore and offshore commercial fisheries. **V:** Recreational fishing.
Hydrological	**F:** Baffles wave energy and currents preventing re-suspension of sediments. **V:** Erosion protection for shoreline and uplands.
Geomorphological	**F:** Sediment stabilization. **V:** Water quality improvement. **V:** Erosion protection for shoreline and uplands. **V:** Counters sea level rise.
Biogeochemical	**F:** Traps, filters, and recycles nutrients, processing the nutrients into other forms or trophic levels. **F:** Contaminant filtration. **F:** Organic matter storage. **V:** Water quality improvement.

Adapted from Kurland (1993), Short and Wyllie-Echeverria (1996), and Short *et al*. (1998).

Potential extent of loss of nearshore habitat

Based on the pipeline trench width and length estimates presented above, excavation of the two Shah Deniz pipeline trenches would result in the direct loss of seabed habitat and benthos over an area of approximately 1.3 ha. Deposition of excavated material adjacent to the trench is estimated to impact an area of at least the same size and possibly up to twice as large as the trench itself. Trench construction activities are therefore, estimated to directly impact at least 2.6 ha of benthic habitat and benthos.

In order to mechanically excavate the trench, it is proposed to construct a finger-pier from the shoreline out to the 2 m depth contour. While alternative civil engineering enabling techniques are under consideration, a rock groyne finger-pier along which the excavator could move is currently the base case option. It is estimated that the base of pier would be approximately 10 m wide and its total length between 50 m and 100 m. The total area of seabed that would be directly impacted by this structure would therefore, be up to 0.1 ha. This would be in addition to that area affected by trenching and trench spoil deposition.

Approximately 450 ha (i.e. 12%) of Sangachal Bay are covered by sensitive habitat (seagrass). Direct loss of up to 2.7 ha (i.e. pipeline trench and finger-pier area) of nearshore habitat would result from trenching, deposition of excavated material and pipeline installation. Vessel operations would also disturb small additional areas of seabed. It is estimated that 20% to 25% of the preferred nearshore pipeline corridor would be high sensitivity (seagrass) habitat. The remainder would be moderate sensitivity habitat (primarily loose sediment) (Chapter 6; Figure 6.38). The total area of sensitive (seagrass) habitat that would be directly impacted as a result of pipeline installation activities is, as a percent of total sensitive habitat in the Bay, very small (i.e. <1%).

Loss of seagrass habitat can result in a decrease in an area's ability to maintain its pre-impact levels of biodiversity and can, in the longer term, contribute to changes in habitat distribution and type as a result of greater mobility of seabed sediments. Changes in habitat distribution would also be likely to effect the distribution and type of benthic organisms.

Benthic habitat and organisms could also be indirectly impacted as a result of increased turbidity in the Bay during pipeline trench construction activities. Depending on the strength of currents at the time of trench construction, sediments could be mobilised, transported and deposited considerable distances away from the immediate construction area.

Current speeds ranging between 0cm/s and 42.5 cm/s were measured in 1999 and 2000 in 6 m depth of water approximately 2.5 km offshore in the Bay. The mean current speed was 7.9 cm/s. Current directions were evenly distributed southwest (down coast) and north-east (up coast) and analysis showed that the higher current speeds were associated with the southwest direction. Analysis of grain size showed that when compared to critical shear velocity, Bay sediments would be easily mobilised and transported by current speeds of 12 cm/s or greater. A dynamic sediment regime in the Bay was also implied by the differences in sediment grain size distribution in the Bay between 1996 and 2000 (ERT, 2000).

An assessment of the sediment movement in the Bay carried out in June 2001 (Chapter 6; Section 6.3.2.) concluded that there is a complex nearshore hydrodynamic circulation pattern and a dynamic sediment regime in the Sangachal Bay nearshore environment. As illustrated in Chapter 6, Figure 6.29, a northward moving sediment plume suggests the presence of currents strong enough to mobilise the Bay's benthic sediments. Sediments mobilised into the water column during pipeline installation activities in the near shore zone would be transported away from the immediate area of activity and would settle elsewhere in the Bay assuming currents of sufficient strength are operating at the time and assuming that no containment device (e.g. silt curtains) was used.

Deposition of sediment on sensitive habitat removed from the immediate area of construction and installation activities may mean that considerably more habitat and benthos could be impacted than that directly effected by trench and finger-pier construction and pipeline installation.

Marine flora and fauna in Sangachal Bay are probably to some degree, accustomed to turbid waters and hence could be expected to be able to sustain short term, low to medium level disturbance. Deposition of significant amounts of sediment over a short timeframe may lead to the smothering of marine flora and fauna with potential mortality of the impacted species. In light of this, the ecological value of and long restoration times (i.e. years) for seagrass habitat, impacts resulting from finger-pier and pipeline trench construction and pipeline installation activities are considered to be of "high" significance as follows:

Likelihood = 5 - certain to occur.
Consequence = 2 - local scale impact.
Significance = 10 - high.

It should be noted that the finger-piers would be removed following pipeline installation. The removal process would result in further disturbance and a re-suspension of sediments and hence additional impact on nearby benthic habitat and resident benthos. Additionally, impacts would also occur as a result of pipeline installation for future stages of the Shah Deniz development and for ACG FFD. Potential cumulative impacts are discussed in Cumulative Impacts (Chapter 12).

In light of the potential to impact sensitive habitat removed from the immediate construction site, it is considered appropriate that the use "silt screens" during the installation activities be evaluated. Silt screens would contain mobilised sediments to a smaller area and hence would reduce off-site impacts associated with sediment mobilisation and deposition. Any need for additional compensatory measures should be determined by monitoring the effects of the habitat loss and disturbance over the medium to long-term following pipeline installation (Environmental Mitigation and Monitoring; Chapter 14).

10.3.4.3 Discharge of drilled cuttings, WBM and cement

Drilled cuttings and WBM

As discussed, a BPEO undertaken to identify the best disposal option for drilled cuttings and drilling mud. The study concluded that the best disposal option for drilled cuttings and WBM from the 28" top-hole sections would be discharge directly to the seabed. Drilled cuttings and SOBM from lower-hole sections will be brought to the platform topside where SOBM will be recovered for re-use and the cuttings shipped-to-shore for treatment and disposal.

Approximately 804 m^3 of drill cuttings from three wells, including residual quantities of WBM, would be discharges to the seafloor during MODU drilling operations. The total volume of cuttings and WBM discharged to the seafloor from the TPG500 platform wells (assuming a total of six wells) will be approximately 1,608 m^3. The total volume of cuttings and WBM discharged to the seabed for the planned nine wells is therefore, 2,412 m^3.

The composition of the WBM to be used is discussed in the Project Description (Chapter 5; Section 5.2.1.3). Although the fluids and WBM are carefully selected to ensure only low toxicity substances are used, their discharge with cuttings represents a potential input of trace metal contaminants, salts and suspended sediments into the receiving environment.

The dispersion behaviour and the likely deposition pattern on the seafloor of drilled cuttings and WBM discharged would be dependent on a number of variables including:

?? prevailing hydrodynamic conditions at the time of the discharges;
?? the volume of material discharged;

?? the rate of the discharge;
?? discharged cuttings and mud particle size and type;
?? dispersion and agglomeration characteristics of the mud and cuttings; and
?? the relative proportion of soluble and insoluble components.

Dispersion modelling was completed for the release of the WBM and cuttings from the 28" section of a single typical Shah Deniz well using MUDMAP a proprietary software application.

The modelling indicated that only the smaller and lighter particle sizes would remain in the water column long enough to be possibly influenced by variations in ambient current velocities (i.e. changes in strength and direction). The settling rates of the larger particles were sufficiently high as to be relatively insensitive to the range of current velocities that were considered. Discharged cuttings and WBM were predicted to form a bell-shaped pile that had the greatest thickness immediately around the discharge point and with an exponentially decreasing thickness with distance from the well head point of discharge.

The cuttings and WBM discharge simulations predicted that the lighter cuttings particles would travel up to 160 m from the discharge point. A maximum theoretical cuttings pile thickness of 2.6 m around the discharge point and a thickness greater than 10 cm out to approximately 16.4 m from the discharge point were predicted.

The results of cuttings and WMB dispersion modelling are summarised in Table 10.22 below. Figures 10.13 through 10.16 illustrate the deposition pattern for various meteorological conditions.

Table 10.22 Predicted dispersal of drill cuttings and WBM during summer and winter

Conditions	Maximum Bottom Thickness (m)	Maximum Distance from the Release Site (m)	Predicted Area of Coverage (m^2)[1]
Winter - low energy	2.28	79	11,260
Winter - high energy	2.19	159	11,896
Summer - low energy	2.57	81	9,662
Summer - high energy	2.51	116	9,985

1. The predicted area of coverage includes cuttings deposition depths of down to 1,000 ? m.

It should be noted that the modelling did not include any provision for slumping of the cuttings pile nor for any additional disturbance caused by the rotation and movement of the drill string. It is also known that due to the clay like nature of the rock being drilled, some of the cuttings will dissolve before dispersion, potentially leading to an overall reduction in the area covered by cuttings from the well from that predicted by the model. The model results represent therefore, a worst-case scenario.

Figure 10.13 Predicted dispersion of discharged cuttings and WBM from a single well during low energy winter conditions

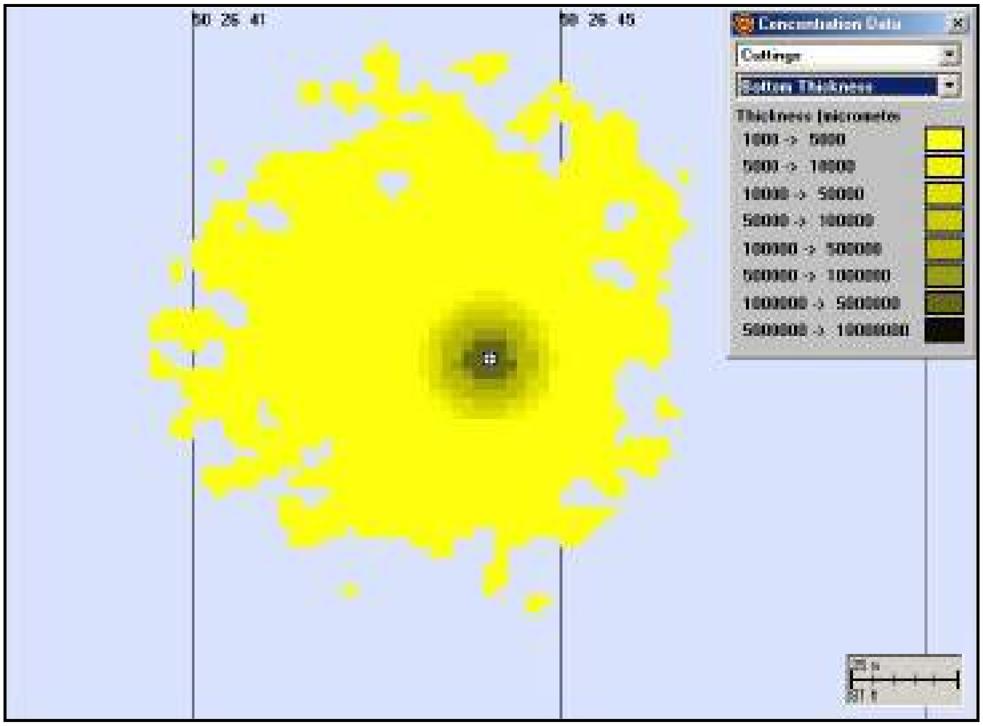


Figure 10.14 Predicted dispersion of discharged cuttings and WBM from a single well during high-energy winter conditions

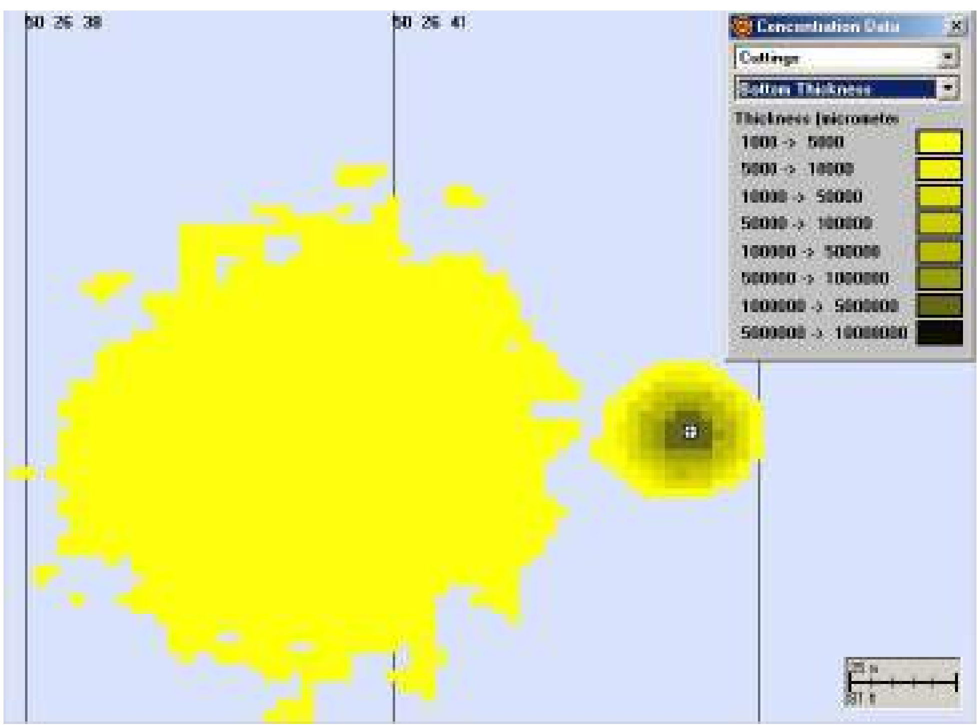


Figure 10.15 Predicted dispersion of discharged cuttings and WBM from a single well during low-energy summer conditions

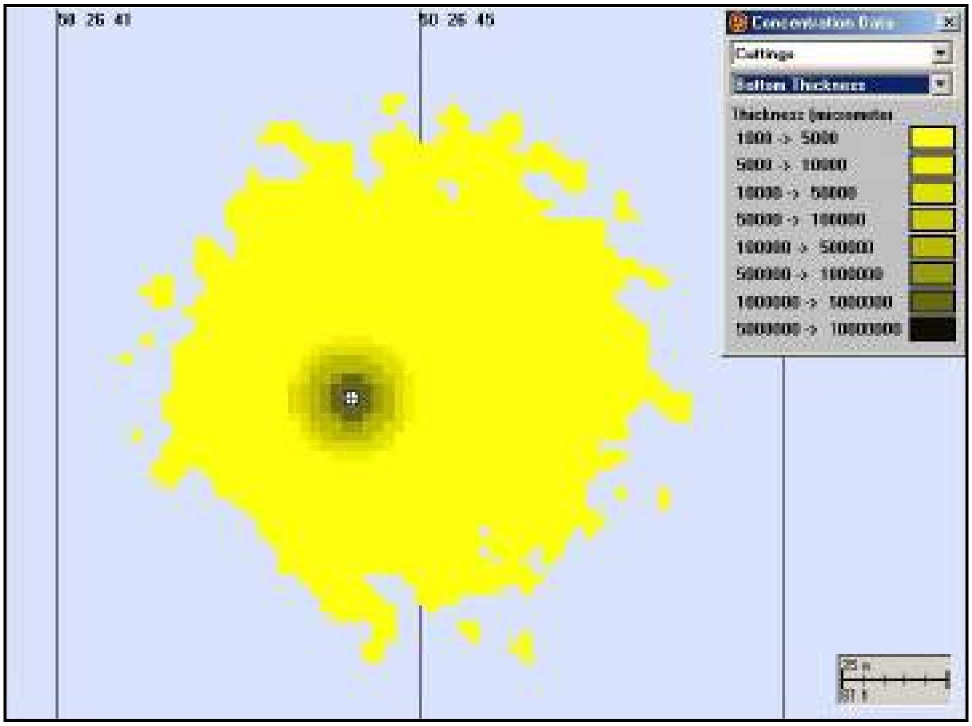
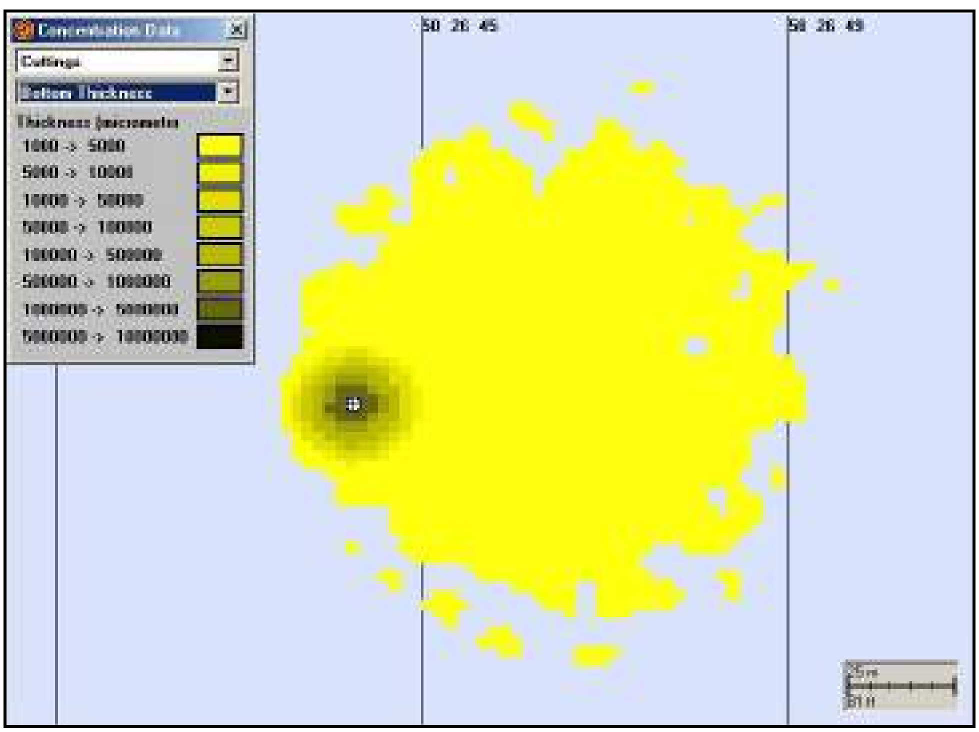


Figure 10.16 Predicted dispersion of discharged cuttings and WBM from a single well during high-energy summer conditions



Cement

As discussed in the Project Description (Chapter 5; Sections 5.2.1.3 (MODU drilling) and 5.3.5.2 (platform drilling)), small quantities of cement may be displaced from the well bore when casings are being secured in place. Under normal circumstances, the cement will be contained within the casings and will not be released in large volumes as discharges will be minimised by analysing well designs and anticipating the total volume required. It may however, become necessary to abort the cementing job, in which case up to 100 bbls of mixed cement may be discharged via the cement dump caisson[8]. This discharge would occur over a short period, assumed to be about two minutes.

To predict the fate of this potential discharge, dispersion modelling of the discharge was completed. The simulation of the cement discharge was completed using "no flow" conditions as the effect of currents in the water column on the cement was considered to be minimal. After its release, the cement would descend rapidly by virtue of its discharge momentum and significant negative buoyancy.

Modelling indicated that the bulk of the cement ultimately hits the seabed and spreads while the settling of any entrained particles continues. The process occurs over a very short period of time (i.e. tens of seconds) thus preventing any significant horizontal dispersion of the discharged material. A mound is predicted to form below the discharge site with a predicted peak thickness of 7.5 mm at the centre point. The mound would cover an estimated area of 36 m^2 and would thin uniformly with increasing distance from its centre.

Due to the depth of the water at the E2 drill site (i.e. approximately 100 m), the weakness of the bottom currents and the cohesive nature of the cement discharge, it is not expected that there would be appreciable re-suspension of the material following deposition.

It should be noted that any discharge of cement from the TPG500 platform would be on top of the drill cuttings already released to the seabed during the MODU and platform drilling programmes. Cuttings released during the drilling of subsequent wells (from the TPG500) would be discharged on top of any cement that had been released during the drilling of earlier wells.

Figures 10.17 and 10.18 show plan and section views respectively of the predicted bottom thickness contours for the discharge of 100 bbls of cement.

[8] The cement discharge caisson is located in Leg 3 of the TPG500 platform.

Figure 10.17 Model predicted bottom thickness contours from 100 bbls of discharged cement under zero flow conditions – plan view

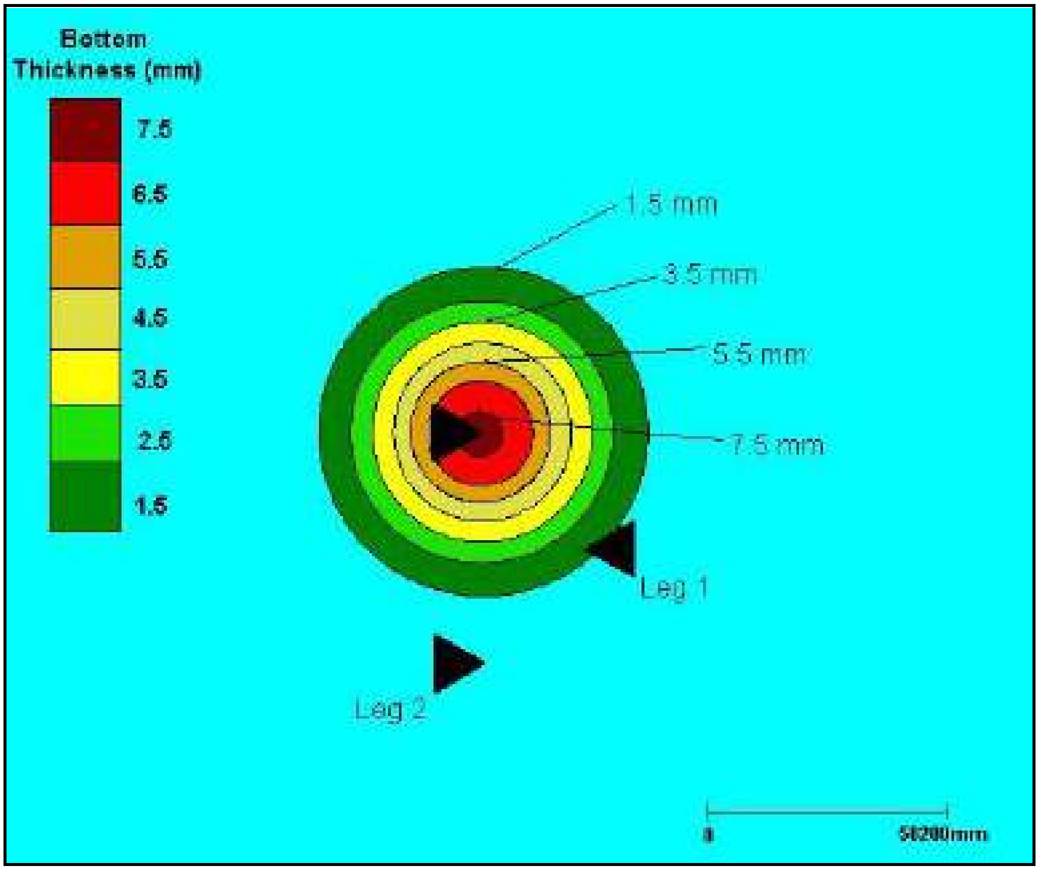
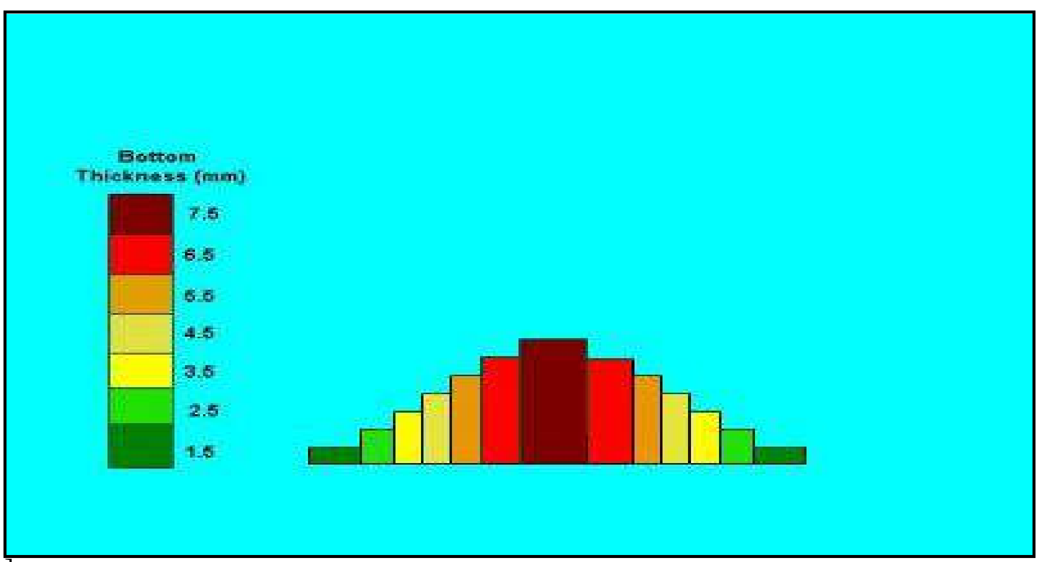


Figure 10.18 Model predicted bottom thickness contours from 100 bbls of discharged cement under zero flow conditions – sectional view



]

Impact significance

Concerns have been raised by Azerbaijani authorities about the proposal to discharge drilled cuttings to the sea. The concern surrounds the perception that any discharge to the sea would result in contamination of the Caspian as well as the loss of feeding and spawning grounds for important fish species. To enable an assessment of the impacts that may be incurred as a result of discharges of cuttings, WBM and cement from the Stage 1 MODU and platform drilling programmes, the site of the proposed offshore development has been surveyed to establish baseline conditions and in particular to characterise the benthic community structure at the location (Chapter 6; Sections 6.2.5.3 and 6.2.6.3).

There are two mechanisms of impact from discharge of cuttings, WBM and cement namely, physical and chemical.

Physical environmental impacts on the seabed are associated with deposition over and above the typical background sedimentation regime for a site. The largest particles in the cuttings discharge that are accumulated bury the pre-existing seabed and associated animals and change the seabed relief. Lighter components are dispersed further and settle to form a layer decreasing in thickness away from the discharge point.

As discussed above, any cement discharge from the caisson would be expected to settle very rapidly with little appreciable lateral dispersion (i.e. predicted total areas of coverage is only 36 m^2). The predicted cement mound would sit on top of the discharged cuttings. The following discussion on the effects of these discharges therefore focuses on the cuttings.

The direct effects on seabed animals from the cuttings deposition on the seabed include infilling of burrows, burial of animals and damage to sensitive respiratory systems and feeding structures.

Indirect effects result from changes in sediment particle size characteristics, possibly affecting the suitability of the seabed for settlement of juveniles, animal mobility and feeding activity. The severity of these effects is likely to be highest beneath the discharge and would decrease with distance from the discharge point.

Benthic organisms are of key importance in the marine ecosystem through the manufacture and regeneration of organic matter. Additionally, they are important prey species for other organisms including demersal fish populations of commercial value. Cuttings continue to accumulate on the seabed as long as drilling activities continue. Re-colonisation is therefore, prevented until drilling stops.

Further disturbance mainly results from the chemicals associated with the discharge. Based on post-drilling environmental surveys of cuttings piles contaminated purely by WBM (ERT, unpublished data), alterations to the chemical characteristics of seabed sediments can be summarised as follows (relative to baseline conditions):

?? elevated levels of barium;
?? low levels of trace metals associated with the barium; and
?? occasional, small areas of low level organic enrichment.

The constituent chemicals in the WBM fall within the lowest hazard categories of the HOCNS classification scheme (Group E) and none exhibit any intrinsic toxicity. In addition as, the chemical components of the WBM are readily soluble; they tend to dissolve within the water column. The main components that get deposited on the seabed, apart from drilled rock cuttings are therefore, the weighting and viscosity control agents (e.g. barite and bentonite).

Barite used as a weighting agent in the WBM during drilling consists of barium sulphate an insoluble, chemically inert mineral powder that can contain measurable concentrations of trace metals. Of course, one of these trace metals is barium, which is in a form that is biologically unavailable (Hartley, 1990) and thus has no measurable toxic effect on the benthic fauna (Jenkins *et al.*, 1989).

The environmental impact of other contaminant trace metals that may be present in the barite depends on their concentration, which in itself depends to some extent on the geological source of the barite. It should also be noted that all barites will be analysed to ensure that the concentrations of the concerning heavy metals cadmium and mercury are less than 3 mg/l and 1 mg/l, respectively. Neff *et al.* (1989a) found that metals associated with drilling mud barite are not in practice bio-available to marine organisms that might come into contact with discharged WBM.

Monitoring results at recent well sites in the southern Caspian have shown that very little chemical contamination was detectable at single well drilling locations where WBM has been used. There have however, been detectable changes in the physical character of the sea bed particularly within 50 m of the well-head where the drilled cuttings from the upper well sections were discharged directly to the sea bed (ERT, unpublished data). Macrofaunal biomass may be reduced by up to 90% close to the wellhead where the cuttings pile is thickest. Beyond 50 m, changes in the benthos caused by cuttings discharge were not distinguishable from those due to natural variation. This is despite evidence, in the form of slightly elevated concentrations of barite in surface sediments of drilling mud deposition as far out as 100 m.

Organic enrichment effects associated with the discharge of cuttings and WBM are typically not detected in post-drilling surveys. In the few cases that organic enrichment effects have been observed, they are usually attributed to the small amounts of pay-zone cuttings that are discharged during drilling of the lowest sections of the wells as these can have elevated levels of hydrocarbons. Pay-zone cuttings would not be discharged during Stage 1 drilling rather would be shipped-to-shore for treatment and disposal. It is not considered therefore, that any organic enrichment effects would be associated with the discharge of WBM and cuttings.

With regard to recovery of the seabed and macrofauna around such wells, the same studies provide evidence that the areas most impacted (i.e. close to the wellheads) can support communities similar albeit somewhat impoverished, to those expected for the region within four months of cessation of drilling. After 12 months, recovering communities at up to 50 m distance from the well-head may have a biomass similar to or exceeding that recorded prior to drilling.

There are insufficient data at present to characterise faunal succession during recovery from these impacts. What can be stated is that species inhabiting the most impacted areas within four months of drilling a single well include abundant populations of the cumacean *Stenocuma diastyloides*, the tube-dwelling amphipod *Corophium* spp. and the mussel *Mytilaster lineatus*. Other species of highly mobile deposit-feeding cumacea have been found to occur in similarly disturbed habitats in the North Sea and mussels typically are hardy opportunistic organisms noted for their fouling capabilities. It should be noted that small crustacea such as cumaceans and amphipods tend to be particularly sensitive to chemical/hydrocarbon contamination and therefore their presence in large numbers may be indicative of the absence of significant chemical impacts.

The dimensions of the zone of physical impact would increase as the number of wells drilled increases although not necessarily in direct proportion to the number of wells. The cumulative effect of drilling a number of wells would be more temporal than spatial; that is, an extended period of discharge or repeated discharge episodes would interrupt re-colonisation and would delay the onset of the natural recovery process, rather than significantly increasing the affected area.

The Stage 1 drilling programme will be completed over a relatively short period of time (i.e. approximately four years) and therefore, the duration of disturbance to the seabed and in particular, seabed biology would also be limited. Additionally, only nine wells will be drilled at the E2 site resulting in the discharge of only 2,412 m^3 of cuttings and WBM that is predicted to cover a maximum area of a little in excess of only 1ha (Table 10.17). It is concluded therefore, that the impacts associated with the discharge of 28" section cuttings would have an impact of "low" significance on the seabed and seabed biology as follows:

Likelihood of occurrence = 5 - certain to occur.
Consequence = 1 - impact largely not discernable on a local scale.
Significance = 5 - low.

Similarly, impacts associated with drilled cuttings deposition on the seabed resulting from the drilling of five wells at the E3 location are considered to be of "low" significance. If these wells are drilled from the TPG500 using extended reach drilling technology, cuttings would be deposited on the existing cuttings pile and therefore, impacts could be less than if the wells were drilled by another rig at the actual E3 site as the area around the TPG500 would have already been disturbed.

Benthic surveys will be periodically conducted to monitor the effects of drilled cuttings discharge on seabed biology and in particular, the rate of re-colonisation and the composition of re-colonising species.

10.3.4.4 Physical presence of marine structures

The physical presence of the TPG500 and subsea pipelines would potentially interfere with fishing activities and shipping movements and these are discussed in the socio-economic impact Chapter (Chapter 11).

The introduction of these physical structures to the marine environment also represents a change to the habitat in which they are installed. In addition, the physical presence may result in an alteration in local hydrodynamic conditions (e.g. refracted waves, changes in current conditions, wave direction and period). These potential impacts are discussed below.

Impact significance

Hydrodynamics

The hard surfaces of the offshore structures (i.e. TPG500 legs and pipelines) represent a physical barrier to the natural movement of water. As the water flows around these structures changes in flow velocity and localised pressure may occur. Where the flow is accelerated removal of sediment or localised scouring around the structure may occur that over the long-term, may expose buried parts of the structure and in extreme cases can affect stability. Conversely where flow is reduced sediment deposition can occur resulting in the burial of exposed structures on the seabed over an extended period of time.

In additional to physical impacts removal or deposition of sediment would have direct impact of benthic communities. These effects would be greater in the nearshore environment where current conditions along the seabed are stronger.

The subsea structures will be routinely monitored to determine any alterations to the physical conditions of the seabed. Where sediment erosion exposes section of the pipeline freespanning may occur. If this should occur any unsupported sections of the pipeline will be stabilised using grout bags.

The impact on the seabed associated with the physical presence of the offshore installations is considered to be of "low" significance as follows:

Likelihood of occurrence = 5 - certain to occur.
Consequence = 1 - impact largely not discernable on a local scale.
Significance = 5 - low.

Habitat

It is not considered that the long-term physical presence of the TPG500 and subsea pipelines would have a significant effect on fish movement and migration. Indeed, the physical structures provide new stable hard areas equivalent to natural outcrops which surface living animals can colonise. The development of such colonies would be beneficial to the local fish populations. The structures may attract marine species to the area as the structures in effect form artificial reefs where fish can seek food, shelter and protection.

A research project carried out in the North Sea compared the relative health of fish populations in three natural and anthropogenic marine environments, namely:

?? fish caught around a typical drilling and production platform;
?? fish caught around a sunken semi-submersible rig, located in the same area as the drilling and production platform under investigation, to represent a man-made but unmanned structure; and
?? fish caught at a remote site on the west coast of Scotland to represent a population unaffected by man-made structures.

The results showed that the fish growing around the manned and unmanned installations were growing better than those from the third location (Mathers *et al.*, 1992b). It was also found that the fish caught around the man-made installations were in good condition with no evidence of lesions or other defects on their skin (Mathers *et al.*, 1992b). This work indicates that there may be a beneficial effect accrued on fish stocks by the presence of offshore installations.

Although there is limited information on Caspian Seal movements offshore, the installations would not be considered to present an obstacle to the movement of these mammals in the area. Indeed, the seal may be attracted to any fish congregating around the offshore structures (see above). Indeed, the Caspian Seal is regularly observed in the waters around the existing Chirag-1 platform.

The impact on seabed biology associated with the physical presence of the offshore installations is considered to be of "low" significance as follows:

Likelihood of occurrence = 5 - certain to occur.
Consequence = 1 - impact largely not discernable on a local scale.
Significance = 5 - low.

10.4 Impacts on onshore environmental receptors

This section presents a discussion on potential impacts to onshore environmental receptors that would occur as a result of routine and planned non-routine Stage 1 project activities. The onshore environment includes, as described in the Environment Description (Chapter 6), coastal habitat and inland (semi-desert) habitat. The following sections are presented:

?? impacts on the onshore atmosphere;
?? impacts on the physical coastline (i.e. shoreline configurations);
?? impacts on groundwater and groundwater aquifers;
?? impacts on hydrological systems and flows;
?? impacts on subsurface geology;
?? impacts on topography and landscape;
?? impacts on coastal habitat, flora and fauna;
?? impacts on inland habitat, flora and fauna; and
?? impacts of project decommissioning.

All potential impacts are discussed whether significant or otherwise to ensure that all Stage 1 onshore activities have been appropriately assessed although greater emphasis has been given to the activities that have been assessed that potentially result in more significant impacts.

10.4.1 Impacts on the onshore atmosphere

Emissions to the onshore atmosphere resulting from the Stage 1 project would result from the following activities:

?? onshore assembly of the TPG500;
?? terminal early civil engineering work programme and construction;
?? pipeline installation between the landfall and terminal; and
?? terminal operations.

The atmospheric emissions generated during these activities are identified and quantified in the Project Description (Chapter 5; Sections 5.5.4.5 and 5.5.4.15) and their environmental fate is discussed in Section 10.3.1. The impact of emissions associated with onshore construction activities and terminal operation is further discussed below.

10.4.1.1 TPG500 assembly, terminal construction and pipeline installation

Assembly of the TPG500 will take place in a yard near Baku although the exact site has not yet been selected. Terminal construction operations will be undertaken at the proposed terminal site immediately adjacent to the existing EOP terminal at Sangachal.

Atmospheric emissions from assembly and construction activities would be limited to small combustion sources such as diesel generators, cranes and other diesel driven equipment located at the terminal site, construction yard and pipeline landfall locations. An increase in lorry, car and bus movements to and from each site would also contribute to a temporary and localised increase in emissions to air in the area.

Impact significance

Estimated quantities of emissions to the atmosphere resulting from activities associated with platform assembly, terminal construction activities at Sangachal and pipelines installation in the nearshore and onshore were found to be very low (Chapter 5; Sections 5.4.8.1 and 5.5.4.5). While the activities could result in an increase in the ambient air concentrations of emitted species near to the source of the emissions, the emissions would rapidly disperse. Further, the temporal and spatial distribution of the emission would be such that they would be unlikely to lead to any significant degradation of local air quality and hence no impact to human health would be expected. The impact significance associated with these emissions is therefore, considered to be "low" as follows:

Likelihood of occurrence = 5 - certain to occur Consequence = 1 - impact largely not discernible on a local scale Significance = 5 - low

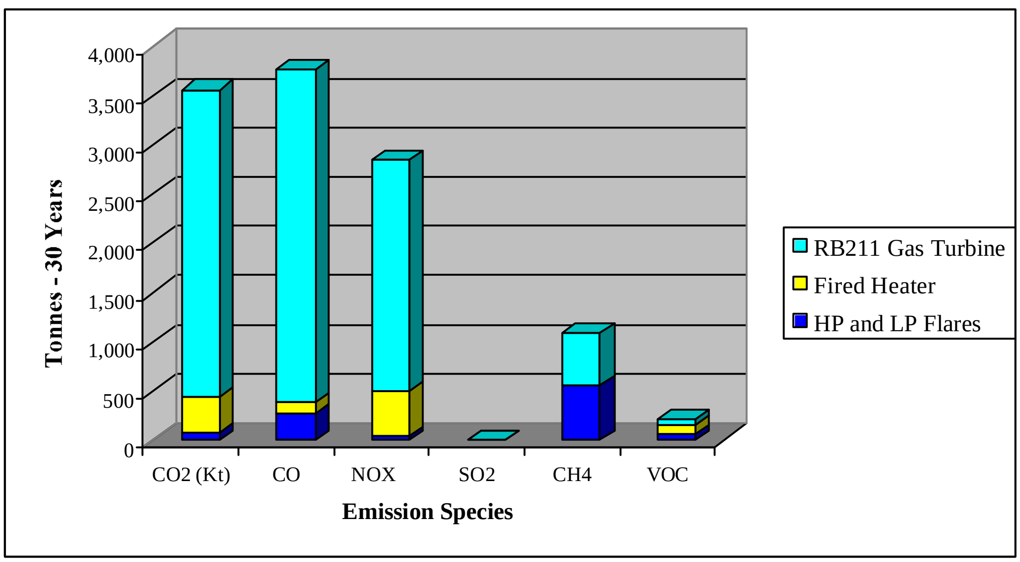
10.4.1.2 Shah Deniz terminal operations

There are a number of sources of emissions to the atmosphere resulting from operations at the gas-condensate reception and processing terminal. The principal sources would include:

?? the RB211 gas turbine;
?? Waste heat recovery package with additional firing
?? fired heater;
?? operational flaring
?? non routine flaring; and
?? fugitive emissions.

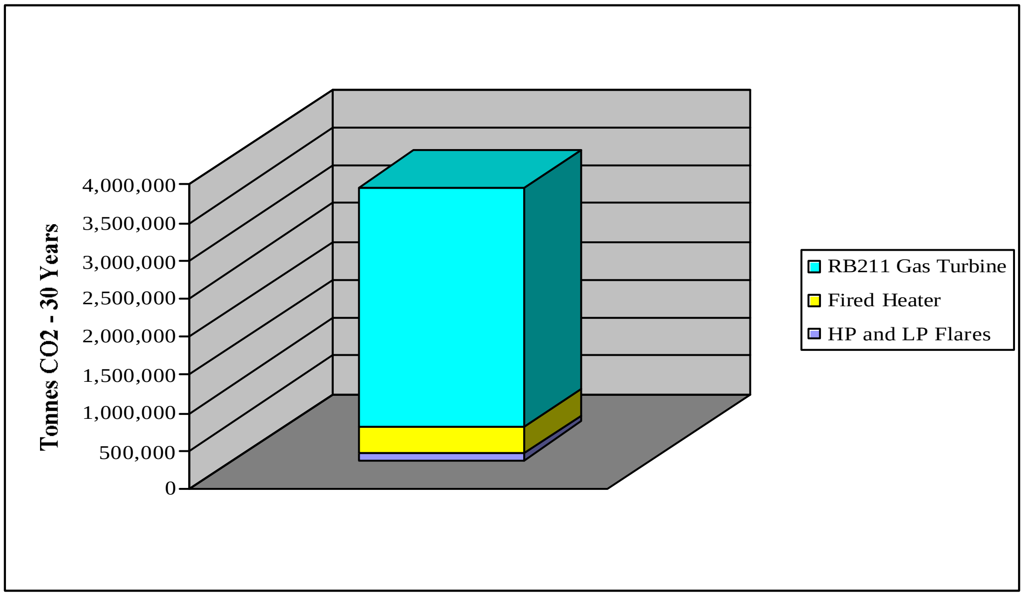
The estimated total emission quantities by species from each of the activities over the 30-year life of the project are illustrated in Figure 10.19 and 10.20.

Figure 10.19 Estimated total emission quantities by species from terminal operations over the life of the project (30 years)



Note: Units of CO_2 are in kilotonnes.

Figure 10.20 Estimated total GHG emission quantities from terminal operations over the life of the project (30 years)



The principle contributors to the total emissions from the terminal would be the RB211 gas turbine and the fired heater both of which are fuelled by gas exported from the TPG500. Fuel gas requirements are based on the predicted production levels from the development.

An emergency back-up stand-alone diesel generator would also be provided at the terminal and would be tested for one hour once per week. The diesel powered firewater pump would also be tested for one hour once per week.

Flaring of hydrocarbon product would only occur during non-routine and shutdown events. Associated emissions have been estimated using the following assumptions:

?? 900 MMscfd twice a year; and
?? 450 MMscfd six times per year.

The power generation emission and flare stack heights would ensure maximum dispersion of the principal emissions from the terminal over a wide area.

Fugitive losses of volatile organic compounds from plant equipment connections and terminal storage tanks represent a relatively minor source of emissions and would be largely controlled by minimisation through appropriate specifications for valves, flanges and seals. Primary and secondary seals with low loss fittings will be installed on the floating roof condensate storage tank resulting in reduced fugitive emissions at the site.

The process releases to the atmosphere that have the greatest potential to impact on human health include oxides of nitrogen (NO_X), carbon monoxide (CO) and volatile organic compounds (VOC). NO_X emitted from the combustion sources comprises a mixture of nitric oxide (NO) and the more toxic nitrogen dioxide (NO_2). NO is partially converted to NO_2 by oxidation in the presence of ozone in the atmosphere. The majority of NO_X emissions would be in the form of NO. The atmospheric dispersion study concentrated on NO_2 due to its greater potential to result in adverse health effects. The model results for NO_2 concentrations were therefore, conservative and leads to higher predicted concentrations for the scenarios modelled.

CO is toxic to humans at high concentrations. The VOC emitted will be predominantly alkenes (propane, butane etc), although the VOC may also contain a small proportion of suspected carcinogenic compounds.

International standards and guidelines for NO_2, SO_2 and CO are presented in Table 10.23. The UK Environment Agency statement on releases of VOC in gas terminals is that they should be minimised. Previously levels of 50 mg/m^3 have been quoted. Other VOC protocols also exist (e.g. LRTAP Convention 1991).

Table 10.23 International standards and guidelines for air quality

Pollutant	Air Quality Objectives		
	Concentration ?gm^{-3}	Averaging period	International Standard or Guideline
Nitrogen Dioxide	400, 200	1 hour mean (99.8%ile)	WHO[1], EU[2]
	150	24 hour mean (guideline)	WHO
Sulphur Dioxide	350	1 hour mean (99.7%ile)	WHO
	40-60	24 hour mean (guideline)	EU
Carbon Monoxide	100 mg	<1 hour (15 min) (99.8%ile)	WHO
	30 mg	1 hour mean	WHO
Ozone (health)	150-200	1 hour mean	WHO
	110	8 hours mean	EU

Notes:
1. **WHO:** World Health Organisation, 'Guidelines for Air Quality', 2000. For PAH and benzene the WHO guidelines state 8.7 x 10^{-2} ug/m^3 (lifetime) and 4.4-7.5 x 10^{-6} ug/m^3 (lifetime) respectively.
2. **EU:** Council of the European Communities, Council Directive on Air Quality Standards for Nitrogen Dioxide (85/203/EEC). Council of the European Communities, Council Directive Amending Directive 80/779/EEC on Air Quality Limit Values and Guide Values for Sulphur Dioxide and Suspended Particulates (89/427/EEC), Official Journal of the European Communities, 1989.

Air dispersion modelling was conducted in January 2002 using best available data for the ACG and Shah Deniz projects. This modelling is ongoing but to date has concentrated on emissions of NO_X based on the emissions estimates calculated for routine and planned non-routine operations at the terminal. In this model the ACG flare stack height used was 38 m and the Shah Deniz flare stack 100 m. Modelling did not include SO_2 emissions from the Shah Deniz terminal as the terminal does not contain appreciable amounts of H_2S. Modelling for whole combined operation of the ACG and Shah Deniz terminals included preliminary estimates of sulphur for occasional flaring by ACG.

The values obtained for NO_X at nearby receptors are provided in Table 10.24 for selected years of the operations. The following operations have been assumed for each year modelled.

?? **2002:** EOP terminal operations (current case).
?? **2005:** year 1 of ACG Phase 1 and EOP terminal operations.
?? **2006:** year 2 of ACG Phase 1, EOP and year 1 of Shah Deniz Stage 1 terminal operations.
?? **2007:** year 3 of ACG Phase 1, EOP, year 1 of ACG Phase 2 and Shah Deniz Stage 1 terminal operations.
?? **2010:** ACG Phase 1 peak production, EOP, ACG Phase 2 and Shah Deniz Stage 1 terminal operations.

Table 10.24 NOX concentrations at receptors nearby the terminal location (?gm-3 99.8%ile 1 hour mean)

NO_X Concentration	2002	2005	2006	2007	2010
Sangachal Town	32	58	58	40	30
Railway Barrier	45	63	65	40	40
Stone Mine	15	44	40	35	29
West Hill Herders	41	77	80	50	48
Cheyildag	32	66	70	60	45
Garadag Cement Plant	23	44	40	35	29
Cement Camp	51	73	75	50	48
Maximum Concentration	96	132	135	124	106

The model used the worst coincidental meteorological conditions for all the cases. The results confirms that NO_X emissions would be well dispersed and predicted hourly concentrations are all well within internationally recognised air quality standards at nearby receptors.

Impact significance

Based on the results of the atmospheric dispersion modelling studies, emissions would be expected to rapidly disperse and hence would be unlikely to lead to any significant degradation of local air quality. Impacts on human health would not therefore, be expected.

Combined Shah Deniz, ACG and EOP onshore terminal operations would also result in considerable amounts of GHG being released to the atmosphere and these would be in addition to offshore emissions of this substance. The total GHG contribution from Shah Deniz terminal operations represents however, a very minor amount of the total combined emissions. Despite this fact, given the international nature of GHG, its apparent potential to contribute to global warming and the fact that project stakeholders have raised concerns regarding GHG emissions from the combined ACG and Shah Deniz terminals the overall significance of GHG emissions is considered as "high" as follows:

Likelihood of occurrence = 5 - certain to occur
Consequence = 2 - public perception / concern regarding GHG
Significance = 10 - high

The release of GHG remains a concern to BP and the total volumes releases over the life of the project will be closely monitored. GHG emissions from the Stage 1 project are further discussed in the Transboundary Impacts chapter (Chapter 13).

10.4.1.3 Dust

The surface soils in the vicinity of the proposed work site consist of predominantly clays and silts and as such are very made up of fine particles (Chapter 6). Any activity that leads to the disturbance of surface soil could increase the atmospheric dust levels. The occurrence and significance of dust generated by project activities is difficult to estimate and depends upon meteorological and ground conditions at the time and location of the activities. It is considered that dust would primarily be an issue during the terminal civil engineering works.

Impact significance

Dust suppression measures, such as watering-down work areas, would be implemented to minimise any adverse effects on construction workers. In the context, the impact significance of dust emissions on the atmosphere and nearby human receptors is considered to be "low" as follows:

Likelihood of activities occurring = 5 - certain to occur Consequence = 1- impact largely not discernable on a local scale Significance = 5 - low

Baseline surveys conducted for this ESIA did not identify contaminated soils within the proposed terminal construction area (Chapter 6) but knowledge of the site as gained during the soil and groundwater studies conducted during the ESIA programme indicated that dust levels can be extreme and could make working conditions difficult. Airborne dust may at times therefore, represent a nuisance to construction workers. It should be noted, however that the study site was not watered-down during the soil and groundwater survey activities. Third party human receptors are some distance removed from the proposed works area and are therefore not considered to be at a significant risk because the majority of dust particles liberated would settle before reaching these receptors.

10.4.2 Impacts on the (physical) coastline

The coastline of Sangachal Bay would be directly and indirectly impacted as a result of the following project activities:

?? construction of a finger-pier (jetty) to enable nearshore trench excavation for the 26" gas and 12"/4" condensate/MEG pipelines; and
?? construction of the pipelines' landfalls (i.e. shoreline crossing).

10.4.2.1 Finger-pier construction

Each finger-pier required for nearshore pipeline installation would be approximately 10 m wide at its base and 100 m long. It would most likely be a rock groyne structure. The project's base-case is for piers to be removed after pipeline installation has been completed.

Physical alteration to the coastline in the north of Sangachal Bay is evident following the construction of a similar jetty structure in 1997 which was required to enable the nearshore installation of the EOP 24" subsea pipeline. The jetty was not removed following pipeline installation. As discussed in the Environment Description (Chapter 6) sediment accretion is apparent on the northeastern side of the EOP jetty and to a lesser extent, on the northeastern side the EOP terminal sewage outfall pipeline. Erosion is apparent on the southwestern side of both structures. Earthworks presumably associated with the installation of the facilities have also changed the shoreline in the north of the Bay by extending the land further into the sea and by changing the beach profile.

Impact significance

The impact assessment on the physical coastline resulting from construction of a finger-pier for the Stage 1 26" and 12"/4" pipelines is considered to be of "high" significance. Impacts would be two-fold as follows:

?? direct alteration of the physical coastline at the points at which finger-pier would be constructed; and
?? indirect alteration of the coastline near and potentially removed from the finger-pier's location due to changed nearshore hydrodynamic conditions.

Construction of a finger-pier for installation of the Stage 1 subsea pipelines would result in direct physical disturbance and alteration of the coastline as occurred with the installation of the jetty for installation of the EOP subsea pipeline. The nature and extent of the change would be dependent on the construction methods used for installation of the rock groyne structure. It would be expected however, that the beach profile in the immediate vicinity of the works would be noticeably changed. Assuming an appropriate level of control of the movement of construction equipment, the area of impact should, however be minimised. There would be an opportunity to restore the coastline following removal of the finger-pier structure.

It is well documented that jetty structures in the coastal environment can change local hydrodynamic conditions and sediment transport regimes and thus, coastline configuration in the vicinity of the structure. In some instances, changes to coastline configuration can be observed at some distance from the structure. Resultant effects can include deposition and erosion of the coastline close to and in areas removed from the facility.

As discussed in the Environment Description (Chapter6), the hydrodynamic regime in Sangachal Bay is dynamic and complex. Importantly, it has been determined by two separate studies that observed current strengths are capable of mobilising and transporting sediment. Observations made during the 2001 investigations for this environmental impact assessment concluded that erosion of the coastline near to the existing EOP jetty is likely to be attributable to that structure.

The finger-pier required for the installation of the Stage 1 pipelines would be a much larger structure than that built for the EOP pipeline and hence could be expected to more significantly alter local hydrodynamic conditions. Exactly what change may occur in the medium to long-term and in terms of the actual effects on the adjacent and nearby (physical) coastline, is difficult to predict without quantitative sediment dynamics modelling. Further, the significance of any change is difficult to gauge but it is considered that any coastal erosion or deposition that adversely affected sensitive coastal areas (e.g. wadis and associated marsh habitat) and/or anthropogenic structures (e.g. the duel carriage road) would constitute a negative impact.

The construction and physical presence of a finger-pier constructed for installation of the Shah Deniz Stage 1 pipelines' would directly impact the coastline and the coastal habitat at the site. Impacts on coastal habitat are discussed in Section 10.4.8 below. Based on the observed nature of the hydrodynamic regime in the nearshore Sangachal Bay environment and on the observed changes to the coastline resulting from the EOP jetty, it is considered impacts on the physical coastline associated with the Shah Deniz finger-pier may not be limited to the immediate site only and would be discernable on a local scale and therefore, are considered to be of "high" significance as follows:

Likelihood of activities occurring = 5 - certain to occur.
Consequence = 2- local scale impact.
Significance = 10 - high.

Given that finger-piers would be removed following pipeline installation, it can be confidently assumed that natural processes would return to their former state of equilibrium. Any adverse change to coastline configuration that had occurred while the facilities were in place may however, require human intervention in the form of pro-active coastline and coastal habitat rehabilitation.

10.4.2.2 Pipeline landfall construction

As discussed in the Project Description (Chapter 5; Section 5.4.2), the base-case for the Shah Deniz pipelines' nearshore approach and landfall site is common with the that of the ACG pipeline. Installation of the gas and condensate export pipelines would require trenching for each pipeline, perpendicular to and through the coastline to facilitate pipe-haul into the onshore area. Trenching and associated earthworks would result in direct impacts to the physical coastline and coastal habitat at the landfall site.

Impact significance

The primary impact of construction of the pipeline landfall would be loss of coastal habitat and subsequent impacts on the fauna that inhabits the area. These issues are discussed in Section 10.4.8 below.

The section of coastline that would be impacted by the construction of the two Shah Deniz pipelines' landfalls (including machinery and vehicular activity) is estimated to be in the order of 50-100 m. Impacts on the physical coastline associated with construction of the pipelines' landfall are therefore, considered to be of "high" significance as follows:

Likelihood of activities occurring = 5 - certain to occur
Consequence = 2- local scale impact
Significance = 10 - high

It should be noted that there would be no permanent above ground structures associated with construction of the pipelines' landfalls and disturbed areas would be rehabilitated to as close as possible to pre-activity conditions. As such, it could be expected that lost coastal habitat could eventually rejuvenate.

10.4.3 Impacts on soils

Soils would be directly impacted as a result of the following project activities:

?? installation of the onshore sections of the 26", 12"/4" pipelines from the landfall to the terminal; and
?? terminal early civil engineering work programme and construction.

10.4.3.1 Pipeline installation onshore

Pipelines would be trenched to a depth of 1 m from top of pipe (TOP). Each trench would be approximately 3 m wide. Excavation of the trench and associated pipe-laying activities would however, require that a width of approximately 25 m along the pipeline corridor be utilised.

The distance from the pipelines' landfall sites to the terminal site is approximately 1.7 km for all shoreline approach / landfall options. Assuming the above working area width of 25 m, the area that would be impacted as a result of onshore pipeline installation would be approximately 4 ha.

It should be noted that all the topsoil removed during the excavation of the onshore pipeline trench would be stock piled and would be replaced once the pipeline has been installed. The location of topsoil stockpiling is yet to be determined.

Impact significance

The installation activities associated with the installation of the 26" and 12"/4" pipelines would result in direct disturbance of soil. Impacts would include localised alteration of the soil profile within the trench footprint and soil compaction is the immediate vicinity as a result of vehicle and plant operations. Disturbed soil can be more susceptible to erosion.

The total area that would be affected by the activities would be limited and the area affected would be rehabilitated following earthworks. The impact significance of this activity on soil is considered to be "low" as follows:

Likelihood of activities occurring = 5 - certain to occur
Consequence = 1- impact largely not discernable on a local scale
Significance = 5 - low

It should be noted that while impacts on soils would be of "low" significance, it is considered that should pipeline route Option 2 be selected, the impacts would be considerably more difficult to manage in areas adjacent to the wadi system where soil and wadi bank stability may be less.

10.4.3.2 Terminal construction

The main impacts on soils resulting from the terminal construction programme would will occur during the early civil engineering works programme which is preparing the site for the Shah Deniz FFD, ACG FFD terminal construction and the construction of the BTC pumping station. As stated in the Project Description (Chapter 5; Section 5.4..2), the ECEWP ESIA has already been approved by the MENR and work is currently ongoing. The impacts associated with this work are, summarised here to provide context to the Shah Deniz terminal development programme of which the ECEWP is a part.

The ECEWP includes the excavation of top and subsurface soil as part of the construction of the drainage channel and the removal of top- and subsurface soils in the area of the Shah Deniz and ACG terminal development areas and the BTC pumping station site. In addition, new roads, a construction camp for the terminal construction workforce and a number of retention ponds for the wastewater treatment at the terminal are being constructed. Although the removed soils are being stockpiled for later use in bund wall construction and land levelling and/or site rehabilitation works, it is lost from its point of origin.

Impact significance

Early civil engineering work has resulted in impacts on soil in the following areas:

??	construction of the drainage channel:	27.5 ha.
??	the clearing, grading and levelling in the area in which the terminal(s) are to be constructed (Shah Deniz, Phase 1 and BTC)	112.3 ha.
??	main new access roads:	7.5 ha.
??	construction camp:	13 ha.
??	retention ponds:	10 ha.

In total, the construction programme for Shah Deniz Stage 1 and ACG Phase 1 has resulted in direct impacts on soil over an area in excess of 170 ha. It should be noted that some soil in areas additional to this would be indirectly impacted as a result of vehicle movements and soil stockpiling. Most of the levelled area lies within the existing EOP land-take area and has previously been impacted as a result of earthmoving activities undertaken for that terminal construction project.

In a local context, soil loss is considered to constitute an impact of "high" significance as follows:

Likelihood of activities occurring = 5 - certain to occur Consequence = 2- local scale impact Significance = 10 - high

In a regional context, impacts associated with the soil loss are considered to be less significant as the total area affected represents only a small percentage of the surrounding (similar) terrain and habitat.

Impacts on terrestrial habitats are discussed in Section 10.4.9 below.

10.4.4 Impacts on groundwater and aquifers

The following project activities have the potential to impact groundwater and aquifers:

?? installation of the onshore section of the 26" and 12"/4" pipelines from the landfall sites to the terminal; and
?? terminal construction.

10.4.4.1 Pipeline installation onshore

Installation of the two Shah Deniz pipelines in the onshore environmental would include the excavation of two trenches from the shoreline landfall sites to the terminal site and as such may result in disturbance of groundwater and/or groundwater aquifers.

An intrusive subsurface investigation undertaken at the terminal site (Chapter 6) in May 2001 found that the groundwater in the vicinity of the proposed terminal development site was only present in one of the six boreholes drilled to a depth of 15 m beneath the surface. The water was found at a depth of approximately 9 m and was perched and discontinuous.

Impact significance

As excavation of the trenches for the onshore sections of the Shah Deniz 26" and 12"/4" pipelines would only be to a depth of approximately 2m, it is highly unlikely that any significant groundwater resources would be impacted. The impact significance of pipeline landfall construction on groundwater is therefore, considered to be "low" as follows:

Likelihood of activities occurring = 5 - certain to occur Consequence = 1- impact largely not discernable on a local scale Significance = 5 - low

10.4.4.2 Terminal construction

Terminal construction activities that would potentially interfere with subsurface hydrogeological conditions would include construction of the main drainage channel, which would be constructed to a maximum of 2 m depth and the laying of foundations and underground services, such as power cables, sewage and drainage pipe work. In this instance, the potential exists for perched groundwater to be intercepted. All evidence collected to date suggests however, that perched groundwater/aquifers are considerably deeper, as stated below.

Impact significance

As described groundwater was only encountered at a depth of 9 m below the surface during intrusive investigations completed for this impact assessment. Underground works for the terminal would not occur at this depth and given the depth of occurrence, the limited extent and apparent lack of any aquifer-based discernable flow, impacts as a result of terminal construction activities on groundwater resources are considered to be of "low" significance as follows:

Likelihood of activities occurring = 5 - certain to occur Consequence = 1- impact largely not discernable on a local scale. Significance = 5 - low

10.4.5 Impacts on hydrological systems and flows

The proposed terminal site and surrounding area is, for the majority of the year, very dry. There are a number of drainage lines and ephemeral creeks that cross or are near to the site. Water flow in these hydrological systems occurs after significant rain events and in some instances can be substantial, although short-lived. Following rain events, standing water can be observed in small depressions. The following activities would result in potential disturbance to these hydrological systems and to the flow regime within the area:

?? installation of the onshore sections of the 26" and 12"/4" pipelines from the landfall sites to the terminal; and
?? terminal construction activities and operations (including the early civil engineering work programme).

10.4.5.1 Pipeline installation onshore

Installation of the onshore sections of the 26" and 12"/4" pipelines would result in disturbances to hydrological systems and to the flow regime within these systems. As the pipeline trenches would be back-filled following pipeline installation, the effects would however, only be short-term. In the longer term, the physical presence of the pipelines underground is not considered to represent an obstruction to surface or near-surface water flow.

Impact significance

Impacts on hydrological systems and flows associated with installation of the onshore section of the Shah Deniz pipelines would be localised, temporary and small scale and therefore, would be of "low" significance as follows:

Likelihood of activities occurring = 5 - certain to occur Consequence = 1- impact largely not discernable on a local scale Significance = 5 - low

10.4.5.2 Terminal construction

The terminal flood protection drainage channel and bund wall to be constructed around the terminal (Chapter 5) would have the potential to alter the physical layout of the hydrological system within the footprint of the terminal area. Similarly, grading of the terminal site and construction of the site access road and associated box culverts would also have the potential to alter the hydrological regime. Surface 'hardening' within the terminal footprint would also modify surface run-off from within the proposed terminal footprint as runoff would be diverted and collected for treatment prior to release to the surrounding terrain and natural waterways.

Impact significance

In terms of altering existing hydrological flow patterns, the drainage channel would have the most significant effect in that the feature would be likely to at least partially divert surface waters away from existing wadis and marsh areas that lie between the south-eastern boundary of the terminal site and the shoreline. It may however, increase the flow of water (after rain events) into marsh areas in and near to the mouth of the Sangachal River to the south-southwest of the terminal site and to the ephemeral creeks east-southeast of the site.

The abundance of wetland vegetation in wadis and marsh areas is dependent on the amount of water that enters them. A reduction in the amount of water would, depending on the extent of any change, be paralleled with a reduction in vegetation abundance. This in turn may incur a reduction in the abundance of faunal species that inhabit the wetland areas or use them for grazing and may also result in increased erosion of the areas as they dry out. Conversely, an increase may result in an increase in vegetation and potentially fauna.

The drainage channel has been designed to protect the terminal site from flooding during periods of high rainfall. At present, rainwater runoff from the hills to the north of the terminal site is channelled towards the terminal location, the speed of which is assisted by the lack of absorbance of the compacted clays in the area. The size of the channel has been designed to allow the rate of water flow from the drainage channel outlets to be limited such that erosional scouring of the ground is unlikely.

Without augmenting existing data on the ecology of wetlands, on seasonal and annual water flow in and through the coastal wetlands near to the proposed terminal site, or on the volumes of water that would be affected by construction of the terminal it is difficult to predict with confidence what the significance of a changed hydrological regime impact would be. Given this uncertainty, these impacts are considered to be of "high" significance as follows:

Likelihood of activities occurring = 5 - certain to occur
Consequence = 2- local scale impact
Significance = 10 - high

10.4.6 Impacts on subsurface geology

The two project activities that have the potential to impact on subsurface geology are:

?? terminal construction (foundations); and
?? produced water injection at Lokbatan.

10.4.6.1 Terminal construction

The drainage channel, terminal and access roads would not physically impact on subsurface geological structures. Further, the subsurface geology in the area that would be covered by these features is not known to host any economic reserves even though historically, oil and gas production has occurred in the nearby area (EOP EIA, 1996). The fact that the area would not be available for exploitation by other users for the life of the development does not constitute an impact on subsurface geology. Interactions with subsurface geological structures and rock units would however, result from the construction of foundations for the terminal's infrastructure.

Impact significance

Impacts resulting from terminal foundation construction would be localised and small scale and therefore, the significance of these impacts is considered to be "low" as follows:

Likelihood of activities occurring = 5 - certain to occur
Consequence = 1- impact largely not discernable on a local scale
Significance = 5 - low

10.4.6.2 Produced water and hydro-test water re-injection

As discussed in the Project Description (Chapter 5), terminal hydro-test water may be disposed of via re-injection onshore. In addition, limited quantities of produced water are anticipated from the Shah Deniz gas-condensate field during the early years of production. As the project matures more produced water will be brought to the surface. The predicted volumes of water that would be produced are expected to be small. Any water contained in the gas and/or condensate streams would be sent to the onshore reception and processing terminal for separation and subsequent disposal.

While alternative disposal routes are being investigated, the base case for the Stage 1 project for the disposal of produced water is injection via dedicated deep injection wells onshore into the aquifer at the Lokbatan oilfield, some 20 km to the north of the terminal site. The main concerns associated with produced water injection are:

?? impacting on the producing Lokbatan oilfield to the north of the proposed injection site;
?? inducing seismic events (e.g. fault slippage) in the subsurface geological structures; and
?? impacts on any groundwater resources.
?? escape/leaking out of produced water out of the reservoir

Impact significance

Additional work will be undertaken to identify the exact location of the preferred injection sites within the southeastern sector of the Lokbatan field. The potential environmental impacts can therefore, only be assessed in a generic sense based on the existing understanding of the proposed injection site.

Produced water injection modelling

Due to the relatively low permeability of the host rock and the need to inject produced water at quite high rates, injector wells would need to be hydraulically fractured to enhance their capacity to accept large volumes of produced water under high pressure. Without a detailed understanding of the deep hydrogeology of the southeastern sector of the Lokbatan field, it is not possible to accurately quantify the direction or velocity of migration of produced water away from the injector wells. It is considered however, that long-term migration of the injected water would in general be controlled by the regional hydraulic gradient.

On a regional scale, hydraulic gradient is controlled by recharge from surface, surface topography and elevation, geological structure (i.e. geological dip of formations and the hydraulic role of faults) and subsurface hydrogeological properties. In addition to these generic factors the local hydraulic gradient in the Lokbatan field is controlled by the degree of pressure depletion that is present within the sandstones as a consequence of oil production to the north of the field. The degree of pressure depletion at the proposed site is related to:

?? the volume of production;
?? the relative location of the production wells to the injection wells both in terms of their horizon and distance; and
?? the presence of major faults that can hydraulically isolate or compartmentalise major areas of ground from the impacts of oil and gas production at Lokbatan.

If the boundary faults to the north of the south-eastern sector act as a hydraulic barrier, then their presence would both isolate the Lokbatan field from the injection process and also impact on the distribution of pressure induced in the host rock by the injection process. Conceptually it is thought that induced produced water flow would be down dip and away from the injector wells in a southerly direction (i.e. away from the northern producing sector of the Lokbatan field). Over time, pressure would gradually reduce and the produced water would mix with the host waters of the sandstones present at depth. At present it is not possible to predict the speed of the migration away from the injection zone or the exact geometry of the injected plume either during or after the injection process.

Injection simulations have confirmed potential issues of fault damage and the significance that sealing faults can have on the distribution of injection pressure away from the injection well. The presence of a sealing fault would disturb the uniform distribution of pressure, significantly increasing the pressure surcharge on the down-dip side and almost entirely isolating the aquifer on the up-dip side. The study confirmed earlier conceptual understanding of the role of sealing faults; the presence of an up-dip hydraulic barrier would induce additional migration of injected fluid to deeper horizons under the sea.

Based on the present understanding, the absence of producing wells and deep freshwater resources confirms that the long-term environmental consequences of produced water injection into the southeast limb of the Lokbatan field would not result in a major environmental impact in terms of groundwater contamination.

Based on the results of preliminary modelling of produced water injection at Lokbatan, it is concluded that the impacts on subsurface geology associated are of “low” significance as follows:

Likelihood of activities occurring = 5 - certain to occur Consequence = 1- impact largely not discernable on a local scale Significance = 5 – low

10.4.7 Impacts on topography and landscape

10.4.7.1 Terminal construction

The proposed terminal site is situated on a coastal plain at a height ranging between approximately 7 m and 20 m. The surrounding terrain is generally flat to undulating with very few elevated features within the terminal footprint. Prominent hills exist to the northwest and north of the site.

Given the fact that a terminal already exists on the site, the proposed additional facilities would result in an incremental change to the visual impact of the terminal on the surrounding landscape.

In order to assess the cumulative visual impact of the proposed expansion to the terminal a series of typical viewpoints were identified in the area surrounding the terminal site. Visual simulations were then prepared to create images of the terminal that show what the terminal would look like after the expansion works are completed. These visual simulations provide the basis for assessing the likely visual impact of the proposed terminal expansion.

Existing EOP terminal

The existing EOP terminal is situated within a broad valley defined by hills to the north, west and southwest. The Caspian Sea coast is located approximately 1.7 km to the southeast of the site.

Views of the existing terminal from public roads are generally limited to a section of the main Baku-Astara Highway between the settlements of Umid and Sangachal and the section of road running northwest to the Cheylidag (Umbaku) settlement. Parts of the existing terminal are also visible from a small herding settlements located to the north and northeast of the site.

The most visually prominent elements of the existing terminal are the storage tanks and the large building located in the northeast corner of the terminal. The symmetrical shape and white colour of these elements contrast with the backdrop of natural hill slopes and ridges. The visual prominence of the tanks and building is significantly reduced when they are viewed with the visible surface in shadow. If the visible surface is in full sunlight however, the contrast with the background is maximised.

Views of the existing terminal from the main coastal road are generally limited to the top portions of the tanks due to the flat landform and the slightly lower elevation of the road relative to the terminal. Due to the higher elevation of areas to the southwest and northeast of the terminal site, views from those locations generally include a larger proportion of the tanks and other elements at ground level. The visibility of the terminal from those locations is however, significantly reduced due to the longer distance of the views and the atmospheric effects, particularly the effect of dust.

Shah Deniz terminal

Information about the extent of the proposed expansion of the terminal was provided to the ESIA team in a series of layout plans and drawings. In addition, a series of views of the three-dimensional computer model of the existing and proposed Shah Deniz and ACG FFD terminal facilities were provided in electronic format.

The proposed new facilities would be located to the north and west of the existing terminal and would be constructed on a series of earth terraces extending up the slope above the existing terminal.

The most visually prominent components of the proposed terminal expansion would again be the storage tanks and flare stacks. The proposed new storage tanks are substantially larger than the existing tanks.

Visual simulations

In order to show what the expanded terminal would look like, a series of visual simulations were prepared. The simulations were based on the views from five view point that were selected on the basis of being representative of a series of viewing situations within the surrounding landscape. The viewpoints are illustrated in Figure 10.21 and summarised in Table 10.25.

Figure 10.21 Location of viewpoints

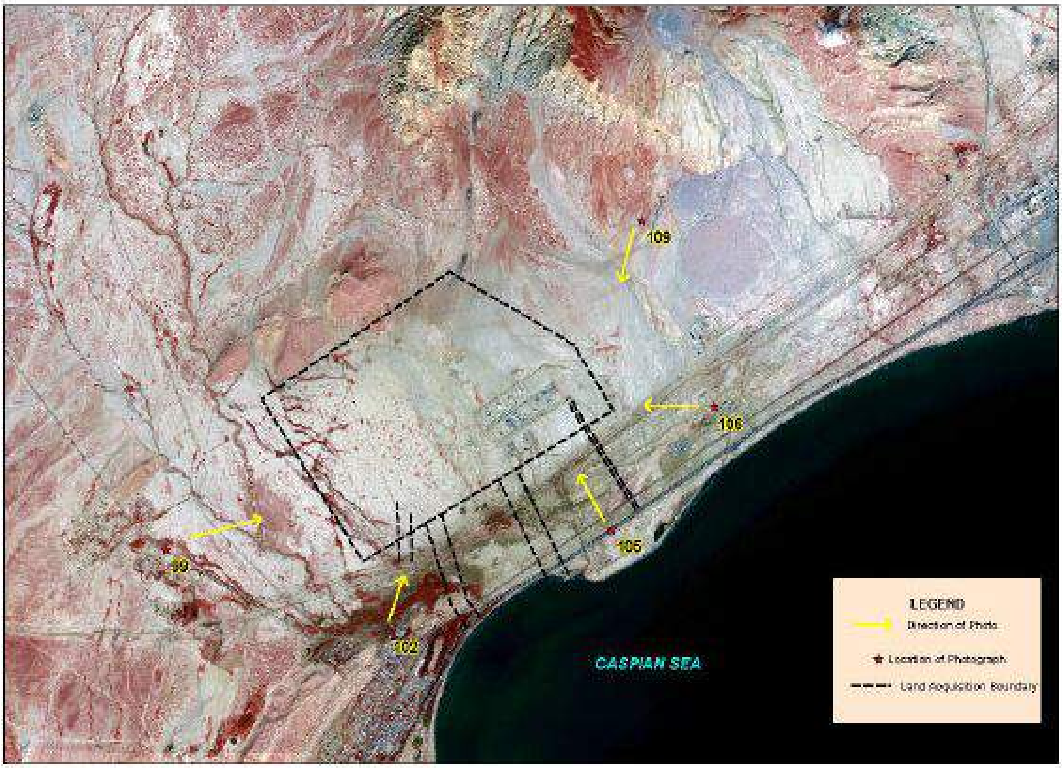


Table 10.25 Viewpoint summary

View Point	Approximate Distance From FFD Terminal (km)	Description
99	4	?? View from public road running northwest from the settlement of Cheylidag (Umbaku). ?? Elevation similar to the terminal. ?? Power lines and poles visually prominent in foreground
102	2.5	?? View from northwest corner of Sangachal Town with background of prominent hills. ?? Slightly lower elevation than terminal site. ?? Power lines and poles visually prominent in mid-distance
105	1.5	?? View from coastal road with background of hills. ?? Slightly lower elevation than terminal site. ?? Power lines and poles in mid-distance
106	2	?? View from Umid IDP Camp area on western side of coastal road with power lines visually prominent in mid-distance. ?? Background of hills in distance. ?? Similar elevation as terminal site.
109	3.5	?? View from area in front of village looking down-slope to terminal site. ?? Background of hills in distance. ?? Higher elevation than terminal site.

Preparation of the visual simulations involved the following process:

?? Photographs were taken from each of the five viewpoints looking towards the terminal site.
?? The photographs were digitised to allow them to be edited using the Adobe Photoshop program.
?? Images of the 3-D (three-dimensional) model as it would appear when viewed from each of the five viewpoints were provided in electronic format.
?? The 3-D model images for each of the five view points were then merged with the digitised photo from each view point using the existing tanks to align the 3-D model image with the photo image.
?? The surfaces of the tanks and other components of the terminal in the 3-D model images of each of the five viewpoints were rendered using PhotoShop to make them appear similar to the existing tanks and other elements of the terminal.
?? Photographic images were prepared for each of the five view points that show the existing view as well as the simulation of the view after the proposed expansion of the terminal is completed. These images are presented on the following pages.

The results of the visual simulations are summarised below.

View Point 99

Figure 10.22 illustrates the view from viewpoint 99 pre- and post FFD terminal development.

Figure 10.22 Viewpoint 99 pre- and post-FFD terminal development

Pre-FFD Development

Post-FFD Development

The view from this point towards the terminal is generally in a northeasterly direction. The visual simulation from this viewpoint illustrates that:

?? the additional ACG FFD tanks would generally be viewed against a background of hills;
?? the upper portion of one of the additional tanks located in the southeast portion of the site would be viewed against the sky that would increase its visual prominence; and
?? the proposed flare stacks would be viewed against the sky although their narrow width would minimise their potential visual impact.

View Point 102

Figure 10.23 illustrates the view from viewpoint 102 pre- and post-FFD terminal development.

Figure 10.23 View from viewpoint 102 pre - and post-FFD terminal development

Pre-FFD Development

Post-FFD Development

The view from this location towards the terminal is generally in a northerly direction. The visual simulation illustrates that:

?? existing vegetation provides visual screening of the lower components of the terminal;
?? the proposed new tanks would be viewed against a background of visually prominent hills;
?? the lower portion of the flare stacks would be viewed against the visually prominent hill while the upper portion of the stack would be seen against the sky; and
?? existing power lines and support structures are visually prominent elements in the landscape.

View Point 105

Figure 10.24 illustrates the view from viewpoint 105 pre- and post FFD terminal development.

Figure 10.24 View from viewpoint 102 pre - and post-FFD terminal development

Pre-FFD Development

Post-FFD Development

From this viewpoint, the visua l simulation illustrates that:

?? existing view from the coastal road towards the site includes visually prominent power lines and poles in the mid-distance, and tanks viewed against hills in the distance;
?? the proposed additional tanks would be seen against a background of distant hills; and
?? the flare stacks would generally be viewed against the sky with only the lower portion seen against a backdrop of distant hills.

View Point 106

Figure 10.25 illustrates the view from viewpoint 106 pre- and post FFD terminal development.

Figure 10.25 View from viewpoint 106 pre - and post-FFD terminal development

Pre-FFD Development **Post-FFD Development**

From this viewpoint, the visual simulation illustrates that:

?? the current view from the coastal road includes visually prominent power lines and poles in the mid-distance and the existing tanks beyond with a background of distance hills;
?? the proposed additional tanks would be viewed against a background of distant hills; and
?? a major portion of the flare stacks would be viewed against the sky.

View Point 109

Figure10.26 illustrates the view from viewpoint 109 pre- and post-FFD terminal development.

Figure 10.26 View from viewpoint 109 pre - and post-FFD terminal development

Pre-FFD Development **Post-FFD Development**

From this viewpoint, the visual simulation illustrates that:

?? the existing terminal facilities are visible in the distance with a background of hills;
?? the proposed tanks would be visually more prominent than the existing tanks but they would also be seen against a background of distant hills; and
?? the lower half of the proposed flare stacks would be viewed against a background of distant hills while the upper half would be seen against the sky.

The visibility of the expanded terminal would depend on the distance of the viewer from the terminal and the screening effect of the landform, vegetation and development located between the viewer and the terminal.

Based on the above criteria the potential visual impacts of the proposed terminal expansion from the five viewpoints have been listed in order of significance from highest to lowest in Table 10.26.

Table 10.26 Ranking of visual impact at viewpoints

View Point Number	Potential Visual Impact
105	Highest (5)
102	
106	
109	
99	Lowest

It should be noted that the terminal would probably be more conspicuous at night as it would be the only significant source of artificial lighting in the area and the prominence of the facility at night is likely to be appreciable. The significance of this impact is difficult to quantify, as intrusiveness of light pollution is very subjective. What can be said is that lighting would be directional into the facility and would only be at levels that ensured operational safety; that is, the project design would minimise as far as is practicable, light pollution.

Impact Significance

Visual simulations concluded that the impact of the terminal facilities on topography and landscape was of "low" significance as follows:

Likelihood of activities = 5 - certain to occur
Consequence = 1- impact largely not discernable on a local scale
Significance = 5 - low

10.4.8 Impacts on coastal habitat, flora and fauna

Coastal habitat, flora and fauna would be impacted as a result of construction of the pipeline landfall and pipeline onshore section between the landfall and the terminal. Construction activities would include:

?? onshore work site preparation;
?? onshore (coastal) site preparation for pipeline beach-haul;
?? pipeline landfall and onshore trench construction; and
?? pipe-laying.

It should be noted that pipeline landfall construction and associated activities would also impact terrestrial habitat as approximately 75% of the onshore pipeline corridor lies within the central south survey sector which has been characterised as inland habitat (Chapter 6). Impacts on terrestrial habitat and specific floral and faunal species and assemblages are discussed in Section 10.4.9.

Impact significance

The impact assessment on biological resources has been completed using gathered available literature and the results of the May/June 2001 field survey conducted with the assistance of local and international experts (Chapter 6). It was noted that much of the available scientific literature regarding the ecology in the Sangachal region was dated and concerns a larger geographic region than that specifically of concern to this assessment. The surveys conducted in 2001 were designed to begin to address the gaps in the available literature and also to focus on the region in which the Stage 1 construction and operational activities are proposed. Further data gathering over different seasons will be conducted to add to this baseline information. When using existing and available literature in the development of the baseline characterisation, some interpretative analysis has been applied.

Individual floral and faunal species and assemblages may be impacted differently by the same project activity. For this reason, comment regarding potential impacts to specific species is made wherever available data supports such an approach. Particular attention is given to those species included in any of the following documents:

?? 1996 IUCN Red List of Threatened Animals;
?? 1997 IUCN Red List of Threatened Plant Species; and
?? 1987 Azerbaijan Red Book.

It is generally accepted that the designations in both the national listing and international listings are in need of revision. This is likely to occur within the next decade or so. Although a number listed species have been encountered during past and recent surveys undertaken as part of various assessments, their distributions and population sizes are subject to broad interpretation, a limiting factor when assigning significance levels to potential impacts arising from the Shah Deniz Stage 1 project. For the purpose of this assessment, qualitative estimates err on the conservative side or to worst-case scenarios.

Impacts on coastal habitat

Sections of the Sangachal Bay coastline and particularly those where it is proposed to construct the pipelines' landfalls and onshore trenches host wetland habitat (wadis) that is biologically productive and that performs critical ecological functions within the broader ecosystem. "Ecotones", transition zones between different coastal floristic communities and between coastal habitat and slightly inland habitat (Chapter 6), are also important in this regard.

Construction of the Stage 1 pipeline landfalls and the onshore sections of the pipelines' trenches would result in disturbance (i.e. loss or degradation) of approximately 2 ha of coastal habitat a percentage of which includes coastal wetlands. In addition, the corridor would traverse the coastal-inland habitat ecotone. Impacts on coastal habitat would take three forms as follows:

?? habitat loss;
?? habitat degradation; and
?? habitat fragmentation.

Loss of habitat can result in an area's inability to sustain the quantity and diversity of biological resources previously supported. The severity of impact varies for different species and is generally dependent on the availability of alternative resources near to the impacted area. Loss of species diversity on a regional level generally does not occur until a significant fraction of the habitat has been lost but once species begin to be lost from an ecosystem, their ongoing decline is typically rapid.

Habitat degradation results in a net decrease in associated biological resources that in turn, lowers the carrying capacity of an ecosystem. This typically results in a parallel decline in various populations of dependent flora and fauna species. Degradation also compromises a habitat's ability to buffer against and sustain more extreme environmental fluctuations and phenomena. Once in a more vulnerable state, habitats become increasingly more susceptible to indirect impacts.

The ultimate consequence of habitat fragmentation is change to species composition, often observable as species diversity reduction, within the habitat. Resultant composition/diversity is largely determined by remnant habitat 'patch' size. Habitat fragmentation also creates more habitat 'edges' thereby, exposing the 'internal' habitat to an increased level of external influences. This phenomena has particular implications for resident fauna as discussed below.

Site preparation works, pipelines' landfalls and trenches construction and pipeline installation in the coastal area would result in the direct loss of coastal habitat and would be likely to contribute to habitat degradation and fragmentation in areas adjacent to the work sites. General vehicle movement associated with the works would also contribute to habitat degradation through the generation of dust. The habitat that would be impacted by these activities is already in a degraded state (as a result of past anthropogenic activity) and additional impact would further undermine the area's ability to support the biological diversity it presently does and its ability to continue to perform its ecological function.

It should also be noted that once habitat is disturbed, opportunistic plant and animal species are likely to take advantage of the more sparsely distributed resources. This 'invasion' hinders the re-establishment of formerly resident populations of flora and fauna thereby causing a shift in the constituent species and community structure of the habitat. Often, the new regime is biologically impoverished in comparison to what was previously present.

Impacts on specific coastal flora species

Impacts on the constituent flora species of the four main observed botanic communities would vary in significance due to the different times necessary for each community to rehabilitate to pre-impact levels and due to their current rarity. Table 10.27 below list the communities identified during the May/June 2001 survey and their normal restoration time listed as percent ground cover reclaimed over time.

Table 10.27 Coastal floral communities natural recovery rates

Community	Soil type	Percentage Ground Cover Recovery[9]									
		1	2	3	4	5	6	7	8	9	10
Thickets	Wet coastal sand	10-20	30-40	100							
Littoral ecotone	Clay/argillaceous sand mixture	10-15	20-30	30-40	40-50	50-60	60-70	70-80	90-100	100	100
Reed beds	Clay/argillaceous sand mixture/wet	60-70	100								
Coastal slightly inland	Clay/argillaceous sand mixture	10-15	20-30	30-40	50	60	70	80	90	100	100

Source: Dr. V. Hajiyev, Azerbaijan Academy of Sciences.

Tables 10.28 through Table 10.31 present breakdowns of each coastal botanic community with recovery time in years for each constituent species. Those with low numbers would be the first to recolonise and hose with larger numbers would recolonise later. Relative percentage of each species can be inferred through the order in which they are presented in

9 Natural variation in re-vegetation time is implied where the "Recovery Time in Years" is a range.

each table with the first species rating highest on the Domin Scale of Cover Abundance (Chapter 6) and the last, the lowest. Note that species with the same rating are in no particular order. It should be noted that the time frames presented below represent normal re-vegetation times in the absence of any further anthropogenic effects.

"E" in the restoration in "Recovery Time in Years" column indicates the species to be either an ephemeral or ephemeroid species. Ephemeral species restore within one year or growing season (i.e. usually one to two months) and live for the same period of time (i.e. the individual does not necessarily grow the following season). Ephemeroids also restore relatively quickly (e.g. one year) but are perennial (i.e. individuals grow season after season). For both types of plants, re-vegetation requires a viable seed source.

Table 10.28 Thickets (Argusicum siberica) species recovery times

Species	Recovery Time in Years
Argusa siberica	2

Source: Dr. V. Hajiyev, Azerbaijan Academy of Sciences.

Table 10.29 Littoral ecotone species recovery times

Species	Recovery Time in Years
Junus acutus	2
Tamarix meyeri	8-10
Phagmites australis	2
Argusa siberica	2
Alhagi pseodalhagi	1-2
Poa bulbosa	E
Medicago minima	E
Cynodon dactylon	E
Astragalus species	E
Allium rubellum	E

Source: Dr. V. Hajiyev, Azerbaijan Academy of Sciences.
E - an ephemeral or ephemeroid species.

Table 10.30 Reed bed recovery times

Species	Recovery Time in Years
Phagmites australis	2

Source: Dr. V. Hajiyev, Azerbaijan Academy of Sciences.

Table 10.31 Slightly inland coastal semi-desert recovery times

Species	Recovery Time in Years
Alhagi pseudalhagi	1-2
Argusia siberica	1-2
Suaeda dendroides	8-10
Salsola denproides	10-12
Bromus japonicus	E
Medicago minima	E
Adonis australis	E
Poa bulbosa	E

Source: Dr. V. Hajiyev, Azerbaijan Academy of Sciences.
E - an ephemeral or ephemeroid species.

Of the three rare and endemic plant species identified during the May/June 2001 survey, two were encountered in and preferentially inhabit coastal areas namely, *Astragalus bacuensis*

(Baku Astragalus) and *Calligonum bacuensis* (Baku Calligonum). Direct habitat loss may result in a decrease in these species' local population numbers. Due to this and the long recovery times of these species, impacts associated with the pipeline construction activities are considered to be of "high" significance as follows:

Likelihood of activities = 5 - certain to occur
Consequence = 2- local scale impact
Significance = 10 - high

Lichen species were identified during the 2001 survey activities. Only a few examples growing on shrub-bark substrate were identified in the southeast coastal sector. Loss of coastal habitat would not significantly impact on lichens.

Impact on coastal fauna

Impacts on coastal fauna are twofold as follows:

?? direct mortality as a result of project activities; and
?? indirect impact as a result of loss, degradation and fragmentation of habitat.

Habitat loss, degradation and fragmentation would potentially result in the alteration of faunal species':

?? population distribution;
?? migration rates between populations; and
?? local population size.

The species that would be mostly affected by impacts on habitat are those with large home ranges such as wolves and some birds of prey. These species can be lost from areas following construction programmes that result in only small remaining habitat fragments in the area.

In the case of potentially newly formed habitat patches and particularly in respect to areas that include dense tamarisk stands, nesting birds would be most significantly effected as nest visibility would increase as a direct result of the decrease in habitat patch size. Predation by foxes, jackals, corvids (i.e. birds from the largely omnivorous Corvine family with includes magpies and hooded crows) and some birds of prey would be likely to increase for breeding birds' whose nests may be further exposed as a result of habitat fragmentation.

Associated with impacts on habitat and in particular habitat fragmentation, is the level of persistence of wildlife "corridors"; that is, areas connecting various remnant habitat patches. Wildlife corridors allow fauna to move between areas and any loss to these results in a reduction in opportunity for the populations to interact with one another. In the longer term, reduced population interaction would result in adverse effects on a population's genetic diversity.

Impacts on specific faunal species that were observed in the area and specifically those recorded as present in the coastal survey sector habitats are discussed in the following sections.

Mammals

Bats may use the coastal area for hunting and particularly reed-beds and water inlets that are rich in insects, a primary food source for bats. Any loss to these habitats may therefore, indirectly impact bats. No roosting structures were identified within the area that would be directly impacted as a result of construction of the pipelines' landfalls and as there is similar coastal habitat nearby that would be accessible to resident bats, impacts of the construction are likely to be short term and of "low" significance.

Hares that presently use the pipeline corridor area for feeding and nesting would be likely to move to adjacent land of comparable habitat once pipeline construction activities commenced. There is a risk of mortality however, to leverets if they are within the impact area and the mother does not move them. An increase in predation and hence mortality could also result from displacement of individuals into off-site areas. As the hare is common to the area and as the females are reflex ovulators (i.e. essentially can become pregnant any time they couple), impacts on this species resulting from pipeline landfall and onshore trench construction and associated works are considered to be short term and of "negligible" significance.

Potential impacts on the four rodent species known to inhabit the coastal sectors are considered of "negligible" in significance. While these species are not reflex ovulators, they can breed year-round.

Wolves do not rely on the coastal area to any great extent for either hunting or rearing young. Considering the limited geographical extent of potential coastal habitat loss (i.e. approximately 2 ha) and the large home range of this carnivore species, impacts are considered to be of "negligible" significance.

Golden Jackals would lose hunting/foraging ground wherever coastal habitat is lost, especially if within their home range[10]. Due to the Jackal's omnivorous nature, this species would be expected to find suitable prey and/or carrion elsewhere on the coast or inland if project activities disturb existing hunting and feeding grounds. The impact of loss of habitat would therefore, be of "low" significance.

The Red Fox would be most significantly impacted of the three carnivorous species as a result of pipelines' landfalls and trenches construction. This species would also lose hunting/foraging ground wherever coastal habitat is lost. In addition, Foxes use the coastal area and especially the southeast, for nesting and rearing young where they burrow in soft coastal sand or use small caves found along the coastline. Home ranges of loosely defined family groups vary in size depending on the quality of the habitat but on average extend between 5 and 20 km^2. Coastal habitat in the vicinity of the proposed pipelines' corridor is considered to be a favourable habitat for Foxes due to the abundance of rodents, lagomorphs and insects that make up the bulk of the species diet.

While adult Foxes would probably modify their home range slightly and move to adjacent favourable habitat, pups that were unable to fend for themselves (i.e. from April to early June) could suffer direct mortality if nests are within the area in which project activities would be undertaken.

The Red Fox would be directly displaced as a result of habitat loss and would lose frequently used coastline wildlife corridors as a result of pipeline landfall construction. On a local scale (i.e. the Sangachal area), impacts on this species are considered to be "high". Regionally, impacts would be of "low" significance.

Herpetofauna

All amphibian and reptile species observed during the May/June 2001 survey would be impacted on a local scale as a result of coastal habitat loss due to pipeline construction and

[10] Families hold hunting territories of 2 to 3 km^2.

installation works and associated activities. The coastal area, including wetlands and coastal semi-desert (slightly inland) areas, are used for[11]:

?? hunting (year round barring hibernation periods);
?? breeding (April to June);
?? egg incubation/pregnancy (June to August); and
?? hibernation (November to February).

Individuals of the various species could suffer direct mortality if excavation and heavy equipment movement destroys underground borrows. Increased mortality could also result from increased predation and pressure resulting from displacement into off-site areas. Marsh frogs and turtle species would be moderately impacted if permanent or ephemeral wetlands (i.e. favoured habitat) were to be lost as a result of trenching and other site works.

Of high significance among the identified herpetofauna species would be impacts on the Spur-thighed Tortoise due to:

?? its red-listed status both nationally and internationally;
?? its dependence on the project area for:
  ?? nesting;
  ?? breeding (April-June);
  ?? egg-laying (June-August); and
?? its low dispersal rate.

Spur-thighed Tortoises that occupy the project area are at risk of being injured or killed as a result of the construction of the pipelines' landfalls and trenches and installation activities that could destroy burrows potentially crushing or entombing individuals. Tortoises may also be injured or killed as a result of vehicle movement within the project area. Tortoise occupying areas adjacent to the project area or that have home ranges that overlap the project area would similarly be at risk if they wandered onto active project areas. Due these potential direct and indirect effects, impacts on the red-listed Spur-thighed Tortoise are considered to be of "high" significance.

Coastal birds

Coastal birds would be affected by any direct habitat loss in the coastal area. Overall, the bird groups that could potentially be impacted are:

?? migrants passing through;
?? over-wintering species; and/or
?? breeding populations.

In the event that habitat was lost, migrants and over-wintering species would be likely to make use of other similar coastal areas for necessary resources. Depending on species' degree of site fidelity, they may return to disturbed areas once project activities have ceased and re-vegetation has begun. Little is known however, about the quantity and quality of alternative coastal habitat and therefore, the significance of any displacements and particularly those relating to changes in population sizes over time, is difficult to predict.

Direct habitat loss has the most severe and immediate effect for breeding populations, particularly if land clearance and other construction activities result in nest destruction and loss (mortality) of a season's clutch of eggs or fledglings unable to escape to adjacent areas

[11] Note that the dates cited are species' averages across months.

with similar resources. Increased mortality would result in indirect mortality from increased predation and pressure resulting from displacement into off-site areas.

Different species breeding within areas of direct habitat loss would be affected to varying extents, depending on the amount of associated resources utilised. For most passerines (e.g. warblers, wheatears and wagtails) the area over which feeding can be expected to have taken place would be relatively small and confined to the area in which they were recorded as nesting. For these species impacts would therefore, be more significant. For other species (e.g. corvids (magpies, ravens, crows and choughs), terns and birds of prey (raptors)), foraging may take place a considerable distance from an actual nest site and over areas away from the nesting locality. The impacts resulting from habitat loss would therefore, be less significant.

Table 10.32 identifies bird breeding colonies as recorded during the 2001 survey that could be directly affected by construction activities in the coastal area.

Table 10.32 Location of important bird colonies in the survey area

Species	Area	Northing	Easting	Estimated No. Pairs
Collared Pratincole	*SE* coast	40.16742	49.47095	5
Common Tern	*NE* coast	40.18939	49.50476	6-8
Little Tern	*NE* coast	40.18939	49.50476	7

Summary

While impacts on some coastal fauna (i.e. bats, hares, wolves, jackals, birds) resulting from construction of the pipelines' landfalls, onshore trenches and associated works are considered to be of "negligible" to "low" significance, impacts on the red-listed Spur-thighed Tortoise are considered to be "high". Overall therefore, the impact significance ranking for coastal fauna is considered "high" as follows:

Likelihood of activities = 5 - certain to occur
Consequence = 3- local scale impact (red-listed species)
Significance = 15 - high

10.4.9 Impacts on terrestrial habitat, flora and fauna

Construction of the terminal and onshore sections of the pipelines would impact on terrestrial habitats, flora and fauna. Construction activities associated with construction of the pipeline onshore sections have been discussed above. Terminal construction activities (including the ECEWP) would include:

?? ground clearance and grading in the area of terminal expansion;
?? excavation of drainage channel/bunding;
?? construction of a bund wall and security dyke;
?? construction of perimeter fencing and lighting;
?? construction of access road, box culverts and new railway crossing; and
?? construction of new gas and condensate processing facilities adjacent to the existing EOP terminal and proposed ACG FFD oil terminal expansion.

Impact significance

Terrestrial habitat

In excess of 170 ha of land would be directly impacted as a result of construction of the Shah Deniz gas and condensate and Phase 1 oil terminal developments. It should be noted that this includes the land clearance and levelling required for the construction of the Shah Deniz terminal within the approved land-take area.

Semi-arid regions are generally underestimated in terms of their ecological value. Locally in the Sangachal area, semi-desert habitats form an integral part of the ecological landscape and have been observed to support a notable diversity of fauna despite the fact that habitat degradation has occurred in the area as a result of industry infrastructure development (e.g. pipelines; power-lines and easements), grazing and natural phenomenon (e.g. 1999 mud flows into the central sector plains). The result of these events is a semi-desert zone with 20-40% less cover abundance than would be expected in semi-desert areas that have not been subjected to environmental stress (*pers. comm.* Hajiyev, Dr. V.; June 7, 2001).

The ecological effects of habitat loss, degradation and fragmentation have been discussed in Section 10.4.8 above in relation to coastal habitat loss. The same principles are relevant to inland habitat loss.

Inland habitat as described in the Environment Description (Chapter 6) includes:

?? semi-desert with desert elements in the central north and central south sectors;
?? tamarisk stands concentrated in the central south sector; and
?? marshy meadow in the central south sector.

These communities would be lost from and would not be able to recover within the footprint of the terminal, access road, drainage channel, bund wall, workers' camp site and sewage pond (i.e. an area of in excess of 170 ha for Phase 1 and Shah Deniz terminals combined) as these features would be, in terms of impact, permanent. They would not however, be lost from the proposed 302 ha "no development zone" in the land acquisition area that in fact may, as a result of this area becoming a controlled zone (i.e. no future development permitted) improve in quality over time, a positive environmental outcome of the development.

The total area of loss of each semi-desert habitat cannot be readily calculated with present habitat mapping data as the May/June 2001 survey focused on percent ground cover of specific species within each identified biotope (Chapter 6) rather than total aerial extent of each habitat. The percent ground cover provides a benchmark against which the future health of the habitats can be monitored.

In addition to habitat loss, habitat degradation may occur as a result of the following:

?? creation of wind blown soil (dust);
?? the new access road , and
?? increased soil erosion resulting in increased sediment loads in ephemeral creeks and marshes.

Dust can accumulate on the leaves and stems of plants thus reducing their ability to photosynthesise and grow. In semi-arid areas, plants are typically well adjusted to hot and dusty conditions (e.g. have thin or small leaves thus reducing potential for moisture loss). Being endemic to semi-arid conditions, the flora species found in the survey area are, to a level, dust and heat tolerant. Increased levels of dust may however, cause additional stress although the extent of this is difficult to predict and quantify.

Minimisation of dust levels in the terminal construction area is currently being addressed by watering-down earthwork areas during the terminal engineering and construction activities. "TerraZyme" will be used in the water-down mixtures to help bind loose soils on the new access road and other areas that may require additional stabilisation. Given the typically windy conditions in the Sangachal area, it can be expected that fugitive emissions of this water-down mixture could be wind blown onto adjacent areas and any plants that grow there. The effect of "TerraZyme" on plants is not known but given the chemical nature of the additive (i.e. organic, multi-enzyme catalyser), it is possible that minor 'burning' of leaves and stems may occur. This indirect impact would be mitigated by, as far as possible, restricting use to where it is absolutely necessary (e.g. roads) using the product during lower wind conditions and by spraying the water close to the ground.

Uncontrolled soil erosion can lead to increased turbidity levels in nearby waterways. Increased turbidity can have a number of resultant effects including reduction of aquatic flora growth rates in waterways and the impedance of physiological functions in aquatic and/or amphibious fauna. At critical levels of turbidity, aquatic ecosystems can cease functioning with resident fauna species moving on to more viable habitat or in the worst-case, dying.

The proposed terminal construction activities would include works in areas where ephemeral creeks and marshes occur (May/June 2001 survey). Project activities may disturb soils that may be introduced to waterways and/or wetlands via surface run-off or by being wind blown. Wetland ecosystems are natural filters and hence it could be reasonably expected that they would be able to sustain a small increase in the turbidity levels if they are not already at their tolerance threshold. Controls (e.g. sediment traps) would be implemented in appropriate places, if deemed necessary, to minimise the opportunity for eroded soils to be introduced into waterways and wetlands nearby to the terminal construction site.

In summary, the direct loss of inland habitats through land clearance and other terminal expansion activities is considered significant due to the potential presence of a threatened species (see below). Other contributing impacts include loss and further degradation of a biotope that is already under pressure from anthropogenic activities and that is progressively disappearing from the Azerbaijani landscape.

Impacts on specific inland flora species

Semi-desert habitats in the area in which the terminal would be constructed support a number of floristic communities as follows:

?? low perennial bushes such as wormwood, *Artemisia fragrans* and saltwort species *Salsola dendroides* and *S. nodulosa* the former of which constitutes an important fodder species for livestock that are grazed in the area;
?? ephemeral species (e.g. *Medicago*, *Plantago* and *Poa* spp);
?? tamarisk stands (*Tamarix meyeri*); and
?? marshes.

Table 10.33 lists the three prevailing semi-desert botanic communities identified during May/June 2001 the survey and their normal restoration time listed in percent ground cover reclaimed over time (i.e. per year). Tables 10.34 through 10.37 present a breakdown of each community with recovery time in years for each constituent species.

Table 10.33 Inland floral communities natural recovery rates

Community	Soil type	Percentage Recovery to Pre-project Level[12]											
		1	2	3	4	5	6	7	8	9	10	11	12
Salsoletum nodulosae + *Suaeda dendroides* association	Argillaceous saline	0	0	5-10	10-20	20-30	30-40	40-50	50-60	60-70	80-90	90-100	90-100
Artemisietum fragrans + *Salsoletum nodulosae* association	Argillaceous saline	0	0	5-10	10-20	20-30	30-40	40-50	50-60	60-70	80-90	90-100	90-100
Tamarisk thickets	Relatively moist Argillaceous soil	10-30	30-50	50-55	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	95-100
Marsh/meadow	Argillaceous saline	10-30	30-40	45-55	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	95-100

Source: Dr. V. Hajiyev, Azerbaijan Academy of Sciences.

Table 10.34 *Salsoletum nodulosae* + *Suaeda dendroides* association recovery time

Species	Recovery Time in Years
Salsola nodulosa	10-12
Salsola ericoides	12-14
Holosnemum strobilacaum	8-10-12
Bromus japonicus	E
Catabrosella humilis	E
Allium rubellum	E
Sideritis Montana	E
Torularia contortu pliceta	E
Anabasis aphylla	E
Nepeta sp.	E
Puccinellia bulbosa	E
Jurinea elegans	E

Source: Dr. V. Hajiyev, Azerbaijan Academy of Sciences.
E - an ephemeral or ephemeroid species.

Table 10.35 *Artemisietum fragrans* + *Salsoletum nodulosae* association recovery time

Species	Recovery Time in Years
Artemisia fragrans	10-12
Salsola nodulosa	10-12
Salsola ericoides	10-12
Catabrosella humile	E
Filago arvense	E
Medicaco minima	E
Medicogo orbicelaris	E
Plantago minuta	E
Agropyrum orientale	E
Veronika amoena	E
Trigonella manspeliaca	E
Allium rubellum	E

[12] Natural variation in re-vegetation time is implied where the "Recovery Time in Years" is a range.

Species	**Recovery Time in Years**
Poa bulbosa	E
Erodium sp.	E
Brachypodium sp.	E

Source: Dr. V. Hajiyev, Azerbaijan Academy of Sciences.
E - an ephemeral or ephemeroid species.

Table 10.36 Tamarisk thickets recovery time

Species	**Recovery Time in Years**
Tamarix meyeri	10-12
Alhagi pseudalhagi	1-2
Allium rubellum	E
Cardus albidus	E
Afremisia canasica	10-12
Rhamnus pallasii	8-10
Lepidium resicarium	E

Source: Dr. V. Hajiyev, Azerbaijan Academy of Sciences.
E - an ephemeral or ephemeroid species.

Table 10.37 Meadow community recovery time

Species	**Recovery Time in Years**
Salsola nodulosa	10-12
Artenisia phrangrans	10-12
Catabrosella humilis	10-12
Salsola ericoides	10-12
Alhagi pseudoalhagi	1-2
Filago arvenisis	E
Trogopason sp.	E
Verinika amoena	E
Comphorosma lessingii	E

Source: Dr. V. Hajiyev, Azerbaijan Academy of Sciences.
E - an ephemeral or ephemeroid species.

Seeds of *Iris acutiloba* (Sharp-edged Darling Iris) a species listed in both the Azerbaijan Red Book and IUCN Red List of Rare and Threatened Plants were found during the May/June 2001 survey within the semi-desert survey area. As this species usually blooms from March to April, it was not observed in flower during the survey. While no firm statement can be made regarding either the distribution or abundance of the species within the proposed development area, the presence of seed indicates that viable habitat occurs within the semi-desert areas or at least near to them.

Summary

Overall, due to the considerable area (i.e. in excess of 170 ha) of terrestrial habitat that would be permanently lost as a result of terminal development, the long restoration times for many of the habitat's constituent species that are indirectly effected by project activities and the fact that the habitat hosts or has the potential to host the red-listed species, *Iris acutiloba*, impacts on terrestrial habitat are considered to be of "high" significance as follows:

Likelihood of activities occurring = 5 - certain to occur
Consequence = 3- local scale impact (red-listed species / habitat)
Significance = 15 - high

Impacts on terrestrial fauna

As with coastal fauna, impacts on terrestrial fauna are twofold as follows:

?? direct mortality as a result of project activities; and
?? indirect impact as a result of loss, degradation and fragmentation of habitat.

The May/June 2001 survey demonstrated that semi-desert habitats within the proposed terminal site host a number and variety of faunal species including amphibians, reptiles and mammals (Chapter 6). The clearing of land for terminal expansion and associated works would further fragment existing habitats and wildlife corridors and hence would disconnect previously connected areas with a resultant restriction of movement of some fauna species.

Mammals

Impacts on bats that inhabit inland area would be the same as those that inhabit coastal areas; that is, "low". Loss of habitat where insect diversity and abundance is high may however, represent a reduction in the availability of local feeding grounds.

Impacts on hares have been discussed above in relation to loss of habitat in the coastal area. Although a greater amount of habitat loss would result from terminal development, the impact significance on this species is nonetheless considered to be "low".

The Long-eared Desert Hedgehog would be directly impacted (mortality) should nests occur in the construction areas or where individuals are in the path of machinery. Indirect impacts may also result from habitat loss where displacement into off-site areas results in increased predation. Adults may avoid this threat but juveniles would be unlikely to be able to. As this species can forage as far as 9 km each night in search of food and due to its extreme resilience to food and water deprivation, impacts other than those associated with destruction of nests and direct mortality of individuals are considered short-term and of "low" significance.

Impacts on the four rodent species known to reside in the semi-desert area would include loss of habitat and foraging ground and potentially, direct mortality from entombment in the area of land clearance and excavation. This loss of individuals may be significant in the short-term as they constitute important prey species for a number of the other resident fauna. As these species are numerous in this landscape and are prolific breeders, it is unlikely that a local population decrease would have any discernable effects after construction activities ceased. Impacts are therefore considered to of "low" significance.

Wolves have stationary and nomadic periods, the former in spring and summer and latter in autumn and winter. Although some wolves exist year-round in the project area (resident information), the majority come in winter following the herds of grazing ungulates (e.g. sheep). Wolves would be likely to lose some local foraging ground as a result of terminal development and, temporarily, as a result of pipeline installation. As the area lost would be small in comparison to the typical range a pack (i.e. up to 1,300 ha) the impacts associated with habitat loss are considered "negligible". It is considered that Wolves are not at risk from direct mortality as a result of vehicle and equipment movement.

Impacts to the Golden Jackal resulting from inland habitat loss would be of "negligible" significance.

Red Foxes may use the larger tamarisk stands in the central plains for nesting and rearing young. While impacts associated with terminal expansion would be most significant for this carnivorous species, overall, it is considered that impact would be of "low" significance as the species tends to favour more coastal areas.

It should be noted that during the 1996 zoological survey for the EOP environmental impact assessment, an individual of the Marbled Polecat (*Vormela peregusna*) was observed. This species is listed in the Azerbaijan Red Book of Threatened Animals. The species was however not observed during the May/June 2001 survey as completed for this environmental impact assessment.

Herpetofauna

Semi-desert populations of herptofauna are more sparsely distributed than in coastal areas. Impacts on these species are discussed above and would generally be the same in semi-desert areas.

For the semi-desert herpetofauna populations, the small lizard species *Eremias arguta* and *E. velox* would be most affected as a result of land clearance. These species is however, common to the region and hence overall, impacts are considered to be of "low" significance.

The Spur-thighed Tortoise stands to be the potentially most significantly impacted species as a result of terminal construction . Impact 'pathways' are described above in relation to this species in coastal habitats. Given the red-listed status of this species, the impact significance is considered to be "high".

Terrestrial Birds

Terrestrial bird species could be affected by direct habitat loss resulting from project activities. Potentially impacted species comprise breeding populations and occasional migratory raptors that use the central plains for hunting ground. Impacts on these migratory species are discussed above and would be the same in semi-desert areas as in coastal areas.

One bird breeding colony was identified during the May/June 2001 survey namely, the European Bee-eater. The species was identified in the central south survey sector and it is estimated that six breeding pairs were present. This species could be directly affected by terminal and pipeline construction activities.

Of note during the May/June 2001 survey was the discovery of Syke's Warblers breeding in the damp scrubland to the south of the EOP terminal access road. This species had not previously been recorded as breeding anywhere in Azerbaijan, although it was known as a scarce passage migrant through the Caspian lowlands. The area in which it was recorded could be impacted as a result of pipeline landfall onshore trench construction. It is possible however, that this species is in fact present in most similar damp scrubby habitats along the Caspian coast and therefore, impacts associated with this small amount of habitat loss are considered to be of "low" significance.

A significant issue associated with direct habitat loss in the semi-desert area is the presence of the Black-bellied Sandgrouse (*Pterocles orientalis*) and Lesser Kestrel (*Falco naumanni*) both were observed during the May/June 2001 survey and these species are listed in the Azerbaijan Red Book and IUCN Red List of Threatened Animals, respectively.

The Black-bellied Sandgrouse is a member of the order *Pterocliformes* of which all members are found only in Africa and Eurasia. Members of this order are unique in that they share aspects with both pigeons and waders. One special feature of Sandgrouse is their long flights to water holes in desert and semi-desert country where they drink and during breeding times, wet their belly feathers to carry water to the chicks.

Direct habitat loss and general disturbance resulting from project activities are the two main issues of concern for this species. It is envisaged that if during breeding season or subsequent incubation and rearing times, pairs of birds might forgo successful breeding or leave their eggs or nestlings if these were located close to an area that was disturbed by project activities. For the next breeding season, it is likely these pairs would move to less disturbed areas for successful parenthood although data are not available concerning their nesting site preference 'commitment'. Impact to this species has been assigned a "high" significance due to the fact that it is red-listed.

Although no breeding colonies of lesser kestrels were identified during the recent May/June 2001 survey, if colonies were to exist in the area, they would most likely reside in some of the larger ravines in the western plains, in the north hills or in the denser tamarisk stands found in the project area. Loss of foraging ground constitutes a significant impact for this species due to its internationally listed status.

Summary

Overall, due to amount of area that would be permanently effected (i.e. in excess of 170 ha) and the fact that the habitat in question hosts red-listed species the impacts on terrestrial fauna associated with terminal development (including the ECEWP) and pipeline installation in the onshore environment are considered to be of "high" significance as follows:

Likelihood of activities = 5 - certain to occur Consequence = 3- local scale impact (red-listed species) Significance = 15 - high

Other impacts on terrestrial flora and fauna

Flora and fauna may be indirectly impacted by a range of activities other than those resulting from habitat loss and potential direct mortality during terminal and pipeline construction. Such activities include:

?? vehicle, equipment and plant operation that creates noise emissions;
?? atmospheric emissions;
?? night lighting of facilities; and
?? a general increase in anthropogenic activity in the vicinity of the terminal facility.

Overall the impact significance of other activities coastal and terrestrial flora and fauna is considered to be "low" as follows:

Likelihood of activities occurring = 5 - certain to occur. Consequence = 1- impact largely not discernable on a local scale. Significance = 5 - low.

Specific potential interactions are discussed below.

Noise

Vehicle and machinery noise can interfere with animal communication essential for social interaction including reproduction, as:

?? many diurnal species, including the majority of bird species, as well as large carnivores such as wolves and jackals use sound in advertising displays and dominance interactions;

?? many nocturnal species use sound in detecting prey (e.g. bats), predators, or conspecifics (other members of their species); and
?? many nocturnal animals use sound for communication.

In addition, hares and rodents may listen for foot-thumping or 'drumming' frequencies as a sign of neighbouring conspecifics, of the presence of different species, or for particular conspecific information regarding:

?? response to predators, often times a variable warning system to alert their kin to the degree of danger present; and
?? ward off both competitors and predators.

Noise-sensitive species would be expected to avoid both the construction and operational areas but would be expected to return when noise-generating operations are discontinued. Similarly, species intolerant of surface disturbance and human activities would also be expected to avoid disturbing construction and operation activities until the emissions ceased. Due to the historic activities at/near the terminal, species that currently inhabit the area are accustomed to a disturbed environment and should be habituated to human and mechanical activity. Noise is not therefore, considered a significant impact.

Atmospheric emissions

Emissions to the atmosphere during the various construction and operational activities such as NO_X and SO_X can undergo chemical transformation in the atmosphere and become dissolved in precipitation to form acid rain. An ecosystem's susceptibility to acidification is determined by the alkalinity or acid neutralizing capacity of its soils and waters. The soils in the project area tend to be slightly to very saline. The build-up of sulphates and nitrates in soils can result in delayed acidification of coastal and inland ephemeral surface waters once saturation is reached. In essence, the water is no longer able to neutralise incoming acids and subsequently pH levels drop.

The effects of decreasing pH on aquatic invertebrates are well documented. Insect taxa differ in their response to acidity. Mayflies (*Ephemeroptera*), known to inhabit the project area, are quite sensitive. Recently there has been a great deal of concern expressed regarding the documentation of worldwide declines in amphibian populations and acid deposition has been hypothesised as a possible cause.

In addition to affecting individual animals or populations directly, air pollutants also affect wildlife indirectly by causing changes in the ecosystem. Vegetation affords cover for protection from predators and weather, provides breeding and nesting habitat and serves as a food source. Any change in vegetation could therefore, indirectly affect animal populations.

Herbivores or partial herbivores are ultimately affected when they are faced with a decrease in the quantity or quality of their food supply. Although birds are not directly affected by water acidification, they can be indirectly affected by changes in the quantity and quality of their food resources for example fish eating birds encounter a decreased food supply when pH levels fall to a point where fish reproduction ceases. The same can be true for waterfowl that feed on invertebrates.

Emissions from Shah Deniz terminal construction and operation activities have been shown to be small and due to these emissions being readily dispersed, the overall impact of NO_X and SO_X on flora and fauna in the vicinity of the terminal is considered to be "negligible".

Lighting

Night lighting at the terminal site would be likely to attract insects. This in turn may draw predatory species to the area. While this would not have any discernable effect on construction or operational activities, any increase in the number of predatory species in an area of intense anthropogenic activity may lead to the mortality of a slightly greater number of individuals.

Anthropogenic activity

Some wildlife species might come under increased pressure from opportunistic predators (i.e. crows, jackals and red foxes) attracted to specific project areas by increased water availability, refuse or noise. In addition, during the life of the project the movements of some wildlife through the project area would be restricted as a result of the general level of human presence and activity. Because of the substantial open space surrounding the project area, these effects are not considered to be significant.

Collective disturbance would increase stress levels for all fauna species. High stress levels can have a number of behavioural effects on animal species with the most serious being those that decrease the chance for survival and reproductive success.

Behavioural effects that might decrease chances of surviving and reproducing include retreat from favourable habitat near noise/activity sources and reduction of time spent feeding with resulting energy depletion. Ultimately serious effects such as decreased reproductive success of mammals, herpetofauna and birds have the potential to occur through:

?? interference during pairing/coupling period;
?? unsuccessful pregnancy;
?? mammals - increase in spontaneous abortions and foetal re-absorption;
?? birds and majority of herpetofauna - non-laying or non-fertilisation of eggs;
?? less resources adjacent to nesting/clutch area result in net decrease of food to/for young animals resulting in lower survival rate. For birds, potentially greater amounts of sibling rivalry with result of less surviving chicks;
?? nest abandonment by parents for those species which lend this type of parental care; and
?? increased predation due to greater numbers of predators attracted to Project activities.

Over the life of the project, additional injuries and mortality to wildlife could result from direct impacts from motor vehicles in the project area. The terminal construction and operations activities will include transport management planning that will limit the movement of all vehicles during the activities to designated areas in order to minimise any impacts due to vehicle movement.

10.5 Impacts associated with waste management

BP has completed a comprehensive review of all waste arising from existing operations and has anticipated waste that would be generated by the Shah Deniz Stage 1 Project and the ACG Phase 1 and Phase 2 Projects. Using this information, an integrated Waste Management Strategy (WMS) has been developed that identifies and categorises the waste streams requiring treatment and/or disposal, assesses the capacity of existing in-country waste management facilities and describes preferred disposal options for each waste stream. In some instances the WMS recommends the development of new waste management facilities in close proximity to project and operational activities. The findings and recommendations of the WMS are discussed below in relation to the Stage 1 project.

10.5.1 Approach to onshore waste management

BP is committed to ensuring that all waste is handled responsibly and that it is stored and disposed of at facilities that are licensed to store, treat and/or dispose of waste in an environmentally acceptable manner. BP requires that all operations are carried out in accordance with the Company's own waste management principles which are outlined below.

Waste management manuals have been developed for BP offshore and onshore operations. Waste management manuals ensure that all wastes generated are managed using environmentally acceptable methods which:

?? maximise protection of the environment;
?? protect the health and safety of employees and the public; and
?? comply with national and international legislation, regulatory requirements, as well as BP requirements.

BP applies the five 'R' principles in waste management:

?? **Reduce:** the quantity of waste generated;
?? **Reuse:** waste directly at source;
?? **Recover:** waste materials than can be used or sold;
?? **Recycle:** waste materials which have secondary value; and finally,
?? **Remove:** hazards from waste prior to final disposal by pre-treatment where practical.

The main elements of the waste management manuals include:

?? waste identification and labelling;
?? waste storage and segregation;
?? waste transportation and transfer;
?? waste disposal; and
?? waste minimisation.

Shah Deniz contractors would be required to develop and implement waste management procedures that align with the requirements contained in the above manuals. BP will ensure that disposal sites and methods used by contractors comply with the PSA and meet an acceptable standard of environmental protection before use and that waste minimisation programmes are carried out on a regular basis.

BP is currently evaluating waste management and disposal options in anticipation of the increased volumes of wastes that will be generated by the Shah Deniz Stage 1 and ACG Phase 1 and 2 projects, particularly during construction. There is a requirement for a waste transfer station to be located in close proximity to the port area for receiving, handling and recycling offshore-generated wastes. It is currently envisaged that the waste transfer station will be equipped with the following utilities:

?? a quarantine area for incorrectly documented and unidentified waste;
?? oil water separation plant for bilge water and washing waters;
?? segregation area for metals, batteries, fluorescent tubes, timber, plastics etc.;
?? steam cleaners for pipe threads;
?? neutralising plant for acids and alkalis;
?? solid phase incinerator for domestic and hazardous solid wastes; and
?? liquid phase incinerator for waxes and hazardous liquids.

10.5.2 Environmental implications of onshore waste management

10.5.2.1 Waste transfer station

Wastes generated offshore, once segregated, will be shipped-to-shore for disposal. Figure 10.27 illustrates the proposed disposal options for these waste streams.

The waste transfer station would be developed to receive offshore and onshore waste streams close to receiving ports, terminal facility and construction yards. This will minimise the risks associated with transporting waste materials. This facility will be subject to a separate EIA.

Figure 10.27 Disposal methods for solid and liquid wastes

Sewage	Offshore treatment using US Coastguard Marine Sanitation Device (or equivalent) - discharge to sea
Putrescible food wastes	Offshore treatment (maceration) - discharge to sea
Drilled cuttings	Discharge directly to seabed - 28” hole section only
	Containerise and ship-to-shore lower hole sections
Produced water	Treatment onshore and injection onshore at Lokbatan
Produced sand	Treatment (hydroclones) - ship-to-shore for onshore treatment and disposal
Non-hazardous waste	Offshore segregation, containerisation ship-to-shore for disposal in landfill or high temperature incinerator
Hazardous waste	Offshore segregation, containerisation and ship-to-shore for disposal in landfill or high temperature incinerator

10.5.2.2 Drilled cuttings and fluids shipped-to-shore

The project's base case for disposal of cuttings is:

?? disposal to seafloor of drilling cuttings and drilling fluids/WBM from surface/top-hole 28" sections; and
?? ship-to-shore for onshore treatment and disposal of lower hole section cuttings.

Subject to MENR approval, cuttings bioremediation trials will be undertaken at BP's existing waste facilities at Serenja. A comparative assessment of the results with other cuttings treatment trials, including disposal in the Garadag Cement Plant's kiln, will be considered in terms of the best options for cuttings waste disposal. The environmental impacts associated with onshore disposal options will be assessed once a decision on which treatment method(s) should be developed has been finalised. This assessment will be completed as part of a separate environmental approval process.

10.5.2.3 Hazardous and non-hazardous wastes

High temperature incineration

Two options have been cited to date, namely the upgrade and use of an existing high temperature (i.e. 2,000^{O}C) kiln at the Garadag Cement Plant or high temperature incinerator units that would be located at the waste transfer station or possibly Serenja. An assessment of the environmental impacts associated with high temperature incineration will be completed regardless of which option is pursued. The key environmental issues would be associated with emissions to atmosphere, potential impacts on human health, and ultimate disposal of the ash residues.

Land-filling

A series of lined landfill cells are likely to be required to receive Shah Deniz Stage 1 and ACG Phase 1 & 2 project wastes. Such wastes would include disposal of incinerated residues, some hazardous solid wastes and potentially treated cuttings.

Existing data on subsurface geology suggests that it is not possible to find a suitable area within the existing non-hazardous Serenja landfill. As such, an alternative site location will be required. In the unlikely event that an industrial cell is not established at Sumgayit, in the first instance waste can be temporarily stored at Serenja until such times that a permanent hazardous waste storage site is developed. Here, an existing site of excavation such as a quarry would be preferred to minimise disturbance through excavation of a virgin site. Previous work carried out indicates that the second choice would be the National Hazardous Waste Site at Sumgayit although other sites, as yet undefined may be suitable.

There is considerable advantage to BP in the use of the proposed Sumgayit site in that is already approved by the Azerbaijan government for the disposal of hazardous waste and is geologically well suited to the purpose having deep clay soils and no shallow groundwater.

In the event that a new-build landfill is required, appropriate environmental assessments would be completed. Broadly, such an assessment would consider:

?? the ecological implications of any loss of habitat should a facility be established in a previously undisturbed area;
?? construction and operation emissions (e.g. odours, gaseous atmospheric releases, noise);

?? additional vehicular loads on local transport networks during both the construction and operation phases;
?? potential impacts on air quality and water quality
?? potential for causing nuisance impacts to local residents during operation (e.g. noise, dust, odour)
?? visual impacts on the surrounding landscape;
?? the potential for disruptions to local services during facility construction and operation; and
?? the potential for conflict with existing uses of the proposed facility development site.

10.5.2.4 Impact Significance

Given the WMS's existing and proposed provisions, including recycling where feasible, the overall environmental impact associated with disposal of Shah Deniz Stage 1 wastes is considered to be "low" as follows:

Likelihood of occurrence = 5 - certain to occur.
Consequence = 1 - impact largely not discernible on a local scale.
Significance = 5 - low.

It should be noted that the total waste generated by the project will be minimised by careful product selection and procurement of only the amounts required by the project.

10.6 Impacts resulting from non-routine (accidental) events

Whilst BP has made and will continue to take every precaution to avoid the occurrence of accidents in all of the Company's activities, all oil and gas development operations carry with them the risk of unplanned events. Within the Shah Deniz Stage 1 project, there is a risk of a condensate or chemical spill occurring at the offshore TPG500 platform and/or fuel spills from support and supply vessels. Such unplanned releases may occur as a result of human operational error or due to natural phenomena (e.g. storms; seismic events). This Chapter addresses the potential impact of the following accidental events occurring:

?? condensate spills at sea;
?? fuel spills at sea; and
?? unplanned release of wastes and/or chemicals to the marine environment.

It should be noted that potential also exists for spills to occur at the onshore terminal facility. Specifically, hydrocarbon product may be accidentally released from the condensate storage tanks, pig launchers/receivers, process train separators and/or other process train equipment. The potential for any hydrocarbon product that was accidentally released to enter the natural environment is however, considered to be very small as all terminal facilities will be appropriately bunded (as required) and spilt fluids would be captured by the terminal's contaminated drainage system. In the very remote case that accidentally released hydrocarbon product was not contained within the terminal facility, it may enter the local hydrological system (if released in large quantities) and/or may soak into the ground resulting in localised soil and potentially, groundwater contamination. Despite this remote possibility, it was not considered necessary to undertake environmental fate modelling of terrestrial releases of hydrocarbon product from the onshore terminal facility.

10.6.1 Condensate spills at sea

The risk of hydrocarbon spills is a key concern to BP as well to the public and was raised as a concern by stakeholders (Chapter 8). BP has invested considerable effort in improving project design, implementing high international engineering standards in the project and conducting coastal sensitivity studies to identify vulnerable areas of the environment to assist in the appropriate placement of spill response equipment, thereby removing and/or reducing the likelihood and consequences of an accidental release of condensate or fuel into the Caspian environment. It is BP's Policy to strive towards a zero spill target in the Company's operations through the use of appropriate equipment, prevention measures and personnel training.

10.6.1.1 Risk assessment

Even with the incorporation of comprehensive spill prevention measures, the residual risk of spills occurring cannot be eliminated and hence, the formulation of detailed spill contingency plans, appropriate to local environmental sensitivities, remains integral to BP's operation. To assist this contingency planning exercise, a spill risk assessment was conducted for the Stage 1 development in order to identify potential sources and probability of condensate and fuel spills occurring during the development.

The condensate spill risk assessment used data on the frequency and consequence of a spill as derived from a number of sources as follows:

Historical spill data from production operations in a range of geographic areas compiled by the International Offshore Association of Oil & Gas Producers (OGP formerly known as the E&P Forum). These data primarily come from fields that have been subject to long term reporting requirements. The application of this data to the Caspian environment is considered appropriate, as the Shah Deniz Stage 1 operations will be run to standards similar to those used in other developments.

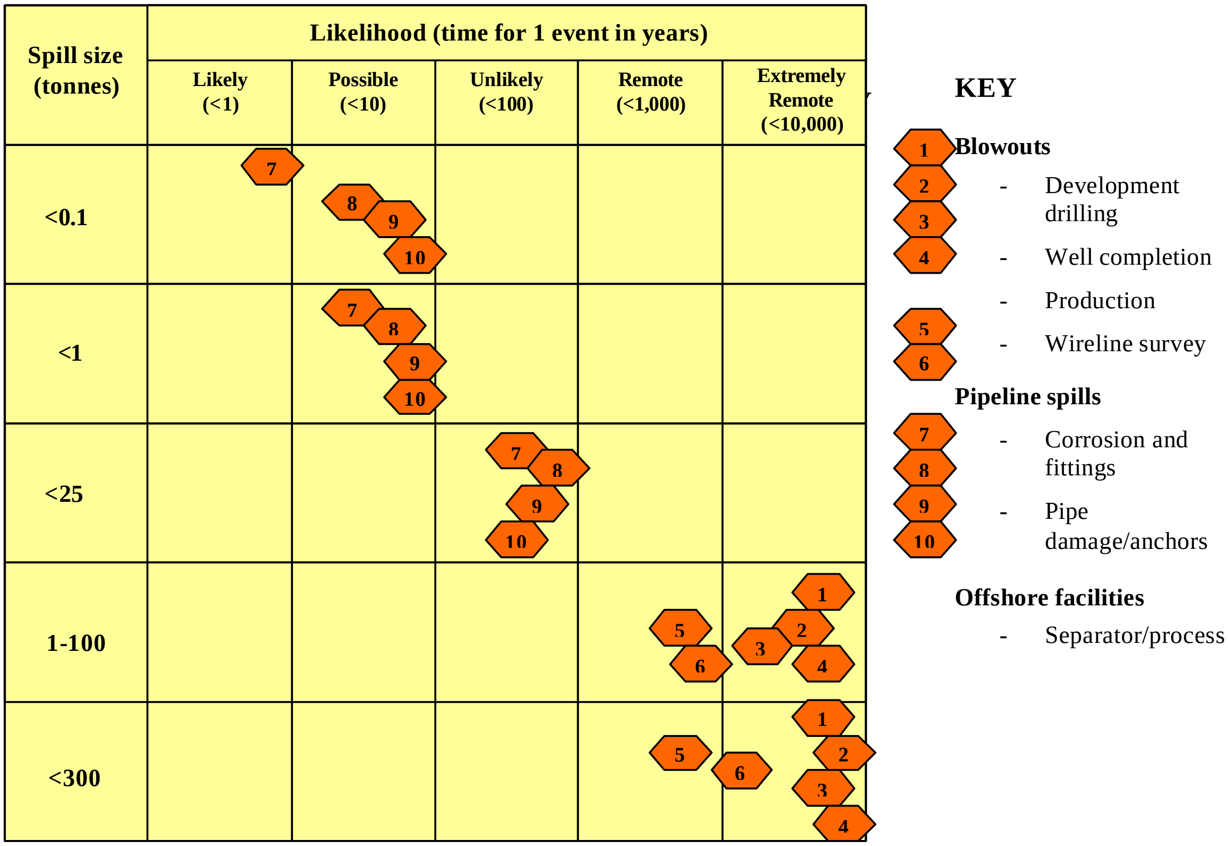
Discussions and workshops held in June and July 2001, involving members of the Shah Deniz design team and environmental specialists when expert opinion and experience was employed and a consensus achieved concerning predicted spill frequency and likely consequence.

The determination of the most likely spill frequency associated with each project activity for Stage 1 was accomplished by dividing the number of spills from the proposed activity (installation and commissioning, drilling, completion, pipelines etc) as reported in the OGP database by the total amount of activity. This result (known as the "computed spill rate") was then multiplied by the amount of the specific activity associated with Stage 1 to determine the most likely spill frequency associated with the project. When discussing the frequency of possible condensate and fuel spills the following terminology is employed:

?? likely: one spill in <1 year;
?? possible: one spill in <10 years;
?? unlikely: one spill in <100 years;
?? remote: one spill in <1,000 years; and
?? extremely remote: one spill in <10,000 years.

The full results of the risk assessment are provided in the Technical Appendix 4and a summary is presented here. Figure 10.28 shows the likelihood per year of condensate spills by size and Stage 1 project source/activity.

Figure 10.28 Likelihood per year of a spill by size and by source/activity from the Stage 1 project



The probability of a spill occurring during the lifetime of the Stage 1 project is very low particularly the probability of a catastrophic well blow-out event. The predicted statistically most frequent events would be associated with small installation spills.

10.6.1.2 Weathering and characterisation of Shah Deniz condensate

Hydrocarbon spilled at sea undergoes evaporation and emulsification processes that change the physical properties of the fluid. These changes are important as they determine the persistence of the fluid and the choice of spill response techniques. Some products and particularly those that do not form stable water-in-oil emulsions are relatively non-persistent and in the event of spillage, might be expected to disperse naturally within a short period of time. Others that form viscous emulsions are likely to be very persistent and may also be resistant to treatment by dispersants unless treated rapidly before emulsions form.

Understanding the behaviour of the condensate is important in determining an appropriate response strategy in the event of a spill and it is essential for contingency planning to take account of the particular properties of the fluid and how these might change with time. Thus, any understanding of the environmental behaviour of an oil or condensate once on the water, requires not only information on the physical properties of the fluid in a fresh state but also on such properties in a weathered and emulsified state. In order to understand changes in the physical properties of the condensate that would occur in the event of a condensate spill , laboratory-weathering studies were conducted on the Shah Deniz condensate and the results of this study are included in the Technical Appendix.

The evaporation potential of the Shah Deniz condensate was measured and as the condensate contains a relatively high light oil fraction this was found to be high. Testing predicted that up to 39% of the volume spilled would be lost rapidly (c. 1 hour) through evaporation and up to 58% would be lost after between 24 and 48 hours following a spill.

Weathering studies found that the condensate would be a light and fluid oil when spilled with only a slight increase in viscosity at higher temperatures as the condensate weathers. The condensate would not form an emulsion at higher temperatures. At low seawater temperatures (c. 6 oC) the condensate is likely to form an emulsion due to the precipitation of waxes as the lighter components evaporate and weather. In these emulsions, the water droplets are fairly large and are held in the condensate primarily by the waxes. The emulsions were however, very unstable and easily broken into their constituent water and condensate fractions. Whilst these weak emulsions may be formed if the condensate is spilt at sea at this temperature, the condensate is unlikely to emulsify unless there is high-energy sea conditions. Even under high-energy sea conditions, the condensate emulsions are very likely to break back to condensate and water once energy levels reduce. The condensate is therefore, only likely to emulsify in certain conditions (low temperatures and low energy sea states).

10.6.1.3 Condensate spill trajectory modelling

Potential sources of condensate and fuel spills to the marine environment from the Shah Deniz Stage 1 project include the following:

- ship/vessel release from:
  - operator error;
  - collision incident and loss of containment;
  - failure in storage facilities;
  - refuelling operations; and
  - failure of oil-in-water treatment system;
- pipeline failure:
  - direct impact (vessel grounding, dropped object, fishing interaction) resulting in loss of structural integrity; and
  - structural failure due to corrosion, manufacturing fault or induced physical stress;
- rig/platform installation release from:
  - well blow out;
  - operator error;
  - collision incident and loss of containment;
  - failure in storage facilities;
  - refuelling operations; and
  - failure of condensate separator.

In consideration of the above and to assess the behaviour of a condensate spill at sea, condensate spill trajectory modelling was conducted using the OSIS[13] spill model. The following scenarios were modelled to represent the three spill sources listed above:

- catastrophic blow-out at platform location with surface release of condensate (worst case spill event);
- loss of inventory of offshore fuel storage tank with release to sea surface of diesel;
- catastrophic failure of main condensate export pipelines to shore with subsea release of condensate including:
  - nearshore (~1.25km); and

[13] OSIS = Oil Spill Information System a computer based industry standard oil spill trajectory modelling application. OSIS3 was used for the simulations.

    - offshore;
- small leak in pipeline with subsea release of condensate including:
    - near shore (~1.25 km); and
    - offshore.

Full technical justification for the modelling scenarios is provided in detail in the Technical Appendix (Condensate Spill Risk Assessment).

Modelling was conducted using the following types of predictive modelling techniques:

- Stochastic modelling, where actual statistical wind speed/direction frequency data was used to calculate a probability range of sea surface oiling representative of the prevailing meteorological conditions. The simulations covered two seasons (summer and winter), each reflecting a distinct wind regime. The model was used to obtain 'worst-case' shoreline impacts without any weathering of the condensate. This predicts the distribution and dispersion of a spill and the extent and location of any shoreline contact under actual meteorological conditions for the region.
- Single trajectory modelling that predicts the weathered state of the oil for the identified 'worst-case' conditions for shoreline impact for each spill scenario as predicted by the stochastic modelling. The trajectory model investigates the time to beach, but excludes prevailing weather conditions and uses a constant wind speed based on the annual wind data during the 'worst-case' conditions predicted. This will predict the fastest beaching time for condensate on the sea and therefore represents the shortest allowable response time available before the condensate reaches the nearest shoreline under the 'worst case' conditions. The trajectory model also provides an understanding of the changes in the nature and state of the condensate after release to the marine environment.

The rationale behind selecting these scenarios, together with the results of the modelling, are provided below.

Catastrophic well blow-out at the Istiglal or TPG500

A well blow-out is an extremely rare event and can only occur when there is a failure in both the primary and secondary well control measures resulting in uncontrolled flow of well fluids from the well-bore. This is mitigated during drilling by two independent barriers; the weighted mud system and in the event that this is lost, the blow-out preventor. Unexpected increases in the pore pressure of the well may cause a high pressure kick and subsequent loss of mud hydrostatic. This is controlled using the BOP and associated secondary well control equipment, but if these fail, then a blowout can occur.

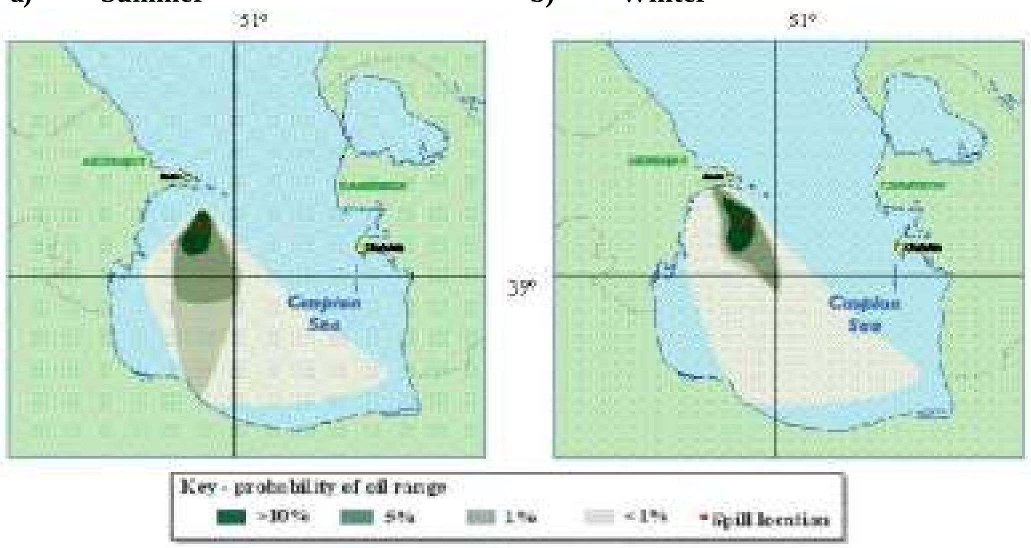
Whilst the probability of a blow-out is extremely small, the consequence represents the worst-case spill scenario and would apply equally to MODU and platform drilling. The worst case duration of the event is based on the time taken to find another drilling facility that can be mobilised to the site of the spill and to drill a relief well. In practice, all available rig/platform based well-kill measures would be attempted before another drilling facility was mobilised to drill a relief well.

For the Stage 1 project, a full bore blowout will result in a total hydrocarbon (i.e. gas and condensate) flow of 230 kilograms per second, of which approximately 23 wt% is condensate. Therefore a volumetric rate of 5,300 m^3/day (33,300 bpd) of condensate would be released. It is estimated that it would take a minimum of 30 days to mobilise an alternative rig to site and an additional 150 days to drill a relief well, making a total time for the worst-case blowout scenario of 180 days. In this timeframe, the total amount of condensate reaching the sea would be: 5,300m^3/day x 180 days = 954,000 m^3.

It was considered that while it was assumed that it would take up to 180 days to drill a relief well, for the purposes of dispersion modelling and hence the prediction of the likelihood and extent of shoreline impacts, it was sufficient and appropriate to model a release equivalent to ten days free-flowing as the condensate would reach a steady-state of evaporation, weathering and persistence by this time. Therefore for the model simulation a total release of 53,000 m^3. Stochastic modelling conducted for this scenario in both winter and summer conditions is shown in Figure 10.29.

Figure 10.29 Stochastic modelling of an accidental release of condensate resulting from a well blow-out

a) Summer **b) Winter**

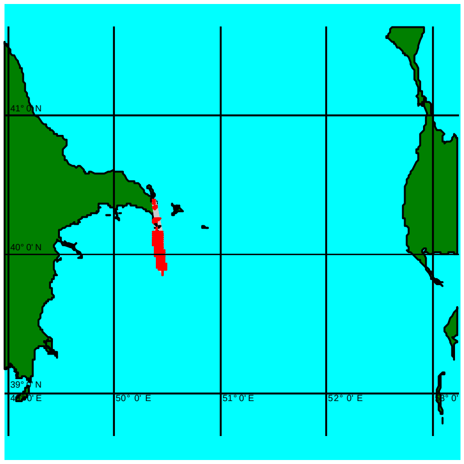


In summer, the modelling predicts that the condensate will be transported predominantly to the south and southeast of the field into the Southern Central Caspian Sea area, with the heaviest area of “oiling” directly to the south of the release location. There is a 1% probability of condensate beaching around the southern Caspian Sea shorelines in Iran.

The modelling indicates that, in winter, the condensate will be transported predominantly in a southeast and northwest direction with the heaviest area of surface cover directly to the southeast of the release location. There is a 5% probability of impact along the shoreline around Baku and a <1% probability of shoreline impact on the southern shoreline of the Caspian west-southwest of Baku (south of the Shah Deniz field) and in the southern Caspian shoreline in Iran.

As described above trajectory modelling was then used to determine the shortest time available before condensate beaching under predicted ‘worst case’ conditions (Figure 10.30). Stochastic modelling predicted winter to be ‘worst-case’ conditions and the trajectory model used a constant 20 knot onshore wind (90^{th}%ile annual wind data) to the nearest beach point on the Apsheron Peninsula.

Figure 10.30 Trajectory model for an accidental release of condensate from a well blow out



Upon release the condensate immediately begins to evaporate and disperse into the water column and thereby, loses a significant percentage of its volume in the early stages of the spill. The condensate is however persistent enough to beach at the nearest landfall after 34 hrs. The resultant fate of the condensate, in terms of volumes, is as follows:

?? 32,882 m3 evaporated;
?? 16,381 m3 dispersed; and
?? 3,536 m3 beached.

Spill scenarios from the condensate export pipeline

There are a number of pipeline spill scenarios that have the potential to occur as a result of the Stage 1 project. These can be classified into minor, moderate and major leaks, with the size of the spill depending upon the rate of leakage of condensate from the pipeline and the time taken for detection and shut-in of production flow. As a result, a minor leak may become major if left undetected for an extended period of time. Using industry accepted definitions for pipeline spill sizes, the leaks may be defined as follows:

?? **Minor leak:** Low release rates (<0.1 m3/hr) and usually from small holes (<0.5 mm). Such leaks would be as a result of pipeline corrosion and damaged or poor fitting flanges or seals at valves. A minor leak is unlikely to lead to any detectable change in pipeline pressure and may not result in a visible surface sheen. Such leaks are difficult to detect and may persist for an extended period before the effects are noticed.

?? **Moderate leak:** Release rates greater than 0.23m3/hr that are not detectable by an online leak detection system (i.e. loss of <10% of the pipeline flow-rate) but is detectable on the sea surface. Moderate leaks would be the result of pipeline damage or prolonged corrosion. Detection is by visual identification of the spill on the water after approximately 24 hours of flow.

?? **Major leak:** Detectable by a loss of total flow-rate and would be as a result of significant physical damage that would rupture the pipeline (e.g. from vessel grounding, anchor dragging or dropped objects).

In consideration of the pipeline leak types discussed, major and minor pipeline spill scenarios were modelled.

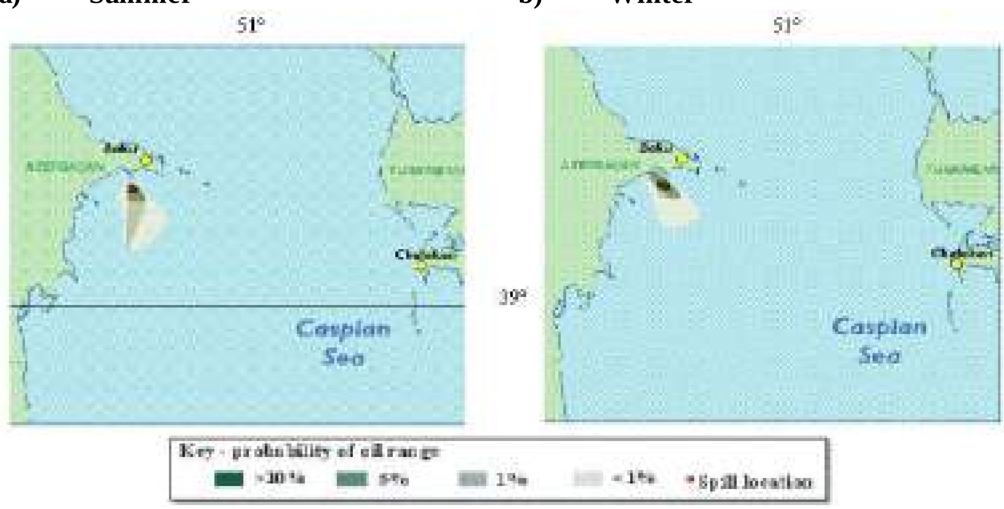
Catastrophic failure of the condensate pipeline

It is considered that a major catastrophic failure of the condensate export pipeline were it to occur would take less than one hour from detection to complete shut-in of production. The worst case for a major pipeline failure is therefore, loss of the entire pipeline inventory plus one hours further production.
The volume of the 12" condensate pipeline is 6,288 m^3. As stated above, the production rate is 5,300 m^3/day or 220.8 m^3/hr. It should be noted that at the time of spill modelling the project design base-case was for a 14" condensate pipeline and the total inventory plus one hour's production was 6,899 m^3. The modelled scenario of the loss of the entire 14" pipeline inventory plus one hour's production is therefore, a slight over-estimate in terms of volume released of the same event occurring with the 12" pipeline.

Stochastic modelling was conducted for the release of the 14" pipeline inventory plus one hours production over a period 19 hours in winter and summer conditions with scenarios run as two separate events assuming nearshore and offshore releases (Figure 10.31).

Figure 10.31 Stochastic modelling of a major pipeline leak (catastrophic failure) in the nearshore zone

a) Summer **b) Winter**



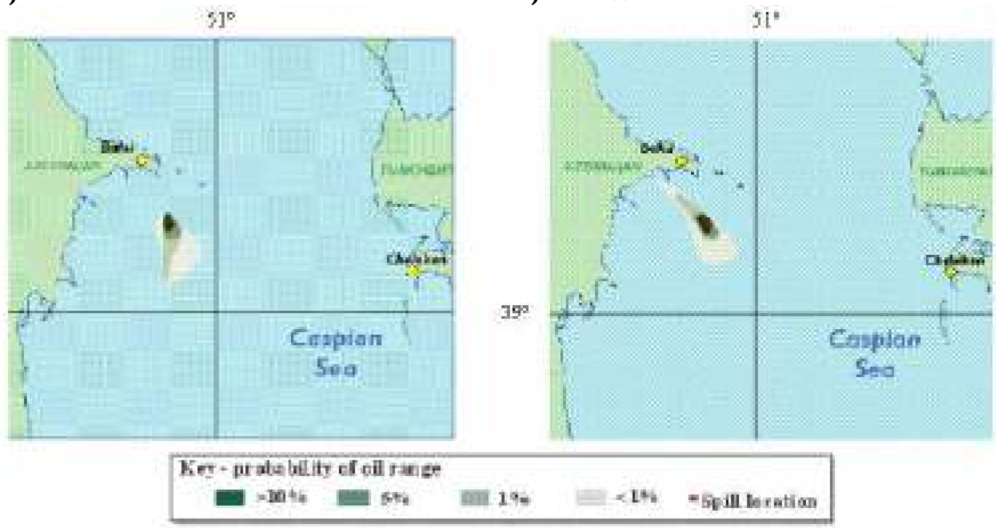
For the summer scenario, the modelling predicts that the condensate will be transported predominantly to the south of the field into the South Central Caspian Sea area. The heaviest area of condensate on water is directly to the south of the release location with no condensate travelling north of the spill location. There is a less than 1% probability of oil beaching anywhere along the Caspian shoreline.

For the winter scenario, the modelling predicts that the main body of the slick will be transported along a southeast and northwest axis with some condensate transgressing to the south. There is a 5% probability that condensate will beach to the northwest of the spill source impacting the shoreline to the west-southwest of Baku.

Modelling of an offshore catastrophic pipeline release was also completed. The results are illustrated in Figure 10.32.

Figure 10.32 Stochastic modelling of a major pipeline leak (catastrophic failure) in the offshore zone

a) Summer **b) Winter**



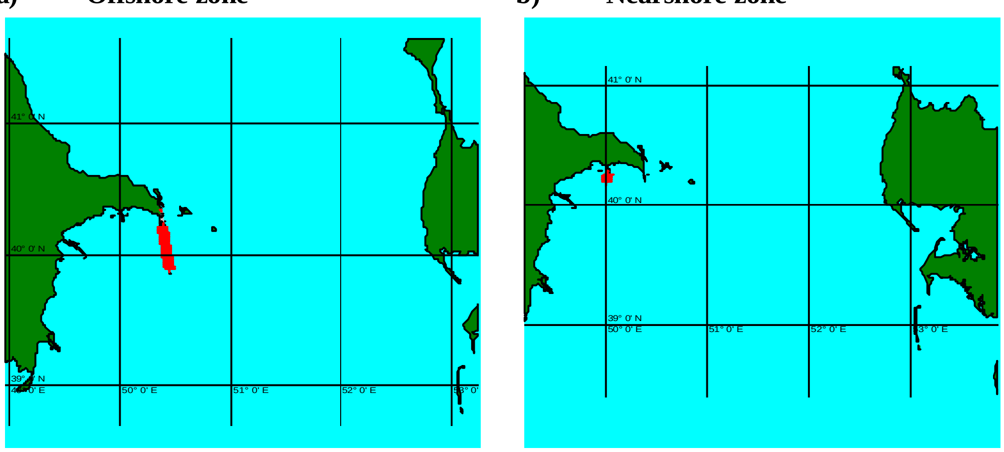
Modelling for summer conditions predicts that under condensate would be transported predominantly to the south of the field into the South Central Caspian Sea area. It is considered unlikely that condensate will beach anywhere along the Caspian shoreline from this spill scenario.

Modelling predicts that, under winter conditions, the main body of the slick would be transported in a northwest and southeast direction with some condensate moving in a more southerly direction. The most likely area for shoreline impact is to the southwest of Baku but the modelling predicts this to be a less than 1% probability.

Single trajectory modelling results are shown in Figure 10.33

Figure 10.33 Trajectory modelling of a condensate spill from a catastrophic pipeline failure

a) Offshore zone **b) Nearshore zone**



Upon release the condensate begins to disperse and evaporate but remains persistent enough to reach landfall after 32 hours. The surface slick volume peaked at 2,897m^3 after 20 hours. The resultant fate of the condensate, in terms of volume, is as follows:

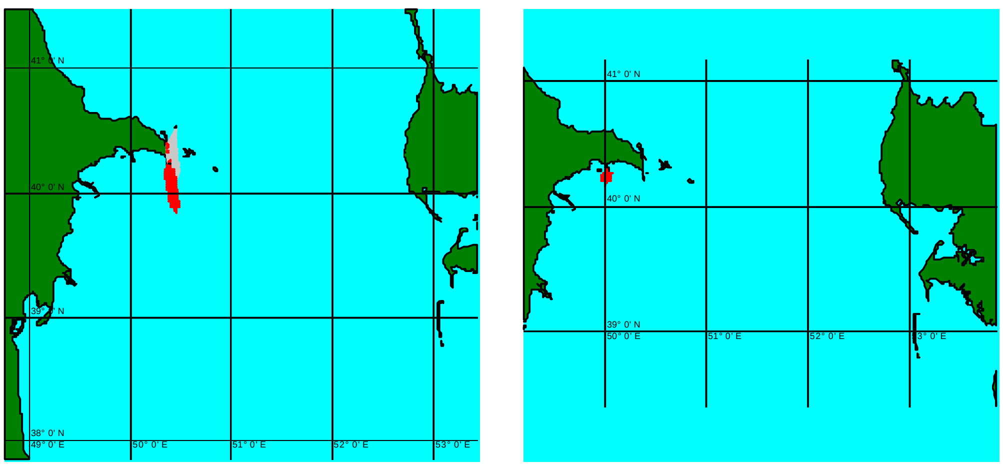
?? 4,727 m3 evaporated;
?? 1,703 m3 dispersed; and
?? 1,163 m3 beached.

Minor pipeline leak

There is potential for delayed detection of smaller leaks with consequent delayed shut-in of production. As a worst case scenario, a pipeline leak flow-rate of up to 1 m^3/hr over a period of 30 days was selected.. This flow rate would also be expected to produce a visible effect on the sea surface. The worst-case small pipeline leak would therefore, result in an amount 720 m^3 of condensate being released to the water column. Only trajectory modelling was conducted for the release of this inventory using the 'worst-case' winter conditions as described above and again offshore and nearshore scenarios were run as two separate events (Figure 10.34)

Figure 10.34 Trajectory modelling of a condensate spill from a minor pipeline leak

a) Offshore zone **b) Nearshore zone**



For the offshore scenario, upon release the condensate increases in volume due to emulsification in the colder winter conditions, before steadily dispersing and evaporating. The released condensate is persistent enough to beach at the point of nearest landfall after 25 hours. The surface slick volume peaked at 44 m^3 after 28 hours and after this, it declines due to the high rate of evaporation and dispersion. The resultant volumes are as follows:

?? 363 m3 evaporated;
?? 335 m3 dispersed; and
?? 105 m3 beached.

As with the offshore scenario, condensate released in the nearshore increases in volume due to emulsification before steadily dispersing and evaporating. The released condensate is persistent enough to beach at the point of nearest landfall after 24 hours. The resultant volumes are as follows:

?? 363 m3 evaporated;

?? 336 m3 dispersed; and
?? 99.4 m3 beached.

Process equipment leak/spillage

Failure of an offshore separator or other process equipment component (e.g. rupture or failure of a valve or pipe-work) could lead to a loss of condensate inventory. Given the proposed equipment operating and maintenance systems, the offshore shut-in and detection system for production process would be highly reliable and offshore production would be shut-down immediately. Further, spilled product would immediately start to rapidly evaporate with any remaining volume being contained within the platform drainage system and thereby prevented from entering the sea. While loss of inventory on the platform would have significant health and safety implications for platform workers, it is considered unlikely that any appreciable volume would be released to the sea surface and therefore unnecessary to conduct spill modelling of this scenario.

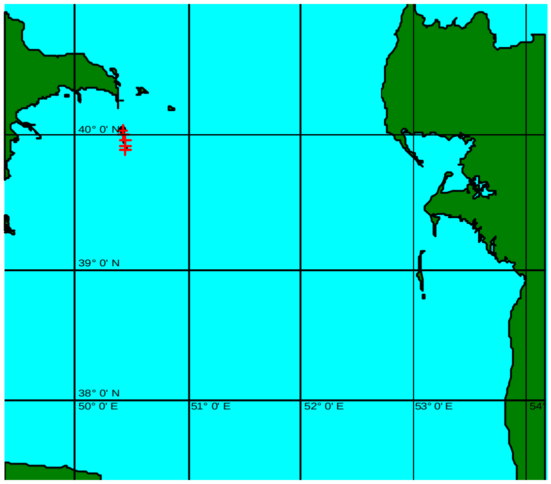
Loss of inventory of fuel/oil storage

One of the most common types of spill on offshore exploration and production operations is the loss of inventory from storage tanks. This can be caused through a number of scenarios as discussed below.

The most common cause of diesel spills recorded from offshore facilities is during supply loading accidents such as overfilling of the diesel storage tank or filling a diesel storage tank which has the drain valve left open or through faulty and or damaged transfer hoses. The diesel storage capacity of the TPG500 is 243 m^3 per storage tank and this has been taken as the highest possible diesel spill that could potentially occur. Offshore spills from vessels servicing the platforms are also possible and for the purposes of modelling, it has been assumed that the support vessels carry approximately the same volume of diesel.

Stochastic modelling was not conducted as it was not considered necessary for diesel as winter conditions have been predicted to be the 'worst-case' conditions in the region. Trajectory modelling was conducted to determine whether this volume of diesel would beach under these 'worst case' conditions and the results are shown in Figure 10.35.

Figure 10.35 Trajectory modelling of an instantaneous release of diesel (instantaneous release from loss of diesel storage tank) in worst-case conditions



Upon release the diesel evaporated quickly. After eight hours, the diesel is virtually completely dispersed and the resultant volumes are as follows:

?? 98 m3 evaporated; and
?? 144 m3 dispersed.

The model predicts that there would be no direct beaching of diesel following a spill of 243 m^3.

The Shah Deniz spill modelling shows that a large spill of condensate from the TPG500 or the 12" condensate pipeline (nearshore and offshore locations) has a low to extremely low probability of impacting the shoreline around the Caspian. The shortest beaching times for large releases from the platform, pipeline nearshore and pipeline offshore locations are 19 hours, 16 hours and 17 hours respectively under 'worst-case' conditions. This length of time is considered to be sufficient for the mobilisation of marine and shoreline response resources.

10.6.1.4 Effectiveness of dispersants

Spill modelling shows that should any of these spill events occur there is a potential for condensate to impact the coastlines of Azerbaijan and, under a worst-case scenario such as a well blow-out event, the coastline of Iran. Potential impacts on neighbouring countries from the Shah Deniz Project such as an accidental release of hydrocarbons are discussed in Chapter 13 (Transboundary Impacts).

Dispersants are frequently to combat spills and prevent them from impacting sensitive coastlines and an early study of the suitability of dispersant use in these cases is provided in Technical Appendix 5. In order to allow for appropriate oil spill contingency planning, it is necessary to test the suitability of dispersants that may be used to combat a condensate spill. It should be noted however, that whilst it is recognised that dispersant use is not the principal response option in Caspian waters and is not the preferred response to combat a condensate spill, dispersants are stockpiled as an option for spill remediation on a case by case basis.

Only one dispersant type (Finasol OSR51) was tested for its effectiveness of dispersing Shah Deniz condensate at various stages in the weathering and emulsification process. The results showed that dispersant treatment of spilled Shah Deniz condensate is an option in warm temperatures combined with low winds speeds.. In low temperatures, the dispersant would have to be present on the scene of the spill if its use was to be effective, due to the short time window available for effective application before the condensate forms an emulsion. In high wind speeds however, when the condensate is only likely to persist for one to two days, the preferred response method may be to 'leave alone' depending on the specific conditions at the time of the spill. If a 'leave alone' response was to be considered as part of the Shah Deniz spill contingency planning process, it would be important to undertake a Net Environmental Benefits Analysis (NEBA) for the areas that may be affected. This would enable BP to determine whether a 'leave alone' response would, on balance, be acceptable.

10.6.1.5 Impact of an offshore condensate spill from Shah Deniz Stage 1

Behaviour of condensate in the marine environment

When a hydrocarbon product is spilled on the surface of the sea it is subjected to several processes and the combined effect of all of these processes is commonly referred to as "weathering". These processes are:

?? spreading;

?? evaporation;
?? dissolution;
?? emulsification;
?? natural dispersion;
?? photo-oxidation;
?? sedimentation; and
?? biodegradation.

These various processes can occur simultaneously, although at very different rates. The rate at which they occur and the extent to which they proceed depends on:

?? the chemical and physical properties of the original product;
?? the prevailing environmental conditions; and
?? the release conditions.

The relative importance of each of the processes varies during the time after a spill, although they are interrelated and it is their combined effect that causes different products to behave in different ways. Consequently, weathering studies are an integral part of spill contingency planning as such studies enable the potential environmental consequences of a spill to be assessed and they can help to determine the most effective oil spill response strategy.

As discussed above, laboratory analyses of the Shah Deniz condensate suggest that the product exhibits unusual weathering behaviour and that this will have a significant influence on the selected spill response strategy. The condensate rapidly loses a high proportion of light ends during the early stages of a spill, resulting in significant reduction in the weight and volume of the spilled product on the sea surface. In cold (6^0C) temperatures, it subsequently forms a viscous, persistent residue. This residue can form a loose, unstable emulsion at these low temperatures. No residue is formed at high temperatures (27^0C) rather the product remains a light and fluid product and does not form an emulsion.

These properties of the condensate suggest that, while it is not impossible, (see above) , a shoreline impact subsequent to a spill event is highly unlikely. The main issues associated with spilled condensate would be health and safety of offshore personnel as the product is highly volatile and has the potential to ignite. Flash points are below 30^0C in cooler (6^0C) conditions and light wind conditions for the first few hours following a spill and will increase for higher winds conditions as the volatile components will evaporate more rapidly, this is illustrated in Figure 10.36. In warmer conditions, the flash point increases more rapidly as the wind speed increases as illustrated in Figure 10.37.

Figure 10.36 Flash points of Shah Deniz condensate at varying wind speeds (60C)

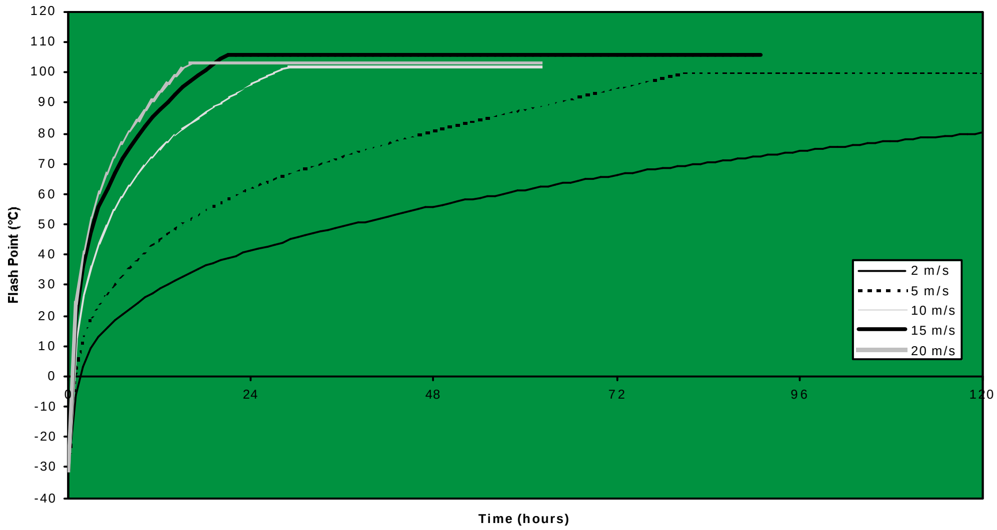
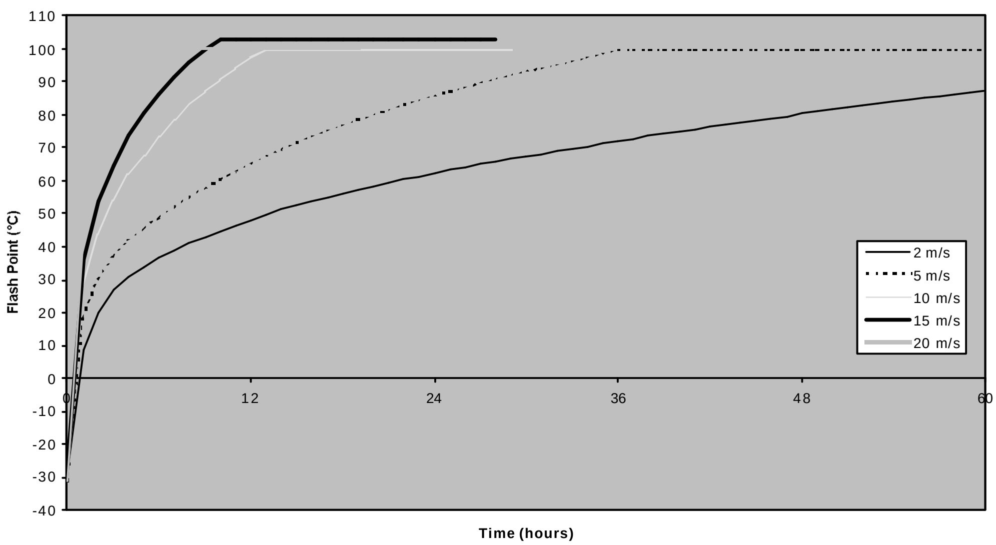


Figure 10.37 Flash points of Shah Deniz condensate at varying wind speeds (27°C)



Impact of a condensate spill from the Shah Deniz Stage 1 project

Condensate is a very light hydrocarbon resembling gasoline and in comparison to oil spills of the same magnitude, the slick areas are relatively small and the hydrocarbon typically displays rapid evaporation and dispersion.

The environmental effects of a potential release of condensate from Shah Deniz would be complicated by the presence and release of associated gas. Environmental effects would be mainly associated with the speed of any gas release through the water column, the toxicity of condensate and gas in the water column and the volatile nature of the hydrocarbon when released to the environment. Spilled condensate is less likely to result in appreciable physical effects on marine organisms given that it is less persistent than crude oil and does not readily form stable emulsions.

Modelling has shown that a condensate spill has the potential to affect both offshore and potentially coastal areas and therefore, potential impacts on these environments need to be considered separately as different parameters will apply.

Offshore environment

Gas

The first important feature of interaction between gaseous traces and marine organisms is a quick fish response to toxicity when compared with fish response to other dissolved or suspended toxicants. Gas rapidly penetrates into the organism (especially through the gills) and disturbs the main functional systems (respiration, nervous system, blood formation, enzyme activity, and others). External evidence of these disturbances includes a number of common symptoms mainly of behavioural nature (e.g., fish excitement, increased activity, scattering in the water). The interval between the moment of fish contact with the gas and the first symptoms of poisoning (latent period) would be relatively short.

Further exposure to toxicity would lead to chronic poisoning. At this stage, cumulative effects at the biochemical and physiological levels may occur, depending on the nature of the toxicant, exposure time, and environmental conditions. A potential effect of a gas release to water is the induction of a gas emboli within organisms. This may emerge if the gaseous release over-saturates the water. The symptoms of gas emboli include a number of effects on fish, such as the rupture of tissues, enlarging of swim bladder, disturbances of circulatory system, and a number of other pathological changes. With regard to vulnerability, fish resistance to the presence of gas at different life stages is greatest in the early life stages. The degree of fish response to gas may also vary between species with fish such as flounder being more sensitive to the effect of gas than sturgeon.

It should be noted that, fish typically avoid areas of reduced oxygen levels and therefore, if possible could be expected to avoid any gas/condensate plume as the gas will strip oxygen from the water it comes into contact with. Individuals that are directly in the path of the plume at the initial time of the spill (blow-out or pipeline rupture/leak where gas is introduced to the water column) would however, be directly impacted as described above.

There is little detailed information on the toxicology of gas to larger organisms, such as marine mammals but it is considered that if individuals were directly exposed, acute toxic effects would be observed.

Condensate

Condensate is a toxic substance which, when released to the water column, would have a number of effects on organisms in the immediate vicinity of the spill consistent with many hydrocarbons. The immediate interaction of the condensate with the water column would result in the rapid consumption of available dissolved oxygen that in turn, could lead to the asphyxiation or marine organisms within the effected area. Fish in the zones of the release may develop significant pathological changes typical for acute poisoning of fish including impaired movement coordination, weakened muscle tone, pathologies of organs and tissues, damaged cell membranes and mortality. These pathological changes may occur in fish at a considerable distance from the place of release.

In the offshore environment, the likelihood of impact of a condensate spill will be determined by the direction of travel of the slick and whether sensitive environmental receptors sensitivities are present in the trajectory path. In open water, marine organisms such as fish have the ability to swim away from a spill by going deeper in the water or further out to sea assuming they are not directly impacted by the initial release. Experience with major oil spills elsewhere in the world suggest that fish can detect hydrocarbon product at low concentrations and therefore, if not directly impacted would be expected to exhibit avoidance behaviour in the event of a condensate spill.

Organisms that have a limited ability to evade a spill, such as plankton, could be expected to experience greater impacts including direct mortality and especially during the early stages of a spill incident when the toxicity of hydrocarbon components is likely to be highest; that is, when the components are in a less degraded state. In the open sea rapid dilution and dispersion of product and its soluble components, as well as the high natural mortality and patchy irregular distribution of plankton eggs and larvae, suggests that the significance of impacts on plankton populations from spilled condensate would be low.

The ability of the Caspian Seal to detect low concentrations of hydrocarbon is unknown. As with fish, it would be expected that seals would move away from and avoid a condensate spill assuming they were directly impacted by the initial spill.

The significance of any impact on seabird species would depend on the type and number of birds present and what percentage of the total population these number represented, the amount of time the birds are actually on the sea surface while at sea, the specific physiological reactions following exposure to spilled condensate. It is considered that in most cases seabirds would move away from and avoid a condensate spill unless directly impacted by the initial spill.

Weathering studies of the Shah Deniz condensate suggest that in the winter months the product can form persistent residues and in the absence of any offshore response, has the potential to remain on the sea surface for a number of days. The rapid evaporation of volatile components of the spilled product would however, significantly and quickly reduce the toxicity of the condensate within a few hours of the spill. Residual effects on offshore species such as seabirds and seals would hence be more associated with physical impact of any residue than with any potential acute toxic effect. The significance of these impacts would depend on the amount of residue by-product on the sea surface and the number of individuals of the at risk species in the vicinity of the spill. Overall, it is considered that given that the volumes concerned (i.e. small given appreciable evaporation and dispersion), the likelihood of impacts being incurred by a considerable number of species would be very low and hence the significance of impacts “low”.

Coastal environments

The likelihood of a condensate spill impacting coastal environments would be directly related to the volume released and the volume of emulsified product that reaches the shoreline. Stochastic and trajectory spill modelling predicts that shoreline impact resulting from a condensate spill would be a very low probability event but nonetheless, may occur under the following scenarios:

a well blow-out where, under summer conditions, there is a 1% probability of condensate reaching the Iranian shoreline and where, under winter conditions, there is a 5% probability of condensate reaching the shorelines southwest of Baku and a <1% probability of beaching on the Iranian coastline;
a nearshore major pipeline leak where, under winter conditions, there is 1% probability of condensate reaching the shoreline southwest of Baku; and
a major offshore pipeline leak where, under winter conditions, there is a 5% probability of condensate reaching the shoreline southwest of Baku.

Trajectory modelling for the three scenarios (well blow-out, major and minor pipeline leaks nearshore and offshore) predicts that the time to impact on the nearest shoreline, location of impact and volume of beached product is as summarised in Table 10.38.

Table 10.38 Summary of trajectory modelling results

Scenario	Time to First Point of Shoreline Impact (hours)	Location of Shoreline Impact	Predicted Volume of Product Beached (m^3)
Well blow-out	26	Apsheron Peninsula: Shahdili Spit, Beuk Tava	3,536
Nearshore major pipeline leak	10	Baku Bay headlands and islands	2,350
Nearshore minor pipeline leak	14	Headlands immediately southeast of Baku	13
Offshore minor pipeline leak	32	Apsheron Peninsula: Shahdili Spit, Beuk Tava	1,163
Offshore major pipeline leak	38	Apsheron Peninsula: Shahdili Spit, Beuk Tava	8.5

Coastal environment sensitivities to spilled hydrocarbon along the Azerbaijan coastline include migrating, nesting/breeding and over-wintering bird populations, resident shore birds (waders and diver species), seagrass habitat and sub-littoral and coastal habitats. These sensitivities are high all year round but may be regarded as being highest during the bird breeding (May - July) seasons and when over-wintering species are resident (December - January) and when/where nearshore feeding activity is high.

The most sensitive shoreline habitats within the potential shoreline impact zone identified above are the coastal wetlands, the most extensive of which are to be found in the Kyzyl-Agach region southwest of Sangachal Bay and along the southern shoreline of the Apsheron Peninsula (see Figure 13.2 Transboundary Chapter). These areas are highly productive ecosystems hosting large numbers of resident and seasonally migratory birds. The nearshore shallow waters of these area also act as feeding grounds for many fish species. In addition, seagrass habitat identified in Sangachal Bay and around the Apsheron Peninsula make the areas biologically productive regions important to fish and bird species including resident, migratory, nesting and breeding species.

As the toxic and volatile light-end components of any spilled condensate would rapidly evaporate on entering the marine environment, the most likely impact of a spill in the coastal zone would be one of physical smothering. Product dispersed through the water column may however, also have detrimental toxicological and physical impacts on benthic habitats and the associated communities although it is considered likely that most condensate residue that entered the water column would be broken-down relatively quickly thereby reducing the likelihood that significant impacts on benthic would occur.

While it is considered a highly unlikely event, there is a potential for spilled condensate and/or residues to reach the coastline of neighbouring Iran. The Iranian coastline is known to be of importance for its coastal wetlands and it hosts a number of sites of designated national and international importance due to the fact that they support significant bird populations including a predominance of waterfowl or shore birds. Sensitive times of the year include spring, summer and autumn (encompassing migration, nesting, fledging and moulting periods).

Impact significance

Impact of condensate spill

Overall, the likelihood of a large and potentially damaging condensate spill occurring is considered to be extremely low, due to the engineering design controls and emergency response procedures that would be put in place. Similarly, while it has been shown through laboratory tests that persistent but unstable residues can be formed from the Shah Deniz condensate at low temperatures, it has also been shown that these readily break-down in warmer conditions. No residue is formed at higher temperatures. Overall therefore, the significance of impacts resulting from a Shah Deniz condensate spill is considered to be “low” as follows:

Likelihood of occurrence = 1 – very unlikely.
Consequence = 5 – transboundary and/or national scale impact.
Significance = 5 - low.

Potential Impact of cleanup operations

In addition to the direct toxic and potential smothering effects of spilled condensate, ancillary impacts may occur during clean-up operations wherever vessels and helicopters are used to recover spilled (residual) product and/or to conduct surveillance sorties and where response personnel movement and activity associated with shoreline cleaning in sensitive coastal areas might be intense. During such response strategies, clean-up operations have, in addition to the spill itself, the potential to disturb more organisms (e.g. seals and birds) and to impact the coastline.

It is noted that, as discussed above, the likelihood of spilled condensate or its residues reaching the shoreline is very low. Further, even if shoreline stranding did occur, it is unlikely, given the properties of the condensate and residue, that product would persist in the environment for more than a few weeks. Depending on the actual volume of a spill, its trajectory and the eventual fate in terms of any shoreline stranding, it may be more prudent to adopt a ‘leave alone’ approach than to mount a shoreline clean-up exercise that could cause more damage to sensitive habitats and resident fauna.

In addition, the nature of a condensate release typically precludes the use of dispersants because by the time dispersant could be applied, the condensate would be likely to have already dispersed. Condensate releases form slicks that are too thin to use oil spill booms and burning may pose a hazard if there is gas and evaporated condensate in the air above the water. Burning would definitely present a hazard in the case of a blow-out because of the attendant safety risks associated with the high flammability of the associated gas and proximity of the offshore platform facility.

10.6.1.6 Produced water re-injection onshore

The project base-case for the disposal of produced water onshore and hydrotest waters from platform, pipeline and terminal commissioning is injection into dedicated disposal wells to be drilled in the Lokbatan field some 22 km north of the terminal site at Sangachal. There are a number of potential non-routine (accidental) events that may occur from this process and these could result in environmental impacts. These events are:

?? loss of injection fluid via an existing well;
?? inducement of a seismic event;
?? loss of fluid to surface via existing major faults;
?? potential loss of fluid at the surface via a new fault after a seismic event;
?? contamination of existing drinking water; and

?? pressurisation of the existing oilfield.

Impact significance

The environmental impacts of non-routine (accidental) events associated with produced water injection are considered to be of "low" significance as follows:

Likelihood = 2 - unlikely. Consequence = 2 - local scale impact. Significance = 4 - low.

Loss of fluid via an existing well

The Lokbatan oilfield has producing oil for over 70 years. This has resulted in the construction of over 1,700 production and exploration wells. At present, data on the integrity of casings of these existing wells is not available. One of the most serious potential environmental hazards associated with the concept of injecting produced water into an existing oilfield is the threat of injected water flowing from the injection horizon around the outside of an existing production well.

Based on an understanding developed from earlier experiences of water injection, the possibility of the occurrence of vertical flow along existing wells cannot be ruled out and should be regarded as a possibility. Clearly the greatest risk would be to very old wells or well casings that have gone through significant deformation as a consequence of over production. If leakage does occur outside existing casings, water would flow under high pressure in a vertical direction towards the surface.

Due to the absence of shallow aquifers containing potable drinking water and the high level of existing surface contamination in the Lokbatan Field, the environmental consequences of this occurrence are classed as negligible to low. The potential for water to flow to surface via an outside pathway is thought to be extremely unlikely unless the induced fracture or high-pressure injection front intersects a poorly completed borehole within 100 m of the injector. The vertical distribution of hydrostatic pressure and permeability of the strata above the production horizon would control the probability of water flowing to surface via this route.

A more serious environmental impact associated with the loss of fluid via existing wells would be if a well was inadequately grouted and the introduction of additional pressure induced an uncontrolled flow of hydrocarbons at surface. Whilst the consequences of this occurrence would be moderate the probability of this occurring are classed as highly unlikely.

Loss of fluid to surface via surface fault

If the produced water injection wells were constructed close to an unidentified fault there would be the possibility that water could flow rapidly to higher levels by flowing existing sub-vertical pathways within the fault plane. Clearly the risk would be much greater if the fault was intersected by the hydraulic fracture induced by the injection process. Evidence presented from the modelling work demonstrated this effect by calculating the presence of a pressure surcharge of 750 psi at a sealing fault positioned approximately 1km from the injection well.

The possibility of a fault occurring that is vertically persistent over the full stratigraphic section and within 300 m of the injector well is considered possible. The environmental consequences of such an occurrence, assuming that the majority of the produced water contained, would be moderate as the intersection of such a permeable feature would be identified via the surface pressure response at the injector wellhead. In this situation the rate of fluid loss up an existing fault plane will be controlled by the permeability of the fault plane.

With the exception of those faults close to the crown of the Lokbatan structure, the majority of faults on the flanks of the anticline are thought to be sealing faults. Evidence from existing records suggest that local faults present to the south of the southern flank are thought to be "sealing" and are responsible for the occurrence of artesian pressures in a number of wells in the immediate vicinity of the proposed region of interest. Without the introduction of significant pressure to hydraulically "open" an existing fault plane, local faults are therefore, unlikely to provide sub-vertical pathways through which water could escape. As a consequence, the possibility of water escaping via groundwater advection along an existing fault plane is considered highly unlikely. If this situation did occur, then the environmental consequences would be negligible.

Contamination of shallow aquifers and drinking water

One of the most important aspects of world-wide legislation controlling the deep disposal of contaminated water is the threat to aquifers and potable water sources that may overly the candidate formations. Pollution of shallower aquifers can occur via poorly constructed injection boreholes leading to annular flows around external casing. Less direct pathways in the short term can occur via faults and adjacent wells with more long-term pollution occurring as a consequence of regional mass flow, often when injected water has migrated into regions of the aquifer whose water quality is suitable for drinking.

Based on the baseline assessment of geology and hydrogeology presented in the Environment Description (Chapter 6), the potential to cause significant impacts at Lokbatan is negligible. This conclusion is based on the following understanding:

1. there are no shallow aquifers that are used to supply potable drinking waters in the immediate vicinity of the injection zone;
2. the injection well casings would be engineered to such a high standard that the potential occurrence of vertical leakage at the well-bore would be effectively eliminated; and
3. the Balakhany and Pereriv formations do not outcrop or contain potable drinking waters at higher elevations.

The probability of this impact occurring is therefore, highly unlikely and the significance negligible given that no sub-surface potable water resources exist within the Lokbatan area.

Pressurisation of the existing well-field

It is standard oilfield practice to enhance both the volume of oil recovered and the down-hole production rate in depleted oil fields by injecting water into the reservoir. If the fault present to the north of the area of interest is permeable then there is the potential for the pressure surcharge imposed at the injector well to increase the regional pressure of the aquifer to the north of the site.

This increase in hydrostatic pressure could be transmitted laterally over several kilometres and as a consequence re-pressurise the producing fields to the north. Quite clearly this phenomenon would only occur if the faults to the north of the injection field are permeable. Based on the present conceptual understanding and the presence of artesian pressures at surface, this conclusion appears to be valid. Based on this preferred understanding the probability of pressurisation of existing the well-field is regarded as highly unlikely.

If the faults were permeable and allowed injection pressures to be transmitted horizontally into the aquifer the consequences of the injection process at a distance in excess of 2,000 m would be low. For the high stress case with no sealing faults, the average reservoir pressure increase at the end of the disposal period (end 2024), in the uppermost injection interval in the oil leg was predicted to be 370 psi. Indeed the consequence of this impact would be beneficial and would not adversely affect the environment. The intersection of the oil-leg from the geological section is at least 3,000 m to the north of the proposed site. If wells were completed in the Pereriv outside this zone, then whilst the hydrostatic pressure would be lifted as a consequence of produced water injection, it is unlikely that oil would flow to surface.

Inducement of a seismic event from re-injection operations

The risk of a seismic event being triggered by re-injection produced water, has been raised as a key concern by project stakeholders.

There have been a number of documented cases where prolonged injection of water in seismically active area has initiated some form of seismic event that may or may not be associated with the release of energy along major faults. The severity of the impact and the probability of the occurrence are very site specific. In terms of their impact on the environment such seismic events can theoretically provide a very positive impact by reducing the shear along active fault planes to initiate a larger number of smaller displacements as compared to a single more dramatic event.

The potential for a seismic event to be triggered as a result of injection of produced water in the onshore environment is considered to be very low due to the limited volumes of water from the Shah Deniz project that would need to be injected. The ACG project plans however, to inject considerable volumes of water and the Shah Deniz injection site is common with ACG.

10.6.2 Seismic events

As noted in Chapter 6 (Environmental Description), the Apsheron Peninsula and adjacent area of the Caspian Sea are located in a zone of moderate seismic activity because of their location in the active Alpine folding zone. The abundant mud volcanoes indicate tectonic activity and the likely presence of oil and gas in the deep strata. Five earthquakes with a magnitude greater than 6 on the Richter scale have taken place since 1842 with the most recent events occurring in 2000; one measuring 6.5 on the 25th November 2000 with an epicentre 30 km east-northeast of Baku and the other measuring 7.2 at the epicentre, occurring 10 days later on the 6th of December off the coast of Turkmenistan.

10.6.2.1 Offshore facilities, wells and pipelines

The seismic activity in the area of the Stage 1 development has been fully considered in the design of the facilities.

There are two levels of integrity designed into the platform structures. The first is a 1-in-300 year event that the platforms are designed to withstand and be able to continue operations. The second level is a 1-in-3,000 year event design factor such that the platform would retain its structural integrity and would remain in place, although depending on the magnitude of the event, the platform's operational capability may be compromised.

Stability and stress analyses have been conducted to ensure that the pipelines are suitable for the environmental conditions in the development area. Predicted fault movements have been safely accounted for within the pipeline design. Additionally, where required, spool pieces will be inserted into the pipeline to allow free expansion and to reduce axial stresses to acceptable levels.

The design of the onshore facility has taken account of the horizontal acceleration[14] arising from seismic events. The design considers an event which would occur once in 500 years and leave the plant fully operational. The design also considers an event which could occur once in 3000 years and leave the plant damaged but without structural collapse. Historical data was used to determine these accelerations based on seismic events dating back to 650 AD located in the region. Statistical analysis of the likelihood of an event, its magnitude and its probable location was used to derive the horizontal acceleration's used for design.

Impact significance

The probability of a seismic event that leads to the total loss of facilities occurring is extremely low given the consideration of these phenomena in the facilities' design. The impact significance of seismic events on the facilities is therefore, considered to be "low" as follows:

Likelihood = 1 - very unlikely. Consequence = 5 - transboundary and/or national scale impact. Significance = 5 - low.

Platform

Platform design has taken into account possible seismic activity in the development region. The facility will remain fully operational in a 1-in-300 year event and would retain its structural integrity in a 1-in-3,000 year event although some operational functionality may be lost.

Wells

All of the Stage 1 wells will be equipped with down-hole safety valves, such that, for any reason that the platform facilities became unavailable, the wells would shut-in by means of these valves, hence preventing any loss of well control or free flow from the wells into the sea.

Subsea pipelines

The on-bottom pipeline should not be adversely effected by a seismic event as the pipeline is flexible, unrestrained and free to move. At the point that the pipeline joins the platform however, the transition between on-bottom and buried sections and within the buried sections, high stresses due to seismic activity could occur. Consequently, the effect of possible seismic activity is to be evaluated, to ensure that the integrity of the pipeline is maintained in the event of a seismic activity, at the following locations:

platform-seabed interface (where spool pieces are covered with mattresses);
seabed-trench transition interface; and

[14] Horizontal accelerations used are related to forces and these can be further related back to different scales commonly used to categorise seismic events; for example relating to the Richter scale. For the 1-in-500 years event, site facilities will survive with little damage or undamaged following an earthquake of 7.0 in Richter Scale. The epicentre is assumed to be 20 km from the site location. For the 1-in-3000 years event, site facilities will not be subjected to uncontrollable collapse during an earthquake of 7.5 in Richter Scale if the epicentre is 20 km from site location.

buried sections (i.e. mud volcano crossing; nearshore zone, landfall; etc.).

The effect of seismic activity, with a return period of 500 and 3,000 years (corresponding to the Strength Level Earthquake (SLE) and Ductility Level Earthquake (DLE) events, respectively) are to be considered in conjunction with the functional load case only.

Onshore facilities

The terminal has also been designed to withstand 1-in-500 and 1-in-3,000 year seismic events. This is considered sufficient to safeguard the terminal facilities against the type and size of seismic events characteristic of the region.

10.6.3 Introduced species

In recent years the transfer of marine organisms into the Caspian Sea from international waters has increased in parallel to an increase in trans- and inter-oceanic movement of vessels into the region and corresponding changes in legislation and technology to prevent the contamination of ballast water taken up and discharged by vessels.

The transportation of pre-fabricated components and equipment for the Shah Deniz Stage 1 project would be from international waters to the Caspian Sea via the Don-Volga Canal or Baltic-Volga Canal and as such, there is a risk that exotic (i.e. non-indigenous) species could be introduced into the Caspian. The key pathways for the introduction of exotic species include:

?? in ballast water[15]; and
?? as sessile hull fouling organisms.

10.6.3.1 Ballast water

An acute problem associated with ballast water is the potential introduction of alien algal species into marine environments in which they do not naturally occur. Of particular concern is the introduction of toxic species of dinoflagellates and microscopic, unicellular algae that may out-compete other indigenous species that represent an important dietary component of indigenous fish and shellfish.

Dinoflagellates and microscopic, unicellular algae may be transported in live form in the ballast water of cargo vessels. Under favourable environmental conditions, planktonic populations of only a few cells can rapidly multiply into dense blooms containing millions of cells per litre. These species can cause significant environmental damage when introduced into areas where they are not naturally found and/or where they may contain toxic phases in the lifecycle (see below).

Other organisms such as marine invertebrates, molluscs, fish and other macrofauna may also be introduced, either as adult individuals or as larval stages, as a result of ballast water discharge. The ability of these organisms to survive within ballast water depends on environmental characteristics in the area of ballast water uptake and on the species present and their tolerance to temperature and salinity.

In addition to site-specific environmental factors, a number of technical considerations can influence the level of risk of transporting non-indigenous species in ballast water. These include:

15 Ballast water is taken up to compensate for low loads and discharged prior to or at the same time as loading takes place.

?? vessel design and ballasting requirements;
?? vessel operation and maintenance procedures;
?? voyage frequency, duration, season and weather;
?? ballast water management practices before, during and after the voyage; and
?? the extent to which ballast water management practices are used including:
  ?? minimising uptake of organisms during ballasting by avoiding areas and times of outbreaks,
  ?? avoiding ballast uptake in shallow water and at night;
  ?? regular ballast tank maintenance and cleaning with removal of sediments;
  ?? adherence to ship Ballast Water Management Plan; and
  ?? ballast exchange at sea.

10.6.3.2 Hull fouling

The risk of organism translocation via hull fouling is as important as that associated with ballast water. Organisms may nestle in sheltered parts of the vessel but more generally include sessile organisms that attach to any suitable substrate and remain fixed for the duration of their adult lives. These organisms can be divided into two main groups:

?? micro-organisms (e.g. bacteria, diatoms, algae); and
?? macro-organisms (e.g. sea squirts, molluscs (mussels), barnacles, sponges, sea anenomies and polychaetes (worms)).

Traditional practice to combat hull fouling has been to physically scrape organisms off the structure of vessels in order to maintain the hydrodynamic efficiency of the vessel. Ships are typically dry-docked every 3 to 5 years for such maintenance works. The time and hence cost aspects of this approach to hull fouling control led however, to the use of antifouling paints (e.g. tributyl tin (TBT)) that are toxic to marine organisms on ship hulls. These chemically treated paints significantly reduce the ability of sessile organisms to inhabit ship hull surfaces.

Concern regarding the long-term fate and toxic effects of these antifoulant agents in the marine environments has resulted in the implementation of restrictions on the use of antifouling paints and a return to a reliance on direct removal measures (i.e. physical hull scraping by divers) while ships are still in-water. Where in-water cleaning takes place, there is an increased risk that non-indigenous species may be introduced to the receiving marine environment as the debris removed may contain surviving species and gametes that can settle to the seabed and successfully establish new populations.

10.6.3.3 Impacts associated with introduced species

The survival and success of species when introduced to a new environment is dependant a number of variables. These include:

?? the presence of a suitable environment (temperature and salinity regimes);
?? the time period in which these suitable conditions are favourable for reproduction of the species; and
?? the presence of predators, food sources and established competitive species occupying the same ecological niche.

The effects of introduced species in the short and long term are difficult to predict. Species such as the planktonic jellyfish *Mnemiopsis leidyi* that are physically visible or noticeably adversely affect other species and especially commercially important species, will rapidly attract the attention of marine biologists and regulatory authorities. Introduced organisms that are not so visible may cause subtle changes to local ecosystems but without being directly noticed. These effects may not become apparent until some time after the species have become prolific and well established.

Some toxic dinoflagellate species are capable of producing resistant cysts that can remain fully viable, under favourable environmental conditions, for as long as 10 to 20 years. Cyst producing species that are introduced via ships' ballast water in their cyst stages may become buried below the sediment surface from which they can become re-suspended into the water column. This process may result in years of recurrent germination attempts by the cysts which, when successful, result in dinoflagellate blooms in the water column. These toxic blooms may adversely affect the quality of the water and may be fatal to indigenous shellfish and commercial fish species. The introduction of such species may also cause problems to fisheries by the clogging of fishnets with mucus. Once the species produces cyst stages it will effectively have colonised a new water body from which it cannot be eradicated.

Of more concern in an enclosed ecosystem such as the Caspian Sea where endemic and specialised species have developed, is the effect of introduced species on the genetic structure of the local population. This is not only true for the introduction of alien species into the area but also for the movement of individuals of the same species (indigenous species) from outside areas. Changes in genetic structure may have a number of resultant effects such as changing the sensitivity of the resident population to diseases or the population's ability to adapt to environmental changes.

The introduction of exotic species also creates the possibility of concurrent introduction of pathogens where the introduced species are pathogen hosts. In addition, water and sediment discharge from ballast tanks can also contain viruses and bacteria that could not only have an effect on Caspian flora and fauna but may also pose risks to human health.

Impact significance

The probability of the introduction of exotic species into the Caspian, given the low volumes of vessels that are proposed for Shah Deniz Stage 1, together with a decision to transfer some loads to existing riverships in the region to gain the necessary draft required for river transport, is low. The impact significance of introduced species is therefore, considered to be "low" as follows:

Likelihood = 1 - very unlikely.
Consequence = 5 - transboundary and/or national scale impact.
Significance = 5 - low.

The application of international standards to project related transportation (i.e. transfer of goods and equipment into the country and out of the country) to safeguard against the potential to introduce exotic organisms to the Caspian marine environment are further discussed in Transboundary Impacts (Chapter 13; Section 13.3.4). In particular, the measures that will be implemented during transportation of the TPG500 hull sections through the canal system north of the Caspian Sea are presented.

10.7 Impacts of project decommissioning

10.7.1 Planning for decommissioning

In relation to offshore facilities, the United Nations Convention on the Law of the Sea (UNCLOS) 1982 states under Article 60(3) that:

"Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, taking into account any generally accepted international standards established in this regard by the competent international organization. Such removal shall also have due regard to fishing, the protection of the marine environment and the rights and duties of other States".

The "competent international organization" under UNCLOS is the International Maritime Organisation (IMO). The IMO Guidelines for Offshore Installations Removal states that platforms in waters deeper than 100 m must be removed to give a clear water column of 55 m for safety and navigation. In addition, all structures installed after 1998 must be designed so as to be feasible for complete removal.

To date, Azerbaijan has not ratified UNCLOS but it should be noted that a call has been made by the General Assembly for landlocked states such as Azerbaijan to consider doing so in light of the importance of the provisions of Part X[16] of the convention for them. Part X relates to rights of access of landlocked state to and from the sea and freedom of transit.

BP will work with Shah Deniz PSA partners and relevant stakeholders to prepare a detailed Field Abandonment Plan (i.e. decommissioning) plan for all Shah Deniz onshore and offshore facilities. The Plan will be produced approximately one year prior to the completion of 70% production of identified reserves. It is likely that all partners involved in the project will be required to contribute a proportionate share of the decommissioning costs to an "Abandonment Fund" such that the funds can be accrued against the decommissioning costs.

The Field Abandonment Plan will include a Comparative Assessment the purpose of which will be to consider the options for field abandonment in terms of:

?? cost;
?? technical feasibility;
?? safety;
?? environment; and
?? external influences.

These five factors will be assessed ranked for each decommissioning option and a most appropriate approach determined. The Comparative Assessment process will be conducted in consultation with stakeholders, including relevant government authorities, to ensure that the most practical environmental (and socio-economic) option is selected. In order to fully evaluate the consequences of the decommissioning programme, a Field Abandonment ESIA will be prepared for review and consultation prior to commencement of decommissioning work.

10.7.2 Approaches to decommissioning

While the TPG500 facility's design allows for a relatively straight forward and standard demobilization process (i.e. jack-down and float-away), it is not possible at this time to list all the specific options or to evaluate each option in terms of their environmental and socio-economic consequences because the operating environment is likely to be very different towards the end of its operational life.

The Comparative Assessment will have to consider advances that have been made in technology as well as advances in equipment that may have occurred over the life of the project. Additionally, it is likely that technological resources that are not presently available

[16] X = Roman numeral for 10.

in the Caspian region will have become so by the time planning for decommissioning is commenced in earnest. Finally, international maritime law and stakeholder expectations may have also changed in the intervening period.

Despite these variables and uncertainties, there are some basic approaches to decommissioning of offshore and onshore oil/gas facilities and these are likely to form the basis from which detailed planning for decommissioning of the Stage 1 facilities will be undertaken. These generic approaches are discussed below.

10.7.2.1 Baseline conditions re-characterisation

It is expected that over the life of the project, there will be some degree of change to the receiving environment within the project area. It is considered therefore, that the environmental baseline would need to be re-characterised on the basis of the continued monitoring that would be undertaken during the project.

The decommissioning strategy for Stage 1 facilities will be developed based on the findings of the Comparative Assessment (Section 10.7.1 above) and will be documented in the draft Field Abandonment Plan. Potential environmental and socio-economic impacts associated with the decommissioning strategy would be dependent on the detail of the strategy and the environmental character of the area at the time. These would be assessed via an ESIA process that would include consultation with relevant authorities and stakeholders, prior to decommissioning commencing. In finalising the Field Abandonment Plan, the facilities owner/operator will take account of the findings of the ESIA and will make any necessary adjustments to the decommissioning strategy.

10.7.2.2 Wells

Before removing the TPG500 facility it will be necessary to plug and abandon all of the Stage 1 wells in order to isolate individual productive intervals and prevent any flow of fluids to the surface. Once the wells plugged, the seabed is typically cleared of any obstructions such as wellheads and conductor casings. Removal of such structures typically requires the cutting of the sub-sea wellheads and conductor casing below the surface of the seabed.

Cutting operations typically result in localised and short-lived re-suspension of sediments that could affect benthic filter feeders through smothering. The degree of disturbance to the sediments and benthos will depend on whether excavation or blasting is required to free the conductor casing, although the impact will still be relatively short-lived and localised. Operations would need to take account of the presence of drilled cuttings on the seabed as it is planned that the surface 28” section drilled cuttings will be discharged to the seabed from each of the Stage 1 wells (Section 10.3.3.3). These sections will be drilled with drilling fluids/WBM that are chemically inert. Any further dispersion of these cuttings would result in localised increase in water turbidity and potentially some additional physical smothering on the benthos in the vicinity of the operations but would not be expected to result in chemical impacts.

In addition to the physical disturbance caused by the well abandonment, there is an issue concerning waste disposal. At the Shah Deniz E2 drill site there will be nine wells to be decommissioned and at the E3 drill site, five. The production tubulars and the conductor casing that is removed will have to be shipped to shore for disposal. It is likely that these facilities will be contaminated with hydrocarbon product and other chemicals (as used during drilling and production operations) and therefore, handling procedures will need to ensure that the risk of these contaminants being introduced to the marine environment are minimised.

10.7.2.3 Process equipment (onshore and offshore)

Process equipment on offshore installations and at onshore receiving/processing terminals are typically decommissioned before the installations themselves are. In regards to the offshore installation, process equipment decommissioning can be completed offshore but is typically undertaken only to the level that ensures safety during installation decommissioning due to the high costs of such activities. Any remaining decommissioning work is completed onshore once the facility has been removed from the offshore site.

Any remaining liquids in the process equipment is typically initially flushed with diesel and then a water-detergent mix. The final step of the decommissioiung process is generally to circulate nitrogen through the process train. The gas strips hydrocarbons that may still be present within the system after initial flushing and hence makes the process train safe. Wastes generated by the stripping process are typically sent to the onshore terminal via the subsea pipeline before the latter is disconnected from the offshore installation. Once received at the terminal, the gas/hydrocarbon mixture is processed to remove the hydrocarbon component as a viable fuel product. In regards to the onshore terminal, depending on the availability of other processing facilities to receive and process the gas/hydrocarbon mixture, wastes may need to be collected and disposed of in an alternative manner (e.g. flared; high temperature incinerator).

10.7.2.4 TPG500

As discussed in the Project Description (Chapter 5; Section 5.3.8), the TPG500 is designed for ease of removal and decommissioning activities are essentially a single event. Taking the platform from its operational state to being ready for removal requires:

?? wells, process equipment and pipeline decommissioning (see above and below);
?? re-commissioning of leg jacking mechanisms and installation of temporary equipment;
?? jacking down and re-floatation of platform ready for tow-away and relocation
?? onshore or near-shore dismantling or re-use of the platform facility.

In order to be able to raise the legs from the seabed, the leg jacking and locking mechanisms will be re-commissioned and the foundation suction pumps will be made ready or reinstalled to enable the legs to be lifted in a reversal of the installation procedure. The hull of the TPG500 will then be lowered onto the sea surface and the legs jacked free of the seabed, using the suction pumps to free the leg foundations. Once the legs have been lifted and locked the platform can be towed back to shore although the suction cans will need to be removed at a location with a water depth of approximately twenty metres. When removed the tow to shore can continue.

Jack-down and float-away activities are likely to result in a level of re-disturbance of seabed including the mobilisation of discharged cutting and sediments into the water column. The activity would however, be relative short-lived and hence the associated impacts of low significance.

The necessity and extent to which the TPG500 will be further decommissioned and dismantled onshore or near-shore will be dependent on whether or not an ongoing use for the facility has been identified. Either way, it is considered likely that the facility would need to be over-hauled and perhaps modified prior to deployment to a new site and therefore, some level of work will be required.

10.7.2.5 Subsea pipelines

Generally, subsea pipeline decommissioning options include complete removal or abandonment *in-situ*. The decision of which option to adopt in regards to the Stage 1 pipeline would be based on an evaluation of cost, safety and environmental impact as well as the potential to re-use the pipeline for other production operations at the timeIt is noted that neither UNCLOS or the IMO Guidelines contain specific specifications for decommissioning of subsea pipelines. Regardless, the guidelines have, not to date, been ratified by Azerbaijan.

Abandoning the pipelines *in-situ* would require that the pipelines are flushed with seawater. The flushing is in effect, the reverse of the hydrotest procedure. Subsequently, any sections of the pipeline that may prevent a snagging risk to fishermen or vessels would be covered or removed.

Complete removal of subsea pipelines would result in similar impacts as described for pipeline installation, principally disturbance to benthos as well as marine flora in the nearshore zone (Section 10.3.4.2).

10.7.2.6 Onshore terminal

A decision on the decommissioning and removal of the terminal facilities would be made based on whether it can be used for ongoing oil and gas production from other fields at the time or if any re-use opportunities are available. If a decision to remove the facility is made, the land would need to returned to its original state.

Site re-instatement after removal of terminal facilities would include:

?? a soil (and groundwater) contamination investigation with remediation as required;
?? landscaping of the area so that it more closely resembles the surrounding terrain; and
?? re-seeding and or re-planting for soil stabilization and habitat restoration.

It should be noted that as with the early civil works programme, terminal decommissioning and particularly landscaping may have an effect on the local hydrological regime and associated wetland features. The implications of this element of the decommissioning programme would need to be assessed.

10.7.2.7 Project facility and materials re -use and recycling

Many of the materials to be used in the Shah Deniz offshore and onshore facilities have high intrinsic value; for example, should the decision be made to dismantle the TPG500 rather than re-use it in another development, the steel used in its construction is likely to have a high re-use value.

BP will promote a recycle and re-use philosophy for all of the decommissioned project components in order to minimize the generation of wastes and maximize the resale value of the installations and equipment. With careful management, decommissioning of oil/gas production facilities and particularly offshore platforms in other parts of the world, have resulted in less than 5% of the platform material ending up as waste.

The opportunity for re-use of the TPG500 will be dependent on the status of other offshore developments in the Caspian that could utilize such a drilling and production facility. The re-use or ongoing use of the gas-condensate receiving and processing terminal will similarly depend on the level of oil/gas production activity in the region at the time. Should ongoing uses for the facilities not be identified, the level of recycling of the platform and of other

Stage 1 facilities that can be achieved will, in part, be dependant on suitable recycling facilities being available in Azerbaijan.

10.7.3 Schedule of abandonment and decommissioning

Table 10.39 presents an approximate schedule for Stage 1 abandonment and decommissioning activities.

Table 10.39 Approximate abandonment and decommissioning schedule

Activity	Approximate Date
Materials inventory:	During detailed design and construction.
Inventory of harmful substances:	During productive life of production facilities and wellhead platforms.
Structural integrity of facilities:	Annually during productive life of the installations.
Certification of platforms as being structurally sound and fit for intended use:	Annually throughout the life of the platforms as required by the certifying body.
Field Abandonment Plan and Comparative Assessment:	At 70% depletion of reservoir.
Decommissioning ESIA:	At 70% depletion of reservoir.
Abandonment management system and environmental procedures:	At 70% depletion of reservoir.
Abandonment Fund:	At 70% depletion of reservoir.
Wells plugged and abandonment:	As required.
Decommissioning:	As logistics allow.
Post abandonment environmental surveys:	2 and 5 years after abandonment.

11 Socio-economic Impact Assessment

11.1 Introduction

Chapter 3 discusses the approach and methodology developed and applied for this impact assessment process. The adopted definition of a socio-economic impact is based upon the definition given for an environmental impact in ISO 14001:1996 Environmental Management Systems - Specification with Guidance for Use (ISO, 1996).

A socio-economic impact is any change to the socio-economic environment, positive or negative, that wholly or partially results from a project activity or an associated process. Relevant (i.e. social-economic) legislation, regulation, standards and policy impacts are considered within the socio-economic impact assessment.

Socio-economic impacts have been identified and assessed for the Shah Deniz Stage 1 Project. The potential for an impact exists where a socio-economic aspect has been identified (Chapter 9); that is, where a project activity has been determined to have the potential to interact with the socio-economic environment.

The primary objectives of the impact assessment are to:

- establish the significance of identified potential impacts that may occur as a result of a project activity being undertaken; and
- differentiate between those impacts that are insignificant (i.e. can be sustained by existing socio-economic systems) and those that are significant (i.e. cannot be sustained by existing socio-economic systems).

11.2 Significance

Significant potential impacts would require alternative and/or additional mitigation measures above and beyond those already incorporated in the base design for the project/activity. It should be noted that there is also the potential for cumulative impacts to occur. These are discussed in Chapter 13.

The significance of an impact is determined by:

- determining the socio-economic consequence of the activity;
- determining the likelihood of occurrence of the activity; and
- subsequently, calculating the product of these two parameters.

The socio-economic impact assessment completed for the Shah Deniz Stage 1 Project has addressed planned (routine) activities only. The consequence and likelihood of socio-economic impacts resulting from planned activities are discussed below. Changes in the planned activities for the Shah Deniz Stage 1 Project would affect both the impact assessment and the planned mitigation activities.

11.2.1 Consequence

Table 11.1 presents the consequence assessment criteria for socio-economic impacts. The level of consequence for each identified impact is determined by examining a number of factors relating to the activity. Each category has a number of parameters as follows:

- community and stakeholder perception of the activity;

- the ability of the social fabric and economic structure to absorb the impact (i.e. adapt to change); and/or
- whether or not the activity results in a breach of legislation, regulation or standards to which the project must comply and/or a breach in operator policy.

Table 11.1 Categories and definition of consequence levels for socio-economic environment impacts

CATEGORY	RANKING	DEFINITION
Catastrophic	5	• Emergency situation with harmful consequences to human health (e.g. fatalities). • Disastrous consequences on the livelihoods of individuals (e.g. curtailment of access to primary income source). • Calamitous consequences on those seeking to access community facilities and utilities (e.g. resettlement of large numbers (1,000s) of households). • Disastrous consequences on the economy (e.g. all employment and supplier sourcing outwith Azerbaijan). • Breach of company social policy and/or legislation.
Major	4	• Major impact on human health (e.g. serious injury). • Significant impact on the livelihoods of individuals (i.e. access to income source restricted over lengthy periods of time). • Serious impact on access to community facilities and utilities (e.g. resettlement of large numbers (10s – 100s) of households). • Notable consequence on the economy, at a local, regional and/or national level (e.g. virtually no local sourcing of supplies or personnel). • Breach of company social policy and/or legislation.
Moderate	3	• Modest impact on human health and well-being (e.g. noise, light, odour, dust, injuries to individuals). • Moderate impact on individual livelihoods (e.g. restricted access to income source). • Medium impact on access to community facilities and utilities (e.g. access to utilities restricted for long periods (weeks) of time). Average impact on the wider economy, at a local, regional and/or national scale (e.g. only moderate levels of employment and supplies sourced within Azerbaijan). • Potential breach of company social policy and/or legislation.
Minor	2	• Limited impact on human health and well-being (e.g. occasional dust, odours, traffic noise). • Some impact on the livelihoods of individuals (e.g. isolated incidents related to ethnic tensions and some restriction on access to income source). • Some impact on access to community facilities and utilities (e.g. access to cultural centres restricted to a limited extent, i.e. (days) • Sparse impact on the wider economy, at a local, regional and national level (e.g. limited procurement).

CATEGORY	RANKING	DEFINITION
Negligible	1	• Possible nuisance to human health and well being (e.g. occasional unpleasant odours) • Very limited disruption caused to those earning their livings (e.g. no noticeable impact on herding operations). • Inconvenience experienced in accessing community facilities and utilities (e.g. electricity supply disruption for short (hours) period of time). • Very limited impact on the wider economy at a local, regional and/or national scale (e.g. no discernable indirect and induced development).
None	0	• No impact on human health. • No impact on livelihoods. • No impact on community facilities/utilities. • No impact on the wider economy.
Limited Positive	+	• Some beneficial improvement to human health. • Benefits to individual livelihoods (e.g. additional employment opportunities). • Limited improvements to community facilities/utilities (e.g. no discernable improvement). • Some impact on the wider economy (e.g. limited local procurement).
Modest Positive	++	• Moderate beneficial improvement to human health. • Medium benefits to individual livelihoods (e.g. employment impacts). • Improvements to community infrastructure/utilities. • Moderate impact on the wider economy (e.g. some local sourcing of supplies).
Significant Positive	+++	• Major beneficial improvement to human health. • Large scale benefits to individual livelihoods (e.g. large scale employment). • Major improvements to community facilities/utilities. • Notable impact on the wider economy (e.g. extensive use of local supplies).

It should be noted that in assessing an impact, the assigned level of consequence might be different for different consequence criteria. Where this has been found to be the case for this project's proposed activities, a rule has been established that the highest ranking criteria establishes the overall consequence ranking for the impact in question.

11.2.2 Likelihood

Table 3.2 in Chapter 3 is re-presented here as Table 11.2. It presents the criteria for the level of likelihood of the occurrence of an activity. The level of likelihood for each identified impact is determined by estimating the probability of the activity occurring.

Table 11.2 Likelihood categories and rankings natural and socio-economic impacts

Category	Ranking	Definition
Certain	5	The activity will occur under normal operating conditions.
Very Likely	4	The activity is very likely to occur under normal operational conditions.
Likely	3	The activity is likely to occur at some time under normal operating conditions.
Unlikely	2	The activity is unlikely to but may occur at some time under normal operating conditions.
Very Unlikely	1	The activity is very unlikely to occur under normal operating conditions but may occur in exceptional circumstances.

11.2.3 Impact Significance

As discussed in Section 3.6.4 the significance of a socio-economic impact is determined by calculating the consequence and likelihood of occurrence of the activity, expressed as follows:

Significance = Consequence x Likelihood

Figure 3.3 in Chapter 3 illustrates all possible consequence x likelihood product results for the five consequence and likelihood categories. The possible significance rankings are presented in Table 11.3 below.

Table 11.3 Socio-economic impact significance rankings

Ranking (Consequence x Likelihood)	Significance
>16	Critical
9-16	High
6-8	Medium
2-5	Low
<2	Negligible

*Positive impacts score simply as positive and so cannot be calculated in a similar equation to negative impacts.

11.3 Summary of significant socio-economic impacts

Table 11.4 presents the results of the socio-economic impact assessment as completed using the approach and methodology described above and in Chapter 3. In the table, project activities are listed down the left-hand column and socio-economic and other receptors in the right-hand columns.

As discussed in Chapter 3, impacts that have a ranking of ">9" are considered to be significant and hence require further examination in terms of alternatives and/or required additional mitigation to reduce the level of anticipated impact. Approaches and techniques for mitigation are discussed in Socio-economic Mitigation, Management and Monitoring (Chapter 15).

Table 11.4 Socio-economic impact assessment - offshore

ACTIVITY \ RECEPTORS		Socio-Economic											Other			
		Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Fabrication, Construction and Assembly in Azerbaijan	TPG500 (existing) assembly yard upgrade and preparation					5	+	5		5	++	+	+		+	
	Mobilisation of TPG500 assembly workforce					15	+		5	5		+	+		+	
	TPG500 assembly yard facilities, services and utilities operations															
	TPG500 assembly yard power generation															
	Assembly of TPG500 (hull; legs)					5	+				+	+	+		+	
	Construction of drilling template					5	+				+	+	+		+	
	Testing and commissioning of assembled TPG500 at assembly yard					5	+					+			+	
Istiglal MODU Installation and Drilling	Mobilisation of the Istiglal (including vessel operations)		5	5			+								+	
	Positioning and anchoring of Istiglal		5	5			+								+	

RECEPTORS / ACTIVITY	Socio-Economic											Other			
	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Float-out, positioning and installation of drilling template (including vessel operations)		5	5			+								+	
Istiglal drilling surface (28") section; discharge cuttings and drilling fluids/WBM to seabed		5	5			+								+	
Istiglal drilling of lower-hole sections; cuttings transfer and ship-to-shore		5	5			+			5					+	
Cement pump / cementing						+								+	
Istiglal utilities operation (sewage, drainage fire water, potable water)															
Istiglal power generation															
Istiglal cooling water uptake and discharge															
Istiglal well flowing and DST fluid disposal to flare (if required)															
Helicopter operations					5	+								+	
Vessel supply and back load (including waste transfer)		5	5			+									

RECEPTORS / ACTIVITY		Socio-Economic											Other			
		Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	Presence of Istiglal offshore		5	5												
TPG500 Drilling and Production	TPG500 float-out and positioning (including vessel operations)		5	5			+								+	
	TPG500 seabed fluidisation for suction anchors and jack-up (including vessel operations)		5	5			+								+	
	TPG500 / pipeline tie-in and commissioning (including vessel operations)		5	5			+								+	
	TPG500 well commissioning						+								+	
	TPG500 drilling of surface (28”) section; discharge drilling fluids (WBM) and cuttings						+								+	
	TPG500 drilling of lower hole sections; cuttings transfer and ship-to-shore		5	5			+			5					+	
	TPG500 cement pump / cementing		5	5			+								+	
	TPG500 utilities operation (sewage, fire water / testing, potable water)						+								+	
	TPG500 power generation						+								+	

	RECEPTORS / ACTIVITY	Socio-Economic											Other			
		Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	TPG500 cooling water uptake and discharge						+								+	
	TPG500 venting						+								+	
	TPG500 drainage						+								+	
	TPG500 corrosion protection						+								+	
	Helicopter operations					5	+								+	
	Vessel supply and back-load (including waste transfer)		5	5			+					+				
	Presence of TPG500 facility offshore		5	5			+				5		+			
Potential Accidental Events	Loss of facilities during transfer to offshore location		3	3							3	2	3			3
	Vessel collision (resulting in a spill)		2	2		2					2					15
	Encounter shallow gas during drilling TPG500 or Istiglal															

RECEPTORS / ACTIVITY	Socio-Economic											Other			
	Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Blow-out at well-head during drilling operations TPG500 or Istiglal		3	3							3		3	3		3
Loss of NWBM over-board from TPG500 or Istiglal															2
Loss of condensate over-board from TPG500															2
Chemical spill TPG500 or Istiglal															10
Loss of fuel inventory (diesel spill) or spill during fuel transfer															5
Loss of containment (fire, explosion) TPG500 or Istiglal		2	2									3			10
Earthquake/other tectonic event resulting in loss of offshore facilities		2	2							3		3	3		5

Note: The direct local positive impacts on oil and gas infrastructure are considered self-evident and therefore, not discussed further.

Table 11.5 Socio-economic impact assessment – subsea pipelines

RECEPTORS / ACTIVITY		Socio-Economic											Other			
		Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oils and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Pipe lay-down area in Azerbaijan	Transportation to / from lay-down area					5	+					+			+	
	Lay-down area facilities/services/utilities operations					5	+					+			+	
Installation onshore (landfall to Sangachal)	Onshore works preparation	5			5	5	+			5		+			+	
	Pipelines trench construction	5			5	5	+			5		+			+	
	Pipe-laying onshore				20	5	+			5		+			+	
	Pipeline crossings of existing onshore services				5	5	+	5		5		+			+	
Installation Coastal/ Nearshore	Site works preparation for beach pulls (onshore)	5	5		5	5	+					+			+	
	Construction of landfalls	5	5		5	5	+					+			+	
	Construction of finger piers	5	5		5	5	+					+			+	

RECEPTORS / ACTIVITY		Socio-Economic											Other			
		Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oils and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	Construction of nearshore trenches		10				+					+			+	
	Pipe-laying in the nearshore (including vessel operations)		10	5		5	+					+			+	
Installation Offshore	Preparation for pipeline crossings (and mud channel crossings) - install grout bags		5	5			+					+			+	
	Pipe-laying (including vessel operations; anchor drag)		10	5			+					+			+	
	Rectification of freespans		5	5			+					+			+	
	Helicopter operations					5	+								+	
	Material and equipment supply (including vessel operations)		5	5			+					+			+	
Hook-up and Commissioning	Tie in of pipelines to TPG500		5	5											+	
	Diving operations (DSV on site)		5	5			+					+			+	
	Dewatering of pipelines															

RECEPTORS / ACTIVITY		Socio-Economic											Other			
		Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oils and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Operations and Maintenance	Pipelines operation (presence)						+					+	+		+	
	ROV check (including vessel operations)		5	5			+					+			+	
	Corrosion protection						+									
Potential Accidental Events	Vessel collision (resulting in a spill)		6	6		4								6		15
	Hydrate formation in pipelines															
	Condensate pipeline leak (>100 but <1,000 tonnes)		4	4									4			4
	Gas pipeline leak		4	4									4			4
	Loss of entire pipeline(s) inventories		6	6									6			8

Note: The direct local positive impacts on oil and gas infrastructure are considered self-evident and therefore, not discussed further.

Table 11.6 Socio-economic impact assessment – terminal

RECEPTORS / ACTIVITY		Socio-Economic											Other			
		Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Civil Engineering and Construction and Commissioning	Land acquisition and tenure				20	5		5	5							
	Ground clearance and grading	5			10	5	+	5		5		+				
	Modification of existing services				5	10	+			5	++	+			+	
	Excavation of drainage channel; construction of bund wall and security dyke				5	5	+					+			+	
	Construction of fencing and perimeter lighting				5	5	+					+				
	Construction of access road and railway crossing				5	10	+			5		+			+	
	Mobilisation of workforce					15	+		5	5		+			+	
	Construction site facilities/services/utilities/operations					5	+	5				+			+	
	Power generation					5										
	Terminal construction (including underground, foundations, buildings)				5	15	+			10		+			+	

RECEPTORS / ACTIVITY		Socio-Economic											Other			
		Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	Demobilisation					5	15			5						
	Commissioning						+								+	
Operations and Maintenance	Process facilities (physical presence)						+					+	+		+	
	Produced water treatment and storage															
	Gas dehydration and conditioning (expansion and re-compression)															
	Flash gas recovery and compression															
	Condensate main tank storage															
	Off-spec condensate storage															
	MEG regeneration and storage (as required)															
	Chemical injection															
	Utilities operation (sewage, drainage fire water, potable water)															

RECEPTORS / ACTIVITY		Socio-Economic											Other			
		Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oil and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	Power and heat generation															
	Fire system tests															
Waste	Produced water (and hydrotest water) disposal via deep well injection onshore					5	+					+			+	
Potential Accidental Events	Extinguishing of flare/flare failure					6										6
	Loss of integrity of water disposal well					4					4					4
	Fire / explosion					3		4			4					10
	Loss of hydrocarbon storage inventory					6							6			8
	Earthquake resulting in loss of inventory					6					8		6			6
	Flaring					5										

Note: The direct local positive impacts on oil and gas infrastructure are considered self-evident and therefore, not discussed further.

Table 11.7 Socio-economic impact assessment – transportation

RECEPTORS / ACTIVITY		Socio-Economic											Other			
		Archaeology / Cultural Property	Fishing	Shipping	Land Use	Population in the vicinity of activity	National Employment Base	Utilities	Community Infrastructure	Transport	Oils and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
Transportation of modules and materials to Azerbaijan	Vessel operations and utilities		10	5		5	+					+			+	
	Rail Transport					10	+			10					+	
	Road Freight					10	+			10					+	
Accidental Events	Introduction of exotic marine organisms		5													

Note: The direct local positive impacts on oil and gas infrastructure are considered self-evident and therefore, not discussed further.

11.4 Analysis of socio-economic impact assessment results

11.4.1 Preamble

Socio-economic impacts associated with the Shah Deniz Stage 1 project are discussed below. The discussion is centred on receiving receptors and within this framework the impacts are discussed in terms of the particular activity or activities that have the potential to cause, or at least contribute to, the impact.

In assessing impact it should be noted that there are two distinct construction activities as outlined in the Project Description (Chapter 5):

- onshore terminal construction (early civil works and main construction work) referred to as ”onshore construction” throughout this document; and
- offshore construction (onshore assembly of offshore facilities and offshore installation of facilities) referred to throughout this document as ”TPG500 construction”.

BP will undertake all of this work via contractors and/or third party owner/operators. At present the location for the onshore assembly of the offshore facilities is yet to be decided. Current plans indicate that an existing fabrication yard within the capital city of Baku will be used for these activities, rather than the SPS yard already being utilised for similar activities by the related ACG Phase 1 project. If the Shah Deniz Stage 1 project utilises the SPS yard, the upgrades necessary for this yard and the relevant socio-economic impacts surrounding its use would need to be appended to this Shah Deniz ESIA report. Similarly, if a yard near Baku is chosen, it will be necessary to assess the likely socio-economic impacts of the use of the yard on the surrounding community via a separate ESIA process and append the report for that process into this ESIA document.

Given the above, the impact assessment process described in this chapter relates only to the onshore terminal construction and laying of onshore and nearshore pipelines. Any impacts related to the TPG500 construction process will be assessed and contained in an addendum to this ESIA report.

11.4.2 Land use

Potential resource use conflicts between Shah Deniz Stage 1 Project development activities and current land use activities have been identified. Current land use activities that will be disrupted are:

- grazing practices in and around Sangachal terminal;
- nearshore leisure activities; and
- existing café/garage business.

Table 11.8 presents a breakdown of existing and proposed land-take areas for the Shah Deniz Stage 1 Project. These land-take areas are the same as those for the related ACG Phase 1 Project as the land-take for the ACG and Shah Deniz terminals has been undertaken as one process.

Table 11.8 Existing AIOC/BP property and Land-take areas breakdown

Shah Deniz Stage 1 and ACG Phase 1 Project Area	Area (ha)
"No development zone":	302.0
Existing AIOC property (including EOP terminal land-take of 40.5 ha):	256.0
ACG/Shah Deniz FFD terminal expansion area (additional existing AIOC property):	146.5
Drainage channel outside of ACG/Shah Deniz terminal expansion area:	15.6
Site access road outside of ACG/Shah Deniz terminal expansion area:	7.5
Proposed construction camp area:	13.0
TOTAL:	**740.6**

The "no development zone" of 302 ha would be available to other users (e.g. herders) and therefore, the total area lost is 438.6 ha.

11.4.2.1 Disruption to grazing practices

The impact assessment process for this receptor has yielded the following impact significance ranking:

Likelihood of activities occurring = 5 - certain to occur.
Consequence of activities = 4 - significant impact on the livelihoods of individuals.
Impacts significance ranking = 20 - critical.

The area around the Sangachal terminal is a grazing ground for both cattle and sheep. The local herding community uses the grazing land around Sangachal during winter for their sheep. The ESIA team also observed herders herding cattle on the same land, and data gathering is ongoing to confirm and clarify the exact land use patterns.

Land use restrictions, or loss of access to land, could potentially impact on the livelihood of the herders. Such restrictions and loss could also impact on the welfare of the sheep and cattle that use the grazing land.

The initial Early Civil Engineering Works Programme (ECEWP), common to both the Shah Deniz Stage 1 and ACG Phase 1 projects, entails building the drainage channel, perimeter fencing and lighting, main construction camp, access road and railway crossing. Following these activities all works will be contained within the actual terminal site (i.e. within the drainage channel). Consequently, it is the land take for the Shah Deniz Stage 1 Project as a whole that has been completed for the early civil works that will have the most impact on the herders' livelihood. In addition the herders may experience nuisance, for both themselves and their animals, as a result of noise and dust whilst they are using nearby grazing land either within or outside the safety exclusion zone.

Encompassing the terminal site will be a safety 'no development' zone and this area will be pegged off, however the herders will be able to gain access and utilise the area for grazing during both terminal construction and operation.

The herders' farmland in the Sangachal area encompasses 1,636 ha of which 1,500 ha are suitable for grazing. The land take for the Shah Deniz Stage 1 terminal construction (including that portion of the existing AIOC/BP property that is presently undeveloped) will result in the loss of 438.6 ha of existing grazing land; that is, approximately 30% of existing grazing land. Data gathering is ongoing to determine the quality of the grazing land that will be lost as a result of this land take. Given that grazing is the herders' main livelihood (Chapter 7) this loss of land is likely to significantly impact their socio-economic status.

At the time of writing the herding communities have returned to the grazing land in the vicinity of the terminal and additional data gathering is underway using an independent Azerbaijani social specialist company, along with an independent expert in relocation and resettlement processes. Information is being gathered on the herding community as follows:

- basic household characteristics of herding settlements and their organization;
- information on living standards, health status, income, sources of livelihood, land tenure and use, assets, access to public and social services, likely impact (assets, livelihood) that will result from the project;
- gender differentiation in potential impacts;
- any vulnerable groups; and
- burial sites, places of worship or other sacred sites in the project area.

At present it is unclear exactly which schools are attended by the herders' children. The data gathering process outlined above will confirm the schools attended and the routes used and whether or not these routes will be affected by the onshore terminal construction activities of the Shah Deniz Stage 1 development.

The herding settlements themselves will not be physically affected by the terminal construction works as both the West Hills and Central North settlements lie outside the proposed terminal site and "no development zone". Changes to the herders' use pattern of the grazing lands resulting from the terminal construction activities however, may have flow-on effects on the siting, use and socio-economic conditions of the herding settlements.

The data-gathering process currently underway will enable the development of an appropriate compensation package, relating to both loss of grazing land and possible alterations to any children's' school route. Data gathering has occurred with both the herder supervisors and the herders themselves; this process is ongoing. In addition herder preferences on compensation and/or resettlement are being actively sought. The compensation package will be discussed and agreed with the herding community (herder supervisors and the herders themselves) prior to commencement of main construction activities and documented in the Resettlement Action Plan (RAP) (Chapter 15).

11.4.2.2 Disruption to nearshore leisure activities[1]

The impact assessment process for this receptor has yielded the following impact significance ranking:

Likelihood of activities occurring = 5 - certain to occur. Consequence of activities = 1 - inconvenience experienced in accessing community facilities. Impacts significance ranking = 5 - low.

The existing jetty (built as part of the Early Oil Project) and near shore area are used for fishing and other activities by local residents. Fishing activities are both recreational and a contribution to local livelihoods (Chapter 7). The disruption to local livelihoods is dealt with in Section 11.4.3 below. Disruption to recreational fishing and other activities in the area of Sangachal Bay will be limited to nearshore and onshore installation and removal of the pipelines.

It is currently planned that installation of the pipelines will take place in the first half of 2004. It is planned that installation of the offshore pipelines will be completed in 218 days. The

[1] The impact of Shah Deniz Stage 1 development activities on fishing is covered below in Section 11.4.3.

exact time that installation will take through the Sangachal Bay area is however, as yet unknown. During these periods the Bay and beach area will be unavailable to recreational and other users.

As there is no available data detailing the number of recreational users of the Sangachal Bay and beach area it is difficult to predict the magnitude of the likely impact of the pipeline installation. Anecdotal evidence indicates that exclusion from the beach and Bay will have some impact on recreational users, however this is likely to be low given that restrictions to the beach and bay will be

- for a limited time period only – approximately three months;
- and restricted to a limited area – approximately 500 metres at the west end of the existing beach area.

There are alternative beach areas either side of the pipeline corridor and adjacent to Sangachal Bay itself that recreational users will be able to access during this period.

11.4.2.3 Existing café /garage business

The impact assessment process for this receptor has yielded the following impact significance ranking:

Likelihood of activities occurring = 5 - certain to occur.
Consequence of activities = 4 - significant impact on the livelihoods of individuals.
Impacts significance ranking = 20 - critical.

As noted above, the installation of the nearshore and onshore Shah Deniz pipelines is scheduled for 2004. The route for this installation has been chosen and will pass under, or close by, the existing café/garage business located near the access road to the Sangachal terminal. This route will entail the removal and relocation of the existing business to alternative site. It is proposed that the alternative site be within the Sangachal area.

It is unclear at this stage whether the existing business profile would be affected by such a relocation process and how long it might take for the business to reach pre-relocation levels of activity. No data is available to indicate the period during which the business will be inactive due to the relocation process. This period of inactivity is likely to have a detrimental impact on the livelihood of the owners and operators of the business. This impact will be immediate, meaning for the period that the business is inactive, and possibly longer term in that customers may find alternative businesses to use in the meantime and not return to the existing business once it reopens. Immediate impact mitigation is relatively straightforward however, the possible longer term negative impacts on the business may be more difficult to rectify.

Discussions are currently ongoing with the café/garage owners to ensure that no disruption to livelihood will be caused by the relocation process. These will be documented in the publicly available Resettlement Action Plan.

11.4.3 Sea use

The area of the proposed development may be used by other vessels. The construction phase will result in the additional presence of vessels and result in the physical occupation of the area of seabed and water column by the offshore facilities. Hence, there is the potential for interference with other sea users (e.g. fishermen, shipping lanes) excluding them from passing through the operational area and causing them to re-route or avoid the area in use.

There are a number of Shah Deniz Stage 1 activities that have the potential to interact with offshore shipping movements and fishing activities. These include:

- transportation by sea of pre-fabricated components to assembly yards in Azerbaijan;
- tow out, launch and installation of the platform components;
- increased shipping activities during commissioning and hook-up operations;
- installation of the subsea pipelines;
- tow out of the pre-drilling rig;
- physical presence of the pre-drilling rig, platforms and subsea pipelines;
- support and supply vessel operations; and
- decommissioning activities.

Each activity increases the number of vessels and obstacles on the sea, creating additional hazards for other users and potentially increasing the possibility of vessel collision.

11.4.3.1 Shipping

The impact significance ranking for this receptor has been calculated to be:

Likelihood of activities occurring = 5 - certain to occur. Consequence of activities = 1- possible nuisance to human health and well being, minor inconvenience caused. Impacts significance ranking = 5 - low.

Many of the project components and material for the Shah Deniz project will be fabricated or obtained outside of Azerbaijan and will be transported into the country. BP has endeavoured to promote transport synergies with its other concurrent Caspian projects (e.g. ACG Phase 1) wherever schedules allow. This will enable the co-ordinated transportation of similar items to minimise the overall load on the transport routes in Azerbaijan. Some of the project options remain under evaluation. As a result, the transportation information set out below is based on information provided at time of writing and further logistics will be defined as the project develops.[2]

Although Azerbaijan is virtually landlocked, there are various possible transportation options available to bring modules, equipment and other supplies into the country. Transportation and logistics studies are ongoing and will further refine transportation options and routes during the execution phase of the project.

The main transport routes are limited by origin of the goods, size, seasonal and flag restrictions, the optimisation of which will determine the final route. An overview of current options is presented in Figure 5.42 in Chapter 5.

It is likely that a considerable volume of the facility components and pipe sections will be transported by sea. As outlined in Chapter 7, sea transportation routes could include:

- from Europe to the Black Sea and into the Caspian through the Don Volga canal; and
- from Europe to the Baltic Sea and into the Caspian through the Baltic Volga canal.

Although exact figures for current volumes of traffic are not available for all sections of all routes, it is known that, for instance, vessel traffic is extremely high in the Turkish Straits generally, and especially in the Bosphorus Strait. There are reported to be upwards of

[2] BP Internal report Total Tonnage ACG-AGT-SD March 2002.

600,000 small boats operating in the Bosphorus and Cannakale Straits. In addition, Tengiz oil from Kazakhstan is anticipated to begin transportation by tanker from the Russian Black Sea port of Novorossiysk in July 2001 that will double the tanker traffic volume through the Bosphorus (Chapter 7).

At this stage of the development of transportation logistics it is estimated that six barges in total will be used to transport Shah Deniz materials through the Don Volga canal – five in May 2004 and one in June 2004. In addition, 13 riverships will be used for transportation through the Baltic Volga canal – two ships in each of June, July and August of 2003, five in May 2004 and two in June 2004.[3] Given the low numbers of ships to be used it is unlikely that the Shah Deniz project itself will significantly contribute to river traffic during the construction period.

All vessels will be of international maritime standard and the use of these waterways will be compliant with this transport infrastructure network. Detailed forward planning will be in place for the project and this will include notification of other users of these transport routes of the schedules to minimise any interference caused and thereby reducing any significant impact to shipping that has not been anticipated.

During installation, commissioning and hook-up activities at the Shah Deniz Stage 1 drilling location a number of vessels will be present that will effectively exclude the area of activity for other sea users. In addition, pipe-laying requires that a lay barge and two support tugs are on location along the pipeline route during the installation of the subsea pipelines. The pipe-lay barge will come into water depths of 8m (around 5-7 km offshore). Estimated time periods and the number of vessels on the sea for each of these activities are given below in Table 11.9.

Table 11.9 Estimated time periods and number of vessels on the sea

Activity	Estimated Duration	Number of vessels
Tow out of TPG500 and installation	10 days	4 support tugs
Pipeline installation (offshore)	180 days (approximate)	1 lay-barge 1 anchor handling vessel 2 pipe-haul vessels 2 support tugs 1 survey/supply vessel
Pipeline tie-ins	90 days (approximate)	1 Diving Support Vessel (possibly the lay-barge) 5 support tugs

When the drilling rig is on location during the pre-drilling operations, and once the fixed platform structures are installed offshore, their physical presence mean that other vessels in transit will be required to change course to avoid the facilities and the area will be effectively lost to fishing operations. A statutory safety zone comprising a 500 m area around the fixed offshore facilities that prohibits vessels from entering the area without permission will be established. In addition, working zones excluding other vessel activity will be in place during installation, commissioning and hook-up operations.

During pipe-lay activities there will be a clearly indicated exclusion zone around the lay barge that moves along the pipeline route over time. This is marked out anywhere between 500 and 1,500 m from the vessel by positioning 12 very large bright red anchor buoys backed up by at least one or usually two anchor handling tugs. Safety zones are designed to reduce the possibility of collision risk, but mean that a relatively small area of the sea will effectively be

[3] Information supplied by BP March 2002 in 'Total Tonnage SD-AGT-ACG'.

excluded from other vessels and fishing operations for a short period of time at any one location along the pipeline route. During operation of the pipelines there will be an additional 1000 m safety zone marked on navigational charts from where the pipelines divert away from the existing ACG pipeline corridor up to the location of the offshore installation. Current information suggests that there are no trawling activities in Azerbaijan waters at present. If trawling activities are present however, or commence during the operation of the pipeline, there is a risk that trawling gear could become snagged and damaged along with a possibility of rupture to the pipeline, particularly as some vessel operators may not refer to navigational charts as required.

Decommissioning activities will also involve a large number of vessels and marine activity. No detailed information is available as yet on the exact process of decommissioning and so no accurate predictions of impact can currently be made. It is likely that the impacts of increased vessel activity due to decommissioning activities will be similar to those associated with the activities outlined in the preceding paragraphs.

11.4.3.2 Fishing

There are key concerns within the fishing industry that the proposed developments will negatively impact on fish resources. It is genuinely believed that it was as a direct result of the Early Oil Project that there were drastic reductions in the number of salmon in the Caspian Sea, and specifically around Sangachal Bay.[4] Although it is acknowledged, by the Caspian Environmental Programme (CEP), that the past history of oil production activities has had some environmental impact on the Caspian Sea and hence on fish stocks, the most recent studies indicate that over fishing and illegal fishing have also contributed to the reduction in fish populations in the Caspian.[5]

As the fish population in Sangachal Bay has been of particular concern, BP commissioned a study designed to assess the current status of fish populations at Sangachal and to provide a baseline against which future trends can be evaluated.

This survey was conducted to fill a recognised data gap (the lack of comprehensive recent data on Sangachal fish populations) and there is thus an inadequate basis for comparison with previous data. Nevertheless, samples caught throughout the survey period showed no external signs of stress or pathology. The report concluded that it was likely the data collected described fish populations that are currently healthy.[6]

The main impact relates to the fishing currently undertaken within Sangachal Bay that will be directly affected by the proposed Shah Deniz Stage 1 developments, as there will be restrictions on access and use of Sangachal Bay during both construction and operation. Whilst the majority of the fishing grounds in the area are located to the south of the proposed development and the disruptions are not expected to be significant, there will still be however, disruption to the subsistence and recreational fishing undertaken in the Bay by local residents (Chapter 7).

The overall impact significance ranking for this receptor has been calculated to be:

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[4] For instance, the non-governmental organisation (NGO) consultation meetings undertaken as part of the ACG Phase 1 and Shah Deniz Stage 1 ESIA processes demonstrated that this belief was held by a number of the Azerbaijan environmental NGOs. The minutes of these meetings are available on request from the BP Baku office.

[5] Preliminary Transboundary Diagnostic Analysis May 2000 (Draft) Caspian Environment Programme.

[6] Fish monitoring report 2002. Supplied by BP. Conducted by Akvamiljo Caspian, Caspian Environmental Laboratory.

Likelihood of activities occurring = 5 - certain to occur.
Consequence of activities = 3- medium impact on human health, well-being, livelihoods
Impacts significance ranking = 15 - high

As detailed in Chapter 7, Azerbalyk uses nets and cages in the Bay for spawning activities and employs three to four fishermen to manage this. As a result of the restrictions on access and use, an agreement was reached with Azerbalyk to move the nets and the one cage lying within the Shah Deniz/ACG pipeline corridor. In the process of removal however, the cage was destroyed and is not available for use by the Azerbalyk fishermen in the alternative fishing grounds selected. Recent discussions with the affected fishermen indicate that the nets are the primary focus of the negotiations.[7]

As 30-40% of the catch from the nets and cage was taken by the fishermen in lieu of wages[8], negotiations are ongoing with the affected fishermen to ensure that their livelihoods are not affected by the removal of the nets and the destruction of the cage and that the effect of the agreed compensation measures is realised. These negotiations will be documented as part of the Resettlement Action Plan that will be publicly available.

Information has been gathered to assess the extent of overall existing fishing activities and establish the legality of those activities. Significant disruption to any legal commercial fishing activities will be compensated. Current understanding is that the only legal commercial fishing activity is the spawning nets and cages of Azerbalyk outlined in the preceding paragraph.

Subsistence or recreational fishing activity and any illegal fishing activities will not be compensated. To avoid destroying existing fishing nets, the need for removal of illegal nets will be widely advertised. The significance of the contribution of illegal and subsistence/recreational fishing activities to local livelihoods is unclear and clarification may not be possible (Chapter 7). Current understanding is that subsistence/recreational fishing activity can be undertaken from comparable places in terms of accessibility and productivity. If not, as noted above, this may adversely affect local socio-economic conditions.

Some 100 boats operate 40-60 km from shore catching sprats and this activity is likely to be negatively impacted by offshore installation of the pipeline. Baku is also home to one of the key fishing markets in the area and those trying to access it are likely to be required to make a small detour during pipeline construction.

Concern has also been raised by stakeholders about the possible effect of pipeline 'vibration' on the behaviour of migrating fish and the possible emission of low-frequency sound from the pipe, generated by pumping activity. While no experimental data are available to address this concern, a number of observations are possible:

- there is no direct evidence that pipelines emit low-frequency sounds, or that any emissions are comparable in magnitude to existing sources, that would prevent or impede the migration of fish;
- low-frequency sound travels very long distances, and is highly non-directional;
- consequently, fish in any given area are likely to be continuously 'bathed' in low frequency sound generated by offshore and coastal shipping activity;

[7] Meeting between BP's Community Liaison Officer, other BP representatives, the affected fishermen and the Sangachal representative of the Garadag Executive Power on 12/03/02. Minutes of the meeting were recorded.
[8] See Chapter 7 Socio-economic Baseline.

- it is unlikely that fish will be able to distinguish between sound emitted by the pipeline and sound emitted from shipping, especially in harbour areas such as Primorsk; and
- avoidance of existing sound sources is just as likely as avoidance of sound emitted by pipelines, in which case, it is therefore to be presumed that existing coastal activity will already have affected migratory behaviour.

11.4.4 Population in the vicinity of the activity

The potential impacts on the population in the vicinity of the terminal site relate to:

- social and cultural interaction issues;
- health; and
- noise, dust and ground-borne vibrations.

The activities that may result in these potential impacts include:

- transporting pre-fabricated components and equipment to Azerbaijan;
- preparing the lay-down area for equipment;
- mobilisation of the workforce;
- demobilisation of the workforce;
- early civil engineering work at the terminal site;
- construction of the terminal;
- installation of the pipeline (nearshore and onshore);
- hook-up and commissioning;
- terminal operations; and
- transportation of wastes for disposal.

The main impacts associated with social and cultural interaction issues will result from the ECEWP at the onshore terminal site and the construction of the onshore terminal itself. Any impacts associated with the onshore assembly of offshore facilities will be assessed as part of a separate ESIA process once yard selection has been completed.

The ECEWP, common to both Shah Deniz Stage 1 and ACG Phase 1 projects, began in January 2002 and will last for approximately six months. The maximum number of workers at the terminal site during early civil engineering will be 350. Of these 54 are expatriate workers, 115 have been drawn from the local area and 181 drawn from elsewhere in Azerbaijan.[9] There will be no need to house any workers on-site in a self-contained camp during the programme. The impacts associated with the programme workforce are dealt with in the socio-economic chapter of the ECEWP ESIA document.

The main terminal construction will begin in mid 2003 and last for approximately 18 months. Current tender information confirms that on average a minimum of 70% of workers employed on construction activities for onshore terminal construction will be drawn from Azerbaijan. It is envisaged at this stage that approximately 40% of workers for the onshore terminal construction activities will be drawn from the area local to the project (either Sangachal, Umid or Primorsk) and hence will not be extra to the area.

For the main onshore terminal construction, workers employed from outside the local area will be transported to and from the site daily or housed in a self-contained construction camp. No workers will be housed within Sangachal, Primorsk or Umid Camp. Over the life of the construction phase of the terminal the number of workers not local to the area who will be on

[9] Information correct as of 6th March 2002 and supplied by BP. The figures are monitored on an ongoing basis to assess compliance with local employment targets.

site during working hours, at any one time will be approximately 135. The number of workers who will be housed in a self-contained camp will be a maximum of around 350. At present it is planned that the construction camp for the onshore terminal construction will be an open camp with workers permitted to leave the camp at regulated times. It is not envisaged that any workers will bring family members with them.

An influx of workers to an area can give rise to social impacts of various kinds. The main perceived problems are associated with often large, transitory and male dominated construction workforces. Tenderers have been required to maximize the percentage of Azerbaijani and in particular, national personnel drawn from the directly affected communities. Such an approach means that many workers will either already be living locally or will be based in the area around Baku and transported to and from the site each day. These housing and transport options may reduce the possibility of negative social impacts, as outlined below, occurring as a result of the Shah Deniz Stage 1 construction activities.

For the onshore construction activities however, a significant number of workers will be housed in an open camp at the Sangachal terminal site.

In addition, internal migration, particularly from rural areas to the town at the proposed terminal expansion site, may occur due to perceived and actual likelihood of increased employment opportunities. These may be opportunities for direct employment by the project or indirect employment resulting from increased economic activity in the area. Whilst there would be benefits through the employment opportunities, the urban drift could create problems in the form of ethnic and cultural tension and pressure on social and physical infrastructure.

During the ESIA process public meetings were held at both Primorsk and Sangachal to provide information about the projects and the ESIA process, and to listen to and discuss the specific concerns of the community. The main concern raised by the local community related to their opportunities for securing employment and was linked to earlier employment experiences with the EOP.

Mitigation measures to address negative impacts on social and cultural interaction, including strategies to minimize inaccurate perceptions about employment in the areas local to the project, and contractor conditions on percent local content of the workforce, are outlined in Socio-economic Mitigation, Monitoring and Management Chapter 15. BP will advertise the specific job opportunities so that the public is well informed and expectations for employment remain realistic (Chapter 15).

The impact assessment process for this receptor has yielded the following impact significance ranking:

Likelihood of activities occurring = 5 - certain to occur.
Consequence of activities = 3- medium impact on human health, well-being, livelihoods.
Impacts significance ranking = 15 - high

11.4.4.1 Social and cultural interaction issues

The potential negative impacts on social and cultural interaction are associated with the mobilisation of the early civil engineering works and terminal construction, along with those migrating to the area in the hope of finding employment.

The likely impacts are associated with:

- tensions caused by labour from outside the local area and/or Azerbaijan;
- the informal economy; and
- market distortion.

Labour from outside the local area/Azerbaijan

Unemployment is high within Sangachal, Primorsk and within the population at the IDP[10] Umid Camp. As outlined above, at public meetings held as part of the Shah Deniz Stage 1 and ACG Phase 1 ESIA process, local residents identified employment opportunities as one of their main interests. Specifically, concerns were focused on percentages of employment for local people, skills transfer, and comparability of wages between local and expatriate workers.[11]

Tensions resulting from a workforce drawn either from other areas of Azerbaijan, or from outside Azerbaijan, could arise, particularly if it is perceived that local people could have supplied these skills and could therefore, have benefited from the perceived and actual employment opportunities. These tensions may become associated with the ethnicity of the workforce from outside Azerbaijan leading to ethnic tensions in the local area.

An increase in workers from outside the local area may also be perceived as a potential security risk. Based on the experience of other projects worldwide, some expatriate workers within the project workforce may perceive themselves as protected and therefore 'immune' to local law, order and customs. This can result in additional friction between local and expatriate groups. Although tender information is not yet finalised, the current indication is that between 15% and 30% of the workforce for the terminal construction will be drawn from outside Azerbaijan. The nationality of expatriate workers is yet to be confirmed.

The effect the Shah Deniz Stage 1 construction workforce may have on the local and broader regional community in terms of tension and security issues will be addressed through worker and camp management plans, including housing and transport options for workers (Chapter 15). The onshore terminal construction workforce will be required to comply with a workers code of conduct.

Informal economy

As noted in the Socio-economic Baseline (Chapter 7), the informal economy is prevalent throughout Azerbaijan. No documented information on the informal sector is available at a local level. Income figures, employment profiles and economic activity spread indicate that with high unemployment and low incomes, residents of Sangachal, Umid Camp and Primorsk may take advantage of increased opportunities for the informal sector to provide additional income to their livelihoods.

Some pastoralists and other households in the local area, such as the IDP households within Sangachal, Umid Camp and Primorsk, may already be separated from the formal economy and follow survival strategies of subsistence farming or making a living in the informal economy (Chapter 7). In the event of the Shah Deniz Stage 1 construction workforce having a significant percentage of workers from outside Sangachal, Primorsk or Umid, this situation may be compounded with perceived and actual opportunities within the informal sector as a result of the increased spending power of onshore and offshore construction commuting employees and the increased availability of hard cash.

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[10] Internally Displaced Persons.
[11] See minutes of public meetings with local residents held during the ESIA process in the first half of 2001.

Market distortion

The onshore construction workforce may distort local markets and pricing mechanisms. The increased spending power of local residents employed by the project may have knock-on effects on the local economy. Local suppliers and vendors may increase prices to take advantage of increased local cash flows. This may negatively impact those in the community who have not benefited from the project employment opportunities and create greater inequalities within the local community. This may have a particular effect on the already impoverished refugee community and on women headed households.

The long-term effects of the Shah Deniz Stage 1 employment opportunities may be to increase the welfare of some residents at the expense of others. Given that construction employment is however, a time limited activity, employment during the onshore operational phase will be a significant reduction in numbers from construction employment and that skills may well be tied to one particular sector of employment, the improvements in welfare for any residents may well be relatively short lived. The long-term sustainability of any change in local livelihoods through direct employment is questionable.

11.4.4.2 Health

National figures on health in Azerbaijan indicate that communicable diseases are a serious public health problem and that the health care system within Azerbaijan is deteriorating and unable to cope with the demands placed upon it. Reliable figures on health issues at local level are difficult to obtain. Based on the information available in the Socio-economic Baseline (Chapter 7) and the Shah Deniz Stage 1 tender submissions, it appears however that the main health issues could include:

- communicable diseases;
- sexual health and contraception issues; and
- restriction of land needed for livelihoods leading to a decline in nutritional health.

Communicable diseases

Within the Sangachal area only basic health care facilities are available for local residents. Both Sangachal Town and Umid Camp have simple, open sewage systems that are often associated with increased risk of communicable diseases. All homes have piped water, gas and electricity that lowers the risk of communicable diseases associated with poor hygiene processes.

Given the tender information outlined above relating to local employment percentages and workers camp design and regulations, it is unlikely that the workers associated with onshore construction will place pressure on the sewage systems of Sangachal and Umid. An increase in the population of either Sangachal or Umid Camp, as a result of actual or perceived employment opportunities (as outlined above) however, may place extra pressure on an already basic sewage system. This in turn may increase the potential for communicable disease outbreaks. It is difficult to predict with any certainty the number of people, if any, who may be attracted to areas local to the project as a result of employment opportunities and consequently difficult to assess the likelihood of such an impact.

In addition, workers from elsewhere in Azerbaijan, outside Azerbaijan and inward migrators may all bring communicable diseases to the local area from their point of origin. It is difficult to predict the impact this may have as one infected person may have a significant effect on the health of the local population if preventive and treatment measures are not implemented effectively. Although healthcare measures can be implemented for official workers, it is difficult to implement such measures with respect to an informal inward migrating population.

Investment in the local community will be made by BP as part of a Social Investment Programme as outlined in Socio-economic Mitigation, Monitoring and Management (Chapter 15), in addition to a communicable diseases awareness and prevention plan for the onshore terminal construction workforce.

HIV/AIDS and sexually transmitted diseases (STD) incidences are increasing in Azerbaijan. Seven HIV cases were registered between 1987 and 1992 but 164 cases were confirmed by January 2000.[12] True statistics may also be much higher as many cases may go unreported and testing levels have decreased in line with a new testing policy at national level. The Azerbaijan Human Development Report 2000 indicates that there are signs of rapid spread. No data is available regarding the current instances of STD/HIV infections or unwanted pregnancies within the Sangachal community (Chapter 7).

At national level, the presence of numbers of male workers away from their families has been cited as a driver of increasing cases of STD/HIV infections. Current tender information outlined above indicates that around 50% of workers for the Shah Deniz Stage 1 onshore construction activities will be either local to the area or transported to and from the site each day. A number of workers from other parts of Azerbaijan and expatriate workers will however, be housed on site in an 'open' camp with regulated hours.

The presence of male workers in the camps may impact negatively on sexual health and contraception issues in the local area of Sangachal, Umid and Primorsk. Workers may create a demand for prostitution or form relationships with local women during recreational periods. Such effects may also be felt in Baku, and to a lesser extent Primorsk, which it is likely many of the workers will visit for recreational activities given the lack of entertainment facilities currently in existence in Sangachal and Umid. The risk of internal inward migration outlined above may also impact on sexual health and contraception issues and will be more difficult to mitigate.

The effect the onshore construction workforce itself may have on the local Sangachal and broader regional community in terms of STD/HIV infections and cases of unwanted pregnancy will be addressed through a workers' Code of Conduct which will include strategies for managing STD/HIV and contraception issues, and through the housing and transport options used for bringing workers to and from the site (Chapter 14).

Loss of livelihood

As outlined above (Section 11.4.2), grazing activities will be disrupted by the Shah Deniz Stage 1 terminal construction activities. Animal husbandry undertaken in the area of proposed works is a key source of income and nutrition for the herding families. Based on observations made during the socio-economic survey, it was evident that the current levels and quality of nutrition are already issues for the pastoralist communities. By restricting or denying use of common land, the potential for the health and well being of these households to be adversely affected is be likely to increase.

During the draft disclosure process for the related ACG Phase 1 project, it was noted that residents of Sangachal also kept grazing animals whose grazing areas may be restricted by the

12 Field Report, Joint UN Project to Prevent STDs and HIV/AIDS in Azerbaijan, March 2000.

terminal land-take and construction activities.[13] If this is the case, this may lead to a decline in nutritional status of the local community if alternative grazing areas are not available.

In addition, the disruption to local subsistence livelihood fishing activities outlined in Section 11.4.3 above, such as illegal nets or legal rod fishing, may also negatively impact on the health and nutritional status of members of the local community.

11.4.4.3 Noise

Perception of noise

Sound may be defined as any pressure variation that the human ear can detect. Compared to the static air pressure (10^5 Pa), audible sound pressure variations are very small ranging from about 20 µPa (2×10^{-5} Pa) to 100 Pa. 20 µPa corresponds to the average person's "threshold of hearing". A sound pressure of approximately 100 Pa is so loud that it causes pain and is therefore, called the "threshold of pain".

The ratio between these two extremes is more than a million to one. A direct application of linear scales (in Pa) to the measurement of sound pressure leads to large and unwieldy numbers. As the ear responds logarithmically rather than linearly to stimuli, it is more practical to express acoustic parameters as a logarithmic ratio of the measured value to a reference value. This logarithmic ratio is called a "decibel" or "dB".

The advantage of using dB is that a linear scale, with its large numbers, is converted into a manageable scale from 0 dB at the threshold of hearing (20 µPa) to 130 dB at the threshold of pain (~100 Pa).

Sensitivity to noise is also determined by the frequency of the noise source. The number of pressure variations per second is called the "frequency of sound" and is measured in hertz (Hz). The normal hearing for a healthy young person ranges from approximately 20 to 20,000 Hz (20 kHz).

Hearing is less sensitive at very low and very high frequencies. The most common frequency weighting in current use is "A-weighting" providing results often denoted as dB_A, which conforms approximately to the response of the human ear.

In terms of sound pressure levels, audible sound ranges from the threshold of hearing at 0 dB to the threshold of pain at 130 dB and over. Although an increase of 6dB represents a doubling of the sound pressure, an increase of about 8 to 10 dB is required before the sound subjectively appears to be significantly louder, perceived as approximately a doubling of loudness. Similarly, the smallest perceptible change is about 1 dB in a good environment, but typically only a 3 dB change is perceptible.

Other factors that should be taken into account with regards to perception of noise include:

- **Continuous noise:** produced by machinery that operates without interruption in the same mode, Tones or low frequencies can be readily identified and analysed if present.
- **Intermittent noise:** the noise source operates in cycles, and the noise may rise and fall of rapidly such as that of an aircraft passing overhead.
- **Impulsive noise:** abrupt and usually upsetting noise such as from an impact or explosion. This is usually perceived as the most annoying form of noise.

[13] The issue was raised during a community meeting at Sangachal in January 2002. The minutes of the meeting are available on request from the BP office in Baku.

- **Tonal noise:** annoying tones are typically created by machinery with rotating parts such as motors, gearboxes, fans and pumps. Tones can be identified subjectively by listening, or objectively using frequency analysis.
- **Low frequency noise:** low frequency noise has significant acoustic energy in the frequency range 8 to 100Hz. Noise of this kind is typical for large diesel and power plants. It is difficult to suppress low frequency noise, and consequently it can propagate easily in all directions for significant a distance. Low frequency noise is more annoying than would be expected from the "A-weighted" sound pressure level.

World Bank Guidelines and nearby sensitive receptors

The World Bank Pollution Prevention and Abatement Handbook (1998) criteria against which estimated noise levels generated by onshore project activities have been assessed are presented in Table 11.10.

Table 11.10 World Bank Pollution Prevention and Abatement Handbook 1998 noise criteria

Area	Daytime (07:00-22:00)	Night-time (22:00 – 07:00)
Residential	$55dB_A$	$45dB_A$
Industrial	$70dB_A$	$70dB_A$

Sensitive and nearby receptors that may be subject to noise impacts during construction and operation of the proposed terminal facility are presented in Table 11.11. The distance between the receptor and the key terminal features are also provided as an estimate of the distance between the proposed activity and the receptor.

Table 11.11 Approximate distances between receptors and terminal construction and operation activities

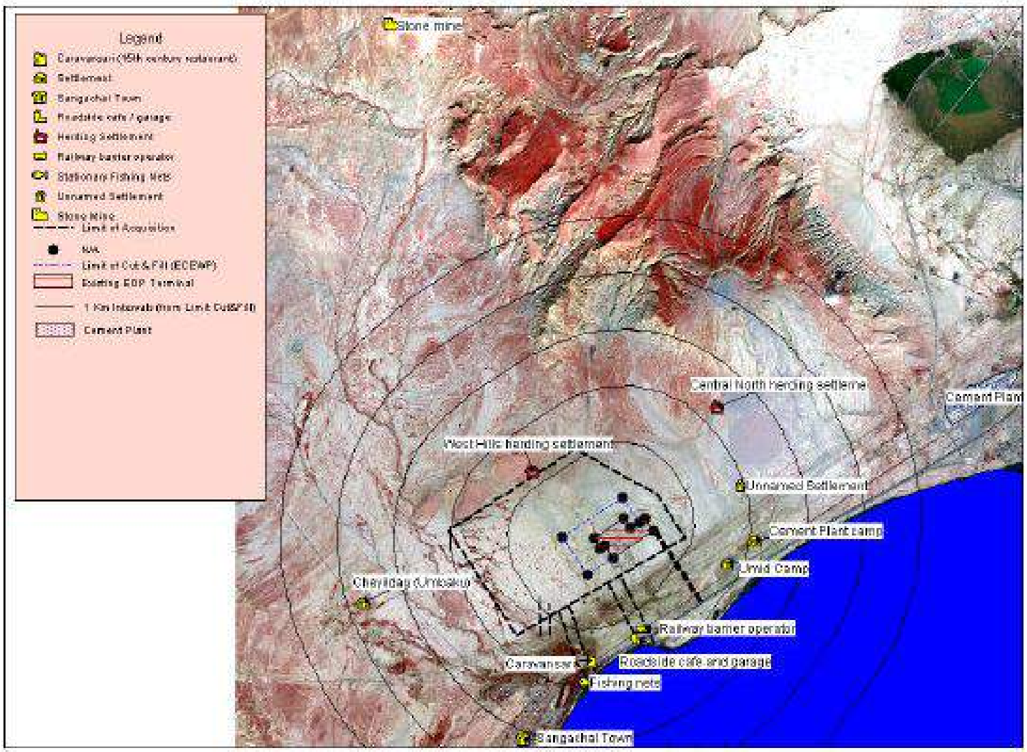
Receptor	Approximate Distance	From
Stone Mine	8.5 km 9.4 km	Limit of land acquisition area Limit of terminal land-take area
West Hills Settlement	70 m 1.3 km	Limit of land acquisition area Limit of terminal land-take area
Central North Settlement	1.9 km 2.3 km	Limit of land acquisition area Limit of terminal land-take area
Unnamed Settlement[14]	1.2 km 1.9 km	Limit of land acquisition area Limit of terminal land-take area
Umid IDP Camp	650 m 830 m 1.6 km	New access road Limit of land acquisition area Limit of terminal land-take area
Cement Plant Camp	1.3 km 1.13 km 2.0 km	New access road Limit of land acquisition area Limit of terminal land-take area
Railway Barrier Operator	Within 1.35 km	Pipeline corridor Limit of terminal land-take area
Roadside Café & Garage	Within 1.4 km	Pipeline corridor Limit of terminal land-take area
Caravansari	890 m 1.5 km	Pipeline corridor Limit of terminal land-take area
Fishing nets (beach landing)	1.92 km 1.14 km	Limit of terminal land-take area Pipeline corridor

[14] This settlement was identified off newly acquired satellite image and is considered to be an oil well operators' camp.

Receptor	Approximate Distance	From
Cheyildag (Umbaku) (part of Sangachal)	2.0 km 3.7 km	Limit of land acquisition area Limit of terminal land-take area
Sangachal town limit	2.0 km 2.23 km	Pipeline corridor Limit of terminal land-take area
Cement plant	5.3 km 5.76 km	New access road Limit of terminal land-take area

Figure 11.1 presents a satellite image of the location of the EOP and proposed terminal facility and shows those receptors presented above in Table 11.11. The concentric lines on the figure represent increments of 1 km.

Figure 11.1 Location of existing EOP terminal, boundary of proposed land acquisition area and nearby sensitive receptors



Existing noise environment

A noise survey was undertaken in November 2001 by Acoustic Technology Limited (KBR, 2002) to measure and record background noise levels in the vicinity of the existing EOP terminal. The survey demonstrated that existing noise levels at the nearest sensitive receptors are below or equal to the World Bank Guideline limits presented in Table 11.10 above. Survey results are presented in Table 11.12 below.

Table 11.12 Existing noise levels in the vicinity of the EOP terminal as measured in November 2001

Location	Noise Level dB_A			
	Leq		L_{90}	
	Day Time	Night time	Day Time	Night time
Roadside Café	67	54	52	45
Umid Camp	48	45	45	40
Umbaki	48	42	41	38
Herdsman's Farmstead	48	40	41	33

Note: A night-time measurement at Herdsman's Farmstead was not possible; levels shown for night time were actually taken in the early morning.

Impact significance

Terminal construction and onshore pipeline installation

The plant and equipment that is operating under the current ECEWP and that is likely to operate during construction of the proposed terminal facility along with the estimated noise emission levels for the equipment are presented in Table 11.13. The majority of heavy equipment movement will be restricted to the terminal land-take area. Some vehicle movement within the wider land acquisition area and to and from the site may however, also occur.

Table 11.13 Noise emission level of plant

Plant	Sound Power Level L_W (dB)	Sound Pressure Level L_P as 10 m L_{Aeq} (dB)	British Standard 5228 Reference
5 Cranes	109	81	C6.18
10 Trucks	98	70	C7.121
10 Trucks	105	77	C3.59
5 Compactors	108	80	C3.118
5 Excavators	109	81	C3.89
4 Generators 500Kva	104	76	C7.49
10 Pick-ups	-	-	No Data available
5 Buses	-	-	No Data available
20 Cars	-	-	No Data available
1 Auxiliary plant	-	-	No Data available

Noise estimates have been completed in accordance with British Standard 5228:1997 and the Standard has been applied to explore the likely propagation of noise from the terminal construction area. The Standard generally requires the input of noise attenuating data (e.g. ground hardness; sound barriers (natural or built); etc.). These factors have an effect on noise levels and especially in regards to the propagation of noise beyond 300 m from the source. As such data was not readily available, the noise emission estimates were calculated without these inputs and therefore, the results of the assessment of noise emissions are likely to be an over-estimate of what in actuality will occur. Noise emission estimates have also assumed a worst-case operational scenario; that is, the simultaneous operation of all plant and equipment. This in reality may not occur. Meteorological conditions at the time of the works would also influence the propagation of noise and hence, what level of noise may be experienced at any given point.

The results of the noise assessment indicate that there is a potential for minor noise impacts (i.e. noise level >55 dB during the day-time) on sensitive residential receptors. Such receptors include:

- the Umid IDP Camp at 650 m from the new access road site;
- the railway barrier operator within the proposed pipeline corridor;
- the roadside café/garage within the proposed pipeline corridor; and
- the caravansari at 890 m from the proposed pipeline corridor.

Noise impacts associated with terminal construction are considered to be of "low" significance as follows:

Likelihood of activities occurring = 5 - certain to occur. Consequence of activities = 1 - possible nuisance to human health and well being. Impacts significance ranking = 5 - low.

Terminal operation

Two Shah Deniz terminal operational scenarios were considered in the noise modelling as follows:

- **Option A:**
  - a single centrifugal recycle compressor running at 100% load;
  - a single export compressor running at 100% load (900 MMscfd) with the other standing by;
  - two turbo-expanders running at 100% load (450 MMscfd each) each.
- **Option B:**
  - one centrifugal recycle compressor running at 100% load;
  - one export compressor running at 50% load with the other on stand-by; and
  - one turbo-expander running at 100% load and the other on stand-by.

Shah Deniz terminal operations were modelled with the existing EOP and proposed ACG Phase 1 terminals also operational.[15] This combined terminal operation scenario most accurately reflects what in reality would occur and, as a potential cumulative impact, is further discussed in Cumulative Impacts (Chapter 12). Noise modelling predicts that, under combined normal terminal operations, noise levels at nearby sensitive receptors would be in compliance with the World Bank Guidelines. Noise impacts associated with normal terminal operations are therefore, considered to be of "low" significance as follows:

Likelihood of activities occurring = 5 - certain to occur. Consequence of activities = 1 - possible nuisance to human health and well being Impacts significance ranking = 5 - low

TPG500 construction

The fabrication yard for the TPG500 construction has yet to be selected. Once the selection has been made the noise impacts will form part of a separate ESIA assessment of the yard impacts.

11.4.4.4 Vibrations

There is no data on existing ground-borne vibrations sources or levels within the area of the Shah Deniz Stage 1 project activities.

[15] Preliminary noise modelling was completed by Halliburton KBR and a full technical report will be made available once final modelling has been completed.

The impact assessment process for this receptor during the construction and operations phases of the project has yielded the following impact significance ranking:

Likelihood of activities occurring = 5 - certain to occur.
Consequence of activities = 1 - possible nuisance to human health and well being
Impacts significance ranking = 5 - low

Vibration impacts associated with construction activities such as earth moving are likely to generate relatively small levels of ground borne vibration and are not anticipated to represent a significant impact. An exception to this would be pile-driving of (fence) pylons (i.e. steel on steel noise). A sensitive receptor would however, need to be within approximately 20 m of the activity to be adversely affected. Given that the proposed temporary safety fence will provide a 100 m buffer between the area in which the terminal security fence construction will occur, it can be reasonably concluded that no vibration impacts would be incurred by sensitive receptors.

It is not expected that the relatively small levels of ground borne vibration generated by road traffic would present an impact to sensitive receptors near to the proposed access routes. However, where particularly heavy traffic is anticipated to occur near to sensitive receptors, a road traffic management plan will be prepared.

Operational vibration is expected to be minimal, as machinery would be normally be operated and balanced to reduce ground borne vibration.

11.4.5 Utilities

The impact assessment process for this receptor has yielded the following impact significance ranking:

Likelihood of activities occurring = 5 - certain to occur.
Consequence of activities = 1- inconvenience experienced in accessing community facilities and utilities for short (hours) period of time.
Impacts significance ranking = 5 - low.

Utilities include the supply of electricity, gas, sewage facilities and water. There will be some disruption to the supply of utilities during construction of the terminal. Although various utility service lines will be crossed by the onshore installation of the pipeline, it is not envisaged that these crossings will cause any disruption to services. On arriving at the landfall the pipeline route will follow a relatively direct route to the terminal facility for a distance of approximately 1.7 km to 2.6 km and will cross the following existing facilities (Chapter 5):

- one crossing of the road (Sangachal to Baku highway);
- one crossing of the railway; and
- multiple crossings of third party pipelines / service lines (various diameters) and facilities.

The nearshore Shah Deniz pipeline route will be common with the ACG Phase 1 project route. Based on the engineering designs and discussions with the engineers, the only utility supply that will be negatively affected will be an electricity line that currently crosses the proposed land acquisition area. This line will be rerouted around the proposed land acquisition area during the onshore construction phase of the project. As the line is a back-up it is not envisaged that any disruption will take place to the stone mine operations.

The onshore installation road and rail crossings will be achieved by using uncased bored crossings or non-conductive casing. These will be run under the road/railway and the annulus between the pipeline and boring/casing will be sealed. Exposed lengths of pipelines and cables will be supported at all times and particular care shall be taken to support the trench sides such that undermining of services is avoided. This method ensures that pipeline crossings can be made without the need for excavation or interference to the services.

The project design indicates that it is unlikely that any other utilities will be negatively affected during the construction phase. Whilst the existing water supply will be tapped into to provide water for the terminal construction operations, the project design engineers have ensured that there will be no disruption to the water supply to other local users. If however, disruptions to supply do inadvertently occur then it is envisaged that impacts will be negligible as disturbance will be minimal, both in terms of the numbers affected and the extent of the disruption.

No disruption to local utilities is expected during the operational phase of Shah Deniz Stage 1.

While the potential impact to utilities is not considered significant and hence no mitigation is required *per se*, disruptions to utilities will nevertheless be monitored by the Community Liaison Officer and reported to the project immediately.

11.4.6 Community infrastructure and housing

The increase in population as a result of employees housed on site for the onshore terminal construction work, as well as any inward migration, may have impacts on existing community infrastructure such as healthcare facilities and schools.

The impact assessment process for this receptor has yielded the following impact significance ranking:

Likelihood of activities occurring = 5 - certain to occur. Consequence of activities = 1- inconvenience experienced in accessing community facilities and utilities for short (hours) period of time. Impacts significance ranking = 5 - low.

It is likely that there will be only minor impacts on existing community infrastructure, during the Shah Deniz Stage 1 construction phase. Current tender information indicates that a minimum of 70% of workers employed on onshore terminal construction activities will be drawn from the area local to the project (either Sangachal/Umid/Primorsk or Baku) and hence will not be extra to the area.

For the onshore terminal construction, workers employed from outside the local area will be transported to and from the site daily or housed in a self-contained construction camp. No workers will be housed within Sangachal, Primorsk or Umid Camp. Over the life of the construction phase of the terminal the number of workers not local to the area who will be on site for working hours only at any one time will be approximately 135. The number of workers who will be housed in a self-contained camp will be a maximum of around 350.

At present it is planned that the construction camp for the onshore terminal construction will be an ‘open’ camp with workers permitted to leave the camp at regulated times. It is not envisaged that any workers will bring family members with them who may utilise facilities such as the Sangachal or Umid schools. The construction camp will have dedicated medical facilities and personnel and if hospitalisation is necessary, workers will be transported to Baku.

Although no workers will be housed in Sangachal, Umid or Primorsk there may however, be increased pressure on community infrastructure as a result of internal migration associated with real or perceived employment opportunities. With a combined population of only 5,000, Sangachal Town and Umid Camp would be affected by a relatively small increase in population numbers. If large numbers of people are attracted to the area in the search for employment, pressure may be placed on the access and use of existing facilities such as the local schools and healthcare facilities. It is difficult to predict how many people may be attracted to the area for employment reasons and hence no real assessment of possible impact can be made at this time.

Investment in the local community will be made by BP as part of a Social Investment Programme as overviewed in Socio-economic Mitigation, Monitoring and Management (Chapter 15).

11.4.7 Transport

There are a number of activities related to the onshore terminal construction and operation that have the potential to disrupt the existing transport infrastructure, including:

- transporting the pre-fabricated components, modules and materials to Azerbaijan;
- mobilisation of the workforce;
- demobilisation of workforce;
- installation of onshore pipeline sections;
- decommissioning of the terminal and pipelines; and
- waste disposal for the terminal and pipelines.

Each activity will increase the number of vehicle movements by either road or rail that if not properly managed may create congestion, potential delays and inconvenience for other users. The transportation methods for the various activities are still under consideration and the total additional traffic load on any one route is yet to be determined however, the potential methods and routes are outlined in the Project Description (Chapter 5). It is envisaged that the main impacts will result from possible over-stretching of the public transport system as camp workers utilize the system for personal transport during the construction phase of Shah Deniz Stage 1 and from extra loads on the main north-south highway route.

The impact assessment process for this receptor has yielded the following impact significance ranking:

Likelihood of activities occurring = 5 - certain to occur.
Consequence of activities = 2 - inconvenience experienced in accessing community facilities and utilities for short (hours) period of time.
Impacts significance ranking = 10 - high

11.4.7.1 Construction phase

Information on the transport systems local to the project area indicates that the rail route is significantly under utilized (Chapter 7) and is operating well below maximum carrying capacity. An increase in rail traffic would therefore, be unlikely to cause any significant negative impacts unless current timetables and frequencies were to be disrupted in order to accommodate BP transport needs. It is not envisaged that this will occur.

The road route local to the project area forms part of the main north-south road network and accounts for two thirds of all road freight transport within Azerbaijan (Chapter 7). The activities outlined above have the potential to create inconvenience and disruption to other road users and also impact on the physical quality and state of the roads themselves, as the number of vehicle movements increase. The majority of vehicle movements for equipment and materials transportation will take place between April 2003 and May 2004.[16] Over this period on average 104 trailers a month will be utilised for road freight transportation with peaks of 203 trailers a month between September and December 2003. Given that available traffic data indicates that approximately 800 vehicles a month pass along the Baku-Alyaty highway (Chapter 7) the extra vehicles related to Shah Deniz represent between 10-25% increase in monthly road traffic. There may be, at times, small convoys travelling between the SPS yard and the terminal site and/or between Baku and the terminal site. Some loads may be considered abnormal and require police escort (Chapter 5).

Proposed methods of waste disposal are unlikely to have a significant impact upon the transportation infrastructure and its users, as it is anticipated that there will be a limited number of road and rail movements associated with waste removal. Waste generation will be minimized and where possible, waste will be re-used or recycled during the programme as outlined in Chapter 5.

There may also be increased pressure placed on the road network as a result of extra delivery traffic for local suppliers who may be supplying goods and services to the onshore construction facilities. The ITTs for the terminal construction encourage contractors to use suppliers local to the project area wherever possible. It is not clear as yet however, exactly how many local suppliers will be used and for what purposes. It is therefore difficult at this stage to make an accurate assessment of any increased traffic associated with local supplier use.

The public transport system in the area local to the project is already overstretched (Chapter 7). Any extra pressure placed on this system as a result of workers using the system for personal transport may create delays, congestion and inconvenience for other users. As the camp is likely to be an "open" camp workers may use the system for transport from the camp to other areas such as Baku. An increase of up to 350 camp workers using the existing public transport system would create a significant impact on an already stretched resource. In addition, extra pressure may be placed on the system if there is an increase in population as a result of inward migration to the area due to real or perceived employment opportunities.

A number of measures will be implemented to mitigate against disruptions to traffic flow in the local Sangachal area and potential damage to transport routes. Such measures may include transportation of equipment and materials in convoy with police escorts, scheduling transportation outside of peak local traffic times, and a programme to monitor and address impacts on road quality. These measures will be documented in a Traffic Management Plan (Chapter 14) for the onshore construction activities.

Potential benefits to the local communities may result from upgrading and maintenance of roads and the rail transport system should the integrity and quality of these be found to be compromised as a direct result of the ACG and Shah Deniz FFD developments.

Any traffic impacts associated with the yet-to-be selected fabrication yard for the TPG500 construction will be assessed as part of a separate ESIA once yard selection has been finalised (Chapter 15).

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[16] Information supplied by BP March 2002 from internal report 'Total Tonnage ACG-AGT-SD'.

11.4.7.2 Operation phase

It is not envisaged that operations activities either onshore or offshore will result in significant increases in either road or rail traffic.

Given that the number of workers employed for the operations phase of the onshore terminal will be a maximum of 45[17] it is not envisaged that the transport needs of these workers, in themselves, will place any significant extra pressure on the existing public transport system. The maximum number of workers for offshore operations is 20 and for pipeline operations is 60.[18] Together with the onshore workers, this total number of 125 employees may increase pressure on the system leading to negative impacts for existing users, if transport management measures are not implemented.

The onshore and offshore operations are not of sufficient size to indicate that use of local suppliers will create any appreciable negative impact on the existing transport system.

11.4.8 Archaeology and cultural heritage

As discussed in the Socio-Economic Baseline (Chapter 7), identified archaeological features are distributed throughout the area surrounding the Shah Deniz Stage 1 project site (Table 11.16). These known features lie outside the proposed land take area and therefore, would not be directly impacted as a result of Shah Deniz Stage 1. It was noted by the local archaeological experts[19] however, that there is a potential for subsurface artefacts to be located within the Shah Deniz Stage 1 project site.

The impact assessment process for this receptor has yielded the following impact significance ranking:

Likelihood of activities occurring = 5 - certain to occur.
Consequence of activities = 1- inconvenience experienced in accessing community facilities and utilities for short (hours) period of time.
Impacts significance ranking = 5 - low.

Ground clearance and grading for the Shah Deniz Stage 1 terminal expansion and associated facilities (access roads, onshore pipelines) and temporary works including storage yards and office sites, etc. pose the greatest risks to potential subsurface archaeological features. Negative impacts however, could result from activities that stand to potentially alter, directly or indirectly, any of the characteristics of an archaeological feature, or diminish its physical integrity during the entire construction process.

An Archaeological Management Plan (AMP; Chapter 15) was therefore implemented for Shah Deniz Stage 1 as part of the ECEWP ESIA. At the time of writing no significant archaeological or cultural finds had been made within the land take area.[20] Some new sites of significance were discovered during the initial investigations outside the land-take area.

Positive impacts can result from Shah Deniz project activities given certain mitigation measures are implemented. If workers have been briefed regarding the archaeology of the region, indicative signs of archaeological remains, and the importance of their due diligence

[17] Source: BP - 30 employees working day shift, 15 working night shift.
[18] Source: BP.
[19] Experts involved in the archaeological field survey were Nadiv Khasanov and Elmira Abbasova of the Institute of Archaeology and Ethnography, Azerbaijan Academy of Sciences.
[20] Information provided by BP. AMP is ongoing.

and immediate reporting of potential finds to the appropriate BP representative, especially while undergoing excavation activities, Azerbaijan's cultural history can be augmented.

11.4.9 National employment, industrial base and procurement

This section has been divided between the construction and operation phases of Shah Deniz Stage 1 in order to take account of the differences in employment and procurement impacts between the two different phases of the project.

11.4.9.1 Construction of Stage 1

Overview

The primary impacts during construction relate to employment and income generated by Shah Deniz Stage 1 and include:

- direct employment associated with the construction programme of Shah Deniz Stage 1;
- indirect employment related to the supply of materials and services to the construction process; and
- induced employment generated by the expenditure of the above two categories of workers.

Despite a strong history in fabricating both small and large structures in Azerbaijan, there is only a small local workforce available in the country, of between 500 and 700 workers,[21] with sufficient experience in international fabrication practices to support the proposed construction programmes for the Stage 1development. A strong training and re-training programme will therefore be implemented to support the construction phase of Shah Deniz Stage 1. Many potential candidates for training have already been identified to support a sustainable increase in skilled labour for the fabrication industry.[22]

An assessment[23] was undertaken of the advantages and disadvantages of the yards visited and the relevant human resource issues pertaining to each. Most of the major issues encountered whilst undertaking the assessment were attributed to differences in approach; for example, health and safety awareness issues are dealt with in a way that may not meet current international expectations. Training of personnel will therefore, be deemed of paramount importance and will include the development of an HSE culture to help ensure that work is carried out with a high regard to safety and the environment. Whilst the sourcing of employment and training is ultimately the responsibility of the construction contractors, guidance has and will continue to be issued by BP with regards to sourcing employees locally, where appropriate, and to ensure that international standards of performance are achieved. This guidance has become part of the tendering process.

Employment growth will also arise through the purchase of goods and services from suppliers for the construction process itself, otherwise known as indirect employment. The impact on suppliers would be driven by the procurement strategy of the contractor and their requirement for local products and supplies, as opposed to sourcing nationally or internationally. BP is actively encouraging their contractors to locally source goods and materials that meet the necessary specifications. Such requirements are included in the contract between the contractor and BP.

[21] Caspian Construction Capacity Report Rev06, April 2000, AIOC Full field Development Project.
[22] Approximately 750 candidates had registered as of end February 2002.
[23] Ibid.

With respect to the full Shah Deniz project, between July and September 1997 BP visited 35 companies that could potentially provide some of the necessary supplies and materials. This procurement study collated detailed information in relation to these companies, including contact information, ownership and control, internal organisation, company history, production facilities and standards, and joint ventures and alliances. In addition, it compiled data relating to the number of employees and the extent of training undertaken. Each assessment concluded with a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis of each individual company. Overall the study provides a detailed and informative assessment and analysis of the potential supplier network within Azerbaijan.

The study concluded that at present, there are no locally manufactured equipment and materials available that meet the international standards used in the global oil and gas industry. Many of the local companies have, however, made contact with international firms to set up joint ventures (e.g. Garadag Cement Works). This co-operation will progress as credible and sustained industrial demand increases. The current Azerbaijani supplier infrastructure can only support a small proportion of the consumable needs. There are also only a few contractors with the capability of carrying out high value service contracts. AIOC/BP's 2000 spend was $245 million in total for all activities carried out within Azerbaijan. Of this, 56% ($137 million) was spent in country. It is acknowledged that small and medium sized enterprise (SME) participation in AIOC/BP activities within Azerbaijan needs to be increased and AIOC/BP are currently examining strategies to achieve this (Chapter 15). It is AIOC/BP's goal to optimise its expenditure in Azerbaijan, by having a higher proportion of locally based suppliers that are able to provide the goods and services needed to meet current and future needs. These suppliers would however, need to meet both international and BP's HSE standards.

A study examining the construction capacity of the Caspian region in 1998 concluded that the Baku area will remain the main provider of both construction and fabrication yards for the Caspian. The survey sought to assess the construction and fabrication capacity within ten companies active within the Caspian area. Each company completed a questionnaire which sought a variety of detailed information, including information on direct and indirect labour, overheads, productivity, training, labour rates, fabrication duration and proposed fabrication strategy.

The study recognised that local facilities would require substantial upgrading to ensure project delivery within the sanctioned budget and schedule and in a manner that was wholly compliant with HSE and quality standards set by international oil companies. As a result of this study, BP has assembled considerable information and data to inform future decisions with regards to construction and specifically the resources, both physical and human, available within Azerbaijan.

Direct Impacts

The sourcing of employment during construction, for both onshore and offshore, is to be determined by the selected contractors. The percent of local content will form one of the evaluation criteria in the tender selection process for all contractors.

It has been estimated that approximately 1,000 people will be employed during the construction of the terminal.[24]

It should be noted that the Shah Deniz Stage 1 terminal will be placed adjacent to the ACG Phase 1 oil processing terminal (currently under construction) as appropriate. BP will operate

[24] Source: BP.

both projects and there are some inherent synergies that can be exploited in the construction, design and operation of these terminals.

It is also the intention that there will be some project overlap with those employed during the latter stages of Stage 1 and those employed may become involved in the development of Stage 2 and also the construction of the related ACG project. It is not possible to establish the detail on the construction worker split between the two projects until the construction contracts have been awarded and detailed planning has been carried out.

A key consideration in estimating the economic impact of Shah Deniz Stage 1 is the extent to which the employment opportunities generated from the activities will benefit local people both from within Azerbaijan as a whole and, in particular, around the local area. This will be driven by two issues:

- the ability of local residents to provide the necessary skills required to complete the construction works; and
- the desire by the constructors to bring in trained "construction gangs" to complete the work.

Although the terminal contractor has been selected it is not yet possible to give full details on the proposed sourcing of the construction workforce for the terminal. It is understood however, that the composition of the workforce will change over time and it is estimated that the Azerbaijani composition during the early stages of construction will be approximately 75%. This will drop to approximately 65% towards the end of construction. The contractors are committed to using a maximum of 15% of the man-hours from outside Azerbaijan. At peak times however, this may equate to some 30% of total personnel. The sourcing of the workforce is a reflection of the work being undertaken, the skills required and the available personnel. It is understood that the onshore construction contractor will only source labour from the international market where the local labour force cannot supply the skills required for the programme. Where nationals are employed this will bring further benefits as wages and salaries are spent within the local economy. This will also be the case, although to a lesser extent, for expatriates when based in Azerbaijan, although it must be appreciated that a large percentage of expatriate salaries will not enter the Azerbaijani economy but will remain in the country of origin.

It is estimated that approximately 300 personnel will be employed for the construction of the pipelines and approximately 75% of those employed will be Azerbaijani. Meanwhile for the construction of the platforms an average of 300-400 people will be employed over a 12-15 month period, peaking at some 500. A target of between 60-70% of this employment will be Azerbaijani.

As noted above for terminal construction, it is again envisaged that there will be some project overlap and those employed during the latter stages of Stage 1 may become involved in the development of Stage 2 and also the construction of the ACG Phase 1 project. It is not possible to establish the detail on the construction worker split between the two projects until the construction contracts have been awarded and detailed planning has been carried out. For offshore, as for onshore, a key consideration in estimating the economic impact of ACG Phase 1 is the extent to which local residents will be able to provide the necessary skills, along with the extent to which contractors select local residents as employees.

As discussed above, some training of the workforce will be required. Until the contractor and also the yards are selected it is not possible to outline the proposed training plans that will be introduced as part of the project.

Training facilities have been identified at Primorsk Technical College. Whilst the college needs some upgrading, there are sufficient classrooms and workshops available to train approximately 220 people per annum. It is currently possible to organise a number of courses, including those in relation to fitters, electricians, steel erecter/assemblers, scaffolders, and crane operators.

Preliminary estimates indicate that **total construction costs** in relation to Shah Deniz Stage 1 will be approximately $2 billion[25]. It has been estimated that some 40% of this expenditure will occur within Azerbaijan (i.e. $0.8 billion). These costs include not only the capital costs of the infrastructure, but also an element of contingency. The costs are defined as Class 3 costs (i.e. +/- 30%).

Indirect and induced impacts

In addition to the above direct impacts, indirect and induced effects will reflect the employment and income generated by the spending of the construction workers and also those employed in providing services to the construction process. The rate at which employment is created can be estimated through the application of conventional employment multiplier techniques. The overall size of the multiplier will depend on the proportion of goods and services purchased from within the local area, and the size of the local area under consideration. The smaller the size of the area under examination, the smaller the size of the multiplier, because there is a greater probability that the income will leak out of the area.

Considering indirect effects (i.e. firms purchases from each other) and induced effects (i.e. wages and net profits) together suggests that the overall multiplier is the inverse of the overall leakage out of the local/regional/national economy (i.e. what does not leave the local/regional/national economy must be retained). Thus, a leakage of 60% implies a multiplier of 1.67 and leakage of 40% implies a multiplier of 2.5. Multipliers for leakages 10% to 90% are given in Table 11.14 below.

Table 11.14 Leakage and multipliers for indirect and induced impacts

Leakage Out Of region (%)	Implied Multiplier
90	1.11
80	1.25
70	1.43
60	1.67
50	2.00
40	2.50
30	3.33
20	5.00
10	10.00

The European Bank for Reconstruction and Development (EBRD) estimates that approximately 70% of expenditure (i.e. procurement and income) will leak from the Azerbaijani economy. On this basis it is considered that a combined indirect and induced multiplier of 1.43 is appropriate for the construction phase on the basis of the size of the area and the limited duration of this particular form of direct employment. For the purpose of estimating the indirect and induced employment effect during the construction phase, the multiplier coefficient applies equally to construction workers recruited locally and those brought in from outside the local area. In both cases, construction jobs represent new employment opportunities for the local economy.

[25] Source: BP.

Based on the above, it has been estimated that the impact of Shah Deniz Stage 1 is detailed in Table 11. 15 below.

Table 11.15 Direct and estimated total (offshore and onshore) impact ($ million)

	Azerbaijan
Direct:	800.0
Indirect and induced:	344.0
Total:	1,144.0

Source: Consultants estimates.

Consideration must be given as to whether the local economy possesses the necessary capacity to respond to the demands of the construction process and the necessary skills to provide the required goods and services.

Wider impacts

The long term sustainability of the local economy built up around one key development would be likely to be limited unless the development draws other investment to the area and also requires construction supplies and materials. For instance, with respect to the local economy, the experience of the Early Oil Project was that although the project resulted in the creation of a number of small roadside businesses in the local area these were opportunistic in nature and did not experience substantial trade, nor were they long lived.[26]

Clearly the local employment created through this expenditure will be lower for construction workers accommodated in a construction camp, simply because of their reduced ability and willingness to spend their incomes locally, as the camp will provide very comfortable living accommodation and recreational facilities. There is however, also the potential for limited negative effects on local business if the construction process results in local wage increases leading to a shortage of certain types of labour (i.e. local fishermen seeking employment during the construction phase of the development). It may also be that the local employment situation distorts the local market (Section 11.4.4.1).

Skills enhancement as a result of employment opportunities associated with the Shah Deniz Stage 1 project construction and operations activities may have a positive impact on the local community. Skills enhancement may come as a result of skills transfer from employees from elsewhere in Azerbaijan or from expatriate personnel. In recent years the involvement of expatriate personnel in the projects has been more readily acceptable to local communities and there is a general acknowledgement amongst the national workforce and local community of the skills and international experience expatriates can bring.

As a result, programmes will be introduced during the onshore and offshore construction processes to maximize the transfer of skills and knowledge from expatriate personnel to Azerbaijani nationals and from both of these groups to local workers. Contractors have been required to include training and skills enhancement programmes, along with targets for skills training for local workforces, in their tender information. This information has been part of the contractor selection criteria.

[26] ACG FFD Environmental and Socio-economic Overview (p.72).

11.4.9.2 Operation of Stage 1

Direct impact

Table 11.16 below details the proposed employment profile during the operational phase. As illustrated in total 65 personnel will be employed.

Table 11.16 Employment during operation

	Number of Employees
Offshore:	45
Onshore:	20
Total:	65

Source: BP.

It is proposed that after 5 years some 70% of operational staff will be Azerbaijani and within this approximately 60% of all of the professional positions will be held by Azerbaijanis.

The key issue during the operation phase will be the role of local people and whether they can benefit from the employment opportunities. As highlighted above, this is very much related to the skills required for the project, the skills held by local people and training that can be introduced to ensure greater local involvement in the project operation. BP has a preference for filling the employment places with local people, whilst bearing in mind the necessary skills and experience that will be required. BP has already registered hundreds of individual at the local employment centres as of early 2002. This process will enable potential candidates for operations jobs to be identified from within the local communities and ensure that those who are hired can undertake the necessary training in advance of the project becoming operational. For example, a National Training School is being set up in Baku to train upwards of 200 trade technicians (i.e. mechanical, electrical, production and instrument technicians) between 2001 and 2005. These 200 or so trained technicians are to be employed across ACG Phase 1, Shah Deniz, BTC and the current EOP operation. Once selection and recruitment has taken place, each technician will undergo a training period of between two and three years before being employed as a full time trade technician in any of the BP field operations areas. The training period will initially be directed towards language, safety, basic operations and behavioural training but later in the programme the focus will change to more specialised technical training required for each of the four trade disciplines.

In addition, BP will also recruit Azerbaijani University graduates into the BP Challenge Graduate Programme. This programme gives both operation, engineering and other onshore support responsibility training over a three year period. It is envisaged that the Azerbaijani staff from both the National Training School and the Challenge Graduate Programme will join the project teams in the UK and other areas before mobilising to Baku for the hook-up and commissioning of both the Sangachal terminal and offshore platforms.

It is estimated that the costs during the operational phase of the project will be approximately $54 million per annum and in the region of 70% of this expenditure is expected to be incurred within Azerbaijan (i.e. $37.8 million). Based on a 30 year operating period for Stage 1, this equates to an estimated total spend of $1,620 million, of which approximately $1,134 million will occur within Azerbaijan.[27]

[27] Source : BP

Indirect and induced impact

As with the construction phase, in estimating the total employment creation impact of Shah Deniz Stage 1 during operation, it is necessary to also consider the indirect and induced jobs to the direct employment. The indirect employment effect arises from secondary business supplying goods and services to on site activities that, in turn, create further economic activity by purchasing additional supplies. The induced employment arises from the creation of additional personal income derived from the first (direct workers), and successive (indirect workers) rounds of spend. The extent of the indirect and induced employment impacts within Azerbaijan will be conditioned by the "leakage" caused by the payment of income (such as the payment of wages and salaries, profits, rents, interest and taxes) rather than the purchase of goods and services to individuals or organisations outside the locality.

The quantification of these impacts is conventionally derived through the application of employment multipliers and the selection of an appropriate multiplier coefficient. As discussed above, EBRD estimates that approximately 70% of expenditure will leak from the Azeri economy and on that basis it is considered that a combined indirect and induced multiplier of 1.43 is appropriate in this instance.

Based on the above, it has been estimated that the impact during the operation of Shah Deniz Stage 1 on the Azerbaijani economy is detailed in Table 11.17 below.

Table 11.17 Direct and estimated total impact ($ million)

	Azerbaijan
Direct:	1,134.0
Indirect and Induced:	487.6
Total:	1,621.6

Source: Consultants estimates.

Wider impacts

The impact of the development proposals on local unemployment can be seen as a wider beneficial impact. A potentially negative impact, judged to be moderate, is the risk of generating induced inflation as a result of high expatriate salaries, local spending and increased local employment.

In response to the demand for services the project may also directly and indirectly contribute to a 'boomtown' effect through a rapid growth of local industry, particularly construction, to support the demands of the project. As such development is reactionary and based purely on the project, long term sustainability is questionable, particularly if the economy cannot supply new opportunities. The negative aspects of the boomtown development (e.g. closure of businesses) can in this case be expected to be minimised given the scale of offshore oil reserves and substantial infrastructure requirements that will be needed in the future. Full Field Development (FFD) of the ACG and Shah Deniz fields would provide work for a number of years and should allow the successful diversification of the sector over the longer term.

The project would also generate a number of permanent employment opportunities directly associated with the new business attracted to the area, some of which will provide support to the oil sector. The total number of new jobs created would depend upon the extent to which these represent net additions to the economy. In economic terms, the benefit of the scheme is measured by the number of new jobs created in the local economy after taking into account additionality factors, displacement and the indirect/induced effects.

Such a transformation of the economy (i.e. the development of a supplier network) by the oil industry does not happen in the short term. Invariably during the initial exploration phases for oil development, a comparatively small number of companies are involved and on a very modest scale. Gradually the impact of oil developments increase as more companies move or expand the scale of their operations. Once the oil industry becomes established, there is potential for an ailing economy to be revitalised, with increased job opportunities, income and wealth.

The worst effects of decommissioning of plant facilities are experienced in communities that have become dependent on the presence of oil and gas development related activities for their livelihood. The loss of income and/or employment in the community can literally means its degeneration to a ghost-town. These effects may be off-set should other resources be found in the region or alternatively if the town or region is in a position to service other fields. Similarly, effects can be off set if the town/community was able to sustain the economic base that existed prior to the oil and gas based industry being introduced into the area.

Employment and supply issues will be addressed through a number of strategies as overviewed in Socio-economic Mitigation, Monitoring and Management (Chapter 15).

11.5 Government revenue

Although Azerbaijan has experienced economic contraction similar to other former Soviet countries, it has sound development prospects due to its natural and human resource base, its diversified industrial potential, and its strategic location. Oil and gas revenues can be expected to impact positively on regional socio-economic development. This is particularly relevant if oil revenues are invested in economic restructuring and development. A revival of national economies, supported by oil and gas revenues, can be expected to generate longer term regional development. There are however, considerable uncertainties about the amount of money that will be generated and its potential economic impact, as the size of the capital injection will depend on the rate of oil and gas exploration and the oil price.

The most substantial and direct economic impact will be the financial contribution to the national economy and growth in GDP. The terms of the Production Sharing Agreement (PSA) define the main income streams to be:

- profit from oil sales, defined as revenue accruing to the State after deduction of transport costs, operational expenditure, capital expenditure and profit due to the consortium partners;
- bonus receipts;
- tax revenue; and
- pipeline transit tariffs.

Additional direct income to the State can also be expected to accrue from:

- labour taxes derived from oil and gas sector workers;
- corporation tax from oil and gas related companies;
- income derived from possible gas sales; and
- indirect revenues from increased economic activity stimulated by the oil sector.

There will also be indirect impacts as a result of the money flowing into the Government treasury, which again will be very dependent on the amount of money and how those funds are used. The broad options for use of the funds include:

- to reduce taxation and therefore boost domestic demand;

- to increase recurrent expenditure on service provision; and
- to finance a major public investment programme to improve national infrastructure, health and education facilities etc.

The potential negative and positive impacts include:

- **Reduction in competitiveness of non-oil sectors**, as the national economy will be provided with substantial foreign exchange revenue that can be used to buy imports. While this may relieve immediate shortages, local agriculture and industry may not be in a position to compete with imports in the medium to long term if the required restructuring is not undertaken in order to increase their potential international competitiveness. This may be particularly evident if the local population, with increased purchasing power, finds imported goods to be of better quality and cheaper than local products. This would also generate a long term negative impact on non-oil sectors in terms of their ability to restructure and develop on the internal and international markets and by association, reduce domestic employment and income generating potential.
- **Delays in restructuring of productive base**. Restructuring of the productive base[28] is crucial and urgent. Experience in countries having undertaken a similar process show that this is a painful process in terms of impacts on the well-being of the population. It requires careful planning and the ability of the Government to take independent and difficult decisions. A danger of over-reliance upon oil revenues is that restructuring may be avoided or delayed and that attempts will be made to offset the negative restructuring impacts by providing artificial financial support that merely delays and prolongs the restructuring period.
- **Multiplier effects and potential misdirection of generated wealth**. Expected revenues from the development of the oil fields are enormous relative to the current GDP. Such injections into the economy can result in both a beneficial/advantageous impact with the generation of large multiplier effects and major negative impact in the case of attempts at diversion and corruption of the use of funds. The IMF has recently approved a $100 million three-year Poverty Reduction and Growth Facility loan for Azerbaijan, $10 million of which is available for immediate use. This agreement seeks to organise the management of billions of dollars of expected oil wealth, in which petroleum profits will be collected and then spent gradually.

Long term positive social impacts can be expected to result from the availability of greater financial resources allowing the State to finance both economic restructuring, thereby stimulating the economy, job creation, and social development services and infrastructure (i.e. hospitals, schools). Such social benefits are unlikely to be immediately available and as such revenues will primarily allow the State a greater degree of freedom to increase the scope of financing priorities and to plan investments with more certainty. A perceived lack of improvement in social conditions may result in social unrest if inequalities are seen to rise too quickly or if the population does not think it is deriving any immediate or long-term benefit. Potential unrest must be regarded as negative in a country that has only recently found stability.

The decision on the balance between these three options is essentially a political one and needs to be considered in relation to the risks associated with over-reliance on oil and gas revenue. The realisation of such impacts is however, ultimately a long way off as Azerbaijan will only accrue the oil and gas revenue after the oil and gas companies have themselves completed their own capital recovery phase. Ultimately though, the realisation of such economic and social benefits depends upon the careful management of generated revenues. It

[28] The productive base of a country is its industrial network (i.e. services and products). This base can be restructured so that its sectoral make-up and reliance can change (i.e. the sectors/supplies/products that make up the industrial network change in a way that effects the overall industrial base).

also requires attention to the resolution of local economic and socio-economic problems in order to develop a strong and sustainable economy.

12 Cumulative Impacts

12.1 Introduction

The IFC Procedure for Environmental and Social Review of Projects (IFC, December 1998) states that environmental assessment includes consideration of:

> *"…cumulative impacts of existing projects, the proposed project and anticipated future projects."*

In regards to qualifying the spatial and temporal relationships of the subject project activities (i.e. those for which the assessment is being performed) and potential future projects, the Procedure states:

> *"Assessment of cumulative impacts would take into account projects or potential developments that are realistically defined at the time the environmental assessment is undertaken, where such projects and developments could impact on the project area."*

Cumulative impacts are those that may result from the combined or incremental effects of past, present or future activities. While a single activity may in itself, result in an insignificant impact, it may, when combined with other impacts (insignificant or significant) in the same geographical area and occurring at the same or similar time, result in a cumulative impact that may have a detrimental effect on important resources. Cumulative impact assessment has a number of components including:

- assessment of the effects of subject activities (i.e. those under review) over a regional area including cross divisional (i.e. jurisdictional) boundaries resulting from interactions between the subject activities and other activities in the same geographical area; and
- an assessment of the effects of subject activities over an extended timeframe resulting from interactions between the subject activities and other activities occurring at the same or similar time.

12.2 Regional context of the Shah Deniz Stage 1 development

As discussed in the Introduction (Chapter 1), there are a number of existing and planned oil field activities in Azerbaijan, including developments in offshore waters under the country's jurisdiction.

12.2.1 Offshore projects

Offshore in Azerbaijan waters, the only field currently operated by BP, on behalf of the Azerbaijan International Oil Operating Company (AIOC), is the ACG Early Oil Project (EOP) with production from the Chirag-1 platform conveyed to the existing EOP terminal at Sangachal. Remaining offshore activities in the area are operated by SOCAR, with the Shallow-Water Gunashli situated adjacent to BP's Deep-Water Gunashli tract in the Contract Area and Oil Rocks located to the northwest.

A number of other offshore PSAs have been also awarded in recent years with those in close proximity to the Shah Deniz field including:

- the Apsheron field to the northeast; and
- the Zafar Mashal, Nakhchivan and Yana Tava fields to the south and southeast.

No PSA development activities in the vicinity of the Shah Deniz Contract Area are however, currently taking place. Many of the PSA Contract Areas are in the exploration phase. The ACG and Shah Deniz fields are exceptions to this as large oil and gas/condensate reserves have been discovered and are targeted for development. Exploration will continue in many of the PSAs, although drilling programmes are constrained by the limited availability of drilling rigs in the Caspian region. It is anticipated that additional rigs will be constructed or imported into the region by the end of 2003 to allow further and more rapid exploration of the area, leading to possible future development of other PSA Contract Areas.

Figure 12.1 illustrates the location of the Shah Deniz Contract Area in relation to the ACG and other PSA contract areas.

Figure 12.1 The Shah Deniz Contract Area and other nearby PSA areas

12.2.2 Onshore projects

Onshore oil drilling and production activities have taken place in Azerbaijan for over a century and many onshore fields have been developed. In the Sangachal region a number of wells have been drilled, although these have since been plugged and abandoned. The closest oilfield development to the proposed Shah Deniz Stage 1 terminal location is situated at Lokbatan, approximately 20 km to the northeast of Sangachal.

The EOP terminal currently operates at the site of the proposed Shah Deniz and ACG terminal facilities. Current planning places the proposed Shah Deniz gas/condensate processing terminal facility immediately adjacent to the proposed ACG facilities that will be constructed as an extension to the existing EOP facility. The proposed additional land-take at the terminal location will be for both the Shah Deniz FFD and ACG FFD terminal facilities.

Oil from the EOP development is currently transported from Sangachal terminal via the Northern Export Route (NER) and the Western Export Route (WER) pipelines. It is currently proposed to construct an additional oil export line from the terminal (the Baku-Tbilisi-Ceyhan (BTC) Main Export Pipeline) and a gas export pipeline for transfer of the Shah Deniz gas product to Turkey.

Aside from the existing EOP terminal, other existing industrial activity in the region around Sangachal (the Garadag District) is limited and includes the Garadag Cement Plant (GCP) and SPS fabrication yard, 6 km and 12 km to the north of the terminal location, respectively. In addition, the mature Lokbatan oilfield operated by SOCAR is situated approximately 22 km to the north of the terminal site. The Gobustan Operating Company are also developing three blocks of oilfields to the northwest, south and west of Sangachal. The block to the south is on the coast and is between 3 km and 4 km from Sangachal settlement, the block to the west is some 16 km to 17 km from the terminal site and the block to the northwest some 25 km. Although exploration and production has occurred within the concession area of these three blocks, there is currently limited activity within the fields.

No known plans for other potential future developments in the area have been finalised, although it is known that two additional terminal developments in the District have been considered. These comprise a possible rail oil-loading terminal to the north of Sangachal (near to the GCP) and a possible oil reception terminal to the south. There is a considerable amount of uncertainty as to whether or not these developments will go ahead and these potential developments are not associated with BP operations in the area.

12.3 Stage 1 development schedule in the context of other related projects

It is important to consider the temporal relationship of project activities when assessing cumulative impacts and identifying methods to mitigate them. If activities are staggered over time, receptor(s) may have time to rehabilitate and restore (with or without human intervention) between successive activities. This temporal factor is extremely important with regards to sensitive environmental receptors (i.e. ecological systems) that may, if not given the opportunity to regenerate, lose their functional integrity and subsequently degrade or die-out. Socio-economic environments can also be irreparably changed as a result of poorly planned development.

The Shah Deniz Stage 1 development is the first stage of the proposed FFD programme. The Shah Deniz terminal facilities and the associated pipeline nearshore approaches and landfalls will also be developed adjacent to the existing terminal near Sangachal settlement.

It is planned that the Stage 1 offshore facilities will be assembled at a yard near Baku. The anticipated timeline for these facets of the development in the context of other project activities in and around the terminal site as well as offshore is shown in Figure 12.2. It is important to note that this schedule is approximate as some aspects of the full programme were only entering the detailed planning stage at the time of writing this document.

Figure 12.2 Estimated schedule of regional development activities

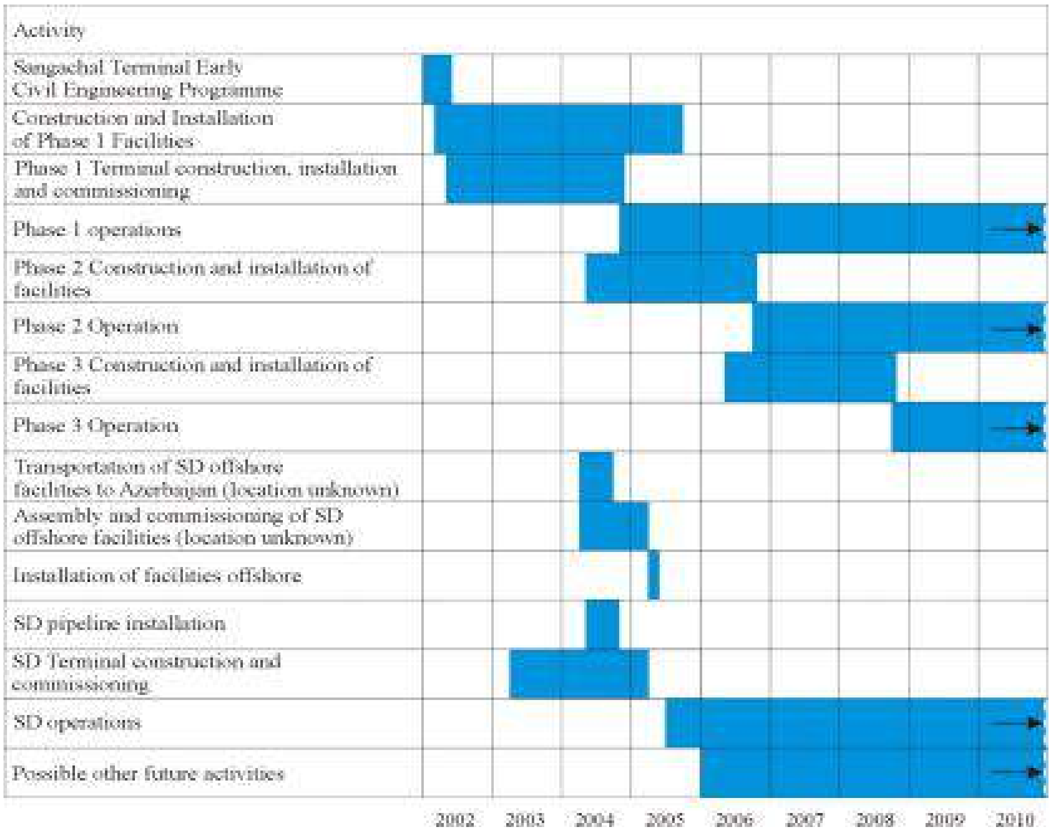


Figure 12.2 shows that, from the start of 2002, the majority of the activity in the Sangachal area will relate to the preparation of the terminal site for Shah Deniz and ACG terminal construction (i.e. the Early Civil Engineering Works Programme (ECEWP)) and the assembly of the ACG Phase 1 offshore facilities at the SPS yard some 14 km to the north. In addition, ACG Phase 1 pipe-laying activities onshore and nearshore will add to the activity in the area around the terminal.

Shah Deniz Stage 1 terminal construction will commence in 2003 and will be more or less concurrent with the commissioning of the ACG Phase 1 terminal facility. Commissioning of the Stage 1 terminal facility will overlap with the commencement of construction of the ACG Phase 2 terminal facility.

The following section examines the aspects of the Shah Deniz Stage 1 development that are considered to have the potential to cause cumulative environmental or socio-economic impacts by virtue the fact that they would be in addition to existing or anticipated future activities.

12.4 Cumulative environmental impacts

12.4.1 Overview

The following sections identify and describe the cumulative impacts associated with Shah Deniz Stage 1 as considered together with other projects in the region (present and future). The sections considers the cumulative impacts associated with the:

- atmosphere;
- marine environment;
- coastal environment;
- onshore environment;
- socio-economic environment; and
- waste (refuse) issues.

12.4.2 Atmospheric emissions

12.4.2.1 Noise

Offshore

Noise emissions associated with Stage 1 activities have been considered and are discussed in the Environmental and Socio-economic Impact Assessments (Chapters 10 and 11 respectively). The distance between the offshore facility and the nearest sensitive onshore receptors is sufficiently large that noise will attenuate to insignificant levels and hence no impacts are expected. Workers on the TPG500 will be protected from noise by adherence to Occupational Health and Safety procedures such as the mandatory wearing of hearing protection in designated areas.

Noise emissions from any offshore facilities developed (installed and operated) for latter stages of the Shah Deniz Gas Export Project would be expected to be similar to those of the Stage 1. Given that these facilities would also be well removed from the nearest sensitive onshore receptors, it is considered that no cumulative impacts would be incurred. Similarly, the ACG facilities would be well removed from the onshore receptors and therefore, would not contribute to any cumulative impact.

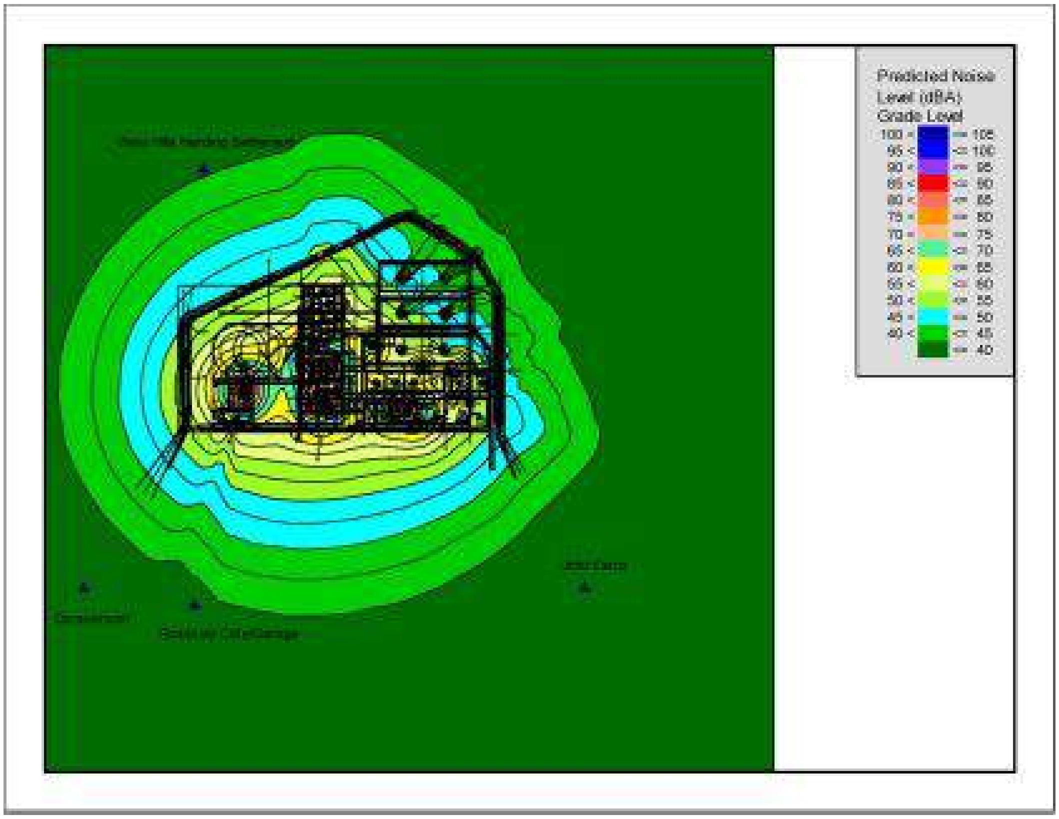
Onshore

Normal Operations

As discussed in the Socio-economic Impact Assessment (Chapter 11), preliminary noise emission modelling for the proposed Shah Deniz Stage 1 and ACG Phase 1 terminal facilities has been undertaken. The modelling has predicted that there would be no impact on nearby sensitive receptors (i.e. Caravansari, Roadside Café/Garage and Umid Camp) under normal operating conditions resulting from the combined operation of the Shah Deniz Stage 1 and ACG Phase 1 and EOP facilities; that is, noise levels at nearby sensitive receptors would be compliant with World Bank Environmental Guidelines. The modelling also concluded that the combined noise levels of Shah Deniz, ACG FFD and EOP terminals, under normal operating conditions, would be compliant with the Guidelines on noise levels for both residential and commercial receptors.

Figure 12.3 illustrates terminal noise emissions for the combined Shah Deniz and ACG Phase 1 and EOP terminal operations.

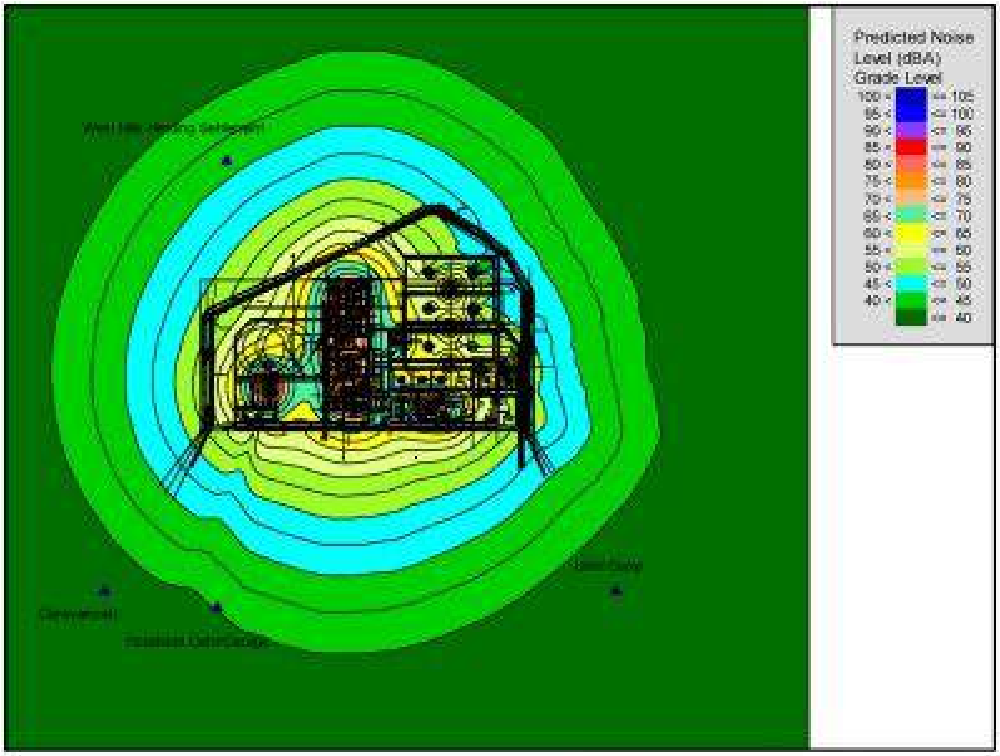
Figure 12.3 Noise emission levels for combined Shah Deniz, ACG Phase 1 and EOP terminals under normal operating conditions



As such, modelling undertaken to predict noise emissions for the combined Shah Deniz, ACG FFD and EOP terminal operations assumed that the Shah Deniz terminal contribution was the same as that used for modelling of the combined operation of the Shah Deniz, ACG Phase 1 and EOP terminals (Figure 12.3). Figure 12.4 illustrates the combined Shah Deniz, ACG FFD and EOP operations.

In the event that latter stages of the Shah Deniz programme do require and expansion of the terminal, additional noise modelling will be undertaken to ensure that the facility's design does not result in the exceedance of relevant noise standards and guidelines

Figure 12.4 Noise emission levels for combined Shah Deniz, ACG FFD and EOP terminals under normal operating conditions



Emergency flaring events

At the time of writing, a final design for the Shah Deniz terminal flare had not been determined. A work programme is however, underway to arrive at a flare tip design and flare stack configuration that satisfies relevant World Bank and World Health Organisation guidelines and standards on resulting noise levels at sensitive receptor points.

Preliminary modelling of noise emissions from the ACG HP flare indicated that the World Bank Environmental Guidelines limits would be exceeded for short periods of time during the initial few minutes of a flaring event. Work was being completed to investigate alternative flare tip designs that would reduce the likelihood of exceeding the limits.

Given the objective for both the Shah Deniz and ACG projects to comply with relevant guidelines and standards during all terminal operations including emergency shut-down flaring events, it is considered that in the rare and perhaps unlikely event that the Shah Deniz and ACG HP flares were operating concurrently, combined noise levels would also be within World Bank limits at nearby receptors.

12.4.2.2 Gaseous emissions

Potential impacts to human health from atmospheric emissions are discussed on the basis of project phase and general activity. It is important to recognise that those species deemed as potentially toxic to humans (i.e. VOCs, CO, NO_X, and SO_X) demonstrate lifetimes of several days to weeks in the atmosphere before breakdown and therefore, are not persistent in their most toxic form and hence, do not present a long-term impact to the environment after their release.

Greenhouse gas emissions that represent a potential transboundary environmental impact are discussed at the end of this chapter and in detail in Chapter 13.

Construction and installation activities

Offshore

Offshore construction activities (i.e. pipe-laying and platform installation) for each of the Shah Deniz FFD construction phases would result in the release of atmospheric emissions. These activities would be a short-term and there would be a considerable period of time between each phase of activity. Emissions from preceding phases would therefore, be well dispersed by the time latter phase emissions were released and hence, no cumulative impact in terms of degradation of local air quality would be expected to occur.

Onshore

The main onshore construction activities for the Stage 1 development comprising the construction of gas/condensate reception and processing facilities adjacent to the ACG/EOP terminal near Sangachal and the assembly of the offshore components (i.e. TPG500) will take place more or less simultaneously. Assembly of offshore components would however, be undertaken at an assembly yard near Baku well removed from the terminal construction site. Given this spatial distribution, it is considered that there is limited potential for cumulative degradation of local air quality associated with terminal construction and platform assembly.

Construction activities associated with each stage of the Shah Deniz development programme and the ACG FFD programme may overlap. If they do overlap, activity associated with the earlier stages will reduce as later stage activity increases so that overall, activity would remain at a high level for a longer period but would not necessarily continually increase.

While scheduling of Shah Deniz and ACG project works remains to be finalised, at the time of writing, it was considered that the time between each phase of activity would allow full dispersion of emissions and therefore, there would be no cumulative impact on air quality. The associated decline in levels of activity as one stage of work nears completion would also contribute to minimising the risk of impacting in a cumulative sense, on air quality.

Operational activities

Offshore

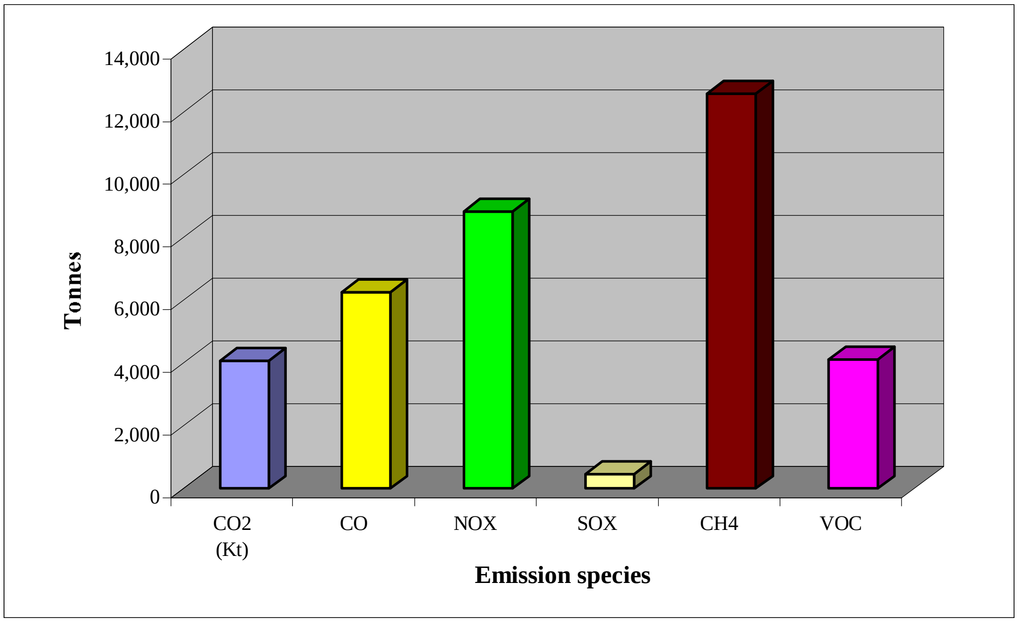
As discussed in the Environmental Impact Assessment (Chapter 10) atmospheric emissions from Stage 1 offshore activities would, as a result of good dispersion, not impact on sensitive receptors onshore. Similarly, given spatial distribution, even when operating at the same time, the combined Shah Deniz and ACG FFD operational activities would not expected to lead to a degradation of air quality offshore or onshore.

Onshore

Atmospheric emissions from Stage 1 onshore activities have been estimated and are presented in the Project Description (Chapter 5). Impacts associated with these emissions were identified and discussed in the Environmental Impact Assessment (Chapter 10). Initial air dispersion modelling, undertaken in 2001, predicted that there would be no significant impacts on local air quality. Further modelling of NO_X and SO_X emissions dispersion, undertaken in January 2002, confirmed these earlier results[1]. Contributions of greenhouse gas arising from Stage 1 terminal operations were not considered to be significant.

Total emissions for Shah Deniz Stage 1 (offshore and onshore) have been estimated using available data and are presented in Figures 12.5. The estimates assume a 30-year operating period for all offshore and onshore activities. It should be noted that emissions generated during Shah Deniz construction, assembly and installation activities are considered insignificant in the context of the whole Stage 1 development and therefore, have not been included in the cumulative emission graphs. The primary sources of emissions from the project are power generation (onshore and offshore), the fired heater (onshore) and flare (onshore).

Figure 12.5 Estimated cumulative onshore and offshore emissions by species Shah Deniz Stage 1 (30 year lifetime)



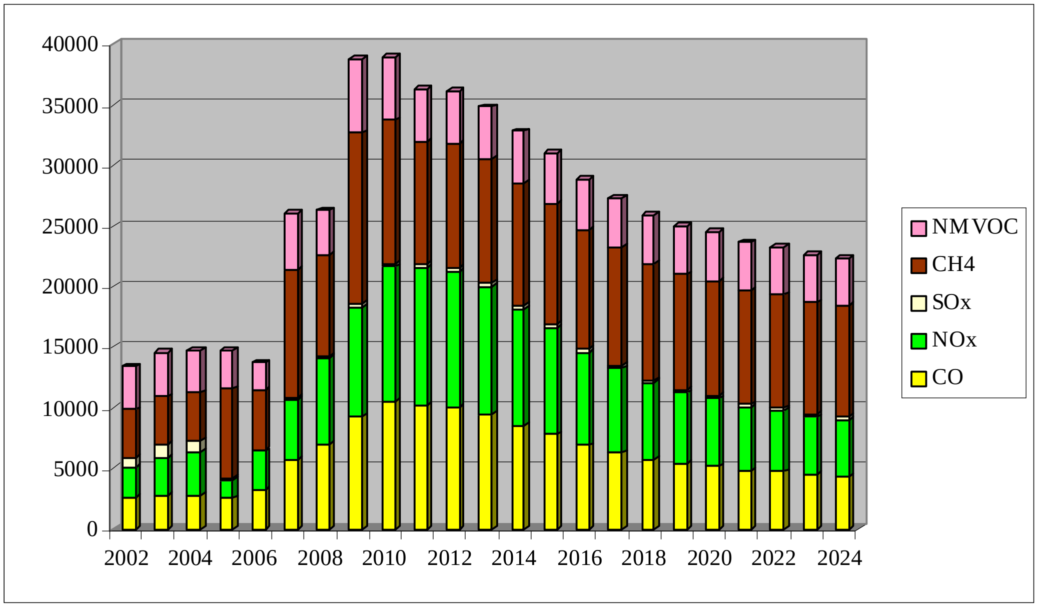
Note: Units of CO_2 are kilotonnes.

At the time of writing, development plans for future stages of the Shah Deniz field were in their infancy. Present thinking is that future stages will include expansion of the onshore terminal to have a receiving/processing capacity of circa 1,500 MMscfd. One additional major offshore facility would be added followed by a number of wellhead platforms or subsea systems (potentially both with zero processing or drilling facilities) to maintain levels of supply to the offshore and onshore facilities. Given the uncertainty surrounding the nature and scope of future stages of the Shah Deniz Gas Export Project, it is not possible to complete a quantitative estimate for the amount of emissions that would be generated and released as a result of the project's activities. An ESIA will be completed prior to any terminal expansion and/or any new offshore development.

Using available data, total emissions from the combined Shah Deniz Stage 1 and ACG FFD (offshore and onshore) have been estimated as illustrated in Figure 12.6.

[1] Air dispersion modelling, undertaken in January 2002, was completed by Kellogg Brown and Root.

Figure 12.6 Estimated cumulative emissions by species generated from ACG FFD and Shah Deniz (tonnes)



From the above figures it can be seen that the total combined tonnage of ACG FFD and Shah Deniz Stage 1 emissions would be significant. Emissions would be mainly attributable to the ACG development.

January 2002 air dispersion modelling, using revised and updated project data and more accurate meteorological information, predicted that ground level concentrations of NO_X at nearby sensitive receptors are compliant with AQS standards during combined Shah Deniz Stage 1 and ACG FFD terminal operations.123

Based on analysis of samples from the SDX1 exploration well, the Shah Deniz gas-condensate product is not considered to contain appreciable amounts of H_2S and therefore, there would no appreciable increase in SO_X emissions as a result of the addition of the Shah Deniz Stage 1 terminal or later future stages.

Based on the anticipated project schedules and the results of the 2002 air dispersion modelling, it is considered that the potential for AQS levels to be exceeded at times when individual terminal phases are being commissioned (i.e. predicted times of high level emissions) and earlier (i.e. previously commissioned) phases are operational is remote.

Air dispersion modelling of combined emissions from fully operational Shah Deniz and ACG FFD (including EOP) is ongoing. As far as possible, such modelling will address scenarios of the commissioning of project phases against a background of operating phases including non-routine flaring scenarios. If modelling determines that AQS levels are exceeded, consideration will be given to:

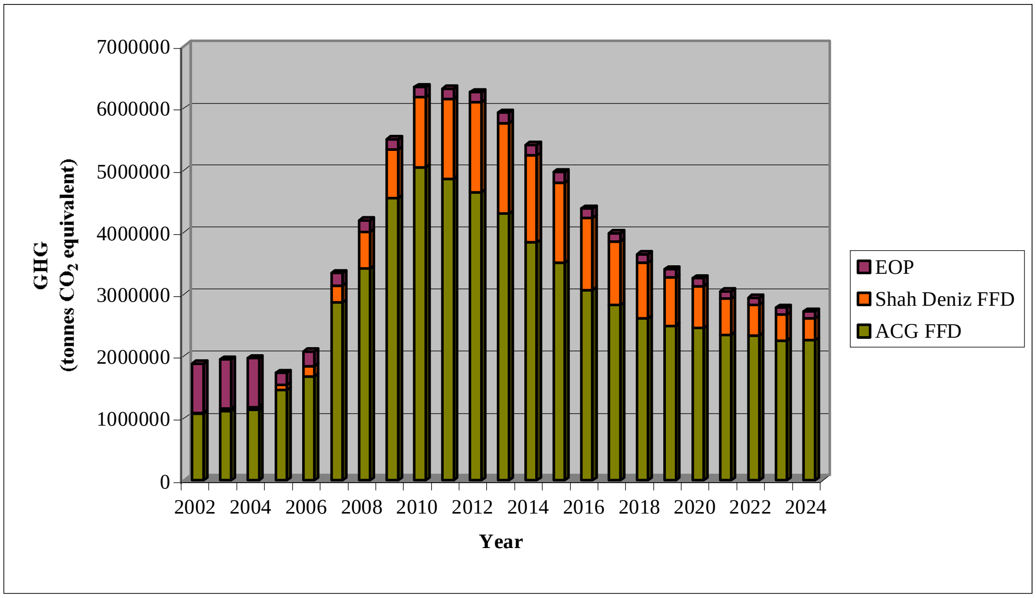
- modifying release points to improve dispersion;
- consideration of other mitigating measures for turbine driven plants such as low NO_X technology; and
- where technically possible, reducing the amount of flaring during commissioning activities.

12.4.2.3 Greenhouse gases

Emissions to the atmosphere that are acknowledged as having global impacts comprise predominantly CO_2 and CH_4. Azerbaijan ratified the United Nations Framework Convention on Climate Change (UNFCCC) on January 1995 and has committed to develop, implement and publish national and regional programmes that will include reduction and mitigation measures for such gases.

The total forecasted greenhouse gas emissions from the Shah Deniz Stage 1, ACG FFD and EOP projects are presented in Figure 12.7.

Figure 12.7 Estimated annual GHG emissions for the Shah Deniz Stage 1, ACG FFD and EOP



As can be seen from Figure 12.7, the Shah Deniz project contribution to combined GHG emissions is less than that of the ACG FFD but more than of the EOP. Projected GHG emissions from the Shah Deniz, ACG FFD and EOP were compared against the UNFCCC forecast and are estimated to constitute approximately 5% of Azerbaijan national emissions in 2010, the year in which maximum emissions from the combined projects are predicted. The combined Shah Deniz, ACG FFD and EOP emissions may have implications for Azerbaijan in terms of its ratification of the UNFCCC and the Kyoto Agreement and hence it is considered that there is a parallel reputation issue for AIOC.

BP will continue to audit its emissions of GHG and investigate cost effective means to achieve its corporate reduction target.

12.4.3 Offshore marine environment

12.4.3.1 Seawater and seawater biology

As described in the Environmental Impact Assessment (Chapter 10), normal Stage 1 offshore gas-condensate production operations would result in a number of discharges to the seabed and/or water column as follows:

- 28” well section cuttings during drilling operations (to seabed);
- treated black and grey water;
- treated putrescible wastes;
- treated drainage water; and
- cooling water (temperature and chemical plume).

It is assumed that the Stage 2 and Stage 3 offshore installations will contribute similar types and amounts of discharges to those generated by the Stage 1 facility, the TPG500. While the Stage 1 facility discharges have been assessed to have minimal impact on seawater and seawater biology (Chapter 10) there is a potential for the cumulative discharge of all three phases to have an impact on these receptors. Of most concern is the potential effect of cooling water discharges that has been treated with antifoulant chemicals. The cumulative discharges of 28” hole section cuttings, black and grey wastes, putrescible galley wastes and drainage waters would not be considered to represent a significant cumulative impact as discussed below.

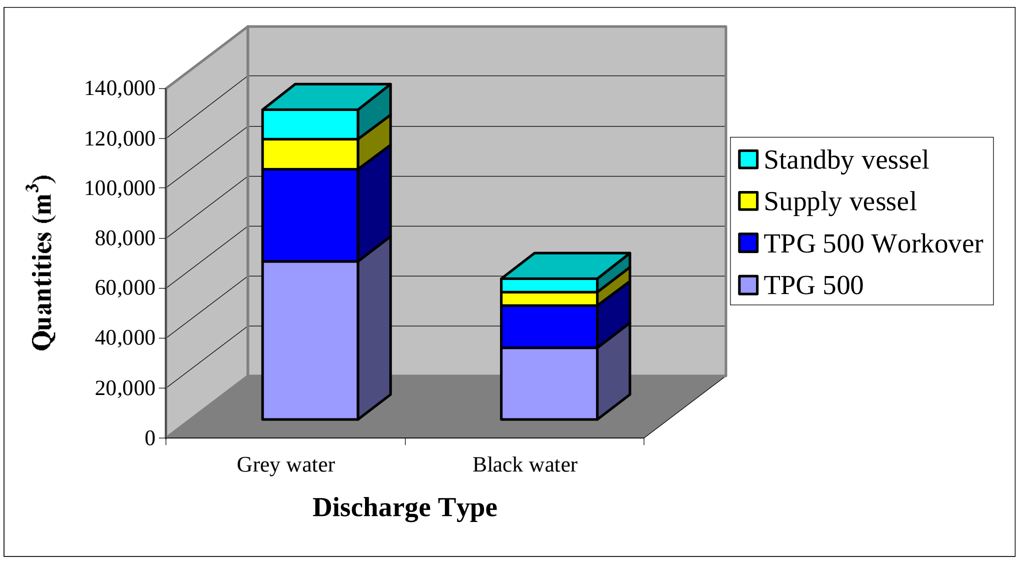
28” hole section cuttings

The temporal and spatial separation of cuttings discharge to water column as undertaken for the latter stages of development would be significantly large enough for the minor impacts that would be incurred during each phase (e.g. increased turbidity; possible ingestion of fine particles by marine organisms) to be recovered by the natural environment without significant adverse effect. There would therefore, be no cumulative impact on seawater or seawater biology as a result of cuttings discharge.

Black and grey water and putrescible wastes

As discussed in the Project Description (Chapter 5; Section 5.3.7.9), aqueous waste (black and grey waters) generated at the Stage 1 TPG500 (including support vessels) would be biologically treated and macerated prior to discharge. Figure 12.8 illustrates the estimated total amount of aqueous discharge that would be released to sea over the anticipated 30-year life of the Stage 1 development.

Figure 12.8 Total sewage discharged to sea from the TPG500 (including support vessels) over the life of the Stage 1 development (30 years)



For assessing potential cumulative effects of the latter Shah Deniz stages' discharges, it is assumed that the latter two developments would discharge similar amounts. In total therefore, Shah Deniz could result in the discharge of up to approximately 124,000 m^3 of grey water and 56,400 m^3 of black water over the life of the combined projects (assuming that latter stages also have a 30 year operational life span like Stage 1). This total discharge is not considered to be significant in terms of the receiving water's ability to assimilate the organic and chlorine content of the discharge.

Putrescible waste will be macerated and discharged overboard.

Treated drainage water

All Shah Deniz Stage 1 clean water discharges will be processed through a tilted plate separator (Project Description; Chapter 5) prior to discharge to ensure that discharges contain no more than 30 ppm oil-in-water. It is assumed that the latter stage installation(s) would employ a similar system. This, combined with the fact that the combined total amount of clean water discharged would be small, implies that there would be no significant cumulative impact.

Cooling water

As discussed in Chapter 10, using the ACG Phase 1 PDQ facility as basis from which to estimate cooling water discharge chemical plume concentrations from the Stage 1 TPG500 facility, a steady state dispersion plume that has maximum chlorine concentrations of 0.06 ppb under worse-case (i.e. least plume dispersion) conditions is expected. The total lateral extent of the plume is predicted to be up to 15 km (i.e. approximately 7 km radius around the TPG500) after seven days with chlorine concentrations at the edge of this area being approximately 0.01 ppb. It is considered that chlorine concentrations in even the core plume would be difficult to measure as a discernable increase to ambient conditions.

Given the likely distance between any latter stage offshore installation(s) and if it is assumed that the latter installations discharge similar amounts of cooling water with similar concentrations of chlorine, it is considered that there is limited potential for the respective cooling water discharge plumes to overlap. Similarly, the Shah Deniz offshore installation would be sufficiently well separated from the ACG offshore installations such that there would be no overlap of the chemical plumes and hence no significant cumulative impact.

12.4.3.2 Seabed and seabed biology

The installation of offshore facilities for later Shah Deniz stages would result in further physical disturbance of the seabed and resultant impacts on benthic organisms. These impacts would occur within the footprint of each structure installed. The cumulative loss from the installations' footprints (i.e. approximately 1 ha) is considered insignificant in terms of the Shah Deniz Contract Area and wider Caspian environment.

Shah Deniz Stage 1 drilling discharges (drilled cuttings and WBM from the 28" hole sections) are discussed in Chapter 10. Modelling of discharges suggests that the maximum horizontal distance travelled by released cuttings/WBM is approximately 160 m from the TPG500.

Shah Deniz Stage 1 drilling discharges (drilled cuttings and WBM from the 28" hole sections) are discussed in Chapter 10. Modelling of discharges suggests that the maximum horizontal distance travelled by released cuttings/WBM is approximately 160 m from the TPG500. Modelling also predicted that the maximum area that could be impacted during conditions where cuttings travel the greatest distance from the point of discharge (i.e. high-energy winter) would be approximately 11.2 ha.

If it assumed that the drilling programmes for latter stages of the programme led to a similar amount of discharge as the Stage 1 drilling operations, the total maximum combined area that could be affected by Shah Deniz drilling activities would be almost 30 ha. While not an inconsiderable area, this is not considered as constituting a significant percentage of the total Shah Deniz Contract Area and is a very minor portion of the total area of the Caspian Sea that falls within Azerbaijan's jurisdiction. Even when the loss of benthic habitat resulting from the combined Shah Deniz and ACG FFD programmes is considered, the total area affected is not significant. It should be noted however, that the benthic environments of the ACG and Shah Deniz Contract Areas are not the same.

Given that the 28" hole sections would be drilled using seawater and WBM, the constituents of which are Categories E and D (i.e. lowest) on the OCNS, no toxic effects on benthic organisms would be expected; that is, impacts would be limited to physical smothering. It would be expected that benthic organisms would re-colonise the area affected by cuttings once drilling operations have ceased.

12.4.4 Pipelines

Anticipated Shah Deniz pipelines include a 26" gas line, a 12" condensate line and a 4" MEG line with a possible further gas lines to shore planned for installation later in the Shah Deniz programme.

In addition to the existing 24" EOP oil pipeline from Chirag-1 to shore, a new 30" oil pipeline will be installed for ACG Phase.1. Further pipelines are planned for ACG FFD as follows:

- Phase 2: a new 30" oil line; and
- Phase 3: a new 30" gas line.

Subsea pipelines from the Shah Deniz and ACG offshore facilities to the terminal at Sangachal will essentially share a common pipeline corridor for a distance of 43 km from the shoreline into Sangachal Bay (Figure 12.1). East of this point, two separate corridors would be established; one out to the ACG field and one out to the Shah Deniz field. The ACG pipelines would more or less follow the same route as the existing Chirag-1 to Sangachal oil pipeline route.

The installation of subsea pipelines impacts the seabed and benthic environment, especially where the pipelines are trenched (for operational safety purposes) into the seabed. It is proposed to trench the Shah Deniz and ACG subsea pipelines from the terminal (approximately 2 km inland from the shoreline) out to a water depth of approximately 5 m. Trenching in Sangachal Bay is likely to impact on seagrass and red algae habitat that form integral components of the ecology of the area. Seagrass also contributes significantly to seabed stability (Chapter 6).

The nearshore part of the route for the Shah Deniz pipelines is within the same corridor as the ACG pipeline route. t. While installation of the Shah Deniz pipelines would lead to impacts on the seabed and benthos, use of the ACG corridor that passes through an area of relatively less seagrass and red algae (a red-listed species) habitat (as compared to other parts of the Bay) would minimise cumulative impacts.

While the area affected by pipeline installation and particularly trenching would be kept to a minimum by utilising the same pipeline corridor for the developments, the current construction schedule has pipelines for the various Shah Deniz stages and ACG FFD Phases being installed at different times. This staggered approach to pipeline installation may mean that disturbed areas of seabed and associated communities would not recover before the next wave of construction activities. A possible remedy to this potential problem would be to install at least the nearshore sections of the pipelines for both programmes at the same time. It is acknowledged that there are likely to be constraints that make this approach technically and logistically difficult but nevertheless, it is considered worthwhile to examine the opportunity. It should be noted that simultaneous pipe-laying would also, to some extent, allay concerns regarding the construction of the landfall for the pipelines. This option is presently under consideration.

A number of inter-field pipelines are also required for the transfer of hydrocarbons from satellite installations (e.g. Shah Deniz subsea completions) to the main platforms. The construction of these inter-field pipelines would include fairly intensive activity in a localised (offshore) area and would be likely to result in disturbance of the seabed and benthic communities within these areas. While the predicted intensity of activity would be likely to result in mortality of those organisms within the impact footprint, the actual size of the area that would be disturbed is not significant in terms of the wider Caspian Sea and therefore, the impacts would be of low significance. Nevertheless, the spatial extent of activities will be limited as far as practicable and unnecessary disturbance of the seabed avoided where possible.

12.4.5 Physical presence

The potential impacts associated with the physical presence of the Shah Deniz Stage 1 facilities are discussed in the Socio-economic Impact Assessment (Chapter 11). If and when additional offshore facilities are installed in the Caspian Sea, their physical presence would mean that other maritime activities (e.g. shipping; fishing; etc.) would be required take to account of the presence of these subsea structures. As the area around each installation will be demarcated as an exclusion zone, it would effectively be lost to fishing operations. A statutory safety zone comprising an area of a radius of 500 m area around each fixed offshore installation would prohibit vessels from entering the area without permission. In addition to the exclusion zone around the fixed platforms, there would be a 1,000 m wide safety zone of along the length of the pipeline corridors. While shipping in this zone would not be prohibited, the presence of exposed pipelines on the seabed would represent a potential hazard to demersal fishing. Based on available information there is no active demersal fishery in Azerbaijan.

It should be noted however, that the proposed offshore route corridor for the Shah Deniz pipelines is common for approximately half its length with the proposed ACG pipelines' corridor. Further, the this common section of pipeline route is the same as the existing EOP pipeline corridor and therefore, the 1,000 m safety zone over this portion of the route is already in place and the EOP pipeline already lies within it. In this sense, approximately 50% of the construction of the Stage 1 pipelines will not result in any significant additional area being demarcated as a safety zone.

To minimise the potential for interference with other maritime activities in the vicinity of the offshore Shah Deniz Stage 1 facilities mariners will be informed by a published notice regarding the timing and location of construction and installation activities. In the longer-term, the presence of the offshore facilities and their surrounding exclusion and safety zones will be included on Caspian Sea charts.

At the time of writing, planning for latter stages of the Shah Deniz programme was not well advanced. Assuming that each stage would require the installation of one offshore facility, the combined Shah Deniz programme would result in the loss of access to other users, via the demarcation of exclusion zones, of slightly in excess of 235 ha. In addition, while not an absolute exclusion zone, the portion of the Shah Deniz pipeline route that is not common with the existing ACG/EOP corridor (i.e. from a point some 43 km offshore to the TPG500 installation; a distance of approximately 50 km) would result in the restriction of certain activities within an area of approximately 5,000 ha.

In addition to the Shah Deniz development, the current ACG FFD development plan includes a maximum of seven offshore installations including the existing EOP Chirag-1 platform. With an exclusion zone of 500 m radius around each of these installations, a total area of some 550 ha would be declared off limit to other users. The existing 1,000 m wide safety zone along the pipeline corridor to the Sangachal terminal would mean that approximately a further 13,000 ha of area would result in further restrictions to certain activities such as vessel anchoring.

It should be noted that offshore installations will eventually be decommissioned and it is quite likely, especially in the case of the TPG500 facility, that the structures will be totally removed. Subsea structures will also be removed or at least made safe so as to not represent a risk to other uses. In this sense, while other uses will not be able to access certain sea areas for an extended period of time, the exclusion zones and restricted areas will not be permanent features.

The greatest impact of the above designations would probably be incurred by the local fishing industry although consultations to date indicate that the Shah Deniz Contract Area is not a particularly important fishing ground. Nevertheless, measures would be put in place to mitigate adverse impacts on the (legal) fishing industry as described in the Socio-economic Mitigation, Monitoring and Management (Chapter 15).

It is usual for offshore structures to provide a physical habitat attractive to some species of fish, particularly if there are no other structures in the vicinity. It can be expected therefore, that fish density may increase in the immediate vicinity of the offshore structures.

12.5 Coastal environment

The main impacts in the coastal environment would be associated with construction of the subsea pipeline landfall as this activity would require the trenching of the pipelines for a distance of approximately 2 km from the Sangachal Bay shoreline to the terminal. In addition, beach haul of the pipeline would require the construction of finger-piers across the shoreline and the landfall point and some distance into Sangachal Bay.

The site of the Shah Deniz pipeline landfall is more or less common with the proposed ACG Phase 1 pipeline landfall corridor that has a planned width of 200 m. It also lies coincident with the existing EOP pipeline landfall. Assuming a total length of 2 km between the landfall site and the onshore terminal, the total maximum area that would be impacted as a result of ACG pipeline installation would be approximately 40 ha. Use the ACG onshore pipeline corridor for the Shah Deniz pipelines may require the width of the corridor to be increased to approximately 300 m. Should an increase in width be necessary, up to 60 ha of area could be impacted.

The coastal area of the proposed Shah Deniz and ACG pipeline landfalls and onshore corridors supports habitat that is important for a range of species including a number of nationally and internationally red-listed species. Minimising the area of disturbance is optimum. Environmentally, he integration of Shah Deniz and the ACG landfalls and onshore pipeline corridors represents an optimum arrangement as the total area impacted will be kept to a minimum even if the ACG corridor required widening to accommodate the Shah Deniz pipelines.

As with the trenching of the pipeline through the nearshore area, impacts of concern on the coastal environment are more related to the recurring nature of the activity than the total area affected. As discussed above, current Shah Deniz construction scheduling has pipeline installations occurring successively as the construction phase of each stage is brought on-line. The timing of these construction activities would be such that coastal habitat would have limited opportunity to recover (including the return of previously resident fauna species) between each successive phase of construction activity. To minimise the duration of impacts on the coastal habitats, it would be optimum to install all pipelines at one time. It is acknowledged that there may be technical and logistical constraints that prohibit this approach from being adopted, however the option is currently under consideration.

Separate landfall sites would necessitate the construction of separate finger-pier structures into Sangachal Bay, resulting in impacts on separate areas of benthic communities including seagrass and algae beds. The piers are also expected to have an effect on nearshore sediment dynamics as evidenced by the existing jetty constructed for the EOP (Chapter 6 and Chapter 10). Jetties typically result in an interruption to long shore sediment transport so that sediments accrete up current of the jetty whilst on the down current side of the jetty the shore is starved of sediments resulting in erosion. Alternatives to finger–piers are presently being evaluated, however at the time of writing these structures remained the base case for pipeline installation in the nearshore zone.

Overall, the construction of pipeline landfalls and finger-piers for both the Shah Deniz and ACG FFD projects would result in a number of impacts in the coastal zone of Sangachal Bay in the vicinity of the terminal. The extent and severity of these cumulative impacts could be reduced by limiting the number of landfall routes and piers and by undertaking the installation of all required pipelines simultaneously.

12.6 Onshore environment

The proposed land acquisition at Sangachal for the development of terminal facilities would take enough land for both the Shah Deniz and ACG FFD requirements. Terminal construction would begin with the development of the ACG Phase 1 facilities adjacent to the existing EOP facilities and would progress more or less directly through the construction programmes for all Shah Deniz stages and ACG FFD Phases.

The estimated timeline for these activities is illustrated in Figure 12.3. As discussed above the Shah Deniz terminal construction programme would commence while ACG Phase 1 terminal construction is ongoing. It is also likely that the Shah Deniz terminal construction programme would overlap with later Phases of ACG FFD terminal development and with the onshore construction of ACG offshore facilities at the SPS yard.

12.6.1 Land

The land that is required for the Shah Deniz and ACG terminal facilities (and BTC pumping station), although alongside the existing EOP terminal, was previously undeveloped. The land acquired for the terminal facilities amounts to a total of 730.6 ha. Three hundred and two hectares has been designated as a “no development zone” and 40.5 ha are already occupied by the existing EOP terminal. Allocated areas within the remaining area designated for terminal facilities are listed in Table 12.1.

Table 12.1 Terminal facility and utility areas allocated within the land acquisition area

Facility	Area (ha)
EOP (existing)	40.5
ACG Phase 1 terminal facilities	41.8
ACG Phase 2 terminal facilities	24.2
ACG Phase 3 terminal facilities	24.7
Shah Deniz FFD terminal facilities	33.3
ACG/Shah Deniz flare area	34.7
BTC pumping station	2.5
Drainage channel	27.5
New access road	7.5
Workers camp area	13.0

Ongoing civil engineering work approved under a separate ESIA submission include the clearing of vegetation and obstructions in areas where the new Shah Deniz Stage 1 and ACG Phase 1 terminal facilities are to be located. Land is also being prepared for the new terminal access road, drainage channel and a metering facility. Areas that have been allocated for subsequent phases of FFD are being utilised as lay-down areas and temporary office space during the Stage 1 and Phase 1 construction programmes to minimise disturbance to adjacent areas within the "no development zone".

Construction of the drainage channel will service both ACG FFD and Shah Deniz FFD terminals. The total surface area of the channel is 27.5 ha of which an estimated 5 ha lie outside the ACG and Shah Deniz terminal in the "no development zone". Excavated subsoil from the drainage channel is being used in the construction of the bund wall that will lie between the channel and terminal development. Construction of the terminal access road includes earth works in an area of 7.5 ha of which approximately 2.5 ha lie within the "no development zone". It is being evaluated as to whether or not topsoil, which is being carefully stockpiled, can be supplied to local communities for land improvement and/or used for future landscaping initiatives around the expanded terminal site.

As discussed in the Environmental Impact Assessment (Chapter 10), the area of habitat that has been lost amounts to approximately 160 ha. Subsequent stages of Shah Deniz and ACG FFD would result in additional civil engineering and the loss of habitat within the perimeter fence, a total area of approximately 230 ha for all facilities. It is expected however, that vegetation will be lost from most of this 230 ha area during the Phase 1 and Stage 1 early civil engineering work programme.

In addition to the above, approximately 30 ha of area would be affected as a result of pipeline installation through the existing ACG/EOP and terminal access road corridor. It is noted that while this is an existing right-of-way, it has been several years since the EOP pipeline was installed and hence some habitat regeneration has occurred. Stage 1 and Phase 1 pipeline installation activities will re-disturb this area.

Should the secondary option for the Shah Deniz pipeline corridor be pursued, an additional area of approximately 25 ha would be impacted and from which vegetation and habitat would be lost. This area is relatively undisturbed and is close to the mouth of the Sangachal River that supports a locally important wetland complex.

In total, the Shah Deniz FFD and ACG FFD programmes will lead to the loss of habitat over a total area of between 250-270 ha. It should also be noted that habitat in the area surrounding the terminal development site while not directly impacted by the FFD terminal development programme may be subject to indirect impacts (e.g. dust emissions; alteration of existing hydrological system and flows).

The habitat lost as a result of the FFD terminal expansion will be for the life of the development and unless the site is restored to its original state should be considered effectively permanent. Any additional loss of habitat in the terminal area as a result of terminal development activity would represent a further degradation of the semi-desert habitats that are already subject to a considerable level of stress as a result of historical anthropogenic activity in the region.

12.7 Cumulative socio-economic impacts

12.7.1 Nearshore and onshore land uses

As discussed in the Socio-Economic Impact Assessment (Chapter 11), previous land use in the vicinity of the terminal site has been disrupted with a resultant loss of access to the terminal area within the perimeter fence. The wider area that has been acquired but will not form part of the terminal footprint will remain available to other users after terminal construction. For safety reasons this land cannot, however, be used by third parties for physical development thus its classification as a "no development zone".

The loss of land within the extended perimeter fence will be of greatest significance to local herders due to the further reduction in available grazing land near the existing EOP terminal.. As the proposed land-take is for all phases of the Shah Deniz and ACG FFD projects, there would be no further disruption to grazing activities in terms of lost grazing land.

12.7.2 Employment

Employment opportunities have been created in the area as a result of the EOP activities that have been ongoing since 1997. Additional activity in the area, starting with the early civil engineering component of the Shah Deniz Stage 1 development would result in additional employment opportunities that would continue through subsequent stages of the Shah Deniz programme.

It is considered however, that personnel employed during the construction programme of the Shah Deniz Stage 1 project would be likely to move on to other projects as they come on line, as the skills developed and the experience gained would be relevant to the subsequent projects. Once a trained construction workforce is established, it would move from project to project rather than a new workforce being created with the initiation of each new project (i.e. net additions to the workforce, once fully established, will be limited). This reflects the short term and temporary nature of construction employment.

If the 3rd party oil terminal project (possibly located ca. 20 km to the south of Sangachal) proceeds, there may be positive and synergistic interactions between it and the Shah Deniz Stage 1 / ACG Phase 1 projects in terms of employment opportunities for local people. There may also be cumulative impacts associated with loads on local transport systems and with international procurement. Although efforts were made to collect information about the 3rd party oil terminal, the proposal is in its infancy and no information was publicly available, thus it is difficult to qualify the nature and level of potential positive and negative cumulative impacts.

12.7.3 Supplier network

A considerable amount of equipment and materials would be required for the Shah Deniz and ACG field developments commencing with the early civil engineering work programme. Wherever possible these would be sourced in Azerbaijan. As the Azeri supplier network is currently undeveloped, a large amount of supplies such as plant would need to be procured from outside of Azerbaijan.

It is anticipated that as the developments progress through the construction and installation programmes and on to operations, the continued demand for goods and services would result in the development of Azeri companies that would be able to service the oil and gas industry. This would be assisted by the activities of BP and other companies to support a local supplier network (Chapter 14). An established service industry would undoubtedly increase employment opportunities in the region. Whilst a long term proposition, the development of a such a supplier network can be regarded as a positive cumulative impact resulting from the ACG and Shah Deniz projects.

12.7.4 Transport systems

The Shah Deniz Gas Export Project would result in an increase in the movement of plant equipment, materials and people into the Garadag District and in the Baku area. This increased transportation activity would add to existing levels in the region.

The Shah Deniz TPG500 offshore facility will be partially fabricated outside of Azerbaijan and transported into the country as a series of hull strips and leg sections. Once in-country, the hull strips and legs will be assembled. The TPG500 assembly yard is likely to be an existing yard near Baku. Assembly works will require movement of some plant and equipment into the Baku area although most imports will arrive directly to the yard by ship. Construction of ACG Phase 1 offshore components will be undertaken at the SPS yard.

The location of Shah Deniz offshore component assembly activities will be distinct from the ACG offshore component and terminal construction activities. While the Shah Deniz activities will have an impact on the local transport system near the yard in Baku they will not have a significant cumulative impact with the ACG project and terminal development activities being undertaken in the Garadag District near Sangachal.

There may, however, be a cumulative impact on the main transport corridors into and through Azerbaijan and on the transport infrastructure in Garadag District in particular. A detailed logistics plan is therefore being developed that considers the quantity and quality of existing infrastructure, road safety and transportation management to reduce congestion, the potential for accidents and inconvenience to other road and rail users. The construction contractors will also be required to prepare Transport Management Plans. All staff requiring transport to and from the terminal site would commute using private buses to avoid impacts on the public system. Within Baku, the impact on the public transport system would not be expected to be significant given the locality of the workforce to the yard. This will, however, be re-examined when the yard has been selected and appropriate mitigation measures will be implemented should they be deemed necessary.

Generally, any increased pressure on the transport system would be obvious to the local population and may be considered a nuisance. To date, consultations with the local affected communities indicate that employment opportunities would be highly valued and, to some extent, would offset possible disturbances caused by increased pressure on transport systems.

12.7.5 Waste (refuse) issues

A large number of waste sources arising from the Stage 1 development have been identified in the Project Description (Chapter 5). Routine waste streams generated during construction, installation and commissioning activities to operations and finally decommissioning have also been identified and their preferred disposal route discussed within the Project Description (Chapter 5) and Environmental Impact Assessment (Chapter 10).

BP has developed a Waste Management Strategy (WMS), which classifies all waste types and identifies strategies for their preferred disposal route (Chapter 10). A number of disposal options are the subject of further studies, including the assessment of new facilities for the disposal of anticipated wastes from all future phases and stages of development. It is anticipated that the provision of new facilities and the upgrade of existing waste handling facilities will represent a significant improvement to the local infrastructure and represent a net benefit to the national environment.

13 Transboundary Impacts

13.1 Background

In 1991 at Espoo in Finland, the Convention on Environmental Impact Assessment in a Transboundary Context 1991 (The Espoo Convention) was established. The Espoo Convention addressed the need to enhance International cooperation in assessing transboundary environmental impacts and highlighted a number of activities that are likely to cause significant adverse transboundary impact, among them offshore hydrocarbon production.

Under the terms of the Espoo Convention on Environmental Assessment, a transboundary impact is defined as:

> "*any impact not exclusively of a global nature, within an area under the jurisdiction of a Party caused by a proposed activity the physical origin of which is situated wholly or in part within the area under the jurisdiction of another party*".

The Espoo Convention requires that if the proposed activity is found to cause significant adverse transboundary impact, the 'party' i.e. the Government of the Country undertaking the activity shall, for the purposes of ensuring adequate and effective consultations, notify any other party (other Country's Government) which it considers may be affected by the activity as early as possible and no later than when informing its own public about the proposed activity. Therefore, if it believed that transboundary effects are possible in neighbouring states from the Stage 1 activities, it is the responsibility of the Azerbaijan Government to inform these states of the potential effects.

Transboundary impacts can be either negative or positive. In this assessment of potential transboundary impacts, the focus is on those project activities that have the potential to cause negative transboundary effects. Positive effects are primarily associated with transboundary socio-economic environments and have been addressed in Chapter 11.

Transboundary impacts are therefore, impacts that affect the natural and/or socio-economic environments outside of the country in which project activities are proposed to occur, namely Azerbaijan. Transboundary impacts are not necessarily limited to those countries that directly neighbour the project's host country rather can include countries or areas some distance away.

13.2 Jurisdictional boundaries of the Caspian

To determine transboundary impacts from a project, it is necessary to understand the jurisdictional boundaries (air/sea/land) for the location of the proposed project. The jurisdictional boundaries for the Azerbaijan sector of the Caspian Sea are currently under a great deal of debate as the national sector model has not been ratified and the issue on how to divide the Sea is very much on the political agenda of the littoral States.

13.3 Potential for environmental transboundary impacts from Shah Deniz Stage 1

The Shah Deniz Contract Area is located approximately 100 km south of Baku in the South Caspian Sea in water depths ranging from 50 m to 500 m. The impact assessment (Chapter 10) has determined that under normal operating conditions, routine releases to atmosphere and to sea at measurable concentrations would be contained within the area of the

Caspian Sea, which under the national sectors model for dividing the Sea between its five littoral countries, belong to Azerbaijan. Potential transboundary impacts from the Shah Deniz Stage 1 development have been identified to comprise:

- atmospheric pollution through the emission of gases that have a Global Warming Potential (GWP) or contribute to changes in air quality;
- pollution in the event of a large condensate spill from the offshore facilities or pipeline;
- risk of introduced species carried by vessels journeying into the region, from organisms contained in either the ballast water or on the external structure (hull and propellers) of the ships; and
- increased demand on transportation infrastructure through the movement of equipment and resources into the Azerbaijan for the project.

Consistent to the scope of the ESIA, the risk of accidental events from vessels journeying to Azerbaijan is not considered in this transboundary assessment.

Potential transboundary impact scenarios are further discussed below.

13.3.1 Atmospheric pollution

Throughout the duration of the project, a number of activities will lead to the release of a number of potentially polluting atmospheric gases. These include gases such as:

- Nitrogen Oxides (NO_X);
- Carbon Monoxide (CO);
- Carbon Dioxide (CO_2);
- Particulate Matter (PM); and
- Volatile Organic Carbon (VOCs).

These gases have a number of potential effects on the environment, as discussed in Chapter 10, including several potential transboundary impacts:

- direct health effects including respiratory and eye irritation and carcinogenic effects.
- acid deposition (wet and dry) and the formation of acid rain;
- generation of tropospheric ozone leading to 'green house' effects gas contributing to climate change; and
- generation of photochemical smog.

The potential for these gases to result in transboundary impacts is dependant upon the residence time (atmospheric lifetime) and the behaviour of the gas once released to the atmosphere. For the majority of gases, the atmospheric residence time following release is one or two days. The majority of gases that would be released continuously during normal onshore and offshore operations would not therefore, persist or result in any transboundary impacts. Exceptions include NO_X and CO_2 as discussed below.

13.3.1.1 Human health impacts

When considering the potential for transboundary impacts, the significant polluting gases for long-term transport are NO_X. In addition, CO_2 has a long residence time in the atmosphere and has potential global consequences, due to its global warming potential.

Mean tropospheric lifetimes for NO_X is 1.5. Hence, a fraction of NO_X emitted to the atmosphere may persist and be transported up to distances of several hundreds of kilometres from the point of release in a single day. This would be sufficient for these gaseous species to enter the atmosphere of neighbouring countries, such as Iran or Turkmenistan.

It is important to recognise, however, that the concentration of these gases is not sufficient to cause impacts on human health in these neighbouring countries and potential impacts would be suitably mitigated through appropriate designed stacks and flares. This is illustrated by the air dispersion modelling conducted for the Stage 1 development (Chapter 10). Transboundary impacts to human health from atmospheric emissions as a result of the Stage 1 development are therefore, deemed to represent a "negligible" transboundary risk to human health.

13.3.1.2 Acidification

Apart from potential effects on human health, NO_X and SO_X may undergo transformation in the atmosphere to acidic species (Table 13.1), eventually leading to acid rain deposition.

Table 13.1 Transformation of gas to acidic species

Gas[1]	Transformation to acidic species
NO_2	$NO_2 + OH^- > HNO_3$
HSO_3	$HSO_3 + O_2 \text{->} HO_2 + SO_3$
SO_3	$SO_3 + H_2O \text{->} H_2SO_4$

[1]. OH: Hydroxyl radical, a very important atmospheric gas that leads to the removal of almost all organic and many inorganic gases. It exists within the sunlit atmosphere at permanent measurable concentrations (steady state).
HNO_3: Nitric acid; HSO_3: Sulphurous acid; H_2SO_4: Sulphuric acid

These transformations represent important removal mechanisms for these species from the atmosphere. As the products of the above reactions are both highly soluble and acidic, their presence may lead to the formation of 'acid rain'. Acid rain has historically been shown to lead to stress of ecosystems and damage to natural and man-made structures such as those constructed of limestone.

Acid rain and its impact have been reported downwind of cities and countries where extensive and sustained generation of NO_X has taken place. For example, impacts of acid rain have been reported within ecosystems several hundreds of kilometres downwind of the UK, where UK based industry, transport and high domestic fuel consumption lead to the generation of over 1,500,000 and 1,700,000 tonnes of SO_X and NO_X respectively (Year 2000 data; NETCEN UK National Inventory). Currently, reliable historical or forecast inventories for emissions of NO_X for Azerbaijan are not available.

At present, there is no available evidence indicating the existence of significant local or upwind sources of atmospheric pollutants that lead to large-scale acid rain scenarios in the Caspian region. The proposed Stage 1 development is predicted to lead to the generation of approximately 9,000 tonnes of NO_X over the 30-year life of the project. Less than 700 tonnes of SO_X is predicted to be generated (as a result of use of diesel for fuel) over the same period.

It can be seen that this is substantially lower than the levels reported for the UK and, in the absence of any significant additional sources of NO_X and SO_X it is anticipated that potentially acidifying species from the Stage 1 project would not lead to any noticeable stress upon sensitive transboundary ecosystems downwind of the proposed developments sites.

13.3.1.3 Global warming potential

An important feature of atmospheric emissions comprises their contribution to global warming; that is, their global warming potential through the generation of greenhouse gases

(GHG). The main contributory emissions of concern for greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and to a lesser extent volatile organic compounds (VOC).

It is not anticipated that N_2O would be emitted in any significant quantities and there would be no emissions of HFCs, PFCs and SF_6 from Stage 1 activities. This impact assessment focuses therefore, on CO_2 and CH_4 emissions only. Subsequently, all the GHG emissions presented below are expressed as "tonnes of CO_2 equivalent" for both CO_2 and CH_4 (i.e. all CH_4 emissions estimates have been factored by the global warming potential of methane as compared to CO_2[1] and added to the forecasted CO_2 emissions).

Greenhouse gases would be generated continuously during the Stage 1 construction and operational activities, with the predominant inputs resulting from operations, in particular from the following:

- power generation both offshore and onshore;
- process fired heaters at the terminal; and
- non-routine flaring of gas onshore and venting offshore during periods of plant unavailability and emergencies.

It is estimated that approximately 4,350,000 tonnes CO_2 equivalent of GHG will be release to the atmosphere as a result of the Stage 1 operations.

Greenhouse gas emissions for Azerbaijan have been forecasted by the United Nations Framework Convention on Climate Change (UNFCCC) for the next 25 years. The predictions increase slightly each year.

The predicted annual Shah Deniz GHG emissions resulting from the combined normal operation of the onshore terminal and offshore facilities (as established post-drilling in 2010) have been compared to the UNFCCC predictions for Azerbaijan for the years 2010, 2015, 2020 and 2024. Table 13.2 presents the results of the comparison.

Table 13.2 Comparison of UNFCCC GHG predictions for Azerbaijan and estimated Shah Deniz GHG emissions

	GHG (Tonnes CO_2 Equivalent / % of UNFCCC Prediction)			
	2010	**2015**	**2020**	**2024**
UNFCCC:	91,922,000	101,795,000	109,895,000	115,630,000
Shah Deniz:	142,318	142,318	142,318	142,318
Percentage:	0.15%	0.14%	0.13%	0.12%

Azerbaijan ratified UNFCCC in January 1995 and hence is committed to developing and implementing measures that will assist it to meet the specified GHG emission targets. The annual average GHG generated by the Stage 1 development has been estimated not to exceed 0.15% of the UNFCCC predictions for Azerbaijan as a whole and therefore, should not significantly compromise the country's ability to reach its goal in regards to the UNFCCC predictions. Despite this fact, the release of GHG remains a concern to BP and as such, it will monitor all emissions over the life of the project and will continue to explore opportunities to mitigate the effects of GHG emissions (e.g. BP internal carbon credit trading scheme) and/or reduce the quantities of emissions.

1 The global warming potentail factor applied in all CH_4 estimates is 21.

13.3.2 Accidental spills

Condensate spill modelling has been conducted for a number of potential accidental events from Stage 1 operations that would result in the loss of hydrocarbons. Modelling was conducted using trajectory (fixed wind direction but incorporating changes in the state of the condensate from weathering) and stochastic (taking account of seasonal changes in wind regimes but assuming no weathering loses) model runs to address the potential movement and behaviour of the oil under the following accidental release scenarios:

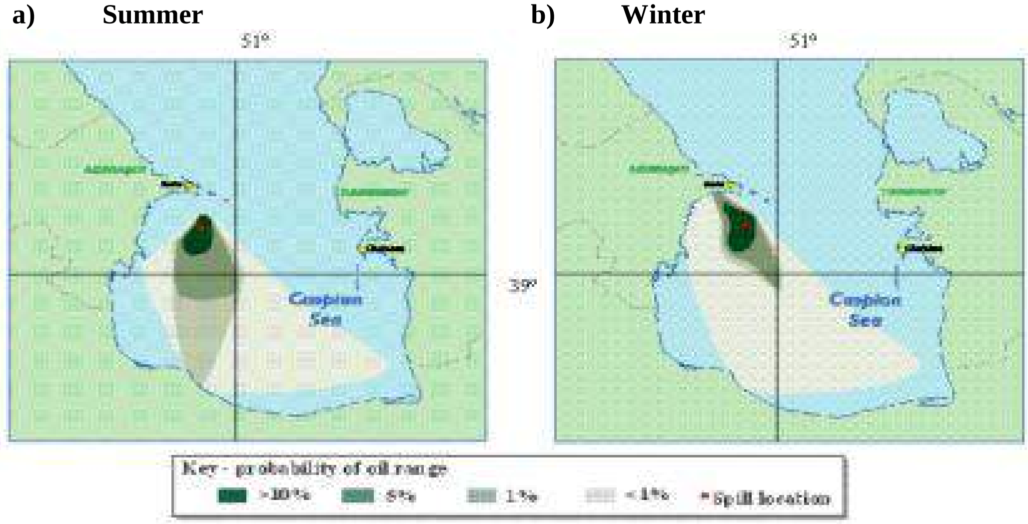
- **Scenario 1 – blow-out scenario:**
  - catastrophic well blow-out at the platform location with surface release of condensate.
- **Scenario 2 - pipeline scenarios:**
  - catastrophic failure of the" 12"export pipeline to shore with subsea release of condensate including:
    - spill in the nearshore (c.1.25 km from shore); and
    - spill at the offshore location.
  - small leak in pipeline with subsea release of condensate including:
    - near shore (~1.25 km); and
    - offshore.
- **Scenario 3 - small spillages:**
  - loss of inventory of storage tank with release to sea surface of diesel.

The rationale behind selecting these spill scenarios and the results are discussed fully in Chapter 10, with a spill risk assessment study and a detailed spill modelling report provided in the Technical Appendices to this report (Appendix 5 and Appendix 6 respectively).

The modelling has shown that, with the exception of a large-scale release of condensate under a blow-out scenario, all other spills including a total loss of pipeline inventory, would be unlikely to impact the coastline of neighbouring countries. Modelling of a blow-out scenario predicts that the Iranian coastline may be impacted by condensate (Chapter 10). The results of the blow-out modelling are illustrated in Figure 13.1 and are summarised below, specific to potential transboundary impacts.

Figure 13.1 Stochastic modelling of an accidental release of condensate resulting from a well blow-out

a) Summer **b) Winter**



It can be seen that during summer conditions there is a 1% probability of condensate beaching around the southern Caspian under this scenario, with the condensate transported predominantly to the south and southeast of the field into the Southern Caspian. The heaviest areas of oiling are directly to the south of the release location as a result. This represents the worst-case scenario and the sensitive resources identified along these coastlines are listed in Table 13.3 and illustrated in Figure 13.2.

During winter conditions, lower temperatures and rough sea conditions actively aid the break up of the condensate with the result that the probability of transboundary shoreline impact on the southern shoreline of the Caspian is <1%. The model predicts the movement of condensate along a predominantly southeast to northwest axis, with the heaviest area of oiling directly to the southeast of the release location within the boundaries of the Azerbaijan Caspian.

It should be noted that the condensate spill modelling assumes that the condensate is allowed to move without any interference from response activities. BP has commissioned a number of studies to assess the status of the coastline between Azerbaijan and Iran, in order to identify areas of vulnerability and assist in oil spill response planning. These include sensitivity studies, coastal surveys to assess shoreline types and accessibility and regional Oil Spill Contingency Planning. From these, the following sensitive areas can be identified (Table 13.3). The potential areas impacted by the worst-case scenario (blow-out event) are illustrated in Figure 13.2.

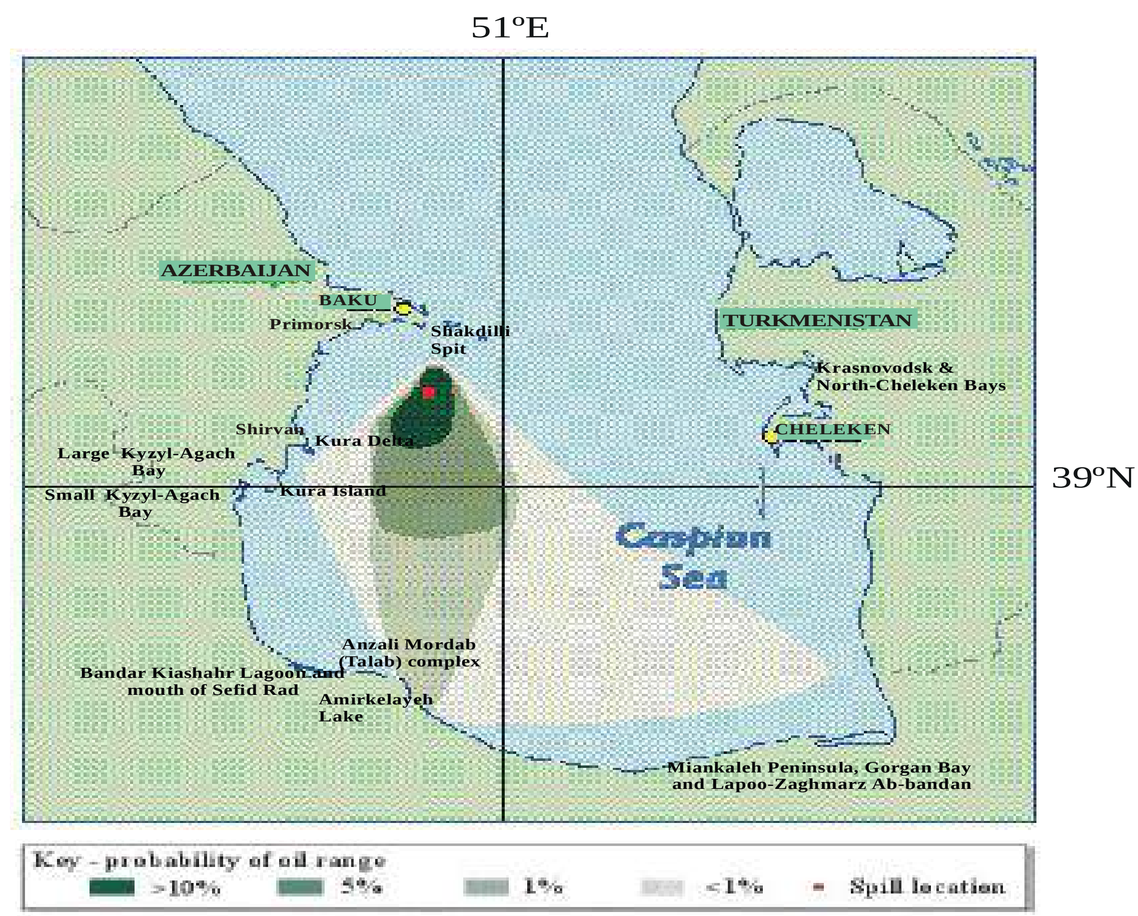
Table 13.3 Sensitive sites identified along the Caspian coast that may be impacted by a transboundary condensate spill incident

Area	Sensitivity
Azerbaijan	
Kyzyl-Agach region (Kyzyl-Agach Bay, Kura spit and Kura River Delta)	Designated site under the Ramsar Convention[1] and State reserve due to its importance as a wetland habitat. Supports large numbers of birds in all seasons (overwintering, migrating, nesting, breeding and feeding) and acts as an important nearshore fish feeding grounds. The wetland habitat also has restricted access from the land and clean-up operations would be likely to cause significant damage
	Kura River Delta is an important site for wintering and migratory wader species, some of which are of global conservation importance
Shakdilli Spit, Yuznaya Kosa Cape on Zhiloy Island and the Dardanelli Reef System around the Apsheron Peninsula	Main haul-out sites for the Caspian Seal. Highest numbers of seals are present at these locations in spring
Shirvan area	State reserve. Important for a number of bird species, some of which are of global conservation importance. The site lies inland from the coast, however, birds may fly to the coast to feed in the day and therefore be at risk if there is an oil slick in the area
Islands of Garasu and Gliniyaniy	The offshore islands in the study area support large numbers of seabirds during the breeding season
The coastline from Primorsk to the Kura Delta	Area supports considerable fishing effort along accessible beach front areas
Coastline and coastal waters of the Apsheron Peninsula south to Kyzyl-Agach	Seagrass communities distributed in patches all along the coast, concurrent with fish feeding and nursery areas which form important fishing grounds

Area	**Sensitivity**
Iran	
Miankaleh Peninsula, Gorgan Bay and Lapoo-Zaghmarz Ab-bandan	Designated site under the Ramsar Convention[1] and state reserve. Supports important bird populations
Anzali Mordab (Talab) complex	Designated site under the Ramsar Convention[1] and state reserve. Supports important bird populations
Bandar Kiashahr Lagoon and mouth of Sefid Rad	Designated site under the Ramsar Convention[1] and state reserve. Supports important bird populations
Amirkelayeh Lake	Designated site under the Ramsar Convention[1] and state reserve. Inland however, birds may fly to the coast to feed in the day and therefore be at risk if there is an oil slick in the area
Turkmenistan	
Krasnovodsk & North-Cheleken Bays	Designated site under the Ramsar Convention[1] and State Nature Reserve (Zapovednik). Site comprises extensive shallow saltwater bays and a chain of smaller islands, (Krasnovodsk and North-Cheleken Islands). The site is a very important staging and wintering area for migratory waterbirds. Also supports a limited commercial fishery

[1] The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) was adopted in Ramsar, Iran, in 1971, and came into force in 1975. In 2000, Azerbaijan became a Contracting Party to the convention. The Convention's mission is the conservation and wise use of wetlands by national action and international cooperation as a means to achieving sustainable development throughout the world.

Figure 13.2 Modelling (Summer scenario) of an accidental release of Shah Deniz condensate resulting from a well blow-out, showing the locations of sensitive receptors identified in Table 13.2



BP has arrangements in place to respond to an oil spill in the unlikely event that such a situation should arrive and an Oil Spill Contingency Plan (OSCP) has been prepared for the Azerbaijan Business Unit. This plan will be updated to incorporate Shah Deniz Stage 1 and future developments.

The littoral states of the Caspian Sea are working towards developing National Oil Spill Contingency Plans. Azerbaijan has yet to prepare a plan and BP is working with industry and government to provide international support for spill response preparedness and mutual aid in the Caspian (Chapter 14).

It should be noted that, in the event that the spill occurs as a result of vessel collision while the vessel is outwith Azerbaijan waters; the responsibility for environmental damage would rest with the owner/operator of the vessel and not with BP.

13.3.3 Transportation of equipment and resources

A significant number of train, vehicle and vessel movements would be required to transport pre-fabricated project facility components and materials for the project into Azerbaijan (Chapter 5). Increased levels of traffic movement have the potential to place a significant additional load on the existing infrastructure of the neighbouring regions, although the predicted increase in river, rail and road movements is known to fall within the design and capacity of the respective transportation routes and infrastructure which are currently under-utilised.

Localised exceptions exist, in the case of the narrow and already busy waterways to the Caspian, namely the Bosphorus (into the Black Sea) and Volga Don Canal (into the Caspian Sea) (Chapter 10), with increased vessel movements as the result of the project likely to result in a degree of localised disturbance to existing shipping in the region. In addition, the rail movement of pipe sections required for the offshore export and interfield pipeline components of the Shah Deniz Stage 1 development has been planned to use all of the existing freight carriages that have the capacity to carry the size and weight of pipe required. This removes the availability of these carriages for other industries or freight transportation. Based on project data, a total of 50 vessels are proposed for transportation of the equipment to Azerbaijan over the period 2003-2004. Using Turkish Maritime Pilot Association data for the Bosphorus Straits, the daily average number of vessels passing through the Straits is 134, with a monthly average of 4,007. The timing of proposed vessel movements from Shah Deniz Stage 1 is shown in Table 13.4. The impacts from the vessel movements required for Shah Deniz Stage 1 are therefore deemed to be negligible.

Table 13.4 Proposed vessel movements through the Bosphorus from Shah Deniz 1

Period	Commodity	Vessel Types	Number of Vessels
June-September 2003	Pipeline	Riverships	37
June 2003-June 2004	Terminal components	Riverships	4
May-Nov 2004	TPG 500	Self floating barges + tugs	5 barges, 4 tugs

13.3.4 Introduced species

Shipping through international waters has the potential to introduce exotic marine species via ballast and bilge waters, engine cooling waters and hull and anchor fouling (Chapter 10). Waterways can also be polluted via the release of ship wastes such as sewage discharge. To minimise the potential for transboundary impacts associated with the transportation of components and materials into Azerbaijan, BP has stipulated that all vessels contracted under the project would be required to comply with relevant voluntary standards such as those issued by the International Maritime Organisation (IMO); as well with MARPOL requirements in terms of ship waste management. In addition, because of the reduced water depths and operating conditions in waterways such as the Bosphorus Straits, project shipments will largely use existing vessels in the area so ballast water will not be carried from foreign waters.

The TPG500 rig deck will be transported to Azerbaijan as four separate self floating barges or strips, which will be connected together on arrival at Baku. As with other vessels travelling through the Bosphorus, the deck strips will require ballasting and deballasting along the route to navigate the differing water depths along the passage. For the purposes of draft control the TPG500 strips will be treated as dumb barges during the transit from Kerch to Baku. To ensure a maximum draft of 3.2 m of the strips for safe travel through the water system, approximately 2,000 t of ballast water will be required to trim all four deck strips to this draft.

In accordance with the International operational requirements for all vessels, ballasting and deballasting of the barge strips will be conducted in accordance with established operational procedures and marine ballasting change requirements that are applicable to barge and river ships transiting the Russian river and canal system. Unlike the vessels that will be used in transportation however, the barge strips will start their journey from outside the geographical region and as it is unlikely that all of the water used in ballasting will be discharged during deballasting on route, it is possible that residual water in the hull may contain foreign species, resulting in a risk of introducing these as exotic species in the Caspian. A consideration however, is the differing hydrological conditions along the route. Water in different parts of the river and canal system will be of different temperature, salinity and possibly oxygen content that the marine water taken in as ballast prior to entering the river system. Such changes in the ballast water and mixing within the hull may serve to reduce the survival potential of any exotic marine species taken in from the marine environment.

The potential therefore, for introduction of exotic marine species to the Caspian or the transfer of species out of the Caspian is considered to be minor.

13.4 Potential for socio-economic transboundary effects from Shah Deniz Stage 1

13.4.1 Resourcing of supplies and employment

The key socio-economic transboundary impacts will relate to the sourcing of supplies and employment outside Azerbaijan. The extent to which this will occur has been discussed in Section 11. In summary, the **proposed total cost** in relation to the construction for Shah Deniz Stage 1 is estimated at $2 billion[2]. It has been estimated that 60% of this expenditure will occur outwith Azerbaijan (i.e. $1.2 billion). These costs include not only the capital costs of the infrastructure, but also an element of contingency.

It has been estimated that approximately 1,000 personnel will be employed during the construction of the Shah Deniz and ACG terminals[3], with approximately 70% of the associated workforces sourced from within Azerbaijan. Although, the terms of the contract stipulate that it is the contractor's responsibility to establish the workforce, the percentage of national personnel has been a condition of contract stipulated by BP. Furthermore, it is estimated that approximately 300 personnel will be employed for the construction of the pipelines and approximately 75% of those employed will be Azerbaijani. Meanwhile for the

[2] Source: BP.
[3] Source: BP. The 1,000 strong workforce will 'float' between the two terminal construction programmes.

construction of the platforms, an average of 300-400 people will be employed over a 12-15 month period, peaking at some 500. A target of between 60-70% of this employment will be Azerbaijani.

The operating and maintenance costs for Shah Deniz Stage 1 will be approximately $54 million per annum and in the region of 30% of this expenditure is expected to occur outwith Azerbaijan (i.e. $16.2 million per annum). Based on a 30 year operating period for Stage 1, this equates to an estimated total spend of $1,620 million, of which approximately $486 million will occur outwith Azerbaijan.

Current information shows that the operation of Shah Deniz Stage 1 will require approximately 110 personnel during drilling and only 18 for the long-term offshore production operations. A further 45 personnel will be required for the onshore terminal operations. It is proposed that after five years some 70% of operational staff will be Azerbaijani. Within this, it is envisaged that almost all technical positions will be held by Azerbaijanis. Approximately 60% of all of the professional positions will be held by Azerbaijanis.

13.4.2 Regional health effects

The main transboundary health impacts that may arise as a result of the Shah Deniz Stage 1 developments are the possible increased transmission of communicable diseases across borders. These diseases may be brought into Azerbaijan by third country national and expatriate workers in the official project workforce, or by an inward migrating cross-border population in search of employment opportunities associated with the project. Diseases may also be spread to neighbouring countries and beyond by workers returning home or to another country, and by economic migrants returning to other countries after a stay in Azerbaijan.

As the project workforce will be required to comply with immunisation and treatment programmes before and during work on the project, the risk of the spread of treatable communicable diseases cross-border via this transmission route is relatively small. In addition, as most third country national and expatriate workers will be housed in ‘open’ but regulated self-contained camps the risks of contracting and transmitting diseases is reduced. In the case of HIV/AIDS the risk of transmission cross-border exists given the ‘open’ nature of the workers camp, which will allow interaction with the local population, both in the area local to the project and within the capital city, Baku. As prostitution is an existing trade within Baku and rates of sexually transmitted disease (STD) transmission increase in areas with large male-dominated workforces disconnected from their families, this possibility must be taken seriously. The project workforce will be educated on HIV/AIDS and other STD issues which will go some way towards lowering the risk of transmission.

Any cross-border migrating population will not be able to have health impacts managed in the same way as the project workforce. As people migrating to the area in search of employment (and leaving again) will be mixing with the local population there is the potential for a negative impact on the health of others, both within and outside Azerbaijan, as a result of treatable communicable diseases and HIV/AIDS.

14 Environmental Mitigation, Monitoring and Management

14.1 Introduction

The Environmental Impact Assessment (Chapter 10), the Cumulative Impact Assessment (Chapter 12) and the Transboundary Impacts (Chapter 13) identify and discuss the various environmental impacts that would arise as a result of routine, planned non-routine and accidental events as a result of Stage 1 project activities.

This Chapter considers all impacts that were identified as being significant using the ESIA significance ranking methodology (Chapter 3) and presents BP's commitments in regards to implementing additional mitigation measures and monitoring programmes to address identified significant impacts. It is emphasised that the mitigation measures that form part of the project's base-case design were considered during the impact assessment process.

Additional mitigation measures as presented in this Chapter, will form the basis of the Mitigation and Monitoring Plan to be developed for the Stage 1 project. Environmental management procedures will be incorporated into BP's Environmental Management System (EMS) that has been certified for its Caspian region operations.

This Chapter is presented into three main sections as follows:

?? **Mitigation:** a discussion of the activities that were found to result in significant environmental impact, the base-case mitigation measures and the additional mitigation measures to be adopted to reduce impact significance.
?? **Environmental management:** an overview of BP's EMS structure.
?? **Monitoring:** a discussion of the monitoring activities that will be adopted to ensure that the additional mitigation measures are being implemented and that further mitigation is being incorporated into designs, operations and procedures as well as to measure actual environmental impact of the Shah Deniz project against the predictions made within this ESIA report.

As noted in the Project Description (Chapter 5), some aspects of the Shah Deniz Stage 1 project design were not available at the time of writing this ES. As such, it has not been possible to fully complete some elements of the impact assessment process. Specifically, the following project elements were not fully defined within the timeframe of the ESIA:

?? location of the TPG500 assembly yard and scope of work for any required yard upgrade;
?? Shah Deniz terminal flare design; and
?? the project's Waste Management Strategy (WMS) in terms of identifying all required waste treatment methods and ultimate disposal facilities/routes.

To address this, additional impact assessment work will be completed and reported as addendum to this ES when project definition is completed. The scope of the work will include but will not necessarily be limited to the following:

?? an assessment of potential environmental impacts on terrestrial and coastal environments resulting from any assembly yard upgrade;
?? an assessment of potential environmental impacts on terrestrial and coastal environments resulting from TPG500 assembly activities including disposal of hydro-test waters;
?? noise emission modelling of the terminal flare in order to demonstrate compliance with World Bank guidelines; and
?? completion of the WMS in terms of identifying waste treatment methods and final disposal facilities/routes.

Dispersion modelling of the cumulative spread of nine wells' top-hole section drill cuttings will also be undertaken. Similarly, dispersion modelling of the cooling water discharge chemical plume for the -10 m depth caisson will also be modelled.

It is anticipated that this scope of work will be completed by the end of 2002.

14.2 Mitigation

14.2.1 Routine project activities

The following Stage 1 routine project activities have been identified as resulting in significant environmental impacts:

?? construction of the nearshore of the 26" gas, 12" condensate and piggybacked 4" MEG pipelines in Sangachal Bay including the construction of finger-piers and excavation of the nearshore trenches;
?? construction of the onshore section of the 26" gas, 12" condensate and piggyback 4" MEG pipelines between the landfall and the terminal site and in particular the excavation of the onshore pipeline trenches;
?? ground clearance and grading of the area required for construction of the terminal facilities and new terminal access road; and
?? construction and operation of the terminal drainage channel.

It should be noted that, at the time of writing, the latter two activities had commenced under the Early Civil Engineering Works Programme (ECEWP). The ECEWP is required by both the Shah Deniz Stage 1 and ACG Phase 1 projects and was the subject of a separate ESIA that has been approved by the MENR. The ECEWP ES report presents details on the strategies that are being implemented to mitigate identified "high" (i.e. >9) significance impacts. These strategies are summarised below in Section 14.2.1.4.

14.2.1.1 Installation of the Shah Deniz pipelines in Sangachal Bay

Any pipe-lay activities in Sangachal Bay will, to some extent, impact the benthic environment and result in the loss of seagrass habitat along and adjacent to the pipeline route. In Sangachal Bay, the base-case Shah Deniz pipeline route is common with the proposed ACG route and corridor that itself is the same as the existing Early Oil Project (EOP) 24"pipeline corridor. Seagrass habitat distribution in the nearshore zone along the selected route is variable and installation activities will be scheduled, wherever possible and practical so as to avoid high biological activity times of the year (i.e. spring through to late summer).

The most significant impacts will be associated with excavation of the pipeline trench. The pipeline contractor will develop a pipeline installation plan that will utilise the narrowest route possible through the nearshore zone. The pipeline trench will be mechanically excavated and will be only as wide as technically required for pipeline installation. Close to shore, this may be up to 8m depending on the strength of *in situ* seabed material. Excavation of the trench through the rocky outcrops present in the nearshore will be limited to breaking and removal using mechanical means. There will no rock-blasting using explosives.

It is planned to construct a finger-pier to support pipeline trench excavation equipment in the area closest to shore. The presence of such a pier may alter the nearshore hydrodynamic regime with a resultant change to natural sediment transport processes (i.e. erosion and deposition) in the Bay. The project base-case is for the pier to be removed once nearshore pipeline installation activities are completed. Pipe-lay activities for the entire pipeline length will take approximately 220 days. The pier is only required for nearshore pipe-lay activities and therefore, may only be required to be in place for a few months.

Given the potential environmental risks associated with the finger-pier, alternatives to finger piers as a method of nearshore pipeline installation are being investigated. Such alternatives include:

?? floating pontoons;
?? floating barge; and
?? amphibious excavator.

The selection of the techniques used for the project will follow an evaluation of the associated impacts and potential difficulties associated with each of these alternatives and in particular, the availability of suitable and appropriate equipment in the region.

The trench section out to the 2 m contour depth will be back filled with the removed material thus reducing the need for further environmental disruption following installation. The section between the 2 m and 5 m contour will be left to backfill naturally. As a result, the seabed profile will be returned to its natural condition in a relatively short period of time. Disturbed or lost seagrass habitat could take several years to recover.

Pipe-lay activities will also mobilise seabed sediments into the water column resulting in the generation of sediment plumes that will move vertically and horizontally through the water column before re-settling. Consideration is being given to the use of silt screens around the pipe-lay activities that will trap and limit the lateral movement of these mobilised sediments.

The pipeline installation contractor will develop a mitigation plan specific to the shore approach prior to any works being carried out. The plan will identify measures that will be employed to avoid or reduce negative impacts. In addition, the selected contractor will maintain an active monitoring and recording programme during all pipe-laying activities. Photographs and sample data will be acquired to record the pre-installation condition of the area with the objective of returning the area to pre-installation conditions following the completion of the installation programme. Re-instatement work will include the removal of the finger-pier. A post-restoration audit will be conducted to ensure that the area has been restored as far as possible to its original condition. The re-instatement will also be followed by regular monitoring surveys to ascertain how rapidly and effectively the habitat is becoming re-colonised. The monitoring surveys will include an assessment of percent coverage of the seabed by seagrass as compared to original baseline conditions and measurements of overall habitat health.

Recovery of the seabed and associated communities around the pipeline route following the installation of the Shah Deniz Stage 1 pipelines would be hampered by the subsequent installation of the future pipeline as required for ACG FFD and possibly latter stages of Shah Deniz. This implies a significant potential cumulative impact on resident benthic communities. If it is determined that significant areas of seagrass have been lost, the option of designing and implementing a compensatory habitat programme and/or Sangachal Bay seagrass restoration programme (i.e. direct planting)will be assessed.

14.2.1.2 Installation of the onshore section of Shah Deniz pipelines

Onshore pipeline installation between the shoreline and the terminal and in particular, excavation of the pipeline trench, would impact on habitat that has been identified as hosting red-listed flora and fauna species.

As with installation in the nearshore zone, the pipeline contractor will develop a pipeline installation plan that will utilise the narrowest possible pipeline corridor in order to minimise the aerial extent of disturbance to habitat. Excavated soils will be stockpiled with the topsoil layer stored separately from the subsoil. These soils (subject to suitability) will be used to backfill the open trench following pipe-lay with the designated topsoil layer being re-instated as close as possible to pre-disturbance conditions. As the area of onshore pipeline installation works will be rehabilitated, this area will not be permanently lost as habitat for any resident species. The potential for direct impact resulting in mortality of individual animals will be mitigated through site control and the restriction of vehicle movements in the area.

Monitoring programmes will be conducted following pipeline installation and site re-instatement to determine the extent to which habitats and specific species have been disturbed as well as to ensure that the area disturbed is being re-colonised with natural flora and fauna. In the event that natural re-colonisation does not occur at an effective rate, habitat restoration will be conducted including the direct planting of relevant flora species.

14.2.1.3 Clearing and grading of land for construction of terminal, new access road and drainage channel

Impacts resulting from the ECEWP are considered to be significant due to the permanent removal of a large area of semi-desert habitat required for the construction of the terminal, the drainage channel, bund wall and the new access road all of which would be permanent fixtures. The habitat that would be lost has been identified as hosting a number of red-listed flora and fauna species (flora: *Calligonum bakuense* (Baku Calligonum), *Astragalus bacuensis* (Baku Astragaslas), *Iris acutiloba* (Sharp-edged Darling Iris); fauna: *Testudo graeca iberica* (Spur-thighed Tortoise), *Pterocles orientalis* (Black-bellied Sandgrouse), *Falco naumanni* (Lesser Kestrel)). In addition to direct habitat loss there is also the potential for ECEWP activities to directly impact specific fauna resulting in mortality.

The ECEWP contractor has developed an environmental management plan in order to minimise direct and indirect impacts to animals in the area. The plan includes provisions for environmental awareness training to ensure that all personnel understand the key sensitivities in the area of work activity and vehicle movement controls.

In addition to the ECEWP environmental management plan, BP and its contractors are implementing a Spur-thighed Tortoise Awareness and Augmentation Programme and are evaluating a Semi-desert Habitat Compensation Programme. These are briefly discussed below. Full details regarding the scope and purpose of the programmes are presented in the ECEWP ES as approved by the MENR.

Spur-thighed Tortoise awareness and augmentation programme

As part of the environmental mitigation effort for the ECEWP and terminal construction, a Spur-thighed Tortoise Awareness Programme has been developed and implemented. The plan includes a captive tortoise-breeding programme with the objective of breeding and subsequently releasing tortoises to the wild thereby adding to currently viable populations in Azerbaijan.

Semi-desert habitat compensation programme

A mitigation programme to compensate for semi-desert habitat loss is also being developed. This mitigation programme will assist in counteracting direct habitat loss resulting from the ECEWP and terminal construction. Importantly, the programme will integrate with BP's Biodiversity Strategy under which, the Company is developing Biodiversity Action Plans (BAPs) at local, national and regional levels.

A habitat compensation programme would mitigate, through semi-desert habitat rehabilitation/restoration, the habitats lost to the most significantly impacted flora, birds and herpetofauna. Measures taken to rehabilitate semi-desert habitat will not only provide compensatory habitat for species either directly or indirectly impacted as a result of terminal development but will also assist the Azerbaijani government in modelling an effort to combat desertification. This is in accordance with the *International Convention to Combat Desertification*, to which Azerbaijan is a signatory.

14.2.1.4 Operation of the drainage channel

It is considered that the operation of the drainage channel would potentially impact on wetland habitat (wadis and marshes) in the vicinity of the terminal site, which would not be directly impacted as a result of construction activities, by diverting surface water flows away from some areas and towards others. During particularly heavy rain events where out-flow from the channel could be substantial and swift, erosional scouring of the land at the ends of the channel may also result.

There is a degree of uncertainty in regards to what effects predicted changes to water flows into and out of wetland area may have and therefore, it is considered prudent to conduct further investigations. Studies will include:

?? a watershed analysis that models water flow from the channel (including seasonal differences) and the spatial fate of discharged water; and
?? a wetlands ecology study to predict the effects a changed hydrological environment will have on wadis and marshes 'down-stream' of the drainage channel.

The ecological study will include the collection of detailed information on existing species distribution within wetland habitats that are identified from the watershed analysis as being at risk (either by being deprived of water or by receiving additional in-flow) and will make predictions, based on simple ecological mass-balance equations, on likely effects.

The dual predictive modelling exercises will be underpinned by long-term monitoring of wetland areas to verify model predictions in regards to habitat change. Surveys of the areas at the end of the drainage channels following substantial rain events will also be completed to map any scouring that may have occurred as a result of high flow episodes.

14.2.2 Accidental events

The potential for condensate/fuel spills resulting from accidental events has been considered in the early stages of the Stage 1 design and the focus has been on spill prevention. As such the facilities have been designed to reduce the likelihood of spills. This has included a minimisation of potential leak sources on the facilities (for example valves and flanges) and the design of adequate secondary containment systems, such as sufficient bunding around storage tanks and processing areas. The hydrocarbon inventories on the offshore facilities (including diesel storage) have been minimised and the potential for overfilling these storage tanks has been reduced through incorporation of over-fill alarm systems. Subsea pipelines for the export of condensate and gas have been designed with adequate corrosion allowance for the life of field and shutdown control subsurface valves (SSSV) are also provided to allow early shutdown in the event of an emergency.

The project will develop procedural measures designed to minimise spillages such as fluid transfer procedures and inspection of transfer hoses and joints. All vessel movements in the area will be monitored and managed in order to reduce the risk of vessel collision with the offshore facilities or with other vessels.

Regular inspections and testing programmes of spill prevention equipment such as blow out preventors and SSSV will be conducted to ensure that they are properly maintained so that required performance standards are always met. The integrity and stability of the pipelines will also be regularly monitored using intelligent pigging and external visual surveys will be carried out using a remote operated vehicle (ROV) with onboard camera.

All observed spill releases however small, will be recorded and reported.

The only accidental event considered as warranting further investigation in terms of appropriate mitigation is the potential for a well blow-out event during drilling operations resulting in an uncontrolled release of hydrocarbons to the sea. As discussed in the Environment Impact Assessment (Chapter 10), the likelihood of occurrence of a well blow-out event is however, considered to be unlikely.

The behaviour of a condensate spill in the Caspian marine environment has been predicted using OSIS modelling for spill scenarios identified during the spill risk analysis for Stage 1 (Chapter 10). These simulations have shown that in the event of a large spill, such as an uncontrolled release of hydrocarbons following a well blow-out event, condensate may beach on the coastline of Azerbaijan and pass into other Caspian littoral states such as Iran. As discussed in Chapters 10 and 13, BP has commissioned a number of studies to assess the status of the coastline between Azerbaijan and Iran, in order to identify areas of vulnerability and assist in spill response planning. These include sensitivity studies, coastal surveys to assess shoreline types and accessibility and regional Spill Contingency Planning.

The key tool for reducing or removing negative impacts that would result from a spill is the Oil Spill Contingency Plan (OSCP)[1]. The purpose of an OSCP is to provide guidance to those involved in responding to an oil spill incident and to initiate all necessary actions to stop or minimise any potential adverse effects of oil/condensate pollution on the environment. The primary step in BP's response to an accidental release of oil/condensate is to first notify the relevant contacts of the occurrence of the incident and to categorise the size of the spill, using the following criteria, to determine the appropriate action:

- **Tier 1** (Minor Event):
  - Tier 1 incidents are defined as small local spills, which require no outside intervention and can be dealt with on site by local staff. Equipment provision is based on estimates of potential small operational spill sizes.
- **Tier 2** (Major Event):
  - Tier 2 incidents are larger spills, which require additional local resources and manpower.
- **Tier 3** (Crisis):
  - Tier 3 incidents are very large, possibly ongoing, spills, which may require additional resources outside Azerbaijan.

This system is internationally recognised as the most pragmatic approach, avoiding excessive costs and seeking shared resources for large, infrequent events. Using this system, the level of response will be dependant on a number of factors including:

- the quantity of oil/condensate spilled and spill location;
- the nature of the spilt product; and

[1] It is noted that the term OSCP is also used in reference to condensate spills.

?? the proximity of the spill to available resources.

BP has prepared an OSCP for the Azerbaijan Business Unit that addresses:

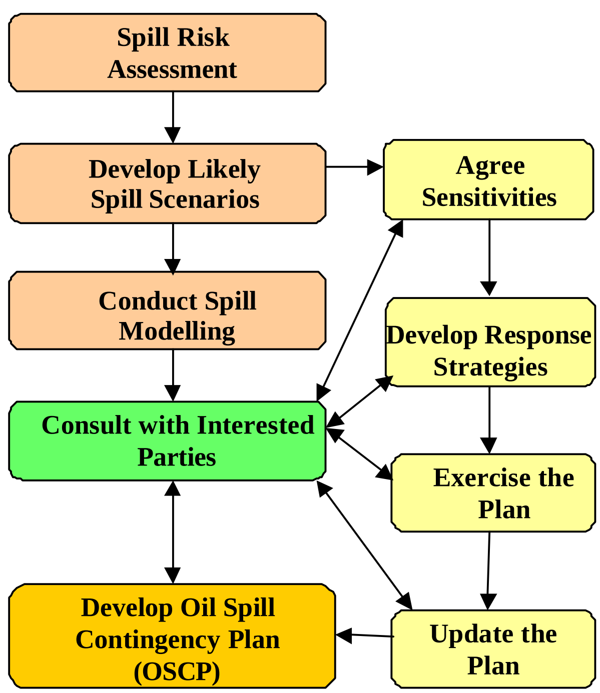
?? onshore and offshore incidents;
?? incident reporting;
?? oil spill remediation contractor databases; and
?? response resource availability.

This plan will be updated to incorporate Stage 1 and future stages of development and an OSCP specific to the Stage 1 project will be developed based on the results of the spill risk assessment and dispersion modelling in a form that is compatible with the current Azerbaijan Business Unit's national plan and OSCPs already in place for other operators in the area. The plan will contain all necessary contact details for appropriate logistical support, together with pertinent contact details for local authorities, NGOs and other relevant bodies for responses to the different tier events. This will allow direction and guidance in responding to a condensate spill.

The plan will also include an assessment of the adequacy of available response equipment and mobilisation effort required for the spill scenarios identified in the risk assessment and recommendations provided (where necessary). Particular attention will also be paid to appropriate shoreline protection and prioritisation of protection to sensitive coastal areas identified as being at risk from the potential beaching of a large condensate spill. A sensitivity map and coastal protection plan have been developed.

The process for developing the OSCP is summarised in Figure 14.1.

Figure 14.1 Summary of the OSCP process



The littoral states of the Caspian Sea are working towards developing National Oil Spill Contingency Plans. Azerbaijan is in the process of preparing a plan while other Caspian states are believed to have plans in various states of completion. In the event of an international oil spill incident (Chapter 13), where there is a potential for condensate to enter the territorial waters of other countries (e.g. Iran), spill response would be complicated by the fact that no agreed regional plan for coordinated response is currently in place. As a result, discussions to ensure cooperation and coordination of international effort between neighbouring countries during a spill response will be conducted with an aim of securing agreements on the appropriate response to an international spill incident.

BP recognises the potential problems and risks and is working with industry and government to provide international support. To this end BP is providing:

?? financial and technical support and involvement in the delivery of the National Oil Spill Plan Workshop in Baku (November 2001);
?? participation in the Caspian mutual aid initiative and workshop (November 2001); and
?? financial and technical input with the industry 'steering group' looking at spill response preparedness and mutual aid in the Caspian and Black Sea region.

14.3 Environmental management

Environmental performance will be one of the key performance parameters of the project. As discussed in Chapter 1 BP is committed to ensuring that the principles and expectations contained within the BP document "What We Stand For" are applied to all aspects of its business operations. In addition, Health, Safety and Environment (HSE) expectations to be adopted by all BP managers and the boundaries within which all BP managers must operate are further described in the document "Getting HSE Right" Corporate standards are implemented at a local level through the formulation of an HSE Policy that is Business Unit specific both in terms of the nature of the operations to be conducted and in terms of local conditions, customs and legislation.

During the construction and commissioning of the Shah Deniz Stage 1 facilities, all Corporate, national, and international requirements will be embodied in a comprehensive Environmental Management Plan (EMP). Shah Deniz contractors will be required to align their own EMPs and implement environmental procedures for their specific work activities.

During operations, HSE Policy will be implemented through a range of instruments including environmental plans, guidelines, procedures and instructions. These instruments will form part of BP's existing Environmental Management System (EMS).

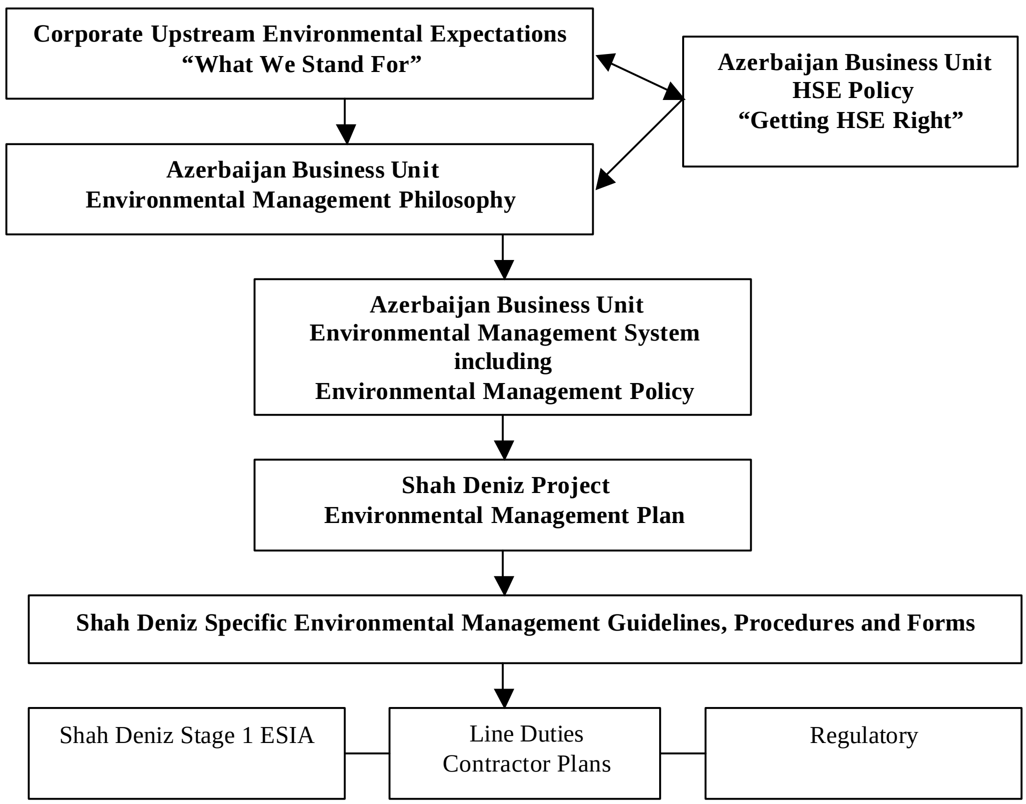
Environmental management follows a hierarchical structure as shown in the Figure 14.2. The philosophy sets the requirement for policy that in turn sets the requirements for the management system to be developed prior to the facilities becoming fully operational. The management system requires an over-arching management plan to be implemented for site-specific operations. The plan is dependent upon a number of components that ensure that environmental issues are managed in a practical sense on a day-to-day basis.

The Azerbaijan Business Unit's is certified to the international standard for environmental management systems ISO14001 and has been structured to address the following elements:

?? identification of significant environmental impacts;
?? establishing objectives and targets;
?? establishing environmental management programmes;
?? establishing environmental improvement plans;

?? identifying legal and other requirements;
?? defining organisation and responsibilities;
?? continuous improvement;
?? operational control;
?? control of contractors and suppliers;
?? document control;
?? monitoring and measurement;
?? non-conformances, corrective and preventative actions;
?? emergency preparedness and response;
?? records;
?? audit;
?? training, awareness and competence; and
?? communication.

Figure 14.2 Hierarchy of the environmental management system (EMS)



When the operational phase of the Shah Deniz Stage 1 project is entered, the project EMS will be incorporated within the overall Azerbaijan Business Unit EMS. The project EMS will address all project activities and will be the key mechanism under which the environmental plans will be implemented and monitored.

The results of this ESIA for Stage 1 and the identified significant impacts will be used to develop an Environmental Aspects Register that will enable the identification of the specific environmental objectives and goals for the project and drivers for the project EMS.

It is important to note that environmental assessment is an iterative process and the results of this ESIA have identified impacts at the Define stage of the project planning process. The process will continue through to the Detailed Design stage. Project specific procedures and training requirements for personnel can then be developed with the roles and responsibilities of company and contracted personnel clearly stipulated. As a result, impacts and thus management methods will change over time.

14.3.1 Contractor environmental management

The environmental performance of all project contractors will clearly be fundamental in the successful overall environmental management of the project. The implementation of activity-specific environmental procedures will be the responsibility of the principal contractors involved including:

?? the drilling contractor;
?? the offshore facilities construction contractors;
?? the pipe-lay contractor;
?? the terminal construction contractors;
?? the shipping contractor; and
?? the waste management contractor.

BP will monitor compliance by the contractors with all stipulated mitigation measures. The project and contractors will be required to demonstrate that their environmental management procedures and systems meet the stipulated requirements. A bridging document will be prepared to link BP standards and procedures with contractor procedures. The bridging document will consist of information on the following:

?? Commitment and Accountability;
?? Human Resource Management;
?? Communications;
?? Incident Reporting and Documentation;
?? Emergency Preparedness;
?? Documentation; and
?? Change Management.

A series of contractor audits will be conducted by BP to ensure that the commitments to environmental mitigation and management are being implemented will be carried out on all contractor activities.

Environmental awareness and management training programmes will be developed and these will include sessions to ensure an understanding of the main sensitivities present in the project activity areas as well as their role in minimising environmental impacts. The training programmes will be a key component to the successful implementation of procedures adopted to mitigate and monitor environmental impacts. Personnel will receive appropriate training and training records will be kept. Personnel selected for specific responsibilities associated with environmental management procedures will receive more detailed training in these areas. These will include, but not be limited to:

?? waste management training;
?? chemical and fuel handling and transfer procedures;
?? spill prevention, handling and response training;
?? site specific environmental sensitivities;
?? environmental audit; and
?? environmental monitoring.

14.3.2 Waste Management

As discussed in the Project Description (Chapter 5; Section 5.7), a preliminary waste stream inventory including predicted waste stream quantities and a WMS for the Shah Deniz Stage 1 project have been compiled by BP. The inventory identifies predicted wastes for the spectrum of activities for offshore and onshore, for the lifetime of the project. Overall, the Shah Deniz Stage 1 WMS adopts the "Five R" philosophy for waste management as follows:

?? Reduction;
?? Re-use;
?? Recover;
?? Recycle; and
?? Remove (disposal).

A range of waste management manuals will be prepared for the Shah Deniz project. These will include:

?? waste identification and labelling;
?? waste storage and segregation;
?? waste transportation and transfer;
?? waste disposal; and
?? waste minimisation.

Shah Deniz contractors will be required to develop and implement waste management procedures that align with the requirements contained in the manuals.

Ultimate responsibility for correct waste disposal lies firmly with BP and as such, BP will ensure that disposal sites and methods used by contractors comply with the PSA and meet an acceptable standard of environmental protection before use and that waste minimization programmes are carried out on a regular basis.

14.4 Monitoring

The long-term environmental management of the Stage 1 project will continue to be subject to assurance reviews through a series of internal and external audits. These will be recorded and reported and corrective actions issued for any non-compliance. Key performance indicators will be developed for the targets and objectives set. The monitoring identified in the EMS will be committed to throughout the life of the project and will include the following checks and controls:

?? correct operation of effluent treatment plant;
?? progress against objectives and targets; and
?? compliance with policy, laws and other criteria.

An audit schedule will be developed as part of the Shah Deniz project EMS.

In addition to regular environmental audits of facilities and procedures, specific activities to monitor any impacts from the development are listed below in table 14.1.

Table 14.1 Monitoring activities

Activity	**Monitoring**
Offshore benthic survey:	Effects of operational discharges (i.e. drilled cuttings and WBM, cooling water and sanitary wastes) and physical disturbance on benthic communities, macrofaunal communities, sediment chemistry and grain size distribution, water column chemistry and temperature.
Nearshore flora and fauna monitoring:	Effects of pipeline installation on seagrass and algae bed distribution, benthic communities and fish monitoring. If required, development and implementation of a Sangachal Bay benthic habitat rehabilitation programme potentially including direct seagrass planting.
Mammals and herpetofauna in the Sangachal area:	Effects of terminal and pipeline construction and terminal operations including mid-March daytime and night-time surveys.
Flora and habitat in the Sangachal area:	Effects of terminal and pipeline construction and terminal operations including mid-March surveys. Monitoring of success of the semi-desert habitat compensation programme.
Terrestrial and coastal birds in the Sangachal area:	Effects of terminal and pipeline construction and terminal operations on over-wintering populations (December/January) nesting populations (late May/early June) and migration (March/April) surveys.
Groundwater:	Presence and chemistry.
Freshwater water quality including wadis at and near to Sangachal:	Water turbidity at defined sampling locations throughout the local hydrological system including in local wadis. Extent of coverage (compared to pre-project levels) and general health of wetland communities (flora and fauna).
Waste water treatment ponds:	Water chemistry and bacteria levels throughout the treatment pond system and in final discharged water.
Noise survey:	Noise levels at nearby sensitive receptors including during emergency flaring event scenarios, from terminal operations
Air monitoring:	Ambient air quality including source emissions monitoring.
Drainage:	Flow rate and water quality. Erosional effects in local natural hydrological system.

15 Socio-Economic Mitigation, Monitoring and Management

15.1 Introduction

This section summarises the socio-economic mitigation, monitoring and management measures proposed for Shah Deniz Stage 1 specifically in relation to:

?? community relations;
?? land use;
?? population;
?? national employment;
?? national industrial base and international procurement;
?? community infrastructure and utilities;
?? transport;
?? social investment strategy; and
?? archaeology.

These measures will be conducted in accordance with existing BP policies, management systems and procedures as applicable.

It should be noted that the on and offshore activities associated with the Shah Deniz Stage 1 Project are likely to have different social impacts. The onshore terminal construction activity will take place in the Sangachal area with potential for social impact. The offshore activities are likely to be undertaken in existing fabrication facilities. These facilities have been used for offshore construction activities for many years and their interaction with the local community is well understood and likely to be of a more limited nature. The exact social and environmental impacts associated with the offshore construction work will be reassessed once the construction location has been established. The strategy for offshore pipe-lay activities is complete with the exception of the nearshore component, which is being finalised. Any local impact will be reassessed once the strategy is complete.

15.1.1 Statement of social objectives

BP has drawn up a Statement of Social Objectives[1] specifically for the project and this is set out below. This statement will be applied by both BP and contractors appointed by the company. The statement provides guidance to the project team on the social issues of direct relevance to the project, in addition to providing a reference point for future action and external assessment of the performance of the project.

BP is committed to delivering mutual benefits to communities near the project and to establishing long-term relationships with these communities during both the construction and operational phases of Shah Deniz Stage 1. To achieve this it will:

?? minimise potential negative social impacts through identification and mitigation, in particular via a social impact assessment;
?? publish regular updates on the environmental and social aspects of the projects, and conduct regular dialogue with interested organisations;
?? maintain regular contact with communities in and near the terminal area through a Community Liaison Officer prior to and during the construction period;
?? compensate for damage to or loss of land and property in a legal, transparent and ethical manner that respects the interests of those involved;

[1] This section draws on the social policy objectives drawn up for the BP midstream projects.

?? manage expectations of employment opportunities, by providing information on the level and duration of employment requirements;
?? seek opportunities to increase employment of country nationals, and in particular those in and near the project area, subject to availability of appropriate skills;
?? establish recruitment procedures that are transparent, public and open to all regardless of ethnicity, religion, gender or sexuality;
?? provide periodic training to enhance the skills and capacity of both employees and contractors;
?? draw up procedures and management plans for all construction camps, in relation to contact with local communities;
?? provide periodic training on liaison with local communities to all staff employed by the Shah Deniz project and contractors, and
?? establish a social investment programme that delivers mutual benefits to BP and communities in and near the project area.

15.2 Methodology for developing mitigation measures

The methodology for determining mitigation measures for Shah Deniz Stage 1 included the following:

?? A list of mitigation measures already agreed for the related ACG Phase 1 project was used as a basis for discussion of appropriate Shah Deniz mitigation measures. The ACG Phase 1 Project mitigation measures were based on meetings held between the ESIA team and the ACG Phase 1 Project teams in mid-2001.
?? Any other mitigation measures that appeared appropriate related to any differences in impact between the ACG and Shah Deniz Projects.

Using these as a basis, the mitigation measures for the Shah Deniz Project were developed with the participation of the ESIA and Project Management Team and are described in greater detail below.

There are two distinct elements to the onshore construction activities described in Chapter 5. The first is the development of a gas and condensate terminal adjacent to the ACG oil terminal at Sangachal. Construction of the terminal requires early civil engineering work (already approved and underway) to prepare the site for the construction of the actual terminal facilities and utilities, referred to as the main terminal construction. The second element is the onshore construction (or assembly) of the TPG500 offshore drilling and production platform.

Depending on which yard is ultimately selected for the assembly of the TPG500, some degree of yard upgrade may be required. The successful contractor(s) may upgrade the yard prior to commencing the actual assembly activities, thus the mitigation measures that apply to the TPG500 will apply to the entire scope of work to be carried out at the yard.

All mitigation measures apply to the construction phase of the project only, except the training strategy outlined in Section 15.6.3, which applies to the operations phase of both onshore and offshore activities. The effectiveness of the mitigation strategy will be monitored during the construction phase. Any additional requirements for mitigation upon reaching the operation phase of the project will be developed and implemented, if necessary.

15.3 Community relations

15.3.1 Overview

There is a desire, as expressed during the consultation process, for all stakeholders to be involved in the project decision-making process and to have access to all relevant information. This section sets out the proposed mechanisms for liaison with communities affected by the Shah Deniz Stage 1 Project. These mechanisms will be outlined in detail in a Community Relations Programme (CRP) to be developed by BP, the Project Management Team and the contractors prior to work commencing.

15.3.2 Mitigation measures

15.3.2.1 Community Relations Programme

The objectives of the CRP will be to:

- provide communities affected by the project with regular information on the progress of work and related implications;
- provide information on recruitment issues and the recruitment process;
- maintain awareness of safety issues among communities;
- inform BP of any community related issues that may impact on any Shah Deniz Stage 1 works;
- identify any significant new issues that may arise during Shah Deniz Stage 1 works;
- develop a community dispute procedure and manage any disputes between BP, the contractors and communities;
- maintain constructive relationships between communities, the construction team and BP;
- monitor implementation of mitigation measures and the impact of construction and operation via direct monitoring and feedback from communities;
- monitor community attitudes to the development and to BP; and
- ensure gender sensitive and culturally appropriate processes are utilised in communication and implementation activities.

The responsibility for the CRP will be divided between the Shah Deniz Project Management Team and the contractors. The CRP and a Community Liaison Officer (this role is described below) will operate on behalf of, and across, both onshore and offshore activities.

The HSE Managers at all sites will have overall responsibility for liaison with communities adjacent to the construction sites during the Shah Deniz Stage 1 construction process.

15.3.2.2 Community liaison officer

A Community Liaison Officer will be assigned to Shah Deniz Stage 1 during the construction phase of the project.[2] The mechanism for continuation of the Community Liaison Officer role during the operational phase of the project will be considered at a later date when actual requirements are known. The Community Liaison Officer will be a key member of the Shah Deniz Stage 1 team and will be responsible for community support. The programme will require the Community Liaison Officer to spend a large period of time with the local communities and the Shah Deniz Stage 1 team. The CLO's responsibilities will include:

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[2] A Community Liaison Officer was appointed in December 2001 to liase with local communities in Sangachal, Umid and Sahil (Primorsk). The CLO is working on behalf of both the Shah Deniz and ACG projects during the early civils construction work period. The benefits associated with having a single CLO in place for both projects will be periodically reviewed to ensure adequate and appropriate resources are allocated to this important activity.

1) continue public consultation with local communities affected by Shah Deniz Stage 1, using appropriate communication processes including consideration of gender and cultural issues;
2) provide input for the ongoing update of the Public Consultation and Disclosure Plan (PCDP);
3) provide the local communities with project information and related issues;
4) monitor compliance of the contractor's recruitment programme;
5) attend public meetings to discuss project related issues;
6) survey potential local sub-contractors and suppliers;
7) identify any significant new issues that may arise during the construction period;
8) work with BP, local communities and the Shah Deniz Stage 1 contractor to resolve any disputes between the parties;
9) provide input to Shah Deniz Stage 1 Social Investment Programme; and
10) maintain records of all consultations, prepare internal and external reports.

Both the Shah Deniz Stage 1 Project and the ACG Phase 1 Project will run CRP's and they will ensure that adequate resources are provided to the CLO function. To ensure consistency across the two projects, as they relate to the same local communities and affected stakeholders, the projects will liase and co-ordinate over the structure and processes of the CRP and CLO's. In order to reduce confusion for the local communities, who are unlikely to distinguish between the two projects but will see all the work as one large project, the CLO will ensure that a seamless face is presented to the communities and concerns relating to either project will be dealt with appropriately.

15.4 Land use

15.4.1 Existing land use

The land used for the construction and assembly of the offshore components of the project will be within existing fabrication facilities in the Baku area. The vast majority of land impacted by the implementation of the Shah Deniz Stage 1 project is therefore related to the terminal at Sangachal.

The majority of the land in the vicinity of the terminal site was unallocated state land that falls under the administrative control of the Garadag District of Baku City. Specific land uses that will be affected by land acquisition for the terminal extension, related pipeline rights-of-way and the surrounding development exclusion area include:

?? part of the winter grazing area of a herder group (to be confirmed);
?? area used for fish breeding by the Azerbalyk State Fisheries Concern at Primorsk; and
?? recreational fishing use of the foreshore.

A group of five or six herders and their families have used the coastal plain where the existing terminal is situated as winter pasture for sheep and cattle grazing for many years. Under Soviet era documentation (dated 1968), the herders had grazing rights over an area of coastal plain and foothills totalling 1,636 hectares. The current status of these grazing rights and the extent to which they may be affected by terminal land acquisition is presently being clarified with Garadag Executive Power.

Azerbalyk State Fisheries Concern is part of a state sponsored fisheries breeding program. The facility at Primorsk is used for acclimatizing salmon fry before they are released into Sangachal Bay to boost natural populations. Salmon fry are hatched in Lake Aggol in Western Azerbaijan. The fry are then transported to the Primorsk facility in early November where they are held in cages and fed for three to six months till they are released. Until recently, the Primorsk facility also maintained a set net that was used for catching Caspian Salmon for roe harvesting for breeding purposes. In previous years, 100-120 fish per year were caught for this purpose, though in the last few years very few or no fish have been taken in the set net. The Azerbalyk State Fisheries Concern employs three to four workers.

The Sangachal Bay foreshore, immediately adjacent to the terminal is used by local rod fisherman for shore based recreational fishing.

15.4.2 Summary of land use impacts

Land use impacts of the project are summarised in the following table.

Land Use	Project Impacts	Affected Party
Winter grazing area	Possible loss of use of part of a winter grazing area.	Qobu Cattle Breeding Enterprise Herders (5-6 herders and families – total 31 people)
Fish breeding facilities at Primorsk	Requirement for the Azerbalyk State Fisheries Concern at Primorsk to relocate a set net and cage from within the pipeline exclusion zone.	Azerbalyk State Fisheries Concern – Primorsk (3-4 employees)
Recreational Fishing	Loss of access to a 500 m length of foreshore during construction. Possible restriction on use of more limited shore zone during operations.	Small number of recreational fishermen.
Existing café/garage business	Relocation of existing business to new premises nearby.	Two business owner/operators.

15.4.3 Mitigation measures

Land use mitigation measures are being dealt with jointly by the ACG Phase 1 and Shah Deniz Stage 1 projects . Since ACG Phase 1 project starts prior to Shah Deniz Stage 1, ACG are initiating the implementation of these mitigation measures. Responsibility will become shared when the Shah Deniz Stage 1 Project is sanctioned. Full details of the land use mitigation measures, and the process of agreeing these, will be made public in a separate Resettlement Action Plan. The development and implementation of a RAP is required by the World Bank and BP is fully committed to this process.

15.5 Population

15.5.1 Overview

In the context of the ESIA, the term population refers to those people who live in the area of project activities and within Azerbaijan generally. Whilst the regional population is of concern it is important that the focal point for mitigation be the local population that would be most exposed to the potential negative impacts discussed in Chapter 11. The main impacts identified for the community surrounding onshore construction activities are:

?? social and cultural interaction issues;
  - tensions caused by labour from outside the local area and/or Azerbaijan;
  - the informal economy;
  - market distortion;

?? health and security issues; and
?? noise, dust and ground-borne vibrations.

Potential impacts on the community surrounding the yard to be used for the TPG500 construction are yet to be assessed. Similar impacts are likely to be found although of a lesser significance due to the use of an existing construction facility and the more substantial use of local rather than imported labour.

Possible ethnic tension along with health and security issues are discussed in Section 15.5.2.

Impacts on the informal economy and the local market, such as market distortion, were seen to be significant and diffuse for onshore activities. No assessment has been made as yet for these impacts in relation to offshore construction activities. These impacts, for both onshore and offshore once assessed, will be addressed as part of BP's wider Social Investment Strategy (Section 14.9).

After the preliminary noise modelling analysis, noise and ground borne vibration were assessed as minor impacts and the facilities will be designed to operate within WHO and World Bank Guidelines relating to noise limits.

Dust measures will be implemented during the ECEWP and will include water dampening and relocation of topsoil mounds to local gardens.

15.5.2 General project mitigation measures

The following general measures will be implemented for both onshore and offshore construction activities. Specific measures relating to onshore or offshore project activities only are contained in sections 15.5.3 and 15.5.4 respectively.

15.5.2.1 Code of Conduct policy

BP will formulate a Code of Conduct to apply to all BP and contractor personnel working in offices and associated facilities managed by the Shah Deniz Stage 1 Construction Project Management Team. The Code of Conduct (currently in draft form) will cover issues such as:

- appropriate behaviour and dress;
- drug and alcohol use; and
- compliance with relevant laws and policies.

The Code of Conduct will contain specific points relevant to workers drawn from outside Azerbaijan. Each employee will be required to sign the Code of Conduct and will be bound by it whilst in the employment of BP or their contractors. Failure to comply with the Code of Conduct will result in disciplinary action.

15.5.2.2 Social Impact Considerations in Invitations to Tender

Social Impact Considerations have been attached to the Invitations to Tender for the early civil engineering and main construction works for the onshore terminal construction. These considerations specifically cover contractor plans for dealing with:

- management of construction workers;
- impact on local employment (Section 15.5); and
- impact on local infrastructure (Section 15.7).

Successful contractors will be expected to present a Social Impact Management Plan, consistent with the mitigation measures already agreed by the Project Management Team, to the Project Management Team for approval. Contractors will be monitored for adherence to these plans by BP and internally through their own management systems as required under each contract.

15.5.2.3 Training for workers on cultural awareness

The construction contractors will be required to provide training for all staff, both national and from outside Azerbaijan, on camp management rules, overall discipline, cultural awareness and appropriate behaviour. This information will be communicated through induction training and toolbox talks.

15.5.2.4 Communicable diseases awareness and prevention plan

Management of the risks of contracting a communicable disease[3] will be the responsibility of the contractor, with support from the BP occupational health department. All workers will be subject to medical assessment prior to mobilisation. All third country nationals (TCNs) will be advised of BP's recommendations regarding immunisation prior to mobilisation to Azerbaijan. Contractors will be obliged to audit compliance with the recommendations and take action where necessary to mitigate the risk of personnel contracting such diseases. BP will develop a detailed project strategy on this issue.

HIV/AIDS, and other sexually transmitted disease (STD) awareness information, including means of preventing contraction of such diseases, will be included in induction training and toolbox talks. In addition, workers will be informed that prostitution is illegal in Azerbaijan and information on the health risks of prostitution will be provided.

15.5.3 Additional mitigation measures for onshore terminal construction activities

The following measures will be applied in order to mitigate potential impacts on the population from the onshore terminal construction activities:

- community relations programme (Section 15.3.2);
- encouraging workforce involvement in the community relations programme, community initiatives and social investment programmes where possible (Section 15.9);
- effective and open complaints procedure to be developed as part of the CRP (Section 15.3.2);
- application of BP and Azerbaijani standards, policies and expectations;
- project social objectives (Section 15.1.1);
- commitments with respect to local and national Azerbaijani content of workforce and appropriate advertisement of job opportunities (Section 15.5);
- consideration by the contractor of all aspects of construction worker management included in the Social Impact Considerations in the contractors Invitation to Tender (ITT's);
- construction camp management plan; and
- management of construction workers, including provision of entertainment facilities.

15.5.3.1 Construction camp management plan

The onshore terminal construction contractor will be required to draw up a construction camp management plan, based on information provided by BP in the Invitation to Tender. This will be developed following the appointment of the preferred construction contractor, and reviewed and finalised by BP. The construction camp management plan will include measures to address the four key issues identified by the project to date in relation to

[3] Communicable diseases such as tuberculosis, cholera and typhoid are present within Azerbaijan as outlined in Chapter 7.

construction camps, namely discipline, community liaison, ethnic tensions and market distortion.

15.5.3.2 Management of construction workers

The construction camp for the main onshore terminal construction work programme will be "open", and workers will be entitled to leave camps outside working hours. This will, however, be subject to a code of conduct to minimise the risk of disputes and incidents between workers and local communities. The Code of Conduct will require workers to carry an identification card at all times to ensure that staff can be accounted for whenever necessary and staff will be required to give notification when entering and leaving the camp. In addition, the Code specifies no 'non-business' access to the surrounding communities at any time. Workers will be required to overnight at the camp. Dedicated recreation and medical facilities will be provided.

The construction camp will include entertainment facilities to reduce the need for workers to leave the camp.

15.5.4 Additional mitigation measures for TPG500 construction

A decision has not yet been reached on which fabrication facility (yard) will be utilised for the assembly of the TPG500. Once a decision has been reached, the following measures will be applied in order to mitigate potential impacts on the local population:

- application of BP and Azerbaijani standards, policies and expectations;
- project social objectives (Section 15.1.1);
- commitments with respect to local and national Azerbaijani content of workforce and appropriate advertisement of job opportunities (Section 15.5);
- consideration by the contractor of all aspects of construction worker management included in the Social Impact Considerations in the contractors Invitation to Tender (ITT's);
- management of construction workers; and
- entertainment facilities in any construction camp.

It is not yet known whether a construction camp will be required at the TPG500 assembly yard. If such a camp is necessary, it is likely to be "open" and workers will be entitled to leave camps outside working hours. There will be security processes controlling entry to and exit from the camp. Dedicated recreation and medical facilities will be provided.

15.6 National employment

15.6.1 Overview

Shah Deniz Stage 1 will provide an opportunity for the employment of local and other Azerbaijani nationals. Tender specifications for the Shah Deniz Stage 1 contract include a pro-active element towards favouring employing local residents and investing in the development of this workforce through skills training programmes.

15.6.2 Mitigation measures for the onshore terminal and TPG 500 assembly yard

The sections below discuss the measures that will be applied by BP to mitigate negative and maximise positive impacts on the national employment base within Azerbaijan.

15.6.2.1 Integration of employment issues into contractor selection

Contractors will be required to be consistent with BP's expectations in relation to employees, relationships and ethics. Contractors will be required to abide by the Shah Deniz Stage 1 Project Statement of Social Objectives. Finally, contractors will be required to abide by the International Labour Organisation standards on employee terms and conditions.

Construction tenderers are required through the Invitation to Tender (ITT) to:

> "*……..design and produce an employment strategy. The Strategy shall incorporate the measures from the table above*[4]*, it shall also provide for preferential employment of local labour whilst balancing issues such as: 1) labour needs balanced against local skills availability 2) political pressures to maximise local labour opportunities against the local / non-local composition that is optimum for the project 3) trainability and physical capabilities of recruits in regard to job competence and HSE&S training*".

The employment strategy shall also identify any schedule, cost and HSE&S implications of employing local labour, and describe how these will be managed.

For both onshore and TPG500 construction, the employment strategy will be finalised and implemented by the construction contractor, although BP will approve the strategy during the contract negotiations.

15.6.2.2 Integration of training proposals into contractor selection

Tenderers will also be asked to develop a training strategy for potential employees in Azerbaijan. The preferred contractor will work with BP to finalise and implement this training programme for potential employees. Contractors will be required to develop a training and long-term skills enhancement programme to raise the skill levels of local employees to international standards.

The contractor will prepare a draft strategy for the scope and delivery of training as part of their tender. This will be reviewed and agreed with BP to ensure that the strategy can be implemented prior to the works programme period. BP and the contractor will liase with existing training providers to develop this strategy. BP will align this strategy with other training projects currently being implemented and under consideration by BP in Azerbaijan. BP will require the contractor to provide dedicated induction and basic skills training for unskilled and semi-skilled workers following recruitment. The primary objective of this induction training will be to ensure compliance with BP HSE objectives.

The objective of the training package will be to deliver the maximum possible increase in the number of local employees involved in Shah Deniz Stage 1. This will be achieved by identifying activities for which Azerbaijani nationals can be trained within the budget and time available.

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[4] Company employees' policy, recruitment principles, training for construction workers, local sourcing.

There is a strong common interest between the ACG and Shah Deniz projects (and other BP projects) in initiating training as early as possible and in increasing local skills levels. The training strategy addresses concerns raised by the local community during the ESIA consultation process regarding the skills base of local people and how this could be raised to the standard required for Shah Deniz Stage 1 enabling local people to take advantage of employment opportunities.

15.6.2.3 Strategy on employment

BP supports projects that increase the proportion of Azeri staff in employment and specifically those resident within the local project area. The potential for employment being created by Shah Deniz Stage 1 to benefit Azerbaijani, and specifically local residents, was a key issue raised by residents in the vicinity of the terminal during the consultation exercise undertaken for the ESIA. BP will agree a target level with the contractor for the proportion of local employment to be used on the project and this will be written into the contractor's contract. The levels of local input will be sub-divided into professional, skilled, semi and un-skilled categories. These proportions will be in line with the expectations contained within the PSA and also those of BP. The initial level will be drawn up and agreed following appointment of the construction contractor. The initial agreed level will be based on skills availability, the current division of labour envisaged by the project and the likely impact of training programmes planned by the project.

BP will require the contractor to monitor the extent of national employment for a range of different skills levels against the level agreed with the contractor and specified in the construction contractors contract. BP Management will oversee the monitoring process and a summary of this information will be compiled every three months during the construction period and will be made available upon request.

It should be noted that the labour required for terminal and TPG 500 construction/assembly activities will be drawn from very different areas. The assembly yard will be an existing facility that has previously been associated with a mature and experienced pool of human resources. Opportunities for additional job creation at the yard will therefore be generally less than at the terminal construction site, although the yard workforce may need to be supplemented with specialist skills. The Sangachal terminal construction site is a new development some distance away from Baku meaning that a significant portion of the workforce will have to be imported. While the contractor will utilise the skills set within their company, the location and scale of the development is such that new employment opportunities are more likely to occur. BP and the contractor will seek to ensure that all communities in the area have an equal opportunity to secure employment on the project.

15.6.2.4 Provision of incentives to contractors

BP will consider ways to provide incentives to the construction contractor to meet the level of local employment agreed with the successful construction contractor.

15.6.2.5 Recruitment principles and recruitment plan

BP has drawn up a set of recruitment principles that will be implemented by the construction contractors. The principles will provide a benchmark for recruitment practices by the project and are designed to increase trust and understanding of the recruitment process among potential employees. The principles will also assist in managing the expectations of applicants and reducing the potential for disputes and hostility to the project among unsuccessful applicants. The principles differ slightly in wording between the onshore and TPG500 construction teams, however the main principles are outlined below:

?? employment strategy shall provide for preferential employment of local labour;
?? co-operate with trade unions and other bodies that represent employees;
?? general recruitment procedures will be transparent, public and open to all;
?? general recruitment procedures will be publicised in advance including distribution of information to communities affected by the project;
?? ensure that recruitment occurs only through authorised hiring processes;
?? personnel will be required to meet skills levels defined for each position;
?? there will be no discrimination on basis of ethnicity, gender, sexuality or other factors;
?? BP will use existing mechanisms for employment at national and regional levels, wherever appropriate, and
?? BP will monitor recruitment practices to ensure they are consistent with this policy.

15.6.2.6 Communication with local communities including disclosure of information, advertising employment opportunities and recruitment methods

The consultation process undertaken during the ESIA highlighted a desire by local residents, near the onshore terminal site, to be kept informed of employment opportunities, including the extent of these positions and the mechanics of the recruitment process. BP will ensure that information on employment is communicated at national and local levels during the ESIA consultation process. This will help manage expectations regarding manpower requirements for the project. Leaflets will be available at BP's head office in Baku to provide information on how to apply for jobs.

Updated information on employment will be made available to the local community upon appointment of contractors. This information will enable the local community to assess employment prospects and apply for jobs, and will include:

?? scale and duration of employment;
?? types of work that will be available (and the skills/experience needed);
?? level of demand anticipated for employment, and
?? recruitment principles.

During the onshore construction process, information will also be available at local recruitment centres in Sangachal, Umid Camp and Primorsk, established by the contractor, prior to construction activities commencing.[5] The local community will also be able to apply for jobs via these centres and register for training opportunities.

15.6.3 Mitigation measures for onshore and offshore operations

15.6.3.1 Training proposals

The Shah Deniz Stage 1 project has an objective of employing a minimum of 50% of the operations staff both onshore and offshore from the local Azeri population, with a view to increasing this ratio over time. In order to achieve this initial ratio a National Training School has been set up in Baku to train upwards of 200 trade technicians (mechanical, electrical, production and instrument) between 2001 and 2005. These 200 or so trained technicians are to be employed across the ACG Phase 1 project, the Shah Deniz Stage 1 project, the BTC pipeline and the current Early Oil Project (EOP) operation. Once selection and recruitment has taken place, each technician will undergo a training period of between two and three years before being employed as a full time trade technician in any of the BP field operations areas. The training period will initially be directed towards language, safety, basic operations and behavioural training with the more specialised technical training required for each of the four trade disciplines being covered later in the programme.

[5] The recruitment centres in Sangachal, Umid and Primorsk became operational in February 2002.

In addition to the offshore and onshore trade technicians, BP has and will continue to recruit Azeri University graduates into the BP Challenge Graduate programme. This programme provides operational, engineering and other onshore support responsibility training over a three year programme. Many young Azeri professionals have already joined the project team in the UK and will eventually return to Baku to assist with the execution of the project.

A training centre will be established adjacent to the Sangachal Terminal to provide a range of training for the local community. This training will include, but will not be limited to, job specific training for BP projects. Other useful courses, such as English language training, will also be offered and trainees will be able to utilise the skills they have learned to take advantage of job opportunities in the wider job market.

The offshore facilities when fully operational will require a number of drilling and operations staff. Given the technical nature of the positions that will need to be filled a programme of selection and training of candidates will be implemented. Training for the drilling activities, one element of the training programme, began in late 2001 with 200 Azerbaijani personnel currently undertaking training in Dubai.

15.7 National industrial base and national procurement

15.7.1 Overview

Shah Deniz Stage 1 will offer business opportunities for companies at the national, regional and possibly local level. Increased supply from these sources would deliver cost benefits to the project and sub-contractors, if safety, technical and commercial requirements can be satisfied. These sourcing opportunities will help to maximise positive benefits to the national industrial base. For the terminal and TPG500 construction activities the specific measures below will be implemented.

15.7.2 Mitigation measures

Measures that will be applied in order to mitigate negative and maximise positive impacts on the national industrial base and national procurement include:

?? national/regional/local sourcing of supplies where procurement criteria are met;
?? review of procurement strategy on a regular basis;
?? support for capacity building (e.g. skills development, knowledge transfer) in regional and local sourcing by providing contracting skills and support for national firms; and
?? effective communication of requirements to sub-contractors.

15.7.2.1 Support capacity building in regional and local sourcing by providing contracting skills and support for national firms

As part of overall activities within Azerbaijan, BP are members of the Enterprise Development Committee (EDC). The goal of the EDC is to facilitate, and contribute to, diverse and sustainable economic development in Azerbaijan. The short and medium term objectives of the EDC are:

?? initially, to help companies to compete successfully for a share of the many upcoming oil and gas contracts, then expand into other areas (such as agriculture);
?? provide a forum for information sharing and co-ordination of new or existing small and medium sized enterprise (SMEs) programmes;
?? creating new initiatives to assist SMEs; and

?? encourage alliances between international and Azerbaijani companies.

There are a number of EDC work groups driving specific initiatives (e.g. supplier training, creation of a supplier database) and BP is an active member of these.

In addition BP plans to establish a business Enterprise Centre in Baku in April 2002. This will complement the EDC work and focus on three key areas:

1. *Improving access to BP business.* Examples include - 'Share Fair' scheduled for 6th March 2002. The Share Fair is targeted at potential suppliers to BP and will advise suppliers of upcoming BP business and introduce them to the major contractors and activities to be undertaken in the future.

The creation of an Azerbaijan Supplier Database is being progressed and is due to be launched during 2Q 2002. The Supplier Database will assist buyers with finding suitable suppliers within Azerbaijan.

2. *Improving supplier competence*: There are a number of aspects to this process – identification of current competence gaps, provision of general and specific supplier training programmes, focused supplier development programs (with external support).
3. *Targeting individual sectors through focused programmes*: This will focus on proactively developing the supply market necessary to support the increased scale of future operations, with emphasis on developing local skills and capability.

At national level, BP will seek to support national firms by providing information and skills that would strengthen their ability to tender effectively for sub-contracts.

At project level, BP will provide information and training to assist companies and communities at the regional and /or local level in identifying and responding to opportunities to supply the ACG Phase 1 project via construction sites and camps. This will be via the project team and via the Enterprise Centre.

15.7.2.2 Effective communication of requirements to sub-contractors

BP, through the Share Fair event, will provide a forum for potential sub-contractors in Azerbaijan to better understand potential opportunities within Shah Deniz Stage 1, other potential projects and existing operations. This forum will be provided on an ongoing basis via the Enterprise Centre.

15.8 Community infrastructure and utilities

15.8.1 Overview

BP has integrated requirements for the management of potential negative impacts on existing infrastructure into the Invitation To Tender for the construction contractor. These measures will be discussed with potential contractors during the tender process and finalised in the relevant construction management plans to be prepared by the preferred contractor. Additional proposals, over and above those set out in the tender document, may be identified in discussion with the construction contractor and/or further mechanisms agreed to monitor implementation of these measures.

15.8.2 Mitigation measures for onshore terminal construction

The Shah Deniz Stage 1 project will pursue the objective of "No Net Loss" in relation to infrastructure and utilities during onshore terminal construction, wherever possible. Measures to mitigate potential negative effects on community infrastructure and utilities during onshore terminal construction include:

?? a public consultation and information campaign;
?? arranging disturbances to utility supplies and services when least likely to impact local users;
?? developing an installation plan which will consider how to reduce/minimise/reduce disturbance;
?? requirements for contractors to produce and adhere to infrastructure impact management plans;
?? development of a compensation plan if appropriate;
?? construction, restoration or replacement of existing and new facilities, and
?? discussions with service providers to ensure increase in loadings is not detrimental.

Prior to making use of the public utilities and services, the successful contractor will be required to undertake a study to determine possible interruption or other negative impacts on the use of these public services or utilities. Adequate measures will be taken by the contractors to ensure minimum disturbance. In the case of interruption of services, the works will be carried out at a time that will result in the least interruption and after informing the affected communities. No significant interruptions are however, anticipated.

BP will publish information describing how electrical power will be generated, water supplies sourced, and the mechanisms for waste disposal. The sourcing of electrical power and the demands placed on the national grid are key issues within Azerbaijan as a result of national energy shortages. BP will disclose information of the proposed electrical power demands under Shah Deniz Stage 1.

The construction contractor, with assistance from BP, will be required to consult with service providers prior to the use of any utilities. BP will require the construction contractor to apply the "No Net Loss" approach.

15.8.3 Mitigation measures for assembly of the TPG 500

When the construction yard for the assembly of the TPG500 has been selected, a number of measures to mitigate potential negative effects on community infrastructure and utilities will be implemented:

?? identification of potential impacts;
?? discussion of these impacts with affected communities in advance; and
?? avoidance of or compensation for any impacts, if necessary.

Procedures and plans will be required for waste management and use of community water sources. These will be developed when the yard is selected.

15.9 Transport

15.9.1 Overview

In the context of the ESIA, the term transport refers to the local and regional transport system. The onshore terminal will primarily require road transport for the supply of materials and equipment, in addition to transportation of personnel. TPG500 assembly activities will also require transport of personnel to and from the workplace, but the majority of workers are likely to live close to the yard. Most steel and equipment for the TPG500 will be delivered by sea directly to the site. Thus, the impact of the Shah Deniz Stage 1 project on local transportation infrastructure will primarily be related to the terminal construction.

15.9.2 Mitigation measures for onshore terminal construction

15.9.2.1 Transport Management Plan

The Shah Deniz Stage 1 contractor will be required to develop a Transport Management Plan specifying routes, speeds, times of travel and key roads in terms of local services. BP has included the requirement for the Plan in the ITT's circulated to potential contractors. Contractors will be required to use private buses to transport staff to and from the site, although most workers will be accommodated in the terminal construction camp.

15.9.2.2 Education on traffic and safety where significant increase in levels of traffic

Communities in areas likely to experience heavy traffic movements will be provided with education on traffic and safety issues.

15.9.2.3 Construction, restoration or replacement of existing and new facilities

The terminal construction contractor will document access road quality prior to and following construction and will be required to restore all access roads to at least their pre-construction condition, should any deterioration have occurred as a result of construction transportation activities.[6]

15.9.3 Mitigation measures for TPG 500 construction

Mitigation measures to be employed by the TPG500 construction contractor to reduce impacts on the local transport systems are discussed below.

TPG 500 assembly yard contractors will be required to:

- draw up a transport management plan;
- consult with relevant authorities and communities on traffic management; and
- agree with BP criteria for the avoidance of communities where traffic may otherwise be excessive.

15.10 Social investment Strategy

The project Social Investment Strategy is being developed in alignment with BP business policies and applies across all BP operations in Azerbaijan. BP considers that:

> *"Where-ever the company operates its activities should generate economic benefits and opportunities for an enhanced quality of life for those on whom the business impacts. The company's conduct should be a positive influence; its relationships should be honest and open; and the company should be held accountable for its actions. The goal of social investment is to create sustainable development for local populations – to generate employment opportunities and a steadily improving quality of life, both during the period when the oil and gas industry is most active, and also in the longer term when operations have concluded."*

BP Business Policies "What We Stand For" June 2000.

[6] Access roads are any roads leading off the main highway, or from towns, that lead directly to the Sangachal Terminal site. This mitigation measure does not apply to the highway itself.

The need for social investment local to the project area is considered important by the project and by stakeholders identified during the consultation process.

Social investment is defined here as:

?? social projects in communities that are impacted by the BP construction activities and operations, to minimise adverse impacts that cannot be avoided and to provide positive benefits;
?? social projects in the project area and elsewhere in Azerbaijan that increase the benefits to the population of BP's presence and contribute to meeting community expectations of benefits from the project, and
?? social projects that deliver mutual gain for communities near the project area, and for BP.

As such the Social Investment Strategy works across the project affected communities and may have an effect on the wider regional and national arena.

The Social Investment Strategy is broader than corporate philanthropy. The goal of social investment is to promote sustainable development for local populations to generate employment opportunities and a steadily improving quality of life, both during the period when the oil and gas development activities is most active and also in the longer term. It should target resources and skills where they can make a positive contribution and be mutually beneficial. The strategy is linked to BP's business objectives in several ways. The programme will:

?? reinforce BP business policy commitments;
?? enable a constructive relationship between BP and the local community;
?? address any negative impacts of resource use and construction; and
?? target resources and skills where they can make a positive social and community contribution and be mutually beneficial.

The Social Investment Strategy will apply criteria for social investment to the selection of both credible partners and individual projects. These may be applied directly by BP or indirectly by NGO partners involved in the design and implementation of projects. These criteria draw on international social investment best practice and local experience gathered through the implementation of the existing BP Social Investment Programme in Azerbaijan. The criteria for the Social Investment Strategy will include:

?? **Community needs based:** programmes and projects would be designed in consultation with communities and other stakeholders. The concerns identified in the Socio-Economic Baseline (Chapter 7) and Socio-Economic Impact Assessment (Chapter 11) would provide the initial means for analysing community needs and priorities.
?? **Impact:** programmes and projects should deliver material and measurable social and/or economic benefits to communities directly or indirectly affected by the project.
?? **Sustainability:** programmes and projects should be designed to deliver lasting benefits, by securing matching funding and/or building increased self-reliance among affected communities.
?? **Transparency:** programmes and projects must be transparent and be open to internal and external scrutiny to allow potential beneficiaries, non-governmental organisations and government departments to understand the approach.
?? **Prevention of duplication:** in selecting projects, every effort would be made to avoid duplicating the efforts of other companies, international and local agencies or government departments.
?? **Measurement:** clear targets and measurements of success for the projects would be identified.

?? **Best practice:** BP would aim to set its strategy and select programmes that are "best practice" in social investment in Azerbaijan.

BP plans to evolve its social investment programme over time. However, the communities in the Sangachal, Sahil (Primorsk) and Umid settlements have some urgent needs that could be met by the implementation of projects focusing on immediate benefits that could be completed within a six-to-nine month time-frame. By initially focusing on these shorter term projects, BP can evaluate its longer-term social investment programme for these settlements and test potential longer-term partnership agreements.

Community engagement will be part of the evaluation criteria for potential implementation partners. Contribution to the Azerbaijani economy through in-country spend and a focus on the long term sustainability of projects linked with community empowerment will also be key considerations in finalising the projects and partners.

15.10.1 Social Projects

BP is currently developing an integrated Social Investment Strategy for Shah Deniz Stage 1 and ACG Phase 1 projects. In developing the strategy, BP has drawn heavily on the findings of the Socio-economic Impact Assessments that were undertaken as part of the ESIAs, in addition to the conclusions of the sociological survey that was undertaken of Umid, Sangachal and Primorsk by the Azerbaijan-Holland Friendship Society. Discussions have also been held with a number of NGOs in Azerbaijan.

Repair work has already been undertaken at Sangachal School. During the public meeting held at the school in June 2001, a prior commitment by BP to undertake this work was highlighted. Following the meeting a decision was made by BP to expedite repair work to the school gym to provide a safe recreational facility for school pupils prior to the new school year.

In addition to the benefits that the physical repair work brought to the children and the wider community who use the school, BP has worked closely with the local contractor to develop a "step change" in performance. It was realised that this step change could only be accomplished if the necessary time and effort was taken to clearly identify what was expected especially with regards to HSE. As a result, a specific safety plan was developed, safety induction courses, 'tool box' meetings and job safety talks were held. This is illustrative of the steps that BP will take in building a sustainable service industry in Azerbaijan. The project provided an opportunity to familiarise and train a local contractor to BP standards, from the tendering process, HSE and quality assurance through to completion and hand over.

15.11 Archaeology and cultural heritage

It was determined (Chapter 11) that the Shah Deniz Stage 1 project has the potential to impact presently unidentified subsurface archaeological sites that may be present in the proposed onshore terminal area (Chapter 7). The mitigation measures for archaeological sites apply only to onshore terminal construction activities.

To mitigate potential impacts on unidentified archaeological features, an Archaeological Management Plan (AMP) has been implemented. The Plan includes procedures for a "watching brief"; that is, for a specialist to be on-site during the early civil works programme to advise the contractor on an appropriate course of action should a site be encountered. Since February 2002, with the commencement of the early civil engineering works, two archaeological specialists from the Azerbaijan Academy of Sciences have been rotating in order to provide a seven day watching brief during working hours at the onshore terminal site. In addition archaeology 'toolbox' talks have been developed and delivered to site workers.

15.11.1 Technical requirements

The primary element of the AMP is visual monitoring of ground disturbing activities by an experienced archaeologist. The programme, and all of its associated reporting and contingency protocols, were established and documented in advance of commencing civil engineering activities. Possible archaeological features identified during these activities will be subject to immediate evaluation. It is anticipated that such spot archaeological evaluation will require contractor "work around" rather than "stop work" contingencies.

Archaeological resources to be monitored for and protected by the program would include:

?? diagnostic artefacts and other remains of past historic or prehistoric occupation;
?? unmarked human burials;
?? cultural and natural soil matrix in which the artefacts or other remains were deposited and preserved; and
?? structural remains such as foundations, wells, storage pits, fortifications and ancient earth works that could be associated with the artefacts, remains, and archaeologically significant soil matrix.

Co-ordination and reporting issues to be addressed by the plan would include:

?? specification of archaeological monitoring requirements in construction contracts;
?? contractor-archaeologist planning and communication;
?? frequency and nature of in-field archaeological reporting and contractor signoff;
?? training for workers on artefact recognition and plan process;
?? establish significance criteria for potential archaeological finds;
?? archaeological salvage contingencies for important finds;
?? possible use of geo-archaeological and human-osteological expertise; and
?? final archaeological reporting.

16 Conclusions

16.1 Introduction

The Shah Deniz Gas Export Project has the potential to deliver significant economic benefits to Azerbaijan. The project together with the linked investments that include further stages of the Shah Deniz Full Field Development (FFD) programme, the Southern Caucasus pipeline, the ACG FFD and BTC projects are collectively, by far the largest investments ever committed in Azerbaijan. They will have a major positive effect on the national economy of Azerbaijan.

With prudent revenue management, the combined projects can lead to positive social and environmental change within Azerbaijan. The economic assessment for the Shah Deniz FFD development so far indicates that revenues from gas-condensate production and transit would be significant constituting a large proportion of public revenues over the life of the project. It is considered however, that while there is a broad range of benefits that can potentially accrue as a result of the project, there are also substantial risks, particularly in terms of economic development in Azerbaijan. These, together with risk avoidance and minimisation strategies will be detailed in a Regional Social, Environmental and Economic study that compliments this ESIA.

The Shah Deniz Stage 1 has the potential to contribute to, or create the climate for, the following positive impacts:

- contributions to the cessation of Government budget deficits assuming that spending remains restrained;
- a yield of revenues that could be used for investment in the non-oil and gas sector;
- a positive effect on development and maintenance of a liberal trade regime by removing the need to raise revenues from import duties and by encouraging the modernisation of customs procedures;
- the creation of an environment that is domestically more favourable to private sector investment and that sets an example making other private sector investors more willing to invest;
- addition of impetus to energy sector reform within Azerbaijan which in turn, should improve the population's access to energy (gas and electricity) and result in the wider use of cleaner fuels, better ambient and indoor air quality and reduced pressure on traditional sources of fuel and hence forest products and subsequently local and regional biodiversity;
- contribution to poverty alleviation and sustainable development via the revenues generated, assuming prudent revenue management; and
- continued enhancement of public awareness and education with respect to the environment;
- creation of both direct and indirect training and employment opportunities.

In completing the impact assessment process, account was taken of those mitigation measures that are incorporated in the project's base-case design. The project's base-case includes a number of initiatives that result in the mitigation of potentially significant impacts to levels that are predicted to be environmentally sustainable. In parallel with these environmental mitigation measures, strategies to mitigate socio-economic impacts have also been developed and while these are typically not engineering solutions, they can be legitimately considered as part of the project's base-case.

Key measures to mitigate potentially significant environmental impacts that have been included in the project's base-case include but are not limited to:

?? the decision to provide separation facilities for gas/condensate offshore thus eliminating the need for a multi-phase subsea pipeline to shore that would have a higher maintenance requirement (i.e. more frequent pigging; injection of more corrosion control chemicals);
?? the decision to use a self-installing jack-up drilling and production facility that requires minimum offshore activity for installation and commissioning and that can be easily decommissioned and removed from site;
?? the decision to use a marine pipeline to transfer produced hydrocarbons to shore as opposed to shuttle tankers thus eliminating the need for a very large offshore processing facility (to process the condensate to export quality), reducing the risk of spills to the marine environment and obviating the increase in emissions that would arise from tanker loading and off-loading operations;
?? the decision to pursue onshore injection into dedicated disposal wells at Lokbatan or treatment and re-use (as irrigation water) of produced water generated at the terminal;
?? use of gas as fuel gas for offshore and onshore facilities;
?? the decision to vent as opposed to flaring gas offshore thus minimising the generation of polluting emissions;
?? the decision to undertake flare gas recovery at the terminal thus eliminating the need to flare internal process valve and seal leakage gas resulting in reductions in atmospheric emissions;
?? use of automatic ignition for the terminal emergency shut-down flare thus negating the need for a pilot-light resulting in reductions in atmospheric emissions;
?? scheduling pipeline installation activities in the nearshore as far as is practicable to avoid environmentally sensitive times (e.g. breeding seasons);
?? the decision for use the EOP/ACG pipeline corridor in the nearshore part of Sangachal bay thus minimising disturbances to the seabed and benthic habitats;
?? the decision to locate the Stage 1 terminal alongside the existing EOP and proposed ACG Phase 1 terminals resulting in a reduced land-take requirement; and
?? the decision to design and install a water treatment plant at the terminal location that will treat sewage waters to irrigation water quality standards.

Key elements of the strategies developed to mitigate potentially significant socio-economic impacts include:

?? maximisation of locally and regionally sourced labour for facility construction and assembly contracts;
?? pro-active training and skills development programmes for the locally and regionally sourced construction and operations workforces;
?? pro-active dissemination of information about the project to those communities that stand to be most affected;
?? social investment activities aimed at the social, environmental and economic enhancement of local communities; and
?? compensatory mechanisms for those individuals and families whose means of livelihood would be compromised by land acquisition for terminal development and/or by pipeline installation and operation in Sangachal Bay.

16.2 Environmental impact assessment

Of the 85 defined planned routine and planned non-routine project activities, 20 have been assessed as resulting in impacts of "high" significance on eight separate receptors. In addition, one "high" significance impact would be attributable to one accidental event offshore. It is noted that no routine or planned non-routine activities were assessed as having the potential to result in environmental impacts of "critical" significance. The contributing activities that would result in impacts ranked as being of "high" significance and the receptors affected are summarised in Table 16.1.

Table 16.1 Summary of Stage 1 activities resulting in "high" significance impacts environmental impacts

Activity Group	"High" Significance Impacts	Number of Environmental Receptors	Contributing Activities
Offshore:	1	1	1 accidental event (well blow-out)
Subsea Pipelines:	10	7	4 planned routine activities (pipeline installation in the nearshore and coastal environments)
Terminal:	10	7	4 planned routine activities (land clearance, drainage channel and access road construction and emissions to atmosphere (GHG))
Transportation:	0	0	0

These identified impacts were taken forward so that further mitigation measures could be assessed and evaluated in order to eliminate, reduce or, minimise them. The additional mitigation measures are summarised in Table 16.2.

Table 16.2 Summary of additional environmental mitigation measures for Stage 1

Project Component	Impact	Additional mitigation
Offshore:	Shoreline stranding of spilled condensate following accidental well blow-out.	Development of Shah Deniz specific spill response plan and on-going development of regional response arrangements.
Subsea pipeline activities	Pipeline trench construction nearshore resulting in direct and indirect impacts on marine flora (habitat) and fauna.	Shore approach pipeline installation management plan. Consideration of use of silt screens. Development and implementation, if required, of benthic habitat rehabilitation programme.
	Finger-pier construction resulting in direct and indirect impacts on marine flora (habitat) and fauna. Potential interference with natural sediment transport mechanisms resulting in changes to shoreline configuration.	Consideration of alternatives to the finger-pier as a means to excavate the nearshore pipeline trench. Removal of finger pier following pipeline installation. Development and implementation, if required, of benthic habitat rehabilitation programme.

Project Component	**Impact**	**Additional mitigation**
	Pipeline trench construction onshore, direct and indirect impacts on terrestrial flora (habitat) and fauna.	Pipeline installation management plan. Spur-thighed Tortoise augmentation programme. Semi-desert habitat compensation programme.
	Ground clearance and grading of terminal location resulting in a permanent loss of habitat. Direct and indirect impacts on flora (habitat) and fauna.	Spur-thighed Tortoise augmentation programme. Semi-desert habitat compensation programme. Landscape management strategy.
Terminal activities	Excavation and operation of drainage channel resulting in the loss of habitat. Direct and indirect impacts on flora (habitat) and fauna. Potential alteration to hydrological systems and associated wetland ecology.	Spur-thighed Tortoise augmentation programme. Semi-desert habitat compensation programme. Watershed analysis. Wetland monitoring and management programme. Landscape management strategy.
	Construction of access road / railway crossing resulting in the loss of habitat. Direct and indirect impacts on flora (habitat) and fauna.	Spur-thighed Tortoise augmentation programme. Semi-desert habitat compensation programme. Wetland monitoring and management programme. Landscape management strategy.
	Contribution to greenhouse gas emissions from terminal emissions.	Minimise flaring through flaring policy. BP internal carbon credit trading.

Further to these specific additional mitigation measures, is considered prudent that the predicted "low" significance impact of discharged cuttings should be monitored to confirm the spatial fate of the cuttings and the rate of re-colonisation of the cuttings pile by benthic organisms.

Full consideration has also been given to cumulative impacts resulting from existing and foreseeable future activities in the Stage 1 project area, as well as any potential transboundary impacts associated with Stage 1.

The following summarises the key environmental issues and residual impacts associated with the project.

16.2.1 Residual environmental impacts

16.2.1.1 Installation of 26" gas, 12" condensate and 4" MEG pipelines

The construction of trenches and the finger-pier through the coastline and in the nearshore zone of Sangachal Bay will result in impacts to marine flora and fauna over an estimated area of 3 ha. Approximately 25% of the proposed pipeline route in the nearshore and inshore areas is covered by seagrass. This habitat and the benthic organisms it hosts would be directly impacted (lost) as a result of pipeline construction and installation activities. Seagrass is an ecologically important feature within Sangachal Bay. It is a spawning and nursery ground for a range of marine organisms including a number of commercially important fish species. While the total area of loss of seagrass habitat in comparison to the seagrass bed distribution across Sangachal Bay is perhaps not significant (<1%), the impact is considered to be significant due to the important ecological role the habitat plays and once lost, would take several years to recover. Further, as seagrass stabilises benthic sediments, any loss may lead to sediment instability and potential mobility predisposing the area to further impacts.

The loss of seagrass habitat in the footprint of the pipeline trenches is unavoidable. Impacts resulting from construction of the finger-pier could be reduced, if not avoided, if a viable alternative to the finger-pier (as a means of facilitating access to the inshore area by the excavator) can be identified. Alternatives (e.g. floating pontoon) are being investigated but as availability of suitable and appropriate equipment in the region is limited, the finger-pier option remains the project's base-case. The physical presence of the finger-pier may also alter the nearshore hydrodynamic regime with a potential resultant change to natural sediment transport processes (i.e. erosion and deposition) in the Bay. The likelihood that changes in the local sediment transport regime will result in significant changes to coastal configuration will depend on the length of time the pier facility is left in place and on the hydrodynamic conditions in Sangachal Bay during the pipeline installation period (estimated to be approximately 218 days for full pipelines installation). It is noted that the project's base case is to remove the finger-pier once installation activities are completed.

Impacts resulting from mobile and transported sediment could be minimised through the use of sediment curtains. Sediment curtains hang vertically in the water column (supported by flotation buoys) and trap mobile sediment that is in the water column thus prohibiting it from moving away from the work area into other areas. Sediment curtains can be deployed entirely around or down-current of the work site or alternatively around sensitive receptors. Given the spatial extent of sensitive seagrass in Sangachal Bay, it is considered that if utilised, the curtains should be deployed around or down-current of the excavator.

Pipeline installation in the nearshore and inshore areas would not, as far as possible, be undertaken during the most biologically sensitive times; that is, spring through to mid-summer.

A significant aspect of impacts on marine habitat, flora and fauna in the nearshore and inshore areas of Sangachal Bay is the successive disturbance that will occur as a result of the installation of potentially more pipelines for the Shah Deniz Gas Export Project and the proposed installation of ACG FFD project pipelines. Technical and logistical constraints mean that it is unlikely that Shah Deniz Stage 1 and ACG Phase 1 pipelines could be installed simultaneously. Further, present uncertainty regarding the future pipeline requirements of the Shah Deniz development programme means that it is not feasible to plan for the nearshore installation of additional pipelines at the present time.

Should monitoring indicate that nearshore benthic habitats in Sangachal Bay do not naturally rehabilitate to pre-project levels (i.e. coverage; health) following pipeline installation (for Shah Deniz and ACG projects), the feasibility of developing and implementing a benthic habitat compensation programme within the Bay will be explored. Such a programme could include direct planting of seagrass in effected areas.

16.2.1.2 Coastal and terrestrial habitat, flora and fauna

The principal resultant effect of the civil engineering works required for the construction of the terminal will be the loss of habitat resulting from the land clearing and ground levelling activities and construction of other associated facilities. Terminal facilities to support the Stage 1 requirements will be adjacent to the AIOC (EOP and ACG) terminal facilities. There are synergies between the design, construction and operation of the terminals. Disturbance of the coastline, coastal area and land between the coastline and terminal location will also result from the construction of the onshore trenches for installation of the onshore sections of the

26" and 12"/4" pipelines. While the pipeline corridor route will be re-instated, the terminal location site will be permanently lost due to the construction of the terminal facilities.

A survey of the area surrounding the proposed development site carried out for the ACG Phase 1 and Shah Deniz Stage 1 ESIAs confirmed that, while in a somewhat degraded state, the semi-desert habitat in the area hosts an appreciable diversity of plant and animal species. While important in its own right, of primary concern regarding habitat loss is the potential for impacts on nationally and internationally red-listed species that were identified to be present in the area in and around the development location. Red listed species identified are listed in Table 16.3 below.

Table 16.3 Identified red-listed species

Species	1989 Red Data Book of the Azerbaijan Republic	1997 IUCN Red List of Threatened Plants	1997 IUCN Red List of Threatened Animals
Flora			
Sharp-edged Darling Iris (*Iris acutiloba*)	✍	✍	
Baku Calligonum (*Calligonum bakuense*)	✍	✍	
Baku Astragalus (Astragalus bacuensis)	✍	✍	
Fauna			
Black-bellied Sandgrouse (*Pterocles orientalis*)	✍		
Lesser Kestrel (*Falco naumanni*)			✍
Spur-thighed Tortoise (*Testudo graeca iberia*)	✍		✍

A mitigation programme to compensate for the semi-desert habitat loss resulting from terminal and associated facility construction is being developed for implementation. This programme will seek to mitigate a previously degraded area (yet to be identified) through the rehabilitation/restoration of semi-desert habitat in an area removed from the project activities as compensation for the habitats lost to the most significantly impacted flora, birds and herpetofauna. Measures taken to rehabilitate semi-desert habitat would not only provide compensatory habitat for these potentially impacted species but would also assist the Azerbaijani government in modelling an effort to combat desertification as per its obligations under the *International Convention to Combat Desertification*.

In addition, a Spur-thighed Tortoise augmentation programme is being implemented in order to compensate for any potential impacts to this species associated with the proposed Stage 1 construction activities. This conservation programme includes a captive breeding effort with assistance from specialists, experienced in the conduct of such programmes, with the objective of breeding the animals and subsequently releasing them to the wild thereby adding to currently viable populations in Azerbaijan. This conservation program is meant not only to educate people regarding this species but also to introduce conservation in general and in practice to the Sangachal area and beyond.

Azerbaijani scientists and NGOs are and will continue to be closely involved with the development of these mitigation programmes and local educational institutions are being included in their implementation.

16.2.1.3 Hydrological systems and associated wetlands (wadis)

It is considered that the construction and in particular, operation of the drainage channel will alter the existing hydrological flow regime in the vicinity of the proposed terminal. This may potentially have a flow-on effect on wetland (wadi) habitat in the area including those around the mouth of the Sangachal River insofar as water flows into wetlands areas may be either increased or decreased.

While no specific additional mitigation measures are proposed to offset potential effects of an altered hydrological regime in the vicinity of the terminal, it is considered prudent that the effects be monitored. BP is presently evaluating options for a wetland monitoring programme. In addition, BP is developing a landscape management strategy. The strategy will investigate ways that treated wastewater streams can be re-used in the natural landscape (e.g. wetland enhancement) or in cultural landscapes as developed in and around the terminal's construction camp and office areas.

16.3 Socio-economic impact assessment

Although, a number of socio-economic impacts were assessed and ranked as having a "high" significance, the impact assessment concluded that many of the activities associated with the Stage 1 development would result in only "negligible" or "low" impacts on the surrounding socio-economic environment.

Of the 85 defined planned routine and planned non-routine project activities, 19 were identified as having the potential to cause 23 socio-economic impacts of "high" significance on six separate socio-economic receptors. Two routine activities were assessed as having the potential to result in a socio-economic impact of "critical" significance and these impacts (on the local herding population and the existing café/garage business) are being addressed through a mitigation process that aims to determine an acceptable outcome to all parties. The contributing planned routine and planned non-routine activities that would result in impacts ranked as being of "high" or "critical" significance along with the receptors affected are summarised in Table 16.4.

Table 16.4 Summary of Stage 1 activities resulting in "high" or "critical" significance socio-economic impacts

Project Component	Contributing Activities	Impacted Receptors
Subsea pipeline activities	Construction of nearshore trenches.	Fishing.
	Pipe-laying offshore and nearshore (including vessel operations, anchor drag).	Fishing land use.
Terminal activities	Land acquisition and tenure.	Land use.
	Ground clearance and grading.	Land use.
	Modification of existing services.	Population in the vicinity.
	Construction of access road and railway crossing.	Population in the vicinity.
	Terminal construction.	Population in the vicinity, transport.
	Mobilisation of workforce.	Population in the vicinity.
	Demobilisation.	National employment base.
Transportation of Materials and equipment into Azerbaijan	Vessel operations and utilities.	Fishing.
	Rail transport.	Population in the vicinity, transport.
	Road freight.	Population in the vicinity, transport.

These identified impacts were taken forward so that further mitigation measures could be assessed and evaluated in order to eliminate, reduce or minimise these impacts. These additional mitigation measures are summarised in Table 16.5.

Table 16.5 Summary of additional socio-economic mitigation measures for Shah Deniz Stage 1

Project Component	Impact	Additional mitigation
Subsea pipeline activities	Pipe-laying requiring removal and resettlement of existing café/garage business.	Ongoing data gathering to clarify impact. Resettlement Action Plan.
	Nearshore trench construction restricting access to and use of local subsistence fishing areas with possible impact on local livelihoods.	Ongoing data gathering to clarify impact. Resettlement Action Plan.
	Pipe-laying interference with recreational and legal commercial fishing and shipping activities and route to market.	Resettlement Action Plan. Planning and notification of disturbances.
Terminal activities	Land take and ground clearance for terminal construction leading to permanent loss of herding community grazing land.	Ongoing data gathering to assess impact. Resettlement action plan.
	Impact on nearby population in terms of transport system and issues such as community tension, health, market distortion associated with workforce and inward migrating population in search of employment.	Requirements of tender regarding local and Azerbaijan national workforce percentages. Communicable diseases strategy. Camp and worker management plans. Transport plan. Social investment strategy.
	Impact on direct, indirect and induced employment.	Training plans. Social investment strategy.
Transportation of Materials and equipment into Azerbaijan	Impacts on the local and regional transport system.	Transport management plan.
	Disruptions to fishing activities in the Caspian.	Detailed forward planning. Notifications to other users of transport activities.

Full consideration has also been given to cumulative impacts resulting from existing and foreseeable future activities in the Stage 1 project area, as well as any potential transboundary impacts associated with Stage 1.

The following summarises the key socio-economic issues and residual impacts associated with the project.

16.3.1 Residual socio-economic impacts

16.3.1.1 Land use

Herding population

The terminal construction activities will impact on the local herder population. Land acquisition and clearance and levelling of the ground in preparation for the terminal facilities construction has required a land take in addition to that already being used for the EOP terminal. The land take, which will accommodate the terminal construction requirements for both the Shah Deniz gas export project and the ACG Phase 1 (including that portion of the existing AIOC property that is presently undeveloped), will result in the loss of 438.6 ha of existing grazing land used by the local herder population; that is, approximately 30% of their existing grazing land in the area. The co location of terminal facilities for both Shah Deniz and ACG will be no future need for additional land-take for future phases of the development. The initial land take however, will result in a permanent reduction in grazing area.

The nature and extent of the Qobu State Cattle Breeding Enterprise herders' grazing rights are presently being investigated. In the event that it is found that their grazing rights are adversely impacted by the project, the issue of any applicable compensation will be addressed in the first instance by the local executive authority, the district Department of Lands and the Ministry of Agriculture (which has administrative responsibility for the Qobu State Cattle Breeding Enterprise). As far as feasible, preference will be given to providing the affected herder families with rights to a replacement grazing area equivalent to that lost to the project.

Commitments and procedures to be followed for project land acquisition will be documented in a Resettlement Action Plan prepared in accordance with World Bank Operational Directive 4:30 on Involuntary Resettlement.

Existing café/garage business

The route for the onshore pipeline installation has been chosen and will pass under, or close by, the existing café/garage business located near the access road to the Sangachal terminal. This route will entail the removal and relocation of the existing business to alternative site. It is proposed that the alternative site be within the Sangachal area.

It is unclear at this stage whether the existing business profile would be affected by such a relocation process and how long it might take for the business to reach pre-relocation levels of activity. No data is available to indicate the period during which the business will be inactive due to the relocation process. This period of inactivity is likely to have a detrimental impact on the livelihood of the owners and operators of the business. This impact will be immediate, meaning for the period that the business is inactive and possibly longer term in that customers may find alternative businesses to use in the meantime and not return to the existing business once it reopens. Immediate impact mitigation is relatively straightforward however, the possible longer term negative impacts on the business may be more difficult to address.

Discussions are currently ongoing with the café/garage owners to ensure that no disruption to livelihood will be caused by the relocation process. These will be documented in the publicly available Resettlement Action Plan.

16.3.1.2 Sea use

Sea use, specifically fishing and shipping activities, will be principally affected by vessel operations associated with offshore installation and operational activities and the nearshore installation of the subsea pipeline.

Sangachal Bay

The recreational and subsistence fishing currently undertaken within Sangachal Bay will be directly affected by the nearshore and onshore pipeline installation activities, due to the restrictions on access and use of the Bay during these activities and there will be some disruptions to the subsistence and recreational fishing undertaken in the Bay by local residents.

As a result of the restrictions on access and use of the Bay, an agreement has been reached with Azerbalyk, the state fishing concern, to move some existing spawning nets and cages. In the process of removal however, the cage in the vicinity of the pipeline corridor was destroyed and is not available for use by the Azerbalyk fishermen in the alternative fishing grounds. Additionally, the new fishing ground selected by Azerbalyk is not considered, by the affected fishermen, to be suitable for their existing nets as the water is too deep. The fishermen retain 30-40% of the catch from the nets and cage in lieu of wages.[1] Negotiations are therefore, ongoing with the three to four fishermen employed by Azerbalyk to ensure that their livelihoods are not affected by the removal of the nets and the destruction of the cage and that the effect of the agreed compensation measures is realised.[2] These negotiations will be documented as part of the Resettlement Action Plan that will be publicly available.

Information has been gathered to assess the extent of existing fishing activities and establish the legality of those activities. Significant, disruption to any legal (licensed) commercial fishing activities will be compensated.[3] Subsistence or recreational fishing activity and any illegal fishing activities will not be compensated. To avoid destroying existing fishing nets, the need for removal of illegal nets will be widely advertised. The significance of the contribution of illegal and subsistence/recreational fishing activities to local livelihoods is unclear and clarification may not be possible (Chapter 7). Current understanding is that subsistence/recreational fishing activity can be undertaken from comparable alternate locations in terms of accessibility and productivity. If not, as noted above, this may adversely affect local socio-economic conditions.

Offshore

Some 100 fishing boats operate 40-60 km from shore catching sprat and this activity is likely to be negatively impacted by offshore installation of the pipeline. Baku is also home to one of the key fishing markets in the area and those trying to access it are likely to be re-routed for a short period of time during construction.

16.3.1.3 Population in the vicinity

The workforce associated with the onshore and offshore construction activities and any inwardly migrating population seeking employment, may have a significant impact on the social, cultural and health issues in the local and regional community.

In the main, potentially significant impacts would be associated with tension created within the local community as a result of labour drawn from outside Azerbaijan, a potential increase in activity in the informal economy in the area, potential market distortion as a result of increased wages and possible associated price inflation and health impacts associated with reproductive health issues and communicable diseases.

Tension may occur within the local community as a result of labour drawn from outside Azerbaijan. Members of the local community may feel that employment opportunities should be for the local and Azerbaijani national population only. These tensions associated with the labour force may become associated with the ethnicity of any labour force from outside Azerbaijan leading to the possibility of local ethnic tension. A number of measures have been included in the operational practices of the project to address this issue including a percentage

[1] See Chapter 7 Socio-economic Baseline.
[2] These negotiations will be documented as part of the Resettlement Action Plan which will be publicly available.
[3] Current understanding is that the only legal commercial fishing activity is the spawning nets of Azerbalyk and, as outlined in the preceding paragraph, a satisfactory agreement has been reached on an alternative site.

target of local and Azerbaijan workforce content as a requirement of tender, and worker and camp management measures, including regulated hours and on-site entertainment facilities.

An increase in money circulating within the local economy as a result of an increase in waged workers, and more (and/or more prosperous) local businesses, within the local community may have an impact on both the informal economy and contribute to local market distortion and price increases. These issues are recognised as being important but diffuse and difficult to address. Direction will be sought through the BP Social Investment Strategy as to the best way to compensate for or mitigate such activities should they occur.

Communicable diseases and reproductive health issues are recognised to be of significance as a result of both the construction workforce and any inward migrating population in search of employment. The worker and camp management measures noted above, along with screening and treatment measures for labour drawn from outside Azerbaijan will go some way towards addressing these impacts. No such measures can be implemented for any inward migrating population in search of employment in the area.

Noise levels from the combined operation of the Shah Deniz, ACG and EOP terminals were modelled for the Shah Deniz and ACG ESIA studies. Results indicate that under normal operating conditions, terminal operations would meet the World Bank Guidelines at all nearby sensitive receptors (i.e. residential: 45 dB_A night-time and 70 dB_A day-time; commercial/industrial 70 dB_A night and day-time).

Design work in relation to the Shah Deniz terminal flare (which will be used for emergency shut-down events only) is ongoing. The final flare configuration will comply with the Guidelines.

16.3.1.4 Transport

The terminal and onshore pipeline construction activity is likely to lead to an increased road traffic load on the main Baku-Alyat highway and may cause some inconvenience and nuisance to local users and possible deterioration in road infrastructure, although no roads within Sangachal, Umid or Sahil will be utilised as part of the construction process. Contractors will be required to supply detailed transport and traffic management plans, including scheduling road traffic activities at times when they will least interfere with other users. The onshore construction contractors will also be required to restore any transport access routes used, to at least their pre-construction condition, should any deterioration have occurred as a result of construction transportation activities. In addition, the onshore construction contractor will be required to provide affected communities with education on traffic and safety issues.

The local Sangachal and Baku public transport systems are already an overstretched resource and any increased load on the system would be likely to negatively impact the local population. It is likely that contractors for both offshore and onshore construction will therefore, use private buses to transport day site workers to avoid impacting on the local transport systems. There will however, still be an increased load placed on the system as a result of camp workers utilising the system to travel to and from the site for entertainment purposes outside working hours.

16.3.1.5 National employment base

Construction phase

Direct effects

The onshore and offshore construction contractors will only source labour from the international market where the national labour force cannot supply the skills required for the programme. A target of 75% locally sourced labour for onshore construction programmes has been set for the Shah Deniz and related ACG projects. The contractors are committed to using a maximum of 15% of the man-hours from outside Azerbaijan. It is anticipated that some training of local workers will be required and as such, training and development programmes are being implemented.

Preliminary estimates indicate that total construction costs in relation to Shah Deniz Stage 1 will be approximately US$2 billion.[4] It has been estimated that some 40% of this expenditure will occur within Azerbaijan (i.e. US$0.8 billion). These costs include the capital costs of the infrastructure, the installation costs (i.e. all associated contracts), owner's costs and contingency.

Indirect and induced effects

The indirect employment effect arises from secondary business supplying goods and services to on site activities, which in turn, create further economic activity by purchasing additional supplies. The induced employment arises from the creation of additional personal income derived from the first (direct workers), and successive (indirect workers) rounds of spend. The extent of the indirect and induced employment impacts within Azerbaijan will be conditioned by the "leakage" caused by the payment of income (such as the payment of wages and salaries, profits, rents, interest and taxes) rather than the purchase of goods and services to individuals or organisations outside the locality.

The European Bank for Reconstruction and Development (EBRD) estimates that approximately 70% of expenditure (i.e. procurement and income) will leak from the Azerbaijani economy. On this basis it is considered that a combined indirect and induced multiplier of 1.43 is appropriate for the construction phase on the basis of the size of the area and the limited duration of this particular form of direct employment. For the purpose of estimating the indirect and induced employment effect during the construction phase, the multiplier coefficient applies equally to construction workers recruited locally and those brought in from outside the local area. In both cases, construction jobs represent new employment opportunities for the local economy.

Based on the above, it has been estimated that the impact of Stage 1 is detailed in Table 16.6 below.

Table 16.6 Direct and estimated total (offshore and onshore) impact (US$ million)

	Azerbaijan
Direct:	800.0
Indirect and Induced:	344.0
Total:	1,144.0

Source: Consultants estimates.

4 Source : BP

Operational phase

Direct effects

The workforce required for the onshore and offshore operations will be smaller than that required for construction being approximately 65 in total – 45 offshore and 20 onshore.

It is proposed that after 5 years 70% of operational staff will be Azerbaijani. Within this it is envisaged that approximately 60% of all of the professional positions will be held by Azerbaijanis.

The operating and maintenance costs for Stage 1 have been estimated at a total of US$54 million per annum[5]. It is estimated that in the region of 70% of this expenditure is expected to be incurred within Azerbaijan (i.e. US$37.8 million). Based on a 30 year operating period, this equates to an estimated total spend of US$1,620 million, of which approximately US$1,134 million will occur within Azerbaijan.

Indirect and induced effects

Considering the indirect and induced effect for offshore construction activities, it has been estimated that the impact during the operation of Stage 1 on the Azeri economy is as detailed in Table 16.7 below.

Table 16.7 Direct and estimated total impact (US$ million)

	Azerbaijan
Direct:	1,134.0
Indirect and Induced:	487.6
Total:	1,621.6

Source: Consultants estimates.

Wider impacts

The impact of the development proposals on local unemployment can be seen as a wider beneficial impact. A potentially negative impact, judged to be moderate, is the risk of generating induced inflation as a result of relatively high expatriate salaries, local spending and increased local employment. Skills enhancement as a result of employment opportunities associated with the Stage 1 project construction and operations activities may have a positive impact on the local community. Contractors have been required to include training and skills enhancement programmes, along with targets for skills training for local workforces, in their tender information. This information has been part of the contractor selection criteria.

The long term sustainability of the local economy built up around one key development would be likely to be limited unless the development draws other investment to the area and also requires construction supplies and materials. For instance, with respect to the local economy, the experience of the EOP was that although the project resulted in the creation of a number of small roadside businesses in the local area, these were opportunistic in nature and did not experience substantial trade, nor were they long lived.[6] Consideration must be given as to whether the local economy possesses the necessary capacity to respond to the demands and the necessary skills to provide the required goods and services.

[5] Information supplied by BP 2002.
[6] ACG FFD Environmental and Socio-economic Overview, p.72.

In response to the demand for services the project may also directly and indirectly contribute to a 'boom-town' effect through a rapid growth of local industry, particularly construction, to support the demands of the project. As such development is reactionary and based purely on the project, long-term sustainability is questionable, particularly if the economy cannot supply new opportunities. The negative aspects of the boom-town development (e.g. closure of businesses) can in this case be expected to be minimised given the scale of offshore oil and gas reserves and substantial infrastructure requirements that will be needed in the future. The Shah Deniz FFD and ACG FFD programmes would provide work for a number of years and should allow the successful diversification of the sector over the longer term. These positive effects are however, dependant on the successful future of oil and gas exploration and production in the Caspian region.

The project would also generate a number of permanent employment opportunities directly associated with new business attracted to the area, some of which will provide support to the oil and gas sector. The total number of new jobs created would depend upon the extent to which these represent net additions to the economy. In economic terms, the benefit of the scheme is measured by the number of new jobs created in the local economy after taking into account additionality factors, displacement and the indirect/induced effects.

Such a transformation of the economy (i.e. the development of a supplier network) by the oil and gas industry does not happen in the short term. Invariably during the initial exploration stages of oil and gas development, a comparatively small number of companies are involved and on a very modest scale. Gradually the impact of oil and gas developments increases as more companies move or expand the scale of their operations. Once the oil and gas industry becomes established, there is potential for an ailing economy to be revitalised, with increased job opportunities, income and wealth.

The worst effects of decommissioning of plant facilities are experienced in communities that have become dependent on the presence of oil and gas development related activities for their livelihood. The loss of income and/or employment in the community can literally mean its degeneration to a ghost-town. These effects may be offset in the event that other resources are found in the region or, alternatively, if the town or region is in a position to service other fields. Similarly, effects can be off-set if the town/community is able to sustain the economic base that existed prior to the oil and gas based industry being introduced into the area.

16.4 Summary

The Shah Deniz Stage 1 Gas Export Project has the potential to deliver major economic benefits to Azerbaijan. Collectively, the Shah Deniz FFD, ACG FFD and BTC Project are by far the largest investments ever committed in Azerbaijan. They will have a major positive effect on the national economy of Azerbaijan. With prudent revenue management, the projects can also lead to positive social and environmental change within Azerbaijan.

In completing the impact assessment process for Stage 1, account was taken of the environmental goals/guidelines and those mitigation measures that are incorporated into and development of, the Stage 1 project's "Zero Damage Base Case" design. The base case includes a number of initiatives that result in the mitigation of potentially significant impacts to levels that are predicted to be environmentally sustainable. In parallel with these environmental mitigation measures, strategies to mitigate socio-economic impacts have also been developed. In addition, BP are committed to the development of an improved understanding of the environmental and socio-economic issues that characterise the project as well as to a programme of continued improvement in environmental and socio-economic performance.

Notwithstanding the base case's provisions for mitigation of adverse environmental and socio-economic impacts, a number of residual environmental and socio-economic impacts of "high" significance have been identified as discussed above. These impacts occur at local/regional and/or national level and may also be felt to a greater or lesser extent within the Caspian as a whole. To address these residual impacts, a number of mitigation strategies, above and beyond those incorporated in the project's base case, have been developed. Full commitment to (and proper implementation and management of) these strategies will be achieved within the framework of a robust EMS that will ensure the potential negative effects of the project will be substantially reduced.

At the local and regional level, project design and mitigation strategies have the potential to contribute positively to economic development and related social development. The environmental management of both the project and the project impacted areas, will demonstrate a high level of expertise and best practice and act as an example to other projects in the area.

On a wider scale, oil and gas revenues can be expected to impact positively on regional socio-economic development. Environmental management will be particularly relevant if oil and gas revenues are invested in economic restructuring and development and in social and environmental development strategies. A revival of national economies, supported by oil and gas revenues, can be expected to generate longer-term regional development.

There are however, considerable uncertainties about the amount of money that will be generated and its potential economic impact, as the size of the capital injection will depend on the rate of oil and gas exploration and the oil price. Possible negative effects are:

- reduction in competitiveness of non-oil sectors, as the national economy will be provided with substantial foreign exchange revenue which can be used to buy imports;
- delays in restructuring of productive base,[7] which is crucial and urgent and similar processes elsewhere have demonstrated that this is a challenging process in terms of impacts on the well-being of the population; and
- multiplier effects and potential misdirection of generated wealth.

The recent Poverty Reduction and Growth Facility loan for Azerbaijan seeks to organise the management of billions of dollars of expected oil and gas wealth, whereby profits will be collected and then spent gradually, in an effort to prevent such problems. Ultimately the realisation of economic, social and environmental benefits depends upon a number of key factors: the careful management of generated revenues; and the resolution of local environmental and socio-economic problems, in order to develop a strong and sustainable economy that impacts positively on quality of life of the Azerbaijan population. Given these factors the Shah Deniz Stage 1 Gas Export Project, together with subsequent development proposals, has the potential to make a very significant contribution to sustainable development within Azerbaijan.

[7] The productive base of a country is its industrial network (i.e. services and products). This base can be restructured so that its sectoral make-up and reliance can change (i.e. the sectors/supplies/products that make up the industrial network change in a way that effects the overall industrial base).

APPENDIX 1
SHAH DENIZ PSA EXTRACT

ARTICLE XXVI

ENVIRONMENTAL PROTECTION AND SAFETY

26.1 Environmental Standards

Contractor shall develop jointly with SOCAR and the State Committee of the Azerbaijan Republic on Ecology and Control over the Use of Natural Resources ("SCE") safety and environmental protection standards and practices appropriate for the regulation of Petroleum Operations. The safety and environmental protection standards shall take account of the specific environmental characteristics of the Caspian Sea and draw, as appropriate, on (i) international Petroleum industry standards and experience with their implementation in exploration and production operations in other parts of the world and (ii) existing Azerbaijan safety and environmental legislation. In compilation of such standards and practices account shall be taken of such matters as environmental quality objectives, technical feasibility and economic and commercial viability. Subject to the first sentence of Article 26.4 the standards, which shall apply to Petroleum Operations from Effective Date shall be the standards and practices set out in part II of Appendix IX until substituted by new safety and environmental protection standards devised and agreed between Contractor, SOCAR and SCE on a date agreed between the Parties and SCE and from such date such agreed standards and practices shall have the force of law as if set out in full in the Agreement. In the event that safety and environmental protection standards and practices are imposed otherwise than with the agreement of Contractor it is agreed that the provisions of Article 23.2 shall apply. The Parties and SCE shall agree a separate protocol for the detailed implementation of the joint development and definition of the new standards and practices for safety and environmental protection. The cost to Contractor of such development and definition shall be Cost Recoverable.

26.2 Conduct of Operations.

Contractor shall conduct the Petroleum Operations in a diligent, safe and efficient manner in accordance with the Environmental Standards to minimise any potential disturbance to the general environment, including without limitation the surface, subsurface, sea, air, lakes, rivers, animal life, plant life, crops, other natural resources and property. The order of priority for actions shall be the protection of life, environment and property. Contractor shall implement an integrated management system covering all health, safety and environmental aspects of the activities carried out in relation to the Petroleum Operations as outlined in part 1 of Appendix IX.

26.3 Emergencies.

In the event of emergency and accidents, including but not limited to explosions, blow-outs, leaks and other incidents which damage or might damage the environment, Contractor shall promptly notify SCE_(Goskomokhrana) and SOCAR of such circumstances and of its first steps to remedy this situation and the results of said efforts. Contractor shall use all reasonable endeavours to take immediate steps to bring the emergency situation under control and protect against loss of life and loss of or damage to property and prevent harm to natural resources and to the general environment. Contractor shall also report to SOCAR and appropriate Government Authorities on the measures taken.

26.4 Compliance

Contractor shall comply with present and future Azerbaijani laws or regulations of general applicability with respect to public health, safety and protection and restoration of the environment, to the extent that such laws and regulations are no more stringent than the Environmental Standards. In the event any regional or multi-governmental authority having jurisdiction enacts or promulgates environmental standards relating to the Contract Area, the Parties will discuss the possible impact thereof on the project. The provisions of Article 23.2 shall apply to any compliance or attempted compliance by Contractor with any such standards which adversely affect the rights or interests of Contractor hereunder.

26.5 Environmental Protection Strategy

An environmental protection strategy shall be developed which shall include:

(a) the establishment of an environmental management system as an integral part of Petroleum Operations and the formation of an environmental sub-committee as described in the Environmental Standards.

(b) an environmental work programme carried out in sequences appropriate to the normal phases of Petroleum Operations as described in the Environmental Standards (seismic survey, exploration drilling, field development and production).

26.6 Environmental Damage

(a) Contractor shall be liable for those direct losses or damages incurred by a Third Party (other than Government Authority) arising out of any environmental pollution determined by the appropriate court of the Azerbaijan Republic to have been caused by the fault of Contractor. In the event of any environmental pollution or environmental damage caused by the fault of Contractor, Contractor shall reasonably endeavour, in accordance with generally acceptable international Petroleum industry practices, to mitigate the effect of any such pollution or damage on the environment.

(b) Contractor shall not be responsible and shall bear no cost, expense or liability for claims, damages or losses arising out of or related to any environmental pollution or other environmental damage, condition or problems which it did not cause, including but not limited to those in existence prior to the Effective Date of this Agreement and SOCAR shall indemnify and hold harmless Contractor, its Sub-contractors and their consultants, agents, employees, officers and directors from any and all costs, expenses and liabilities relating thereto.

(c) Any damages, liability, losses, costs and expenses incurred by-Contractor arising out of or related to any claim, demand, action or proceeding brought against Contractor, as well as the costs of any remediation and clean-up work undertaken by Contractor, on account of any environmental pollution or environmental damage (except for such pollution or damage resulting from the Contractor's Wilful Misconduct) caused by Contractor shall be included in Petroleum Costs.

ARTICLE XXVI - APPENDIX IX

ENVIRONMENTAL STANDARDS AND PRACTICES

I. Integrated Management System

A. Environmental Sub-Committee

1. The formation and organization of an environmental sub-committee of the Steering Committee shall be set forth in a proposal of Contractor which will be submitted to SOCAR_for approval. Once approved SOCAR, the environmental sub-committee shall be formed in accordance with the approved recommendation and shall be composed of environmental representatives of Contractor Parties and SOCAR, the State Committee of the Azerbaijan Republic on Ecology and Control over the Use of Natural Resources, Azerbaijan Academy of Sciences and other relevant research institutes.

2. Responsibilities of the environmental sub-committee shall be to:

   - Design monitoring programme for monitoring of selected environmental parameters
   - Coordinate monitoring program
   - Review results and propose recommendations
   - Publish annual report

B. Environmental Work Programme

The environmental work programme to be pursued during Petroleum Operation pursuant to Article 26.2 shall be phased as follows:

1. For seismic surveys
   - Environmental impact assessment
   - Health, safety and environmental management plan for seismic operations, including emergency procedures, oil spill contingency plan, waste management plan and an audit programme

2. For exploration drilling
   - Drilling environment impact assessment
   - Baseline environmental study
   - Health, safety and environment management plan for exploration drilling, including emergency procedures, oil spill contingency plan, waste management plan (including drill cuttings disposal) and an audit programme.

3. For development and production
   - The environmental work programme for the Development and Production Period shall be submitted together with the Development Programme to SOCAR for approval.

II. Environmental Standards

The following are general and specific guidelines relating to discharges associated with oil and natural gas exploration and production activities.

A. General Guidelines

1. There shall be no discharge of waste oil, produced water and sand, drilling fluids, drill cuttings or other wastes from exploration and production sites except in accordance with the following guidelines.

2. There shall be no unauthorized discharges directly to the surface of the sea. All discharges authorized by these guidelines shall be controlled by discharging into a caisson whose open end is submerged, at all times, a minimum of two (2) feet below the surface of the sea.

B. Discharge Guidelines and Monitoring

1. Produced Water

(a) Contractor will endeavour to utilize produced water for reservoir pressure maintenance if, through standard compatibility testing with Caspian Sea water, no damage to the reservoir resulting in a reduction in overall hydrocarbon recovery would occur by mixing the two water streams. In the event that the two water streams are compatible, Contractor may only discharge a volume of produced water after treatment to the Caspian Sea that exceeds the total volume required for reservoir pressure maintenance or in the event of an emergency, accident or mechanical failure. In the event that the two water streams are not compatible, Contractor may discharge produced water to the Caspian Sea after treatment in accordance with generally accepted international Petroleum industry standards and practices.

2. Drill Cuttings and Drilling Fluids

(a) There shall be no discharge of oil based drilling fluids, other than low toxicity and biodegradable drilling fluids.

(b) There shall be no discharge of drill cuttings generated in association with the use of oil based drilling fluids, invert emulsion drilling fluids, or drilling fluids that contain radiation, if any, waste engine oil, cooling oil, gear oil, or other oil based lubricants, other than cuttings generated in association with the use of low toxicity and biodegradable drilling fluids.

(c) There shall be no discharge of drill cuttings or drilling fluids if the maximum chloride concentration of the drilling fluid system is greater than four (4) times the ambient concentration of the receiving water.

(d) Prior to the start of the drilling programme, a drilling mud system will be designed and laboratory tested under the U.S. EPA, 96-hour acute toxicity test using mycid shrimp_or other indicator organisms of the Caspian Sea agreed between Contractor and SOCAR. Those muds biodegradable and of low toxicity will be authorised for discharge during the drilling programme.

(e) During drilling operations, mud samples will be collected periodically to determine toxicity using procedures established for the Caspian Sea.

(f) The composition of the mud system may be altered as necessary to meet changes in the drilling operations. The modified mud system may be discharged if it has been shown to meet the above limits on oil, salinity and toxicity.

3. Other Wastes

(a) Sanitary waste may be discharged from a U.S.– Coast Guard certified or equivalent Marine Sanitation Device (MSD) with total residual chlorine content greater than 0.5 mg/l but less than 2.0 mg/l as long as no floating solids are observable. The Hach method CN-66-DPD test shall be used to measure the residual chlorine.

(b) Domestic wastes and gray water may be discharged as long as no floating solids are observable.

(c) Desalinization unit wastes shall be discharged.

(d) Deck drainage and wash water may be discharged as long as no visible sheen is observable. Oily and clean drainage or wash water shall be segregated: clean water shall be discharged to the sea and oily water shall be treated as provided in B.1 above.

(e) Trash shall not be discharged offshore. Trash shall be transported to an appropriate land-based disposal facility.

4. Monitoring

(a) Produced water

1. The volume of produced water discharged and concentration of oil and grease contained in the discharge will be monitored daily.

2. The daily maximum and monthly average oil and grease concentration will be reported to the appropriate environmental authority monthly.

(b) Drill Cuttings and Drilling Fluids

1. An inventory of drilling fluids additives and their volumes or mass added to the drilling fluid system will be main–tained for each well.

2. Drilling fluid properties, including volume percent oil and concentration of chlorides, will be monitored daily for each well.

3. The estimated volume of drill cuttings and drilling fluids discharged shall be recorded daily and reported monthly to the appropriate environmental authority.

(c) Other Wastes

1. The estimated volume of other wastes discharged shall be recorded daily and reported monthly to include:

    (i) Sanitary waste
    (ii) Domestic waste
    (iii) Deck drainage and wash water

C. Air Emission Guidelines and Monitoring

Contractor is authorized to discharge air emissions. Such discharges will be limited and monitored in accordance with generally accepted international Petroleum industry standards and practices.

D. Safety Guidelines

Contractor shall take into account subject to the provisions of Article 26.1 relevant Azerbaijani regulations and the following international safety and industrial hygiene standards in conducting its Petroleum Operations under the Agreement:

1. Oil Industry International Exploration and Production Forum (E&P Forum) Reports - HSE Management
2. International Association of Drilling Contractors (IADC) – Drilling Safety Manual.
3. Association of Geophysical Contractors International (IAGC) - Operations Safety Manual.
4. Threshold Limited Values for Chemical Substances in the Work Environment – American Conference of Governmental Industrial Hygienists.

APPENDIX 2
SHAH DENIZ STAGE 1 HSE DESIGN STANDARDS

HEALTH

DESCRIPTION	STANDARD
MEDICALS	• Medical support will be provided to all project construction work sites.
HYGIENE	• Routine assessment of water quality and catering facilities will be conducted at project construction work sites in Azerbaijan; • Changing, toilet and washing facilities will be provided at project construction work sites in Azerbaijan; • Lunch will be provided at project construction work sites in Azerbaijan.
NOISE	• During project execution, tasks and working environments will be assessed for noise and measures put in place to ensure that levels will be kept as low as possible. The codes used are Noise & Statutory Nuisance – EPA 1990 / 1995 and UK HSE "Control of Noise (COP for Construction and Open Sites Orders 1984 / 1987)" and "Noise at Work Regulation 1989"; • The design will be assessed for noise and the following measures used : 1. 85 dBA (average level) exposure for a maximum of 12 hours 2. 45 to 60 dBA inside the accommodation (depending upon location – such as office or sleeping areas).
HEALTH RISK MANAGEMENT	• Workplace, environmental, and travel health hazards are identified and risks assessed;

SAFETY

DESCRIPTION	STANDARD
TRAINING	• All project personnel will receive an appropriate level of safety and environmental training; • A training matrix will be developed for each site • Project leadership will be trained in Advanced Safety Auditing and Accident and Incident investigation.
DESIGN SAFETY REVIEWS	• A qualitative risk-based design approach will be adopted, supported by blast calculations, escape and evacuation assessments, Hazops, Hazids, formal project safety reviews and Temporary Refuge impairment analysis.
SAFETY CASE	• An operational Safety Case will be prepared and approved by the Business Unit Leader
SIMULTANEOUS OPERATIONS	• Simultaneous Operations (e.g., drilling and HUC, drilling and production, installation and production) will be assessed and procedures will be prepared to control the identified risks to an acceptable level.
MANUAL HANDLING	• A lifting and access assessment of the design will be completed to eliminate the need for manual handling > 50 kg between two men in the operating phase; • During project execution, tasks will be assessed and the need for manual handling > 50kg between two men will be eliminated.
HAZARDOUS SUBSTANCES	• The design will be based on eliminating the exposure of individuals to hazardous substances in the operating phase, including well work; • Particular emphasis will be placed, in the design phase, on assessing and eliminating the gaseous emission of the carcinogens benzene, toluene and xylene (BTX) in the operating phase; • During project execution, tasks will be assessed to ensure adequate controls are in place to minimise the impact of hazardous substances on individuals.
SEISMIC EVENT	• The platform will be designed to withstand the 500-year return period seismic event where no loss of life, no loss of containment and little or no damage to the platform is expected; • Design will be checked against the 3000-year return period, where the platform can sustain damage but should not collapse and there should not be major health or safety consequences.
STORM	• The offshore design will be such that personnel can survive a 100-year storm without leaving the platform.
ROAD SAFETY	• Project road safety standards and practices will be developed which will be in harmony with the goal "no accidents, no harm to people". This will include the elements of training, near miss and accident reporting, vehicle operating and maintenance standards, vehicle equipment, and competency.

ENVIRONMENT

DESCRIPTION	STANDARD
MONITORING AND MEASUREMENT	• The design will provide sufficient sample and measurement points to enable adequate monitoring of emissions and discharges during the operating phase.
OZONE DEPLETING SUBSTANCES (ODS)	• These substances will not be used. • ODS are defined as those substances which are controlled by the Montreal Protocol on Substances that Deplete the Ozone Layer.
OTHER HALOCARBONS WITH POTENTIAL FOR GLOBAL WARMING	• Other halocarbons that do not deplete the ozone layer, but which have other Environmental concerns such as a high global warming potential (GWP) will not be used unless suitable alternatives are not available. These include Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur Hexafluoride (SF6).
	1.
LANDTAKE AT SANGACHAL	• The design of Sangachal will minimise the footprint, without compromising safety.
NUISANCE AT SANGACHAL	• During project execution the impact on the community of dust, noise, light, odours and general disruption will be minimised.
OPEN DRAINS OFFSHORE	• There will be no visible sheen from deck and open drain discharges; • Sample points will be provided to enable measurement of the oil in water discharge quantity.
OPEN DRAINS ONSHORE	• Clean drains will discharge to the Caspian at less than 10mg/l monthly average and 19mg/l on a daily basis. Any fluids discharged will be treated to ensure there is no significant or long lasting impact on the environment; • Sample points will be provided to enable verification of the above standard (i.e., measurement of water quality and quantity); • Dirty drains water will be routed to the produced water disposal facility.
VENTING UNBURNED GAS	• During project execution cold venting will not take place unless it is required for safety reasons; • The design will balance environmental impact and safety associated with unburned gas venting in the operating phase.
CHEMICALS	• The design will challenge the need for all chemical use; • A management strategy will be put in place to minimise the environmental impact of chemicals through correct selection, transportation, storage, deployment and disposal; • Chemicals known or suspected to cause taint, endocrine disruption or contain heavy metals as defined by UK OCNS will be avoided. In the event that suitable alternatives are not available, the impact of the chemical will be risk assessed and mitigation measures agreed as part of the EIA process; • Only heavy metal free pipe dope will be used; • Chemicals will be evaluated and tested based on the European Harmonised Offshore Chemical Notification Format (HOCNF) and UK OCNS classification, until such time as Caspian-specific standards are agreed; • No chemicals will be discharged to land or sea in the project execution phase (e.g., chemically treated hydrotest fluids) without complete identification and a thorough assessment of their impact; • The facility design will prevent so far as reasonably practical, the need to discharge production and utility chemicals to land or sea.

ENVIRONMENT (cont'd)

DESCRIPTION	STANDARD
SEWAGE	• Offshore design for sewage treatment will be discharge to sea following treatment using a US coastguard approved Marine Sanitation Device without chemical treatment, (i.e., chlorine - subject to approval by the SCE); • The design will ensure that there are no floating solids; • Discharge will be via a caisson that is permanently submerged and at least 60 cm below the surface.
DESALINATION WASTE	• Desalination unit waste shall be discharged via a caisson that is permanently submerged and at least 60 cm below the surface.
PIPELINE CONSTRUCTION	• Activities will be timed to ensure impact on the fish population and other marine life is minimised.
SAND	• The design will enable sand and any associated liquid to be re-injected offshore; • In the event that re-injection is not possible sand will be transported to shore, treated and disposed of onshore at a location approved by the regulator.
LIQUID AND SOLID WASTE	• There will be no discharge of solid and liquid waste to sea during project execution or operations except as provided for elsewhere in these standards; • During project execution waste will be managed according to the following hierarchy: reduction at source, re-use, recovery, re-cycle and rendered harmless through treatment; • The design will ensure waste production in the operating phase is minimised and waste can be handled safely. • Wax disposal and handling - Alternative methods of wax treatment and disposal will be reviewed using the BPEO process and taking into consideration BACT. An effective option will be selected so that the impact of wax waste on the environment is minimised.
SEAWATER ABSTRACTION FOR OPERATIONS	• The design will allow seawater to be abstracted during operations at depths > or = 50m.
PRODUCED WATER OFFSHORE (FFD)	• In FFD the design will permit produced water to be re-injected; • In the event of the plant being unavailable, produced water discharged to the Caspian must not exceed oil and grease concentration < 42 mg/l on a daily basis or < 29 mg/l monthly average. The design will incorporate treatment facilities to meet these discharge standards; • Operational procedures will be developed when the produced water facilities are installed to control the time allowed for overboard discharge.
DECOMMISSIONING	• Design will ensure that the facility can be safely decommissioned without long term impact on the environment.
FUGITIVE EMISSIONS - STORAGE TANKS	• Fugitive emissions from the Sangachal oil storage tanks will be controlled using external floating roof technology with primary, secondary rim seals, and low low loss fittings.
FUGITIVE EMISSIONS - COMPRESSORS, VALVES, SEALS, FLANGES	• The aim will be to minimise fugitive emissions throughout the design process by measures including: - Component evaluation and selection - Material evaluation and selection - Best Available Control Technology (BACT) - PSA

ENVIRONMENT (cont'd)

DESCRIPTION	STANDARD
COMBUSTION EMISSIONS	• The design will be based on minimising combustion emissions (e.g., SOx, NOx, CO2, CO and particulates) • BACT will be used, as required by the PSA • Use the AIOC air quality standards (these are based on international standards – WHO/EC) – e.g. Low NOx burners The AQC for the Shah Deniz Stage 1 and ACG Phase 1 Projects are representative of the lowest concentration limits proposed as targets to be achieved within the next 15 years within Europe and more demanding than current standards from the United States. AQC are listed below: **AQC** (see table below)
PRODUCED WATER ONSHORE	• Re-injection of onshore produced water from Sangachal Terminal is the Base Case.
ROUTINE FLARING - ONSHORE	• The flare will be designed for continuous flaring and emergency relief. • Any flaring will be smokeless under normal operations. • Flare gas metering will be installed • The design will minimise flaring from purges and pilots, without compromising safety. This will include installation of purge gas reduction devices and conservation pilots.. • Flare gas recovery will be installed • An operational flare policy will be developed during the Execute Stage
ENERGY EFFICIENCY	• Waste heat recovery schemes, evaluated during advance define, should not be implemented onshore or offshore.

AQC

Pollutant	Concentration Limits (µg/m$^{3)}$	Averaging Period
Carbon Monoxide (CO)	10,000 30,000 60,000 100,000	8 hours 1 hour 30 minutes 15 minutes
Nitrogen dioxide ($NO_{2)}$	200 40	1 hour 1 year
Sulphur Dioxide (SO_2)	500 350 125 50	10 minutes 1 hour 24 hours 1 year
Particulate matter (PM_{10})	50 40	24 hours 1 year
Benzene (C_6H_6)	16.25	1 year

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Final

TITLE:

Dispersion modeling for the Shah Deniz Gas Condensate Field
-Cooling water
-Drill cuttings
-Cement

AUTHOR(S):
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CLIENT:
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Executive summary

BP Exploration Ltd and its partners are proposing to exploit the Shah Deniz gas condensate field, which is located in the south Caspian Sea, approximately 100km south east of Baku. BP Exploration Ltd will be operator of the field and requires that the project be executed in an efficient, safe and environmentally responsible manner to achieve the BP corporate expectations for all HSE activities (BP, 2002).

Applied Science Associates were commissioned by Technip-Coflexip, on behalf of BP Exploration Ltd, to provide environmental modeling support for a number of engineering issues and for an Environmental Impact Statement (EIS) for the Shah Deniz field development. The environmental modeling was used to predict the likely fate of discharges that would or may occur at the location during the development and operational phases. These discharges included drill cuttings and drilling fluids that would be discharged during drilling of the production wells; cement that may be discharged during setting of the subsea casings; and cooling water and sewage, which would be released during the operational phase. Modeling accounted for the nature of the discharges, the proposed discharge method and the local hydrodynamic setting.

Hydrodynamic simulations were conducted for the Caspian Sea using ASA's HYDROMAP. The simulations were conducted during the summer and winter seasons of the year 2000, June through August and December through January, respectively. The computational grid covered the entire Caspian Sea with coarse resolution (20 km) in the northern Caspian on and progressively finer resolution covering the southern Caspian Sea (5km) and the Baku region (2.5 km). Wind data obtained from the NCEP global atmospheric model (NOAA-CIRES) was used as environmental forcing (there being no tidal forcing in the Caspian Sea). The hydrodynamic model was validated using current meter data collected within the Caspian Sea along a pipeline route between Chirag and Sangachal Bay during the winter season from 01 February to 01 April 2000. The validation consisted of both qualitative and quantitative measures. The validation showed the model reproduces the major current trends within the region very well. Model current predictions were more energetic than the data at offshore data collection stations and slightly less energetic at near shore data collection stations. The difference between the energetic state of the model and data was within commonly accepted modeling guidelines except for one station offshore Kala, where discrepancies can be attributed to local bathymetric or shoreline characteristics not resolved by the computational grid.

A validated near-field dispersion model (OOC), was used to simulate thermal dispersion simulations for cooling water discharges of 1000 m^3/hr via combinations of 3 discharge depths (10, 30 and 50 m), and 2 pipe orientations (horizontal to the west or vertically downwards). Simulations assumed average, low-wind, current speeds of 10 cm/s. Separate simulations were carried out with the currents from the north (representing winter) and south (representing summer). The modeling accounted for seasonal variation in discharge temperature, the vertical structure in the temperature and density of the sea at the site and wake effects set up by the legs of the facility. Simulations indicated that the thermal discharge would cool rapidly on discharge into the receiving waters. Cooling to within +3°C above ambient water temperature was predicted to occur within 10-12 m of the discharge point under all combinations of discharge configurations and seasonal conditions that were tested. Thus, the suggested discharge would meet the World Bank Standard for cooling water to return to within 3^{o}C of ambient temperature at 100m from the discharge point, irrespective of the depth and orientation chosen. There were differences in the distance the plume was predicted to travel and in the resulting area of effect, which were functions of the discharge depth, season and orientation. Thus, dispersion of the thermal plume could be optimized to minimize thermal effects further. The orientation of the discharge was predicted to affect the rate of cooling and area of the plume. Simulations indicated that the horizontal discharge was more efficient (if directed perpendicular to the seasonal current axis) because the plume would spread in both the direction that the jet was facing and with the prevailing current. With a vertical discharge downward, the jet was predicted to lose velocity rapidly because it would be positively buoyant. Thus, horizontal movement would be due to the ambient currents alone. The season of discharge was another significant co-variable. For a given discharge type, a significantly smaller area of effect was predicted during summer. The plume area (area > + 3^{o}C above ambient) was predicted to range from approximately 7 m^2 to 9 m^2 during summer for the horizontal discharge, depending upon the discharge depth, and from approximately 10 m^2 to 14 m^2 during summer for the vertical discharge. During winter, a plume area of approximately 13 m^2 to 14 m^2 was predicted for the horizontal discharge and approximately 17 m^2 for the vertical discharge. The depth of discharge was a third co-variable that affected the predicted area of effect, but there was no consistent trend with increasing depth. However, the 30 m horizontal discharge was predicted to result in the minimum plume area during each season. The 10 m discharge was predicted to rise to the surface before cooling to below the threshold in summer.

Simulations indicated that the thermal plume should cool to +1^{o}C above ambient before traveling the distance separating the cooling water discharge and intake points. The highest risk of recirculation was expected during summer, when prevailing currents are towards the intake. However, the plume was predicted to cool before traveling 25% of the distance separating the discharge and intake during summer temperatures, with currents expected during moderate wind speeds.

The dispersion of cuttings from drilling of one of the production wells was modelled using ASA's MUDMAP. A volume of 302.4 m^3 of cuttings was assumed, with an expected mean rate of 42 m^3/hr. An assumed 10% additional mass of drilling fluids was assumed to be lost with the cuttings. Model predictions of seafloor settling were computed only for the cuttings portion. The model was used to examine the likely dispersal and settling of the drill cuttings, given the grain-size distribution supplied by BP Exploration Ltd, if discharged at 1m, 2m or 3.2m above the seabed as a vertical (facing upwards) discharge. Separate simulations were carried out under time-varying currents from example summer and winter periods with low (< 2 cm/s) and high (> 6 cm/s) mean speeds, relative to overall current speeds predicted for the site. Simulations indicated that cuttings should form a bell-shaped pile that had the greatest thickness immediately around the discharge and with an exponentially decreasing thickness with distance. The thicker sections were predicted to form uniformly around the discharge, irrespective of the prevailing current direction within the range of current speeds tested. Raising the discharge height from 1m to 2m was predicted to significantly affect the thickness and area of the central pile. Based on the sinking rate of particles and prevailing current speeds, a theoretical thickness of 8m was expected with discharge at 1m. This predicted cuttings pile thickness decreased to 3.6 m by raising the release elevation to 2m. Thicknesses greater than 10 cm were predicted to extend out to 7.5 m from a 1 m discharge and approximately 10.5 m with a 2m discharge. This would increase the area with > 10 cm thickness by 90%. The effect of current speed on the spread of currents was relatively low over the range between the low (< 2 cm/s) and high energy (> 6 cm/s) conditions expected at the site due to the rapid settling time of the mid-weight to heavy particles. During both the summer and winter cases, the extent and area of thicknesses greater than 10 cm were predicted to be approximately the same for both the high and low energy cases for a discharge at a given height. However, the lighter materials were predicted to spread out over a larger area and to be offset further in the direction of the major current axis with increased current energy.

The U.S. Army Corps of Engineers multiple dump fates model, MDFATE, was used to examine the likely deposition of cement which may be discharged if it becomes necessary to abort cementing of the drill-casing. The discharge was assumed to be 100 barrels at 15 m below sea level through a vertical pipe from Leg 3. The cement was assumed to clump together with characteristics similar to a typical cohesive sand mixture. The cement was predicted to remain in the water column for a very short period of time (seconds), reducing the horizontal dispersion of the dumped material. The settlement mound was predicted to be centered below the discharge site with a peak thickness of 7.5mm and an area of approximately 36 m^2. The mound was predicted to thin with distance from the center and have a thickness of between 5.5 and 3.5 mm in the area of the well-head and drilling template. The cement was predicted to have a thickness of around 7.5 mm around the spud can on Leg 3 and up to 1.5 mm around the spud can of Leg 1.

1 Introduction

BP Exploration Ltd and its partners are proposing to exploit the Shah Deniz gas condensate field, which is located in the south Caspian Sea, approximately 100km south east of Baku (see Figure 1). BP Exploration Ltd, as operator of the field, has an overall objective to deliver a low unit cost gas production system after rapid implementation of the development. However, BP Exploration Ltd also requires that the project be executed in a safe and environmentally responsible manner and achieves the BP corporate expectations for all HSE activities (BP, 2002).

To achieve these objectives Applied Science Associates were commissioned by Technip-Coflexip, on behalf of BP Exploration Ltd, to provide environmental modeling support for engineering studies and an Environmental Impact Statement (EIS) for the Shah Deniz field. The environmental modeling was used to predict the likely fate of discharges that would occur at the location during the development and operational phases. These discharges are:

- Drill cuttings and drilling fluids discharged during drilling of the production wells,
- Cement discharged during setting,
- Cooling water released during the operational phase, and
- Sewage released during the operational phase.

Modeling took account of the nature of the material, the proposed discharge method and local hydrodynamic circulation.

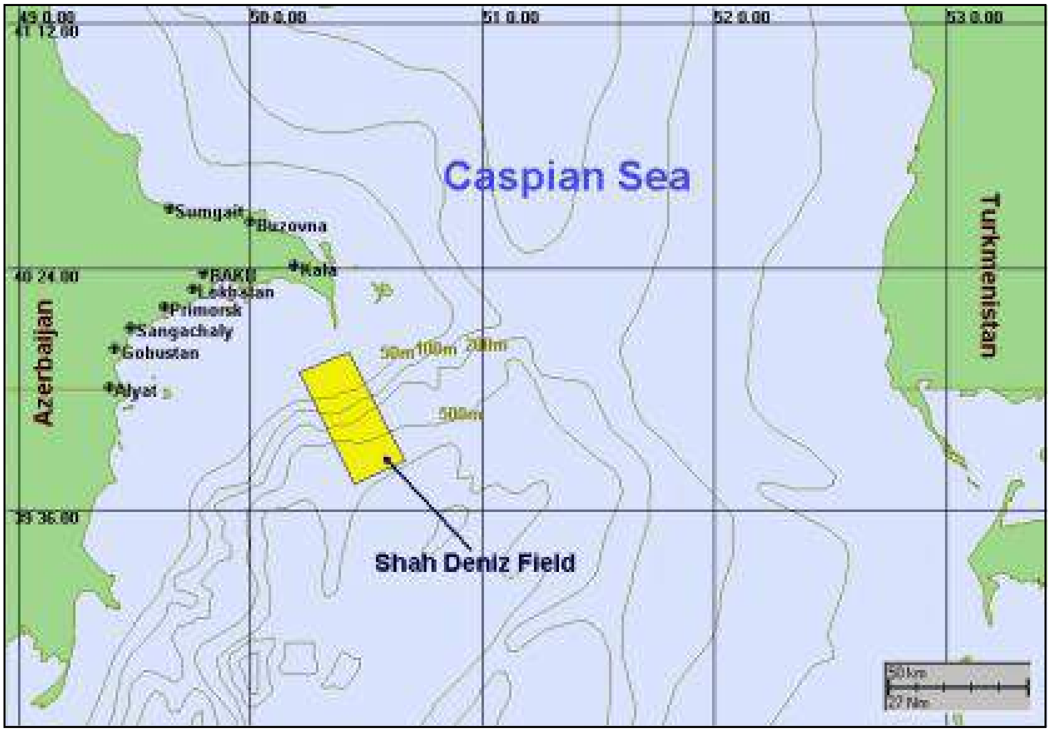


Figure 1. Shows the location of the Shah Deniz field in the south Caspian Sea.

This report documents the development of the hydrodynamic simulations and the objective environmental modeling. Section 2 describes the models used for the environmental modeling. Section 3 presents the development, confirmation and application of the hydrodynamic model for the study area. Section 4 presents the simulation of the cooling water discharges. Section 5 presents the likely dispersion and deposition of drill cuttings. Section 6 shows the predicted dispersion of cement discharges. Section 7 presents the likely fate of sewage. Section 8 presents the major conclusions of the study.

2 Description of the Study Site

The Shah Deniz platform is located within the southern Caspian Sea approximately 100km southeast of Baku, Azerbaijan (Table 1). The Caspian Sea (Figure 2) is the largest inland water body on the planet and has no connections to the world oceans. It extends zonally from 46.6 to 54.8 E and meridionally from 36.6 to 47.0 N. The sea is divided into three parts, the Northern, Middle and Southern Caspian with total sea areas of approximately 25%, 37.5% and 37.5% respectively. However, the ratio of total water volumes are dramatically different for each region with the Northern Caspian containing approximately 0.5%, The Middle Caspian containing approximately 34% and the Southern Caspian containing approximately 66% of the total water volume.

Table 1: Location of the proposed discharge point

Name	Latitude and Longitude	Depth
Shah Deniz	39^o 53’ 49” N 50^o 26’ 45” E	100.1m

Since the sea is not connected to the ocean, the main cause of currents is wind action, especially in the surface layer, and variations in density. The currents in the southern Caspian Sea have been characterized as having no general quasi-steady pattern (Kosarev, 1994). Instead, the currents correspond to the main wind fields. During periods of calm winds, only weak currents exist due to density differences. Thus, the strongest and most stable currents are set in motion by regional winds that cover broad areas, while in the coastal areas the currents are influenced by local winds and local shoreline geometry.

Figure 3 presents typical current patterns for the Mid to Southern Caspian Sea for north-westerly and south-westerly winds as presented in Klevstova (1966). The currents moving along the western coast of the Southern Caspian typically follow the wind. However, near the Baku Archipelago, the currents usually oppose the wind. Current velocities along this shore typically reach 10-20 cm/s with light winds, 30 cm/s due to moderate winds and 40-50 cm/s under the influence of strong winds.

Due to the large latitudinal spread of the Caspian Sea, the distribution of temperature in the surface layers is not homogeneous during the winter. However, thermal gradients are small due to the intensive development of convectional mixing (Kosarev, 1994). During the summer, climatic conditions influencing the Caspian region are fairly uniform. Thus, there is very little latitudinal thermal variation in the surface layers. However, thermoclines appear at 20-30 m during the summer with a characteristically strong thermal gradient (Kosarev, 1994). Figures 4 and 5 present characteristic water surface temperatures over the Caspian Sea for the months of February and August, respectively, as presented in Kosarev (1994).

Figure 2. The extent of the Caspian Sea and the surrounding countries.

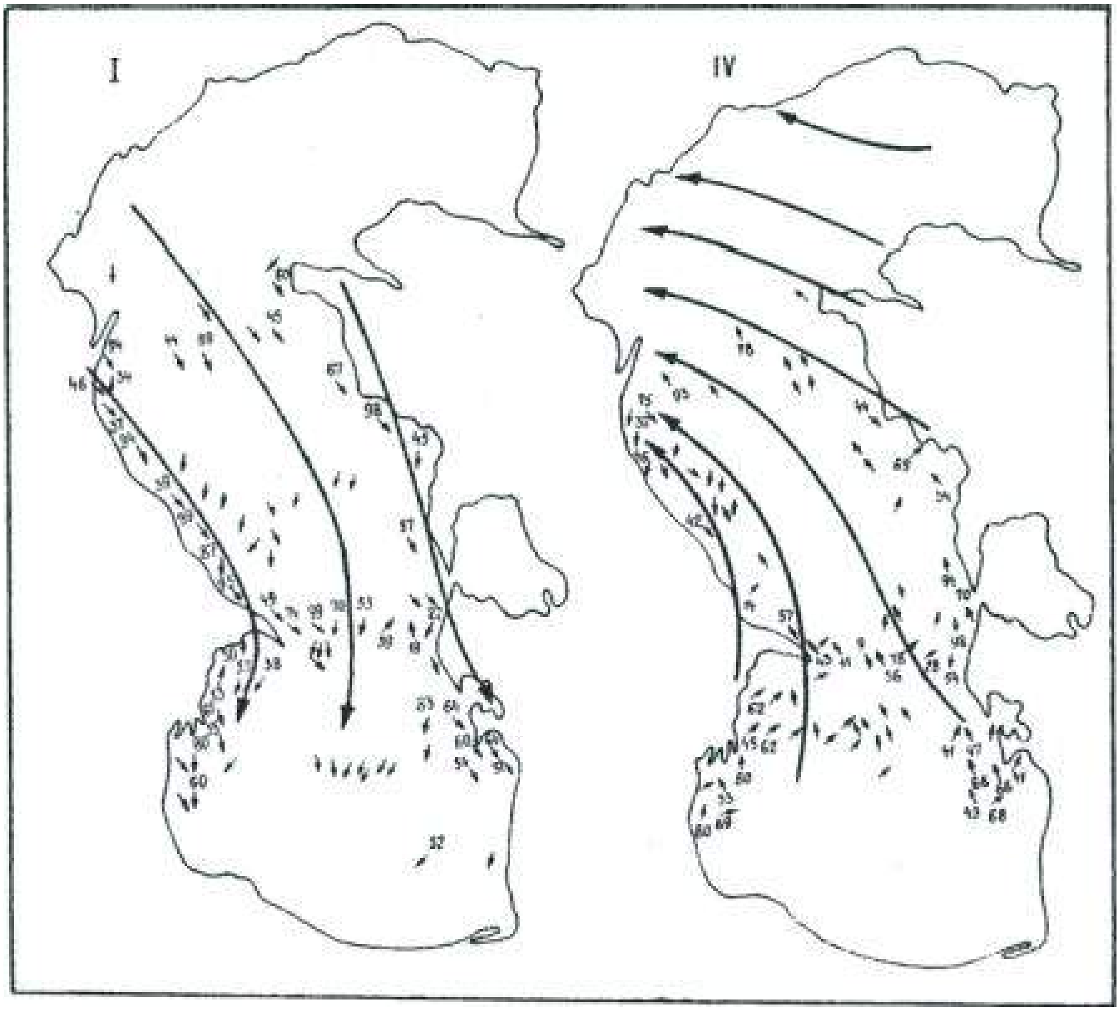


Figure 3. Surface currents developed from the influence of northwesterly (I) and southeasterly (IV) winds (Klevtsova, 1966). Long arrows represent wind direction, short arrows represent currents and the numbers indicate stability values in %.

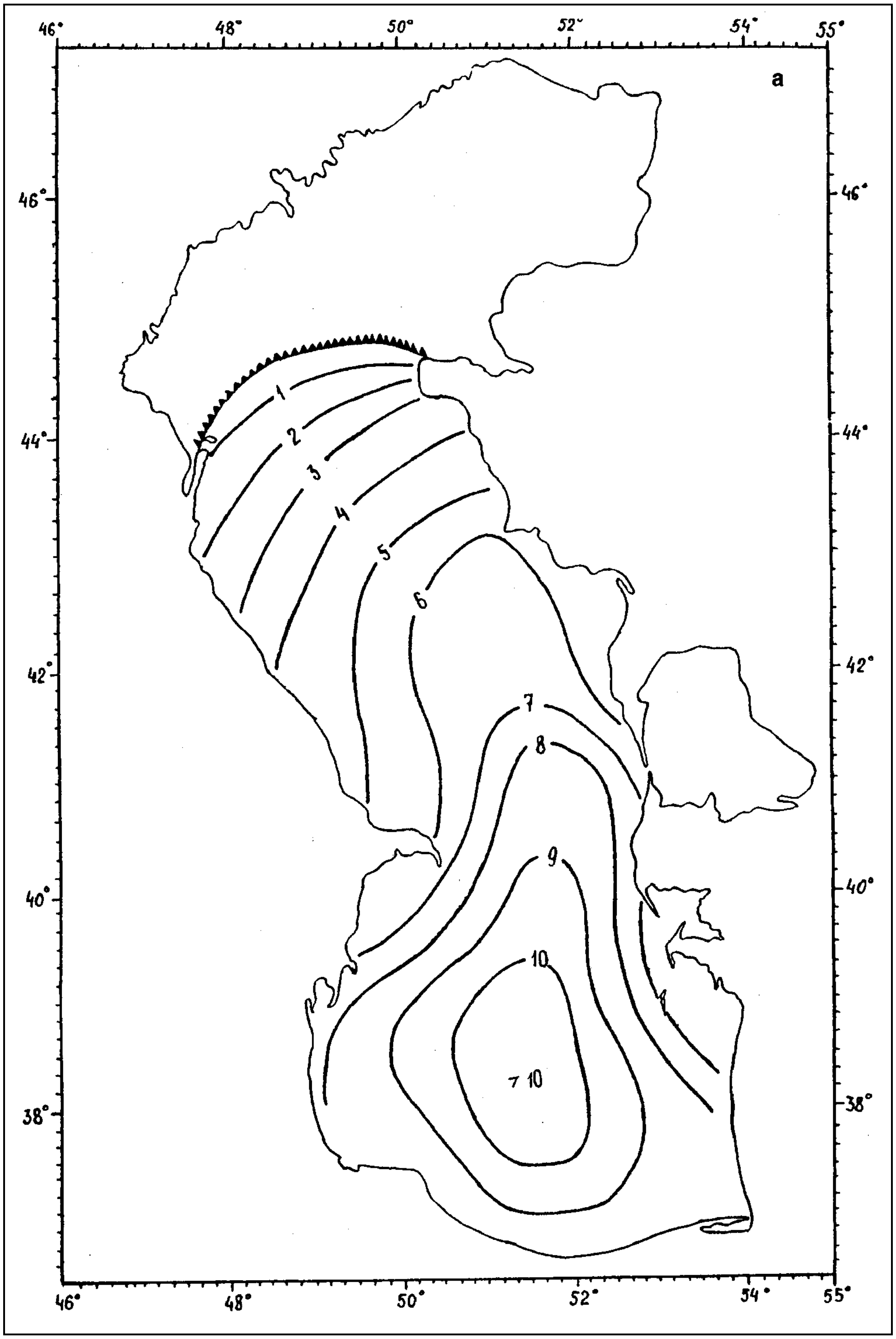


Figure 4. Characteristic surface water temperatures for the month of February (Kosarev, 1994).

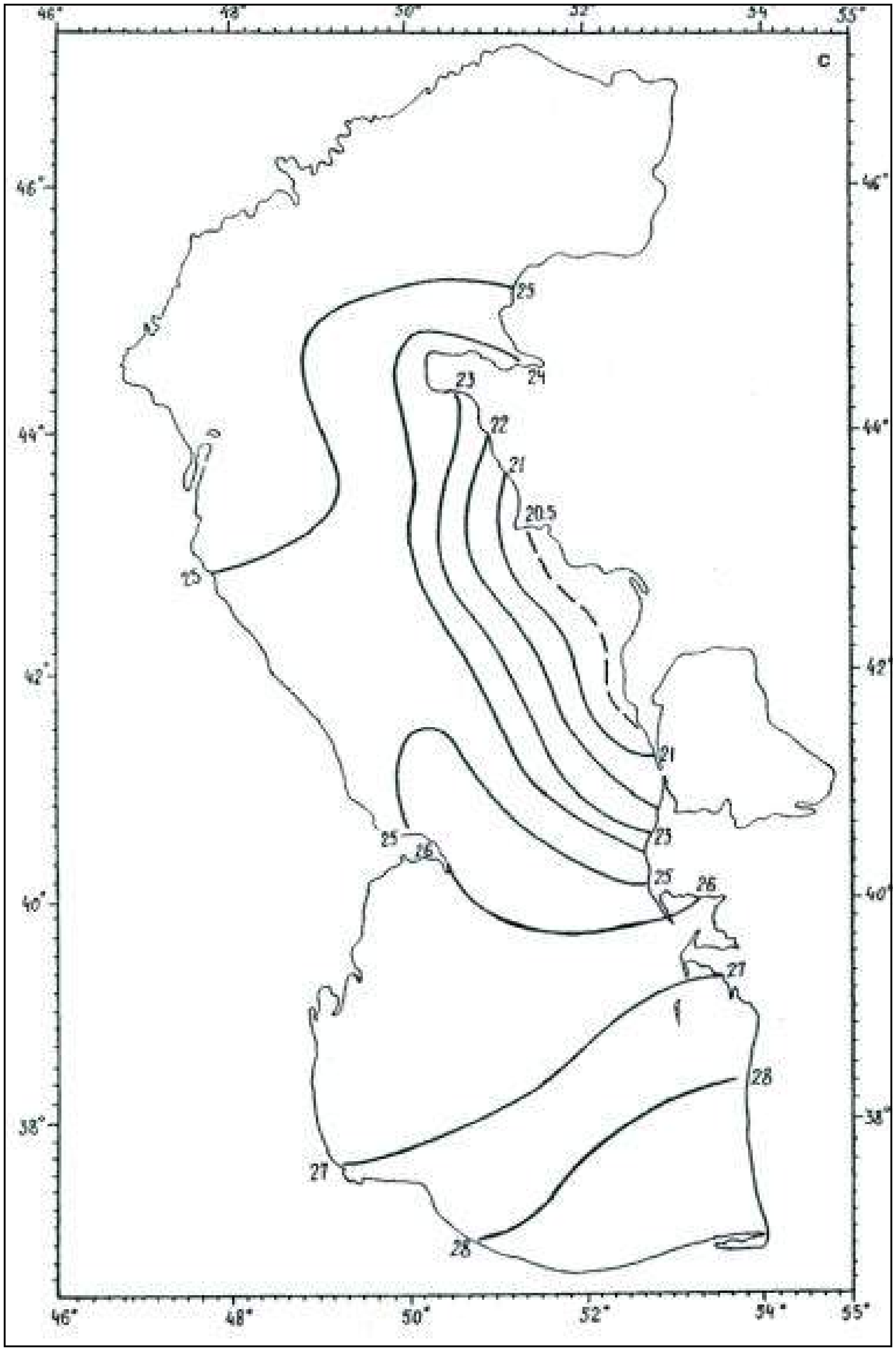


Figure 5. Characteristic surface water temperatures for the month of August (Kosarev, 1994).

3 Methodology

The objectives of the study were met through a series of integrated modeling stages. Hydrodynamic simulations were developed for the entire Caspian Sea, with highest resolution in the area offshore Baku, using ASA's HYDROMAP. Thermal dispersion simulations were conducted to characterize cooling water discharges using the OOC near-field dispersion modeling system; and simulations for the dispersion of sewage, drill cuttings and drilling fluids and cement were conducted using ASA's MUDMAP. The following sections provide a description of each modeling systems functionality and purpose.

3.1 HYDROMAP

HYDROMAP is an ocean/coastal circulation model that simulates the flow of ocean currents within a model region due to forcing by astronomical tides, wind stress and bottom friction efficiently for any location on the globe. HYDROMAP employs a novel dynamically-nested, rectangular griding strategy with a step-wise-continuous calculation of current speed and direction over changes in grid resolution. The term step-wise continuous implies that the boundaries between successively smaller and larger grids are managed in a consistent model time-step. Up to six levels of resolution may be used within the one grid domain allowing for resolution to be optimised for locations of greatest interest to a study.

To simulate ocean circulation over any area of interest, the model must be provided with the following basic data:

(1) Measured bathymetric data for the area, which is used to define the shape of the seafloor.

(2) The amplitude and phase of tidal constituents, which are used to calculate sea heights over time at the open boundaries of the model. Changes in sea heights are used, in turn, to calculate the propagation of tidal currents through the model region.

Tidal heights at the open boundaries of the model were calculated for real times using the latest Schwiderski Global tidal constituents, which provide worldwide estimates of the dominant tidal constituents at a horizontal scale of 1 degree (Schwiderski, 1979).

The numerical solution methodology follows that of Davies (1977 a, b) and Owen (1980). The resulting equations are based on a space staggered-grid scheme in the horizontal plane to define the study area. Sea surface elevation and vertical velocity are specified in the center of each cell while the horizontal velocities are given on the cell face.

To increase computational efficiency, a “split-mode” or “two-mode” formulation has been included (Owen, 1980; Gordon, 1982). In the split-mode, the free surface elevation is treated separately from the internal, three-dimensional flow variables. The free-surface elevation and vertically integrated equations of motion (external mode), is initially solved to ensure that the CFL (Courant-Friedrichs-Lewis) limit is met.

HYDROMAP has further been refined to separate the effects of surface gravity waves from the three-dimensional equations of motion (internal mode), this is to no-longer limit the internal mode calculations and much longer time steps are possible. A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Owen (1980).

3.2 OOC MODEL

The Offshore Operators Committee Mud and Produced Water Discharge Model (OOC Model), a validated near-field model, was used to examine the mixing and dilution of the thermal dispersion from seawater discharge in the vicinity of the discharge. The governing equations and solution methodology for the model was originally developed by Koh and Chang (1973) and extended by the work of Brandsma and Smith (1995), Smith *et al*., (1994), and Brandsma and Sauer (1983) for the convective phase and dynamic collapse phase of plume motion. The far-field (passive diffusion stage) employs a Lagrangian scheme of discrete clouds of particles with a defined mass. The model predicts the dynamics of the plume and concentrations in the near-field and the concentration and bottom deposition patterns in the far-field.

The four dimensional (space & time) model predicts the transport and dispersion of the discharged effluent through three independent, but integrated stages. Independent stages are necessary since the dilution of heated water occurs at different time scales and stages. The stages are:

Stage 1: **The convective (jet) phase** that predicts the initial dilution and spreading of the discharged material in the immediate vicinity of the release location. This initial dilution is driven by the buoyancy and momentum of the heated water as it is jettisoned from the discharge pipe.

Stage 2: **The dynamic collapse phase** that estimates the growth and dilution of the release cloud, as it impacts either the surface or bottom or becomes trapped by a strong density gradient in the water column.

Stage 3: **The dispersive phase** in which the model predicts the transport and dispersion of the discharged material caused by the local current system.

The model has been applied to many areas around the world, including the Gulf of Mexico, the North Sea (Terrens and Tait, 1994) and for the Halibut platform in Bass Strait, Australia (King and McAllister, 1998).

3.3 MUDMAP

MUDMAP is a personal computer-based model developed by ASA using similar principles to the OOC model to predict the near and far field transport, dispersion, and bottom deposition of drilling muds and cuttings, as well as water-based discharges such as produced water (Spaulding *et. al*; 1994; Spaulding, 1994). In MUDMAP, the equations governing conservation of mass, momentum, buoyancy, and solid particle flux are formulated using integral plume theory and then solved using a Runge-Kutta numerical integration technique. The model includes the same three stages employed by the OOC model: convective descent/ascent, dynamic collapse and far-field dispersion. Thus, MUDMAP allows the transport and fate of the release to be modeled throughout all stages of its movement. The initial dilution and spreading of the plume release is predicted in the convective descent/ascent stage. The plume descends if the discharged material is denser than the local water and ascends if the density is lower than that of the receiving water. In the dynamic collapse stage, the dilution and dispersion of the discharge is predicted when the release impacts the surface, bottom, or becomes trapped by vertical density gradients in the water column. The far-field stage predicts the transport and fate of the discharge caused by the ambient current and turbulence fields.

MUDMAP is based on the theoretical approach initially developed by Koh and Chang (1973) and refined and extended by Brandsma and Sauer (1983) for the convective descent/ascent and dynamic collapse stages. The far field, passive diffusion stage is based on a particle-based random-walk model. This is the same random walk model used in ASA's OILMAP spill modeling system (ASA, 1999). MUDMAP provides an embedded geographic information system, environmental data management tools, and procedures to input data and to animate model output. The system can be readily applied to any location in the world.

Spaulding *et. al.* (1994) presents an application of MUDMAP to predict the transport and deposition of heavy and light drill fluids off Pt Conception, California and the near field plume dynamics of a laboratory experiment for a multi-component mud discharged into a uniform flowing, stratified water column. King and McAllister (1996, 1998) present the application and extensive verification of the model for a produced water discharge on Australia's northwest shelf.

3.4 MDFATE

MDFATE was used to examine the likely deposition of the discharged cement. MDFATE (Multiple Dump Fate Model) was developed by the US Army Corps of Engineers to predict bathymetric changes resulting from ocean-disposal of dredged material. MDFATE simulates the short– and long-term behaviour of dumped material within an open water disposal site using two integrated models, STFATE and LTFATE, to predict the dispersion, settlement and re-transport of material by ocean currents, with resulting change in bottom thickness. The model may be used to model for single or multiple dumps of material. The MDFATE model has evolved from several earlier concepts (Moritz and Randall 1992). STFATE (Johnson 1990) and LTFATE (Scheffner et al., 1994) are numerical models developed at the U.S. Army Engineer Waterways Experiment Station.

The MDFATE model can be used to assist with the selection of the most efficient layout for a proposed disposal site.

For this application, all the short-term processes influencing disposed material were modelled to account for all momentum imparted to the material from the defined dump. These processes included convection, diffusion and impact with the bottom, with resulting re-suspension.

4 Hydrodynamic Simulations

4.1 Grid Generation and Bathymetry

The computational domain of the hydrodynamic simulation consisted of the entire Caspian Sea in order to minimize the complexity of environmental forcing data. The computational grid developed for this area was handled through the application of HYDROMAP's step-wise-continuous-rectangular griding strategy (Isaji 2001). Coarse grid resolution, on the order of 20 km, was sufficient to capture the large-scale dynamics and appropriate volumetric transport of water in the northern Caspian Sea. To refine the dynamic circulation within the immediate study area, the grid resolution was increased to approximately 5 km over the southern Caspian Sea (south of 41.5°N) and a very fine scale grid of 2.5 km was applied over the waters off Baku. Figures 6 and 7 show the entire computational grid and the fine resolution grid within the Baku region, respectively.

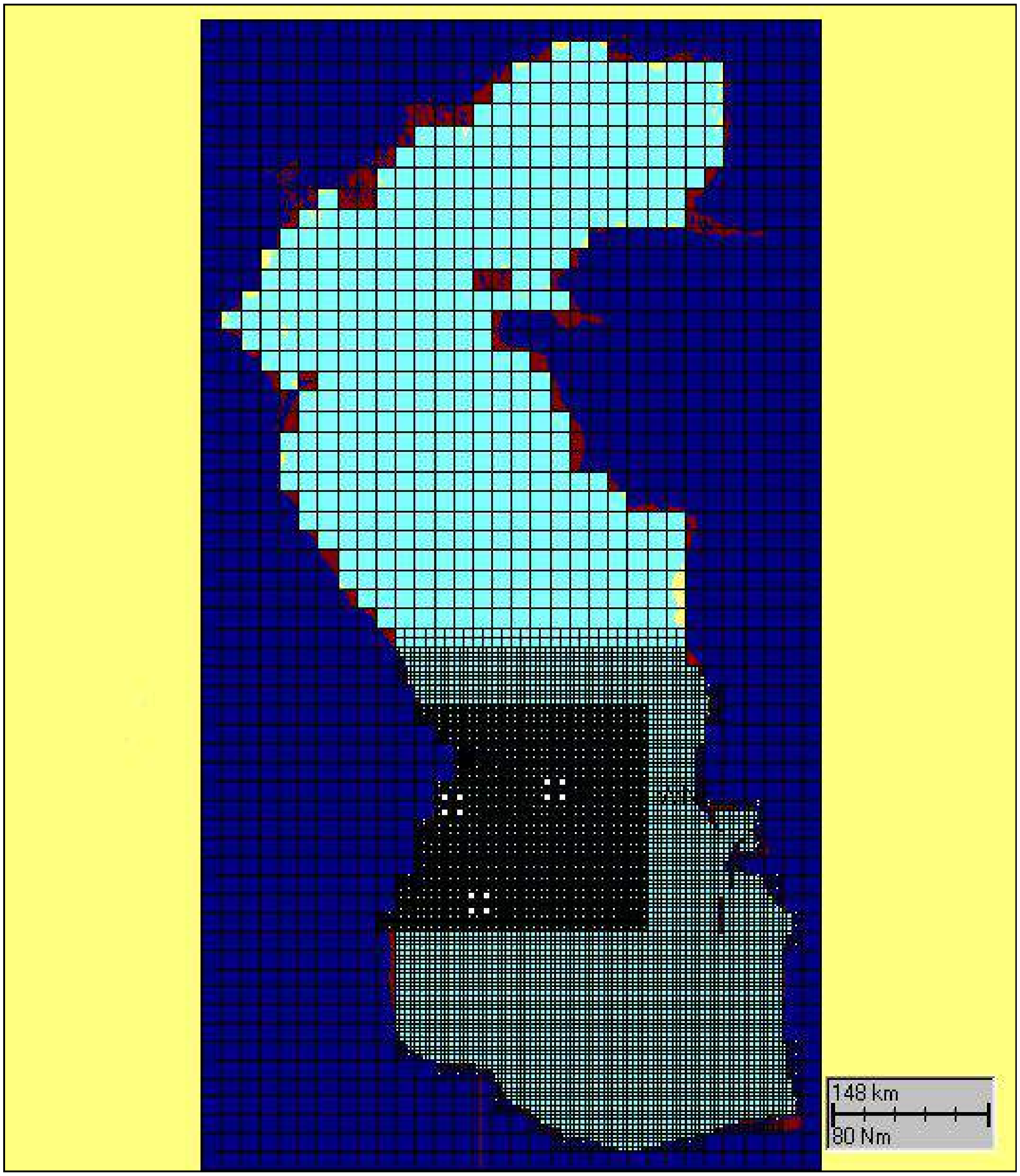


Figure 6. Computational grid for simulation of hydrodynamic circulation in the Caspian Sea.

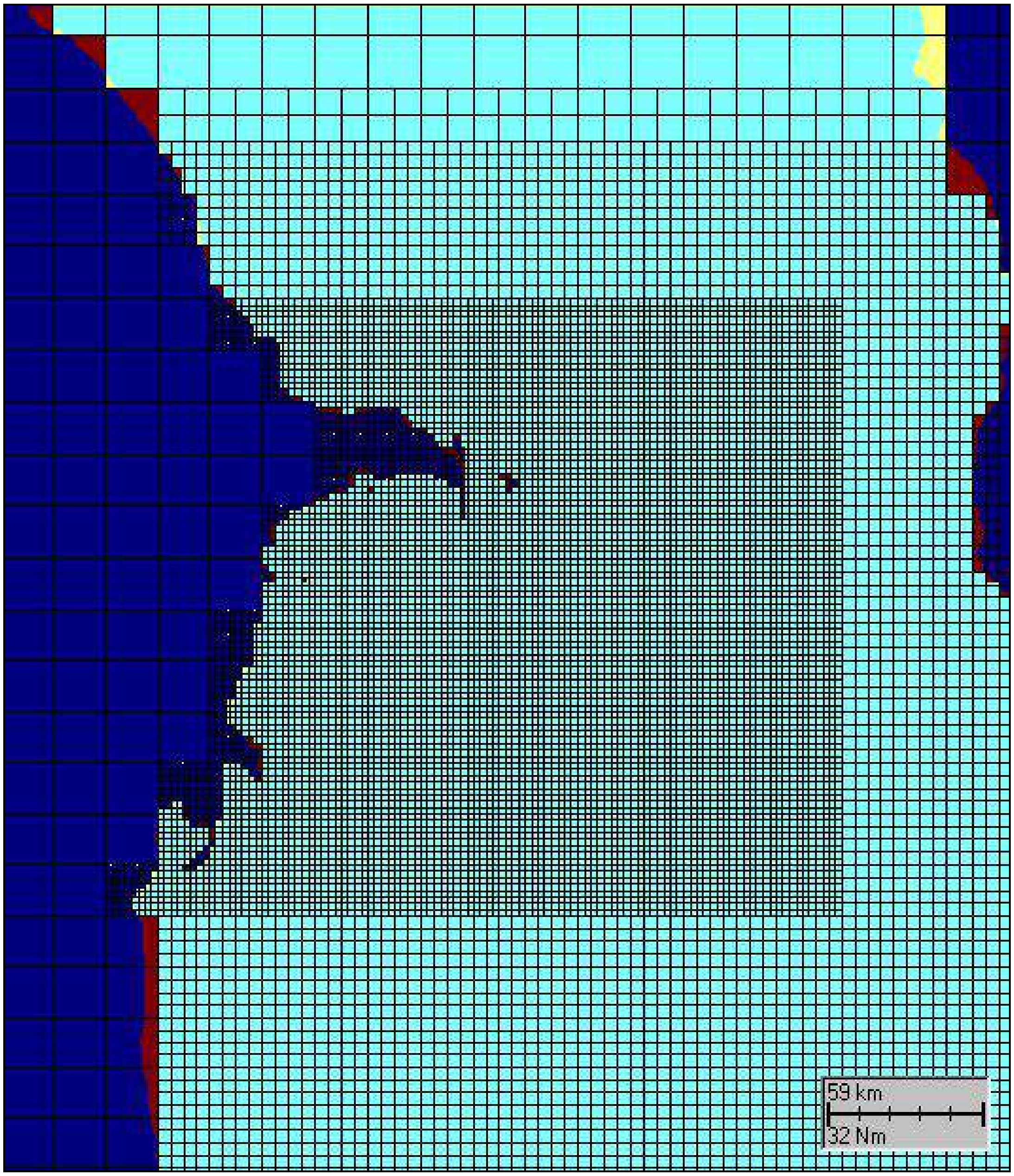


Figure 7. Details of the computational grid offshore Baku.

Each cell within the computational grid requires a discrete depth value. These data were developed from the navigational charts published by the Navigation and Oceanography Department of the Defence Ministry of the USSR and bathymetric isolines provided by the Caspian Environment Program (http://caspianenvironment.org). Figures 1 presents a sample of the bathymetric isoline offshore Baku.

4.2 Model Environmental Forcing Data

Environmental forcing data is used by the model to drive the circulation throughout the computational domain. This time-varying data can be river-flow inputs, atmospheric effects such as wind, air temperature, and solar radiation, tides and density gradients. Since the

Caspian Sea is an enclosed sea with no attachment to the world ocean the primary forcing is wind stress. The wind data used in this study are output from a numerical atmospheric model: NCEP model reanalysis, provided by the NOAA-CIRES Climate Diagnostics Center, Boulder, Colorado, from their Web site at *http://www.cdc.noaa.gov/*. Data from 18 model grid locations, covering the entire Caspian Sea, were downloaded from the NOAA/CDC ftp site for the 10m elevation for the years 1991 through 2000 (ten years). Wind roses for these data were generated in order to define seasonal patterns among months of the year. Figure 8 presents monthly wind roses for these 10 years of data from a model grid location at 41.68° N 50.77° E.

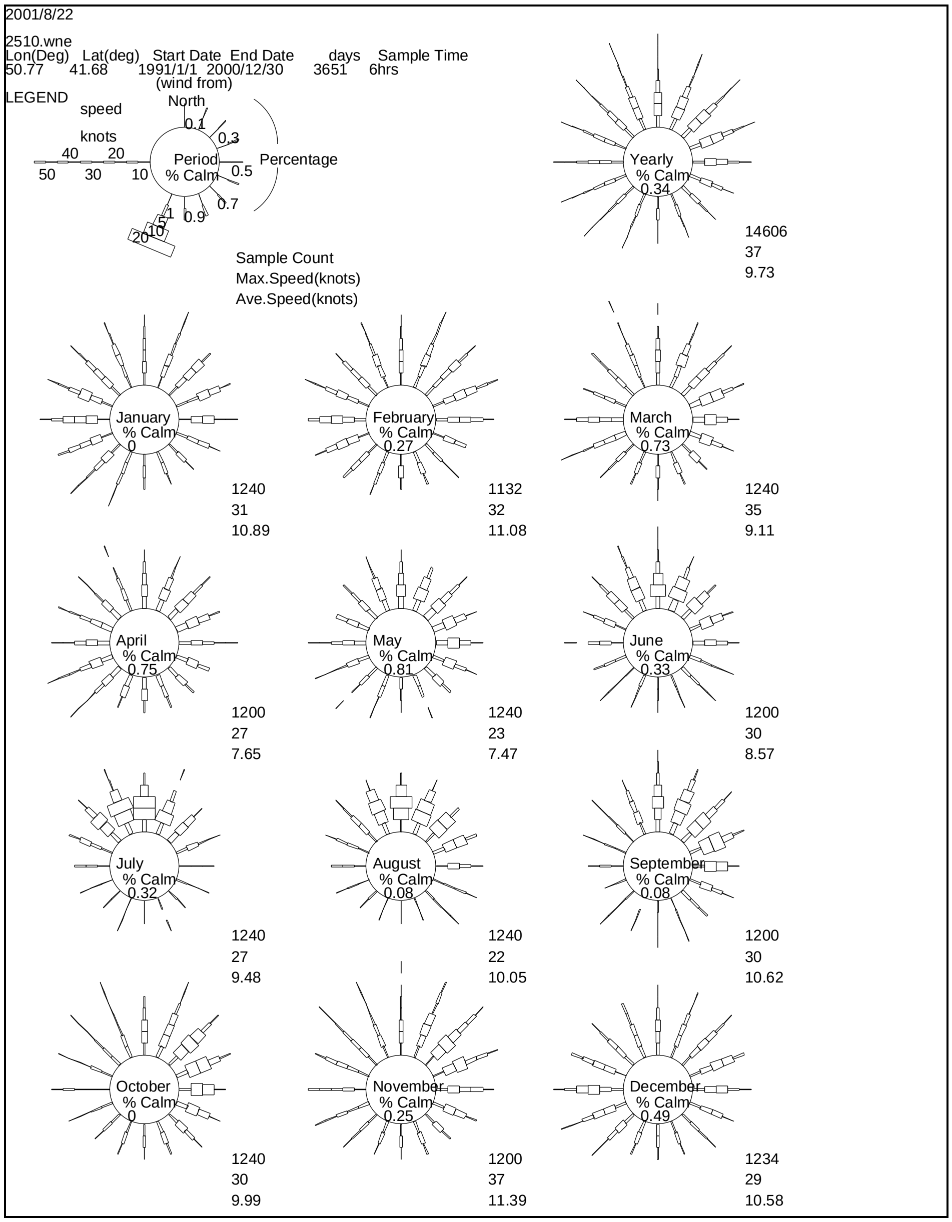


Figure 8. Wind rose generated from 10 years of NCEP model output at 41.68° N 50.77° E for the years 1991 through 2000.

Through inspection of the NCEP model output, the winter season was defined as December through January, while the summer season was defined as June through

August. Within each season, two 14-day periods were selected as inputs to dispersion modeling, based upon seasonal characteristics of the wind climatology.

Winter

- 01 January to 15 January 2000:-This period is characterized by strong winds primarily from the northeast.
- 15 January to 31 January 2000:- This period is characterized by strong winds highly varying from the north and south.

Summer

- 13 July to 28 July 2000:- This period is characterized by light variable winds predominantly from the northern and eastern quadrants.
- 02 August to 17 August 2000:-This period is characterized by strong winds predominantly from the north.

The year 2000 was determined to be a typical year because the wind rose for this year showed a similar distribution of wind speed and direction to the 10 year wind-rose. Figure 9 presents monthly wind roses for NCEP model output data for the year 2000 from the same grid location as the 10-year wind-roses shown in Figure 8.

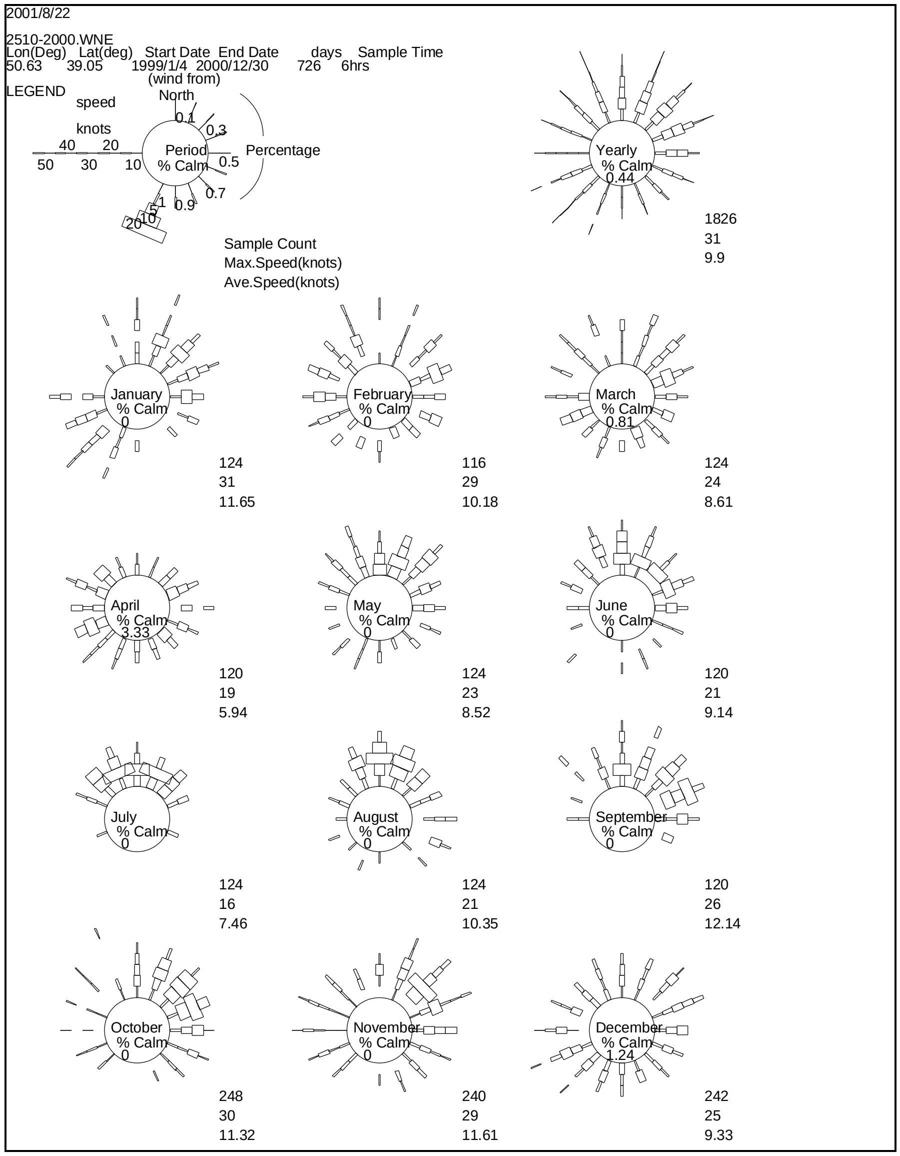


Figure 9. Wind rose generated from NCEP model output at 41.68° N 50.77° E for the year 2000.

4.3 Model Validation

The hydrodynamic model output was validated through comparison to current measurements collected by the Azerbaijan International Operating Company along a proposed pipeline route between Chirag and Sangachal in the South Caspian Sea for the winter season from 01 February 2000 to 01 April 2000. Figure 10 shows the location of the data collection points, which are designated KP174, KP145, KP115, KP85, KP65, and KP45. Note no data was available during this period for site KP85.

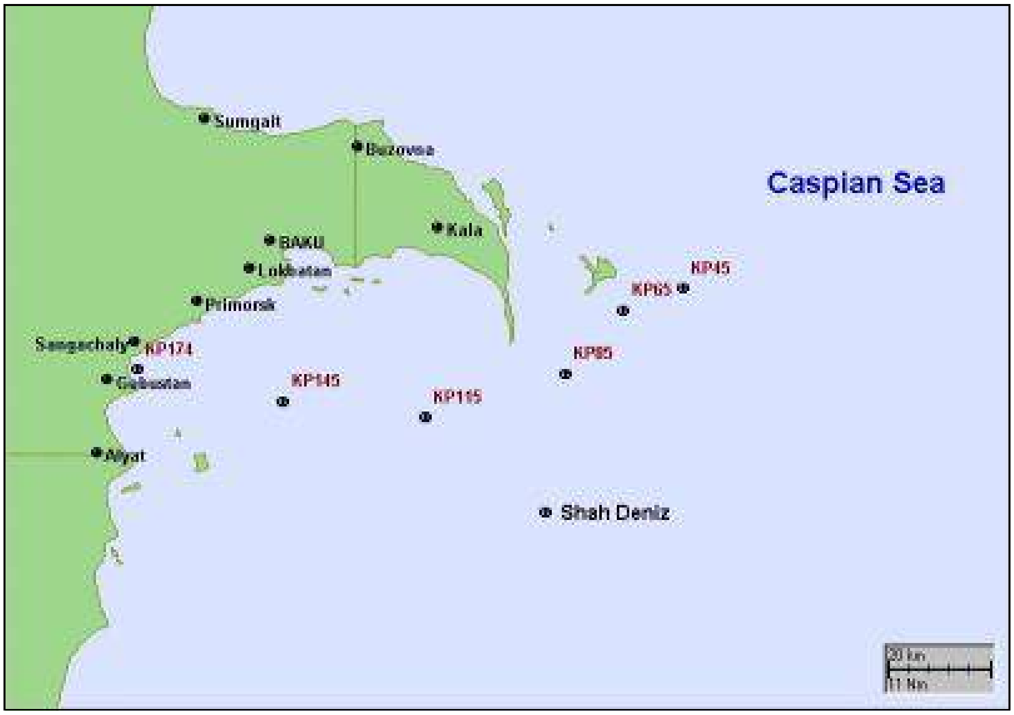


Figure 10. Current measurement data collection sites.

The observational data was prepared for comparison to the model predictions by first applying a band-pass filter with a frequency range of 12 and 0.25 cycles/day. This removed non-weather related events from the data sets. This filtering is appropriate because the only environmental forcing applied in the model was wind stress. Once filtering was complete, the data was sub-sampled to match the 1-hour output rate of the hydrodynamic model. The processed field data was compared to the model output using both qualitative and quantitative methods.

The qualitative comparison consisted of plotting the model output and current data together. This comparison provides information on the model's ability to predict the range of variability evident in the current data. Figures 11 through 15 present the qualitative model to data comparisons for the north-south (V) velocity component, the east-west velocity component (U), the current speed and direction as a function of time. At site KP174 (Figure 11), the model predicts the amplitude and variability of the V-component with reasonable accuracy, however the model under-predicts the U-component. At site KP145 (Figure 12), the model over-predicts the V-component at times but captures local events and features of the current. At site KP115 (Figure 13), the model is out of phase at times with the observed current and over-predicts certain events. At site KP65 (Figure 14), the model reproduces major trends extremely well, however the model is less energetic than the data for the U-component. At site KP45 (Figure 15), the model again reproduces the structure of the currents extremely well with slightly higher speeds during certain events.

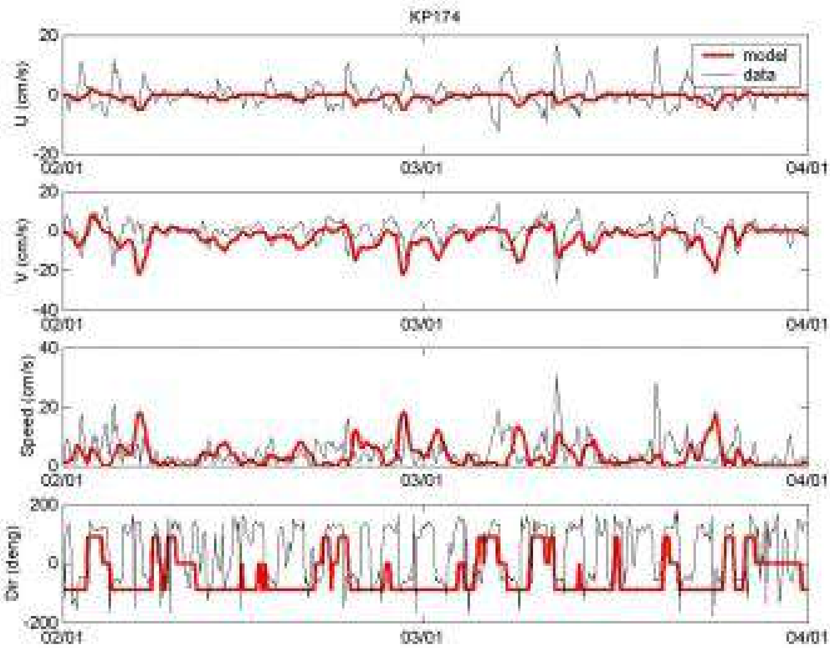


Figure 11. Qualitative model to data comparison at site KP174.

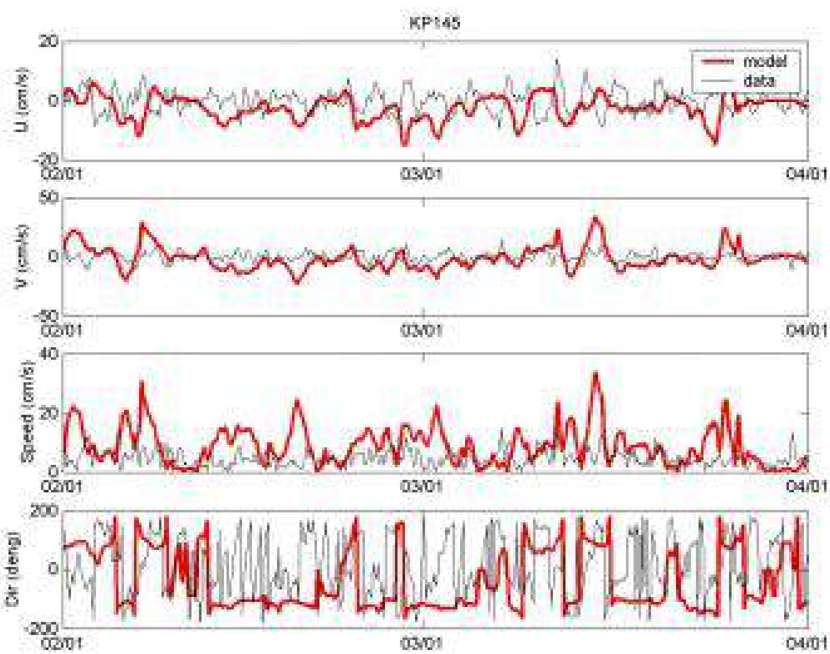


Figure 12. Qualitative model to data comparison at site KP145.

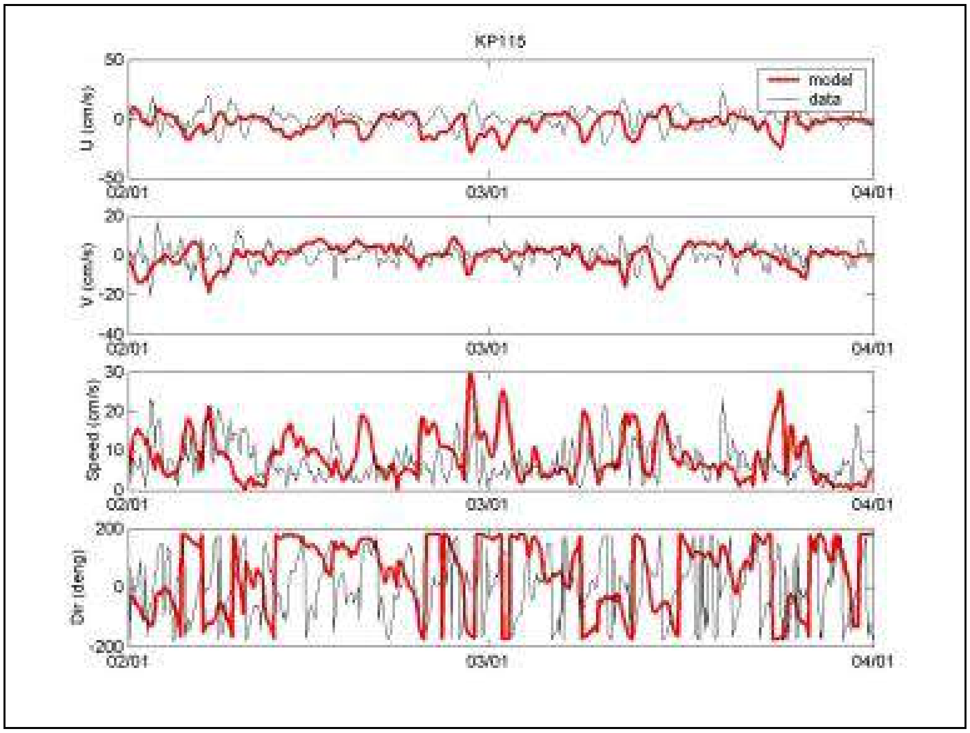


Figure 13. Qualitative model to data comparison at site KP115.

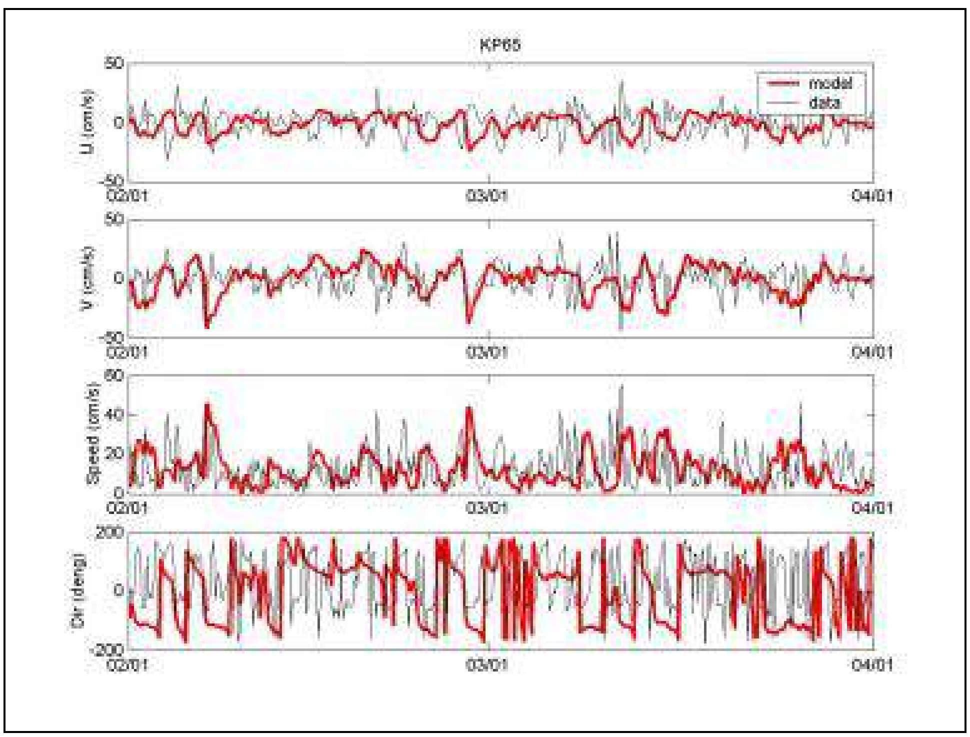


Figure 14. Qualitative model to data comparison at site KP65.

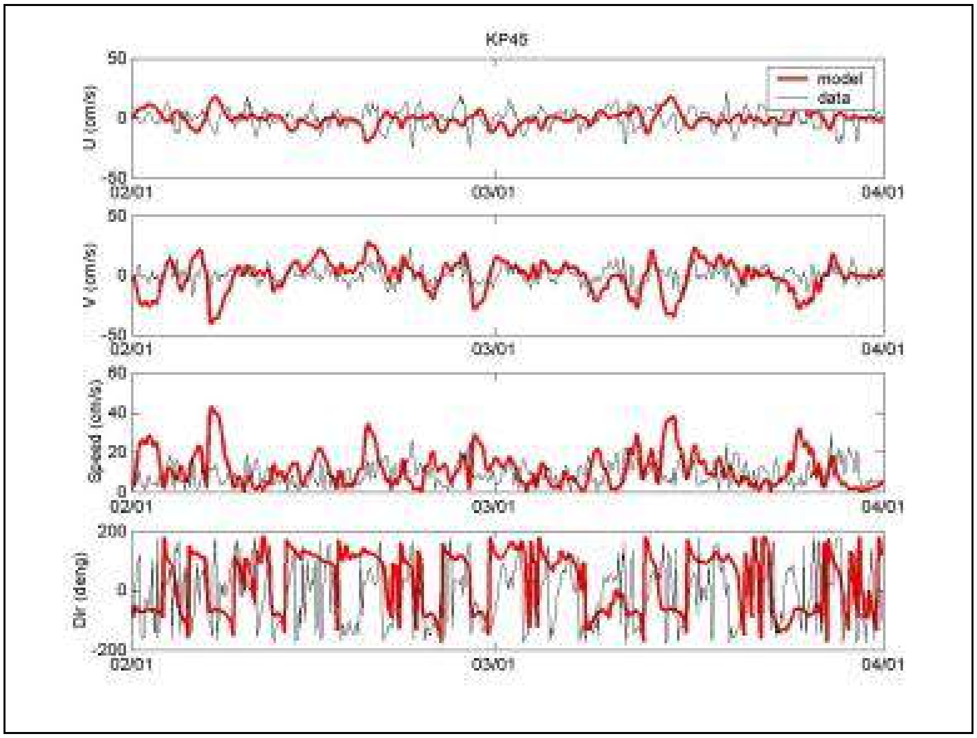


Figure 15. Qualitative model to data comparison at site KP45.

Quantitative comparisons are statistical measures that can be applied to model predictions and field data sets to provide a numerical assessment of the comparison. These statistical measures can be grouped into two major components: those measures that describe an individual set of data and those that relate the degree of difference between two data sets. The individual statistics (Table 2) used in this study are the mean speed, maximum speed and minimum speed of the model predictions and field data sets. The error statistic (Table 2) used in this study was the relative mean error which measures the difference between calculated and observed mean values and provides a useful indicator of model performance. The individual statistics show the model to be slightly less energetic than the data at site KP174 and KP65 and more energetic at sights KP145, KP115 and KP45. The relative mean error estimates are within the commonly accepted level of 30% as described by McCutcheon, *et. al.* (1990), except at site KP145. The overly energetic state of the model at this location is most likely due to some local bathymetric or shoreline characteristic not resolved by the computational grid.

4.4 Model Application

The hydrodynamic model was applied to simulate circulation patterns over the study region during each of the defined 14-day winter and summer sample periods. The ability of the model to reproduce circulation patterns reported by Klevtsova (1966; Figure 3) for summer and winter conditions is illustrated in Figures 16 and 17, respectively.

Table 2. Quantitative statistics for model to data comparisons.

Location	**Mean (cm/s)**		**Maximum (cm/s)**		**Minimum (cm/s)**		**Relative Mean Error (%)**
	Data	Model	Data	Model	Data	Model	
KP174	4.95	3.48	30.52	18.00	0.03	0.00	30
KP145	4.69	8.70	14.95	34.01	0.04	0.00	86
KP115	7.52	8.52	23.00	29.73	0.17	0.00	13
KP65	13.07	12.06	54.98	45.69	0.81	0.00	8
KP45	9.08	11.56	29.48	43.32	0.23	0.00	27

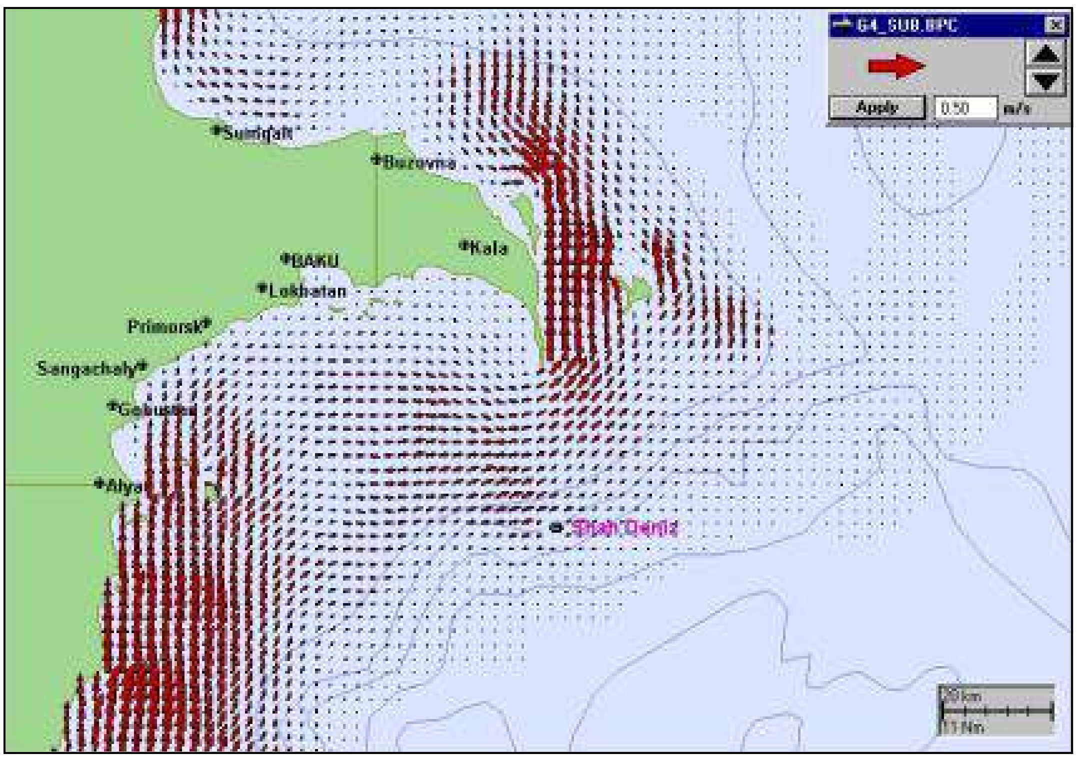


Figure 16. Characteristic hydrodynamic model output for the winter season.

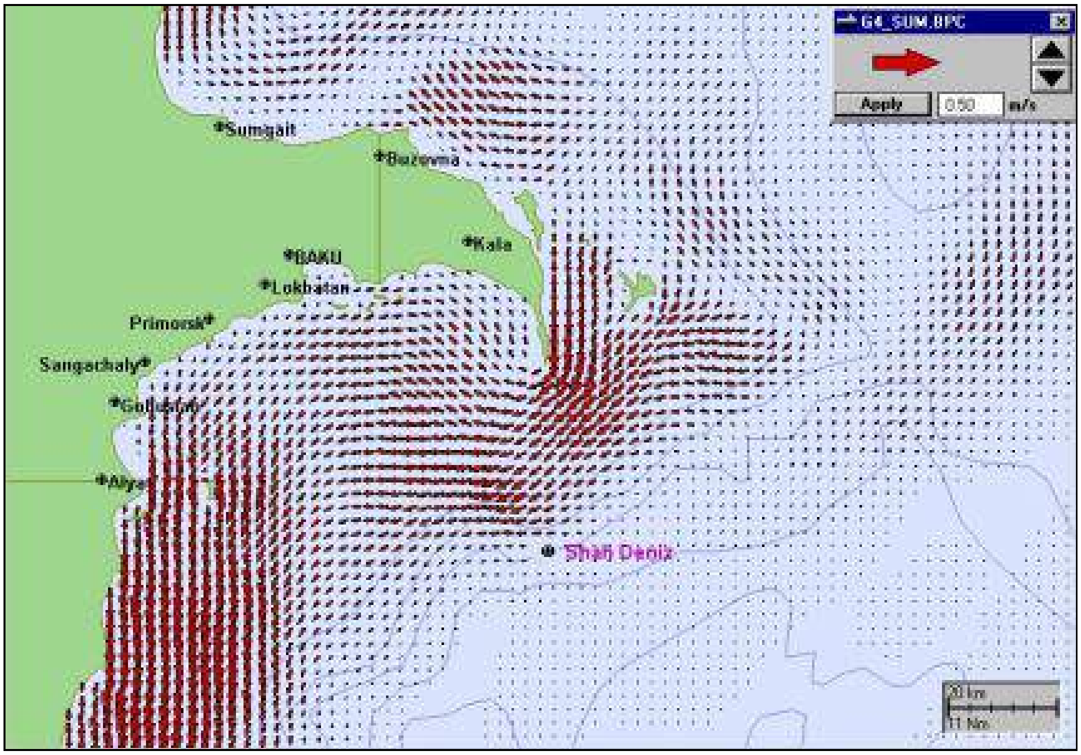


Figure 17. Characteristic hydrodynamic model output for the summer season.

5 Thermal Dispersion

Seawater is used on the Shah Deniz platform as a cooling medium. The cooling water is drawn from a depth of 50 m through one of the legs of the platform and returned to the sea through a 900 mm diameter caisson penetrating one of the other legs. The Shah Deniz project sought an assessment of the likely mixing and dilution patterns for the cooling water after discharge to the receiving waters. The modeling assessment had two main aims:

a. Firstly, to determine whether the proposed design configuration will meet environmental standards for thermal dispersion. The World Bank Standard for cooling to within ± 3°C of ambient temperature at 100m from the discharge point was adopted as the required standard.

b. Secondly, to determine the likelihood that discharged cooling water would be drawn up by the inlet before cooling to near-ambient temperatures (+ 1°C), leading to recirculation of heat.

5.1 Discharge configurations

BP Exploration Ltd provided detailed information on the composition of the cooling water and the potential volumes that would be released (Table 3). These details were used to configure the thermal-plume module of the OOC model. The model was used to examine the mixing and dilution of the plume given combinations of practical options for the release depth (10, 30 or 50 m) and orientation (horizontal or vertical) of the discharge pipe. The discharge was assumed to have the same temperature, discharge rate and initial discharge velocity in each case.

Table 3: Summary of discharge settings used by the thermal-plume model

Discharge Rate	1000m^3/hr
Pipe Diameter	900mm
Pipe Depth	10m, 30m or 50m
Pipe Orientation	Vertical (downwards) or Horizontal
Pipe bearing (if horizontal discharge)	West (270 degrees) *
Period of Discharge	Continuous
Discharge Duration	5 days
Cooling Water Temperature	
- Summer	40 ^oC
- Winter	25 ^oC
Cooling Water Salinity	4 ppt

* Note: for the horizontal discharge simulations, it was assumed that the pipe would point to the west, based on design plans supplied by BP EXPLORATION LTD .

5.2 Platform Wake Effects

In the OOC model, the effects of the wake of the drilling and production platform are accounted for by introducing quasi-random fluctuations of the positions and sizes of the cooling water clouds down-current of the platform. This is based on studies of wake intensity by Lin and Pao (1979). The magnitude of the fluctuations in flow depends on ambient conditions and on the underwater configuration of the platform. Table 4 contains the data that were used to specify the structural configuration used in estimating the wake effects.

Table 4: Structural configuration used in estimating the wake effects

Platform length	80m
Platform width	58.2m
Working draft	Negligible
Diameter of submerged structural members	15.5m
Spacing of structural members	39.82m

5.3 Model Grid

Due to the rapid mixing and small scale affect of the cooling water discharge, it was necessary to use a very fine grid to track the trajectory of the plume. The model was run using a square grid with 0.61m (2 feet) resolution.

5.4 Hydrodynamic input

Initial simulations showed that the thermal plume discharges would cool within seconds of discharge. Thus, it was appropriate for the simulations to be conducted in a parametric manner under constant current conditions (Table 5). Note also that the average current in the region is small compared to the discharge velocity defined for all discharge configurations. Consequently, transport of the near-field thermal plume was expected to be mainly from momentum and buoyancy and minimal contribution by the ambient current.

Based on the above assumption, a single uniform current was used as input into the OOC model to determine the level of mixing and dilution of the cooling water discharge (see Table 5). Predictions from the hydrodynamic model, data presented by Klevstova (1966), and field measurements described in section 4.3 indicate that current velocities will typically reach 10-20 cm/s with light winds, 30 cm/s due to moderate winds and 40-50 cm/s under the influence of strong winds (Figures 3 and 12 - 15). A current speed of 10 cm/s was used to represent current velocities under light wind conditions, when dispersion rate would be at the low end of the range expected at the site. Separate simulations were carried out with the winds blowing northward and southward (Table 5).

Table 5: Current speed and direction

Season	Current speed	Direction
Summer	10 cm/s	Southward
Winter	10 cm/s	Northward

5.5 Receiving Environment

The vertical structure of temperature for each season was developed from data provided by URS Dames and Moore and characteristic temperature profiles for the entire southern Caspian Sea as presented in Kosarev and Yablonskaya (1994). The summer season is characterized by two dominant thermal layers with surface and bottom temperatures of approximately 25 and 7°C, respectively, with the major thermocline at approximately 40m depth. The winter season is characterized as thermally well mixed with an average temperature of 7°C and surface to bottom gradients no greater than 1°C. Table 6 presents the vertical temperature structure used for the cooling water thermal dispersion simulations.

Table 6: Seasonal vertical structure for water temperature.

Depth (m)	Summer Temperature (°C)	Winter Temperature (°C)
Surface	25.0	7
10	24.1	7
20	24.0	7
30	24.0	7
50	9.3	7
75	7.9	7
100	7.3	7

5.6 Cooling Water Results

5.6.1 Influence of discharge depth and orientation

Tables 7 and 8 present results for combinations of discharge depth and pipe orientation for both summer and winter conditions. Results are summarized as the depth of the plume centerline at the point where the plume reaches a temperature +3°C above ambient (Plume Depth), the maximum horizontal distance the +3.0 °C above ambient contour travels from the discharge site (Plume Travel), and the overall radius of the +3.0 °C above ambient contour (Plume Radius). The plume radius is defined as orthogonal to the plume centeline. The additional measure of plume area is the sectional area of this orthogonal section to the centerline.

Simulations indicated that the defined thermal discharge should cool rapidly on discharge into the receiving waters. Cooling to +3°C above ambient water temperature was predicted to occur within 10-12 m of the discharge point under all combinations of discharge configurations and seasonal conditions that were tested (Tables 7-11). Thus, the discharge should meet the World Bank Standard for cooling water to return to within 3°C of ambient temperature at 100m from the discharge point, irrespective of the depth and orientation that is chosen.

Results indicated that the orientation of the discharge would influence the distance traveled before +3°C above ambient, as well as the shape and area of the cooling cloud. The horizontal discharge was predicted to spread as north or south component, but also in a westerly direction, which was not the case for the vertical release (see Table 7 and 8). Note that in all cases, the plume was predicted to travel further to the west before cooling to +3°C above ambient than in the direction of the current. Model results from the vertical discharge showed that there was no initial horizontal velocity and the downward vertical velocity of the jet is progressively damped through buoyancy before a point is reached where the plume begins to rise. All horizontal movement, apart from lateral expansion of the plume, would be due to the ambient currents in this case.

A comparison between the horizontal and vertical simulations for a given discharge depth and season, indicated that there would be a marginally higher dilution rate from a horizontal discharge and that the area affected by the plume should be less (Tables 7–10). For example, during summer the plume area (measured perpendicular to the plume centerline) was predicted to range from 6.8 m to 8.6 m for the horizontal discharge, depending upon the discharge depth, and from 10.1 to 13.8 m for the vertical discharge. Other co-variables that were found to affect the plume area were the season (involving the overall ambient water temperature) and the discharge height (interaction with the vertical temperature structure).

Table 7: Predictions for cooling to within 3°C of ambient temperature during summer

Depth	Port Orientation	Plume travel (south) (m)	Minimum Plume depth (m)	Plume travel (west) (m)	Plume Radius(m)	Plume Area (m^2)
10m	Vertical	2.67	9.07	0.00	1.79	10.06
	Horizontal	2.79	5.22	4.35	1.62	8.23
30m	Vertical	2.57	30.46	0.00	1.79	10.08
	Horizontal	2.30	25.83	4.11	1.47	6.77
50m	Vertical	3.23	48.29	0.00	2.10	13.80
	Horizontal	2.58	45.13	4.19	1.65	8.59

Table 8: Predictions for cooling to within 3°C of ambient temperature during winter

Depth	Port Orientation	Plume travel (north) (m)	Plume depth (m)	Plume travel (west) (m)	Plume Radius(m)	Plume Area (m^2)
10m	Vertical	2.85	11.83	0.00	2.42	18.39
	Horizontal	2.68	7.77	4.36	2.00	12.56
30m	Vertical	2.95	31.79	0.00	2.31	16.78
	Horizontal	2.68	27.77	4.36	2.00	12.56
50m	Vertical	3.08	51.75	0.00	2.31	16.78
	Horizontal	3.06	47.52	4.53	2.13	14.27

The second objective of the thermal plume modeling was to estimate the potential for heat to be recirculated between the discharge and inlet sites on the facility. A temperature differential of +1°C was used as the minimum threshold for this outcome. Tables 9 and 10 present results for the thermal plume modeling based on a return of the plume to within +1°C above ambient temperature. As noted previously, the horizontal discharges were predicted to result in movement to the west as well as down-current.

The inlet pipe is located approximately 40m to the southeast from the discharge point. Thus, the greatest risk of recirculation should exist during summer, when the prevailing current is to the south. The maximum distance the plume was predicted to travel south from the discharge before cooling to within +1°C above ambient was 7m during summer, about 17% of the distance, which indicates that recirculation is unlikely. The plume was predicted to travel up to 12 m down-current during the winter before cooling to +1°C above ambient. However, the prevailing winter currents flow away from the inlet.

Results also indicated that the thermal discharges will be vertically separated from the intake point because the intake is planned for 50 m depth and the plume was predicted to rise above this depth in each case. Results from the 10m and 30 m discharge options indicate that there would be at least 20 m vertical separation even in the situation where plumes had not cooled to +1°C above ambient before reaching the horizontal position of the inlet. The margin for error for the 50 m discharge is of the order of a few meters of vertical separation only.

During summer, when the discharge is expected to average 40°C and the water is thermally stratified, there would be a 15°C temperature differential compared to the top 10-30 m and over 30°C differential around the 50 m discharge level. The horizontal discharges were predicted to rise 8 to 10 m above the discharge depth before cooling to +3°C above ambient, while the vertical discharges were predicted rise 2 to 4 m above the discharge depth before cooling to this level. Results for the 10 m vertical discharge under summer temperatures indicated that the plume would reach the surface layer before cooling to +1°C above ambient. During winter, when the cooling water is expected to average 25°C, and the water column will be 7°C throughout the depth range, the temperature differential would be reduced to 18°C, irrespective of the depth level. Under these conditions, the plume area was predicted to be about 50% greater than the area predicted for equivalent discharge configurations during summer.

Based on minimizing the plume area during year-round operations, the 30 m horizontal discharge was predicted to be the optimum discharge configuration. This was predicted to result in a plume area of approximately 6.8 m^2 during summer and 12.6 m^2 during winter (Tables 7 and 8).

Figures 18-35 show the plume trajectory, to within 1^{o}C of ambient temperature, as a function of depth and distance for each of the pipe configurations and the varying depths.

Table 9: Predictions for cooling to within 1^{o}C of ambient temperature during summer

Depth	Port Orientation	Plume travel (south) (m)	*Plume depth (m)	Plume travel (west) (m)	Plume Radius (m)	Plume Area (m^2)	Minimum Dilution
10m	vertical	5.9	5.1	0.0	2.6	21.0	9.08
	horizontal	5.7	1.6	5.2	2.4	18.7	8.11
30m	vertical	6.3	24.7	0.0	2.7	23.1	10.45
	horizontal	6.9	20.0	5.4	2.7	23.3	10.57
50m	vertical	4.8	46.8	0.0	2.8	23.8	8.16
	horizontal	4.7	43.2	4.9	2.6	21.2	6.56

Table 10: Predictions for cooling to within 1^{o}C of ambient temperature during winter

Depth	Port Orientation	Plume travel (north) (m)	*Plume depth (m)	Plume Travel (west) (m)	Plume Radius (m)	Plume Area (m^2)	Minimum Dilution
10m	vertical	11.0	7.3	0.0	3.7	43.0	11.87
	horizontal	8.8	4.4	5.8	3.7	42.0	11.55
30m	vertical	11.0	27.3	0.0	3.7	42.9	13.01
	horizontal	9.4	24.1	5.9	3.8	40.4	11.84
50m	vertical	11.9	46.8	0.0	3.9	57.7	15.6
	horizontal	9.4	44.1	5.9	3.8	45.1	13.81

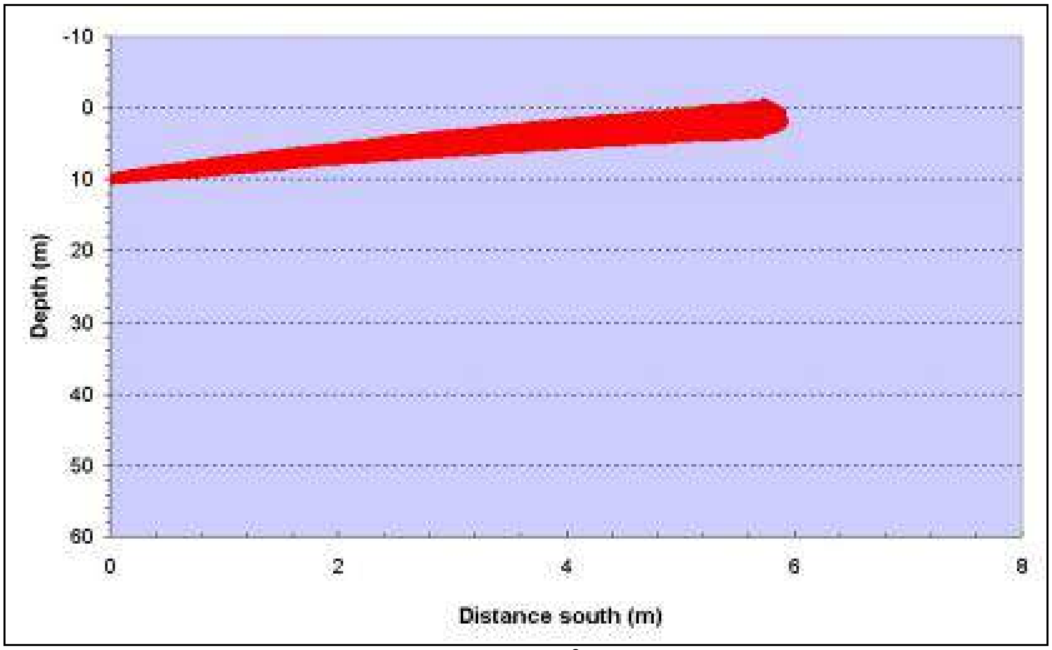


Figure 18: Shows the plume trajectory, to within 1^{o}C of ambient temperature, as a function of depth and distance when released horizontally from a 10m depth during summer.

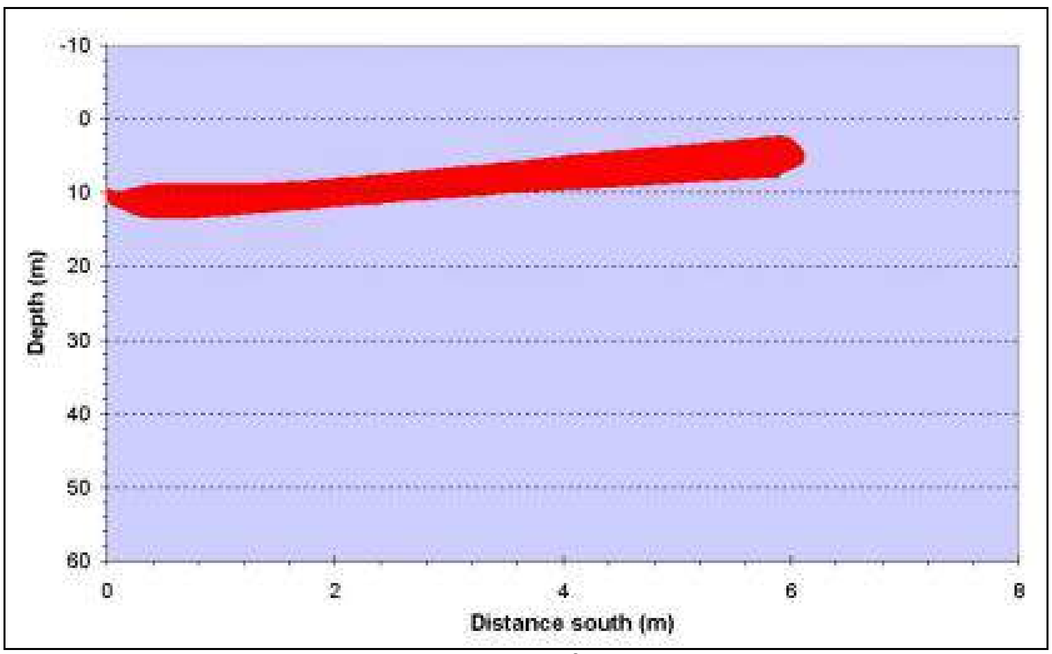


Figure 19: Shows the plume trajectory, to within 1^{o}C of ambient temperature, as a function of depth and distance when released vertically from a 10m depth during summer.

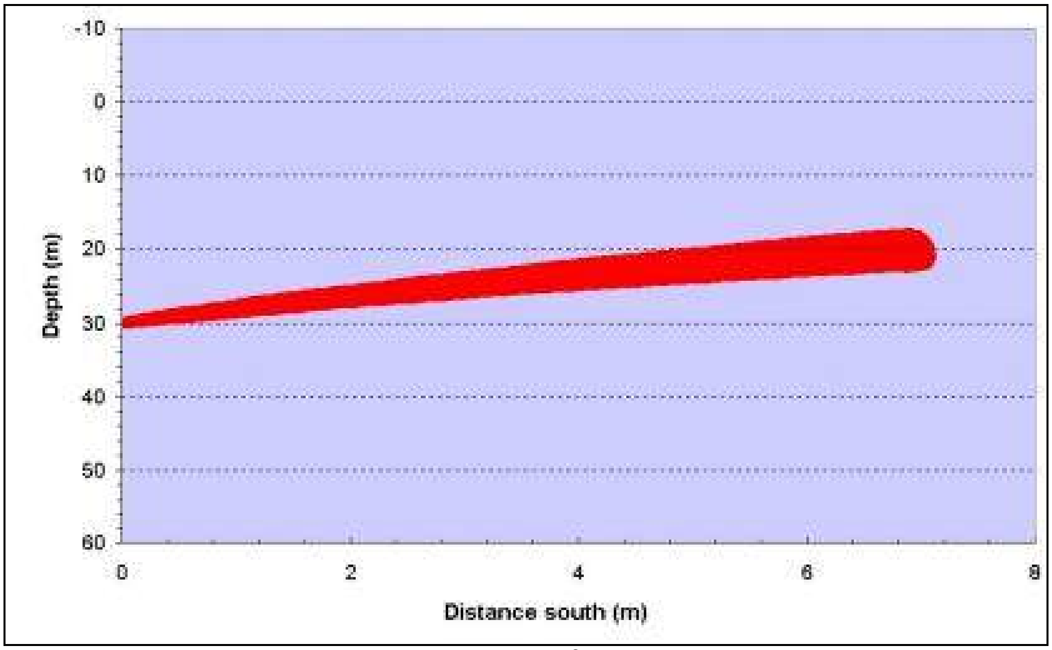


Figure 20: Shows the plume trajectory, to within 1^{o}C of ambient temperature, as a function of depth and distance when released horizontally from a 30m depth during summer.

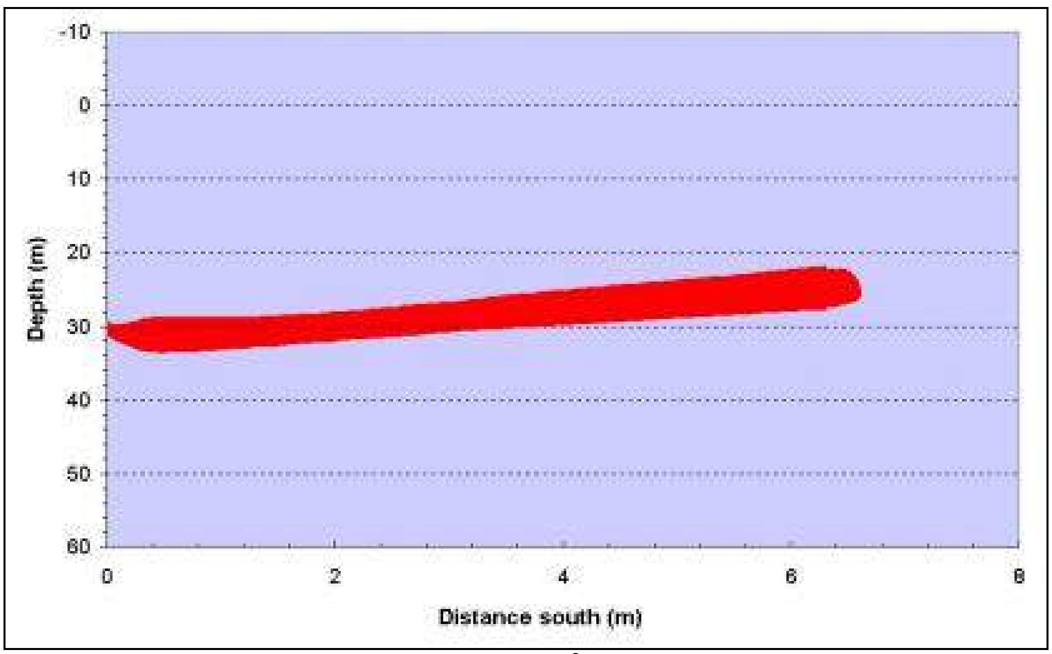


Figure 21: Shows the plume trajectory, to within 1^{o}C of ambient temperature, as a function o depth and distance when released vertically from a 30m depth during summer.

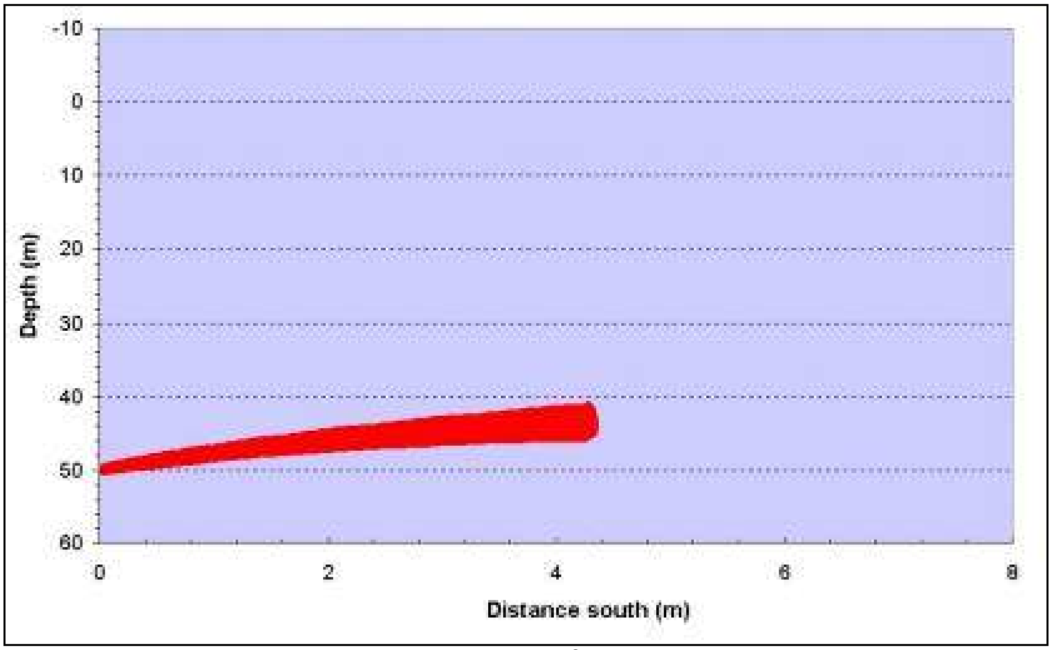


Figure 22: Shows the plume trajectory, to within 1^{o}C of ambient temperature, as a function of depth and distance when released horizontally from a 50m depth during summer.

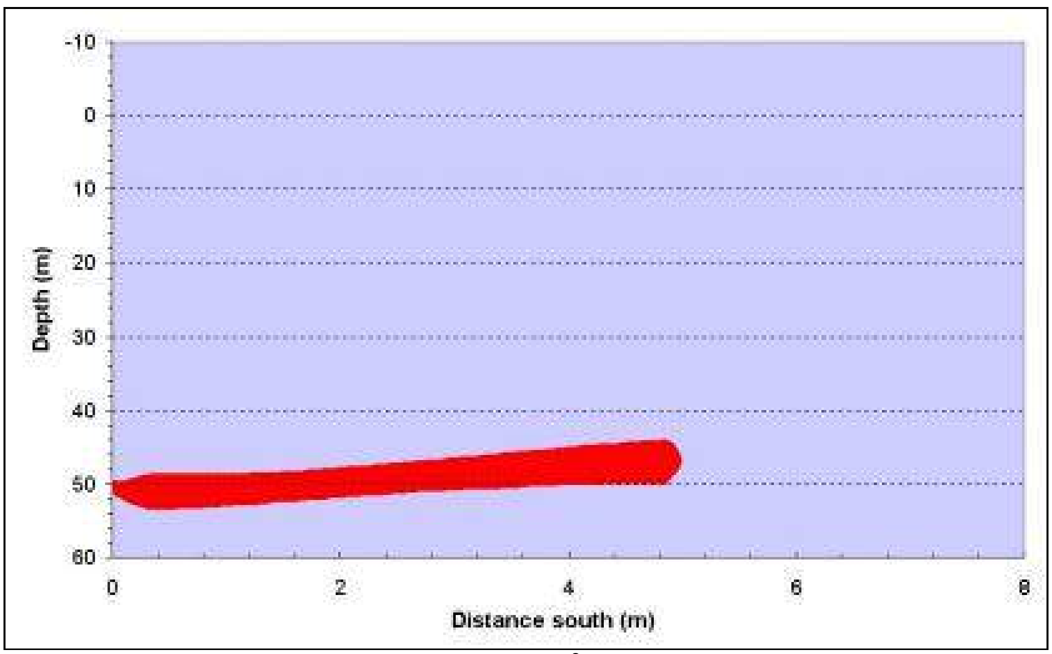


Figure 23: Shows the plume trajectory, to within 1^{o}C of ambient temperature, as a function of depth and distance when released vertically from a 50m depth during summer.

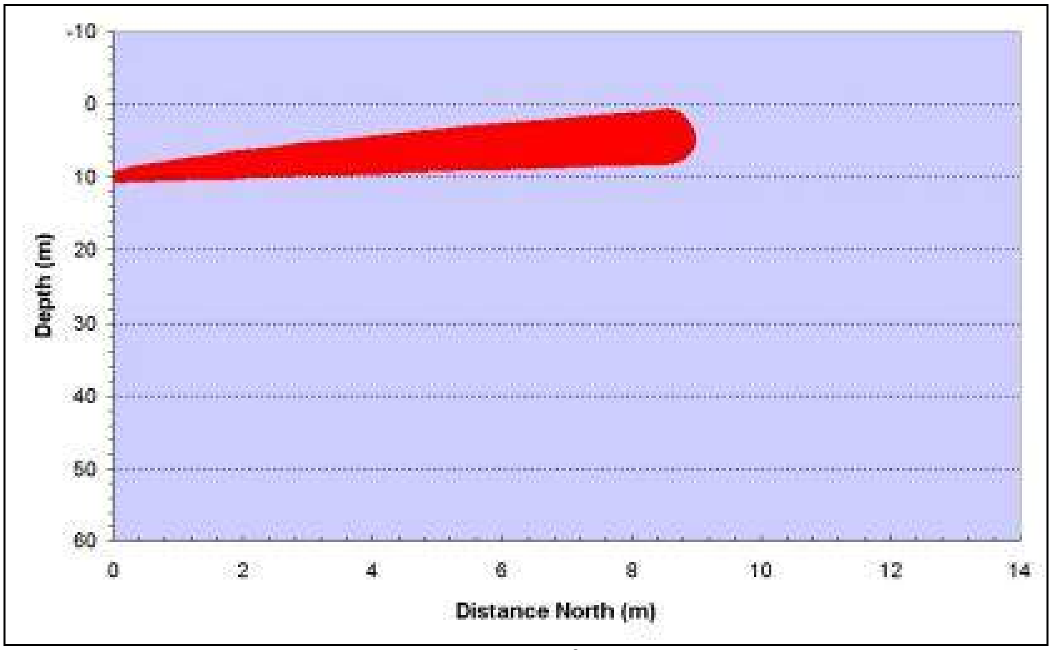


Figure 24: Shows the plume trajectory, to within 1^{o}C of ambient temperature, as a function of depth and distance when released horizontally from a 10m depth during winter.

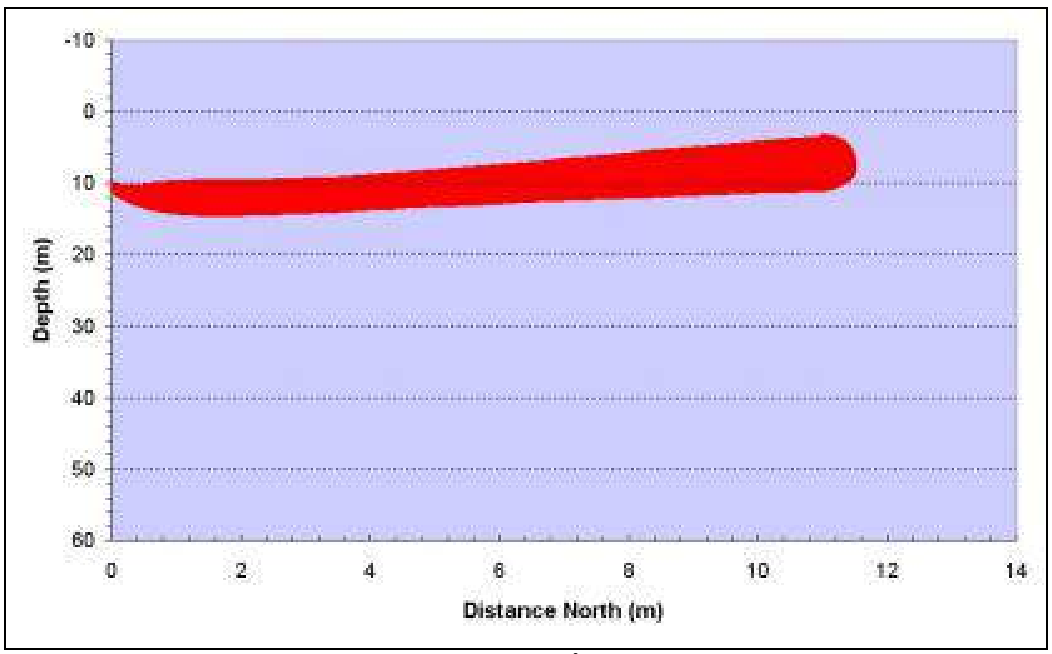


Figure 25: Shows the plume trajectory, to within 1^{o}C of ambient temperature, as a function of depth and distance when released vertically from a 10m depth during winter.

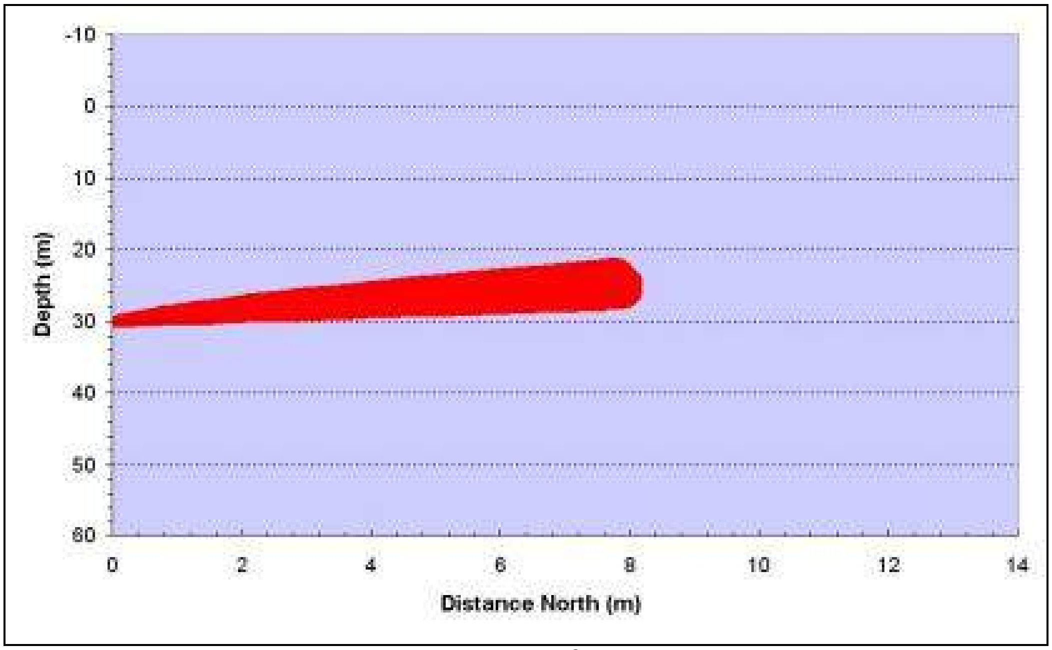


Figure 26: Shows the plume trajectory, to within 1^{o}C of ambient temperature, as a function of depth and distance when released horizontally from a 30m depth during winter.

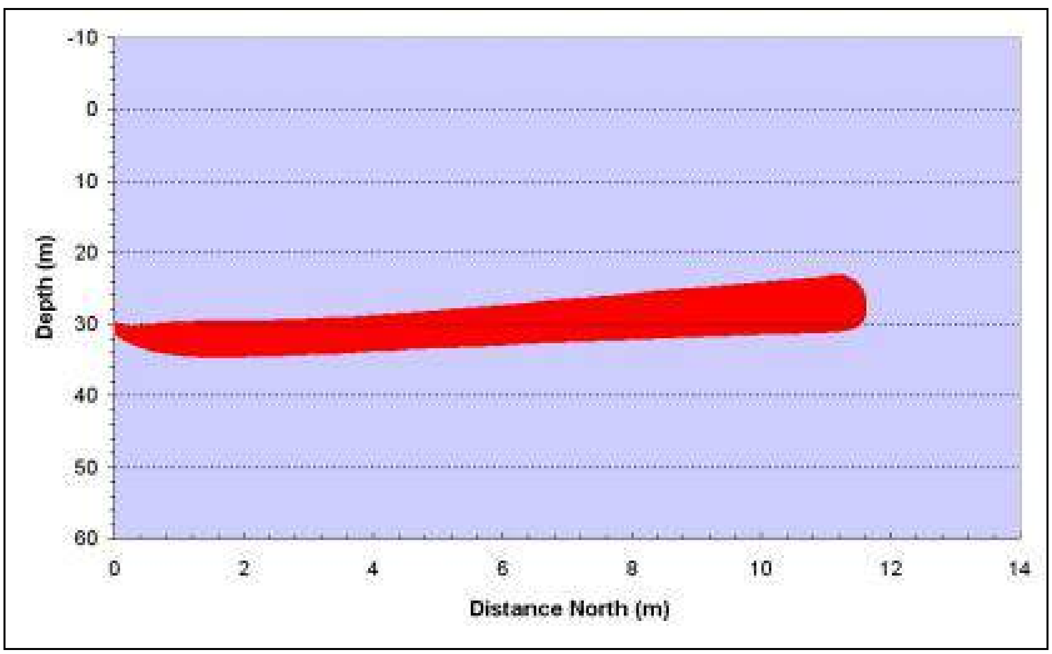


Figure 27: Shows the plume trajectory, to within 1C of ambient temperature, as a function of depth and distance when released vertically from a 30m depth during winter.

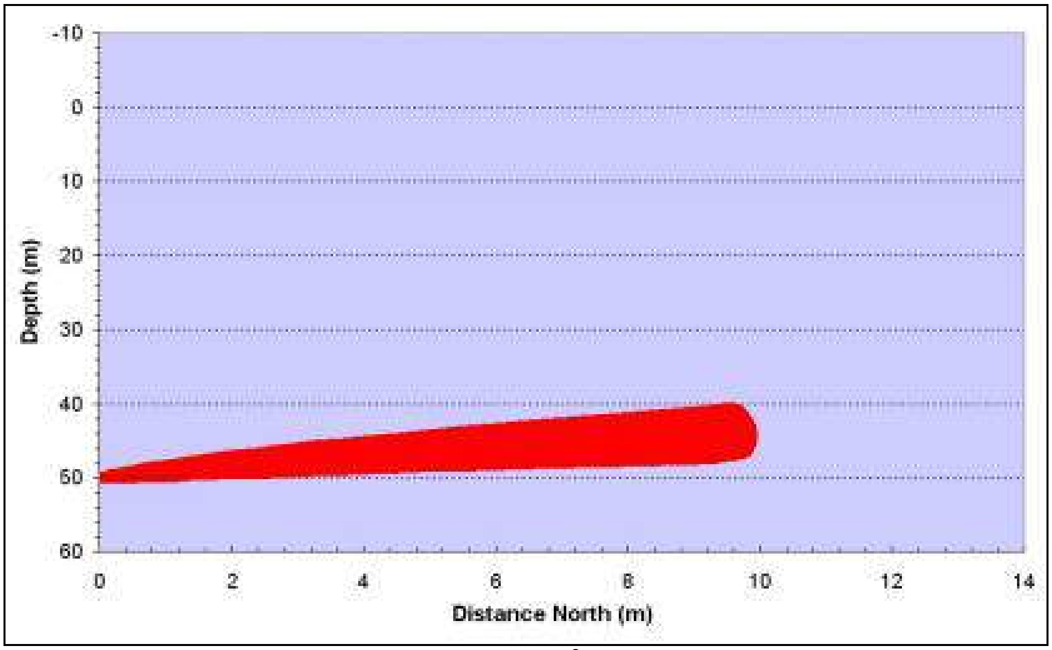


Figure 28: Shows the plume trajectory, to within 1°C of ambient temperature, as a function of depth and distance when released horizontally from a 50m depth during winter.

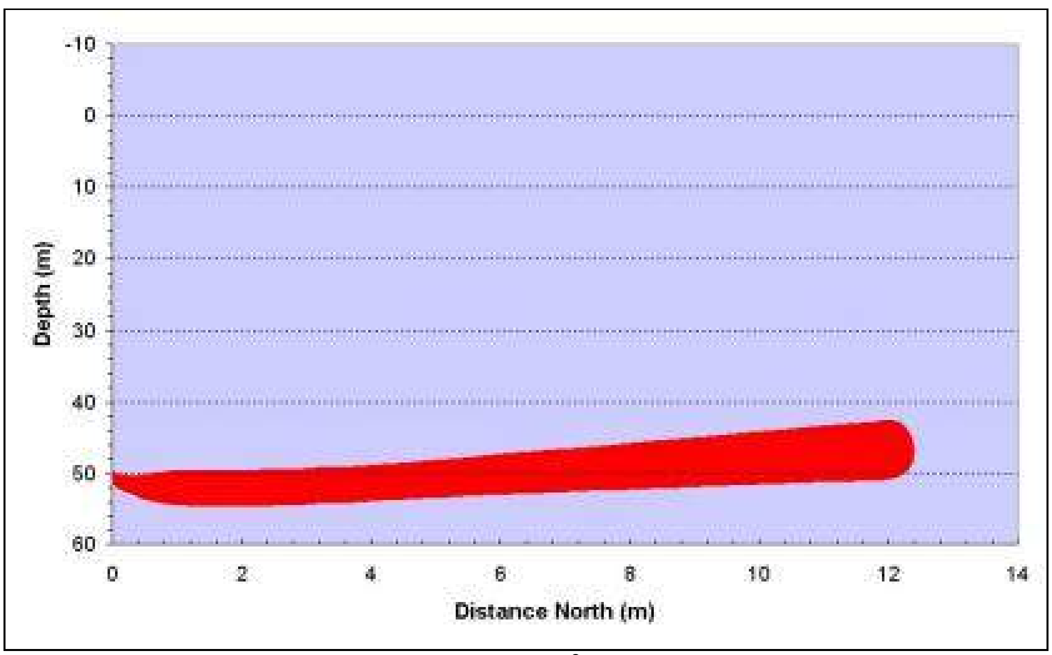


Figure 29: Shows the plume trajectory, to within 1°C of ambient temperature, as a function of depth and distance when released vertically from a 50m depth during winter.

5.7 Sensitivity of results to current velocity

Further simulations were carried out to test for sensitivity of model outcomes to potential variations in current speeds at the site. The model was run for mean current speeds of 5cm/s and 20cm/s for the discharge that was expected to have the greatest potential of resulting in recirculation of the heated plume. This was the 50 m release depth with currents running to the south. Table 11 presents results for these two cases in comparison with the previously reported results for a 10cm/s mean current.

Table 11: Predictions for cooling to within 1°C of ambient temperature for discharge under different levels of current energy

Pipe orientation	Current Speed (cm/s)	Plume travel (south) (m)	Plume depth (m)	Plume travel (west) (m)	Plume Radius(m)	Plume Area (m^2)	Minimum Dilution ratio
Vertical	5	2.77	45.84	0.00	2.81	24.87	6.86
	10	4.83	46.80	0.00	2.76	23.85	8.16
	20	8.54	48.13	0.00	2.64	21.88	10.26
Horizontal	5	1.84	42.58	5.25	2.11	11.20	4.55
	10	4.66	43.21	4.90	2.61	21.21	6.56
	20	6.71	47.50	2.20	2.60	21.26	9.82

Plume dimensions were predicted to respond to combinations of the ambient current speed and pipe orientation. Compared to simulations with a 10cm/s current, the 5 cm/s current was predicted to result in reduced spread of the plume along the axis of the currents and a greater rise in the plume before cooling to +1 C above ambient (Figures 30–33). However, the overall plume areas for the two cases were predicted to be similar (Table 11). The 20 cm/s current speed was predicted to double the plume travel along the current axis and reduce the rise of the plume to less than 2m above the discharge and intake levels (Figures 34–35, Table 11). However, even with current speeds of this magnitude, the plume was not expected to travel more than 25% of the distance between the discharge and the intake point. These results indicate that it is unlikely that heated water from the discharge would contaminate the intake under the wider range of current speeds that could occur at the site.

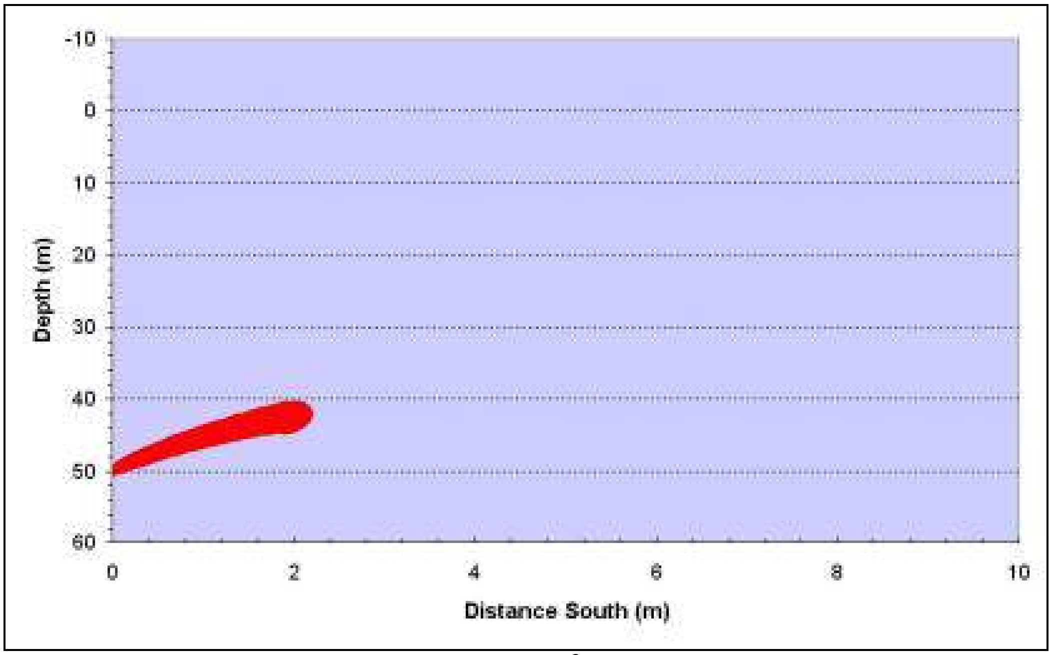


Figure 30: Shows the plume trajectory, to within 1°C of ambient temperature, as a function of distance and depth when released horizontally at 5cm/s from a 50m depth during summer.

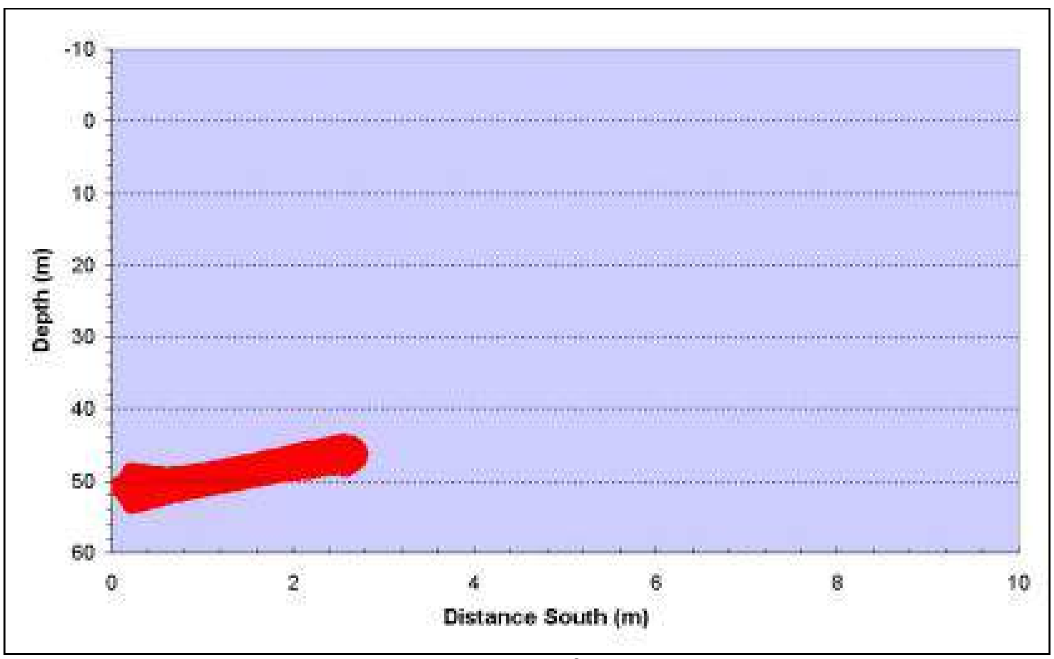


Figure 31: Shows the plume trajectory, to within 1°C of ambient temperature, as a function of distance and depth when released vertically at 5cm/s from a 50m depth during summer.

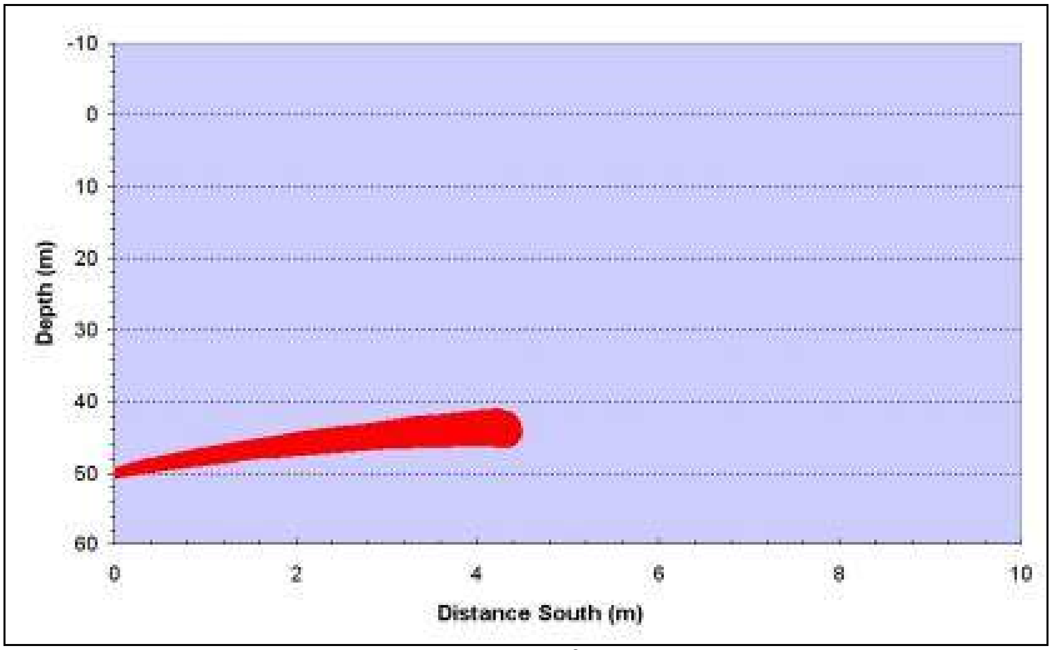


Figure 32: Shows the plume trajectory, to within 1^{o}C of ambient temperature, as a function of distance and depth when released horizontally at 10 cm/s from a 50m depth during summer.

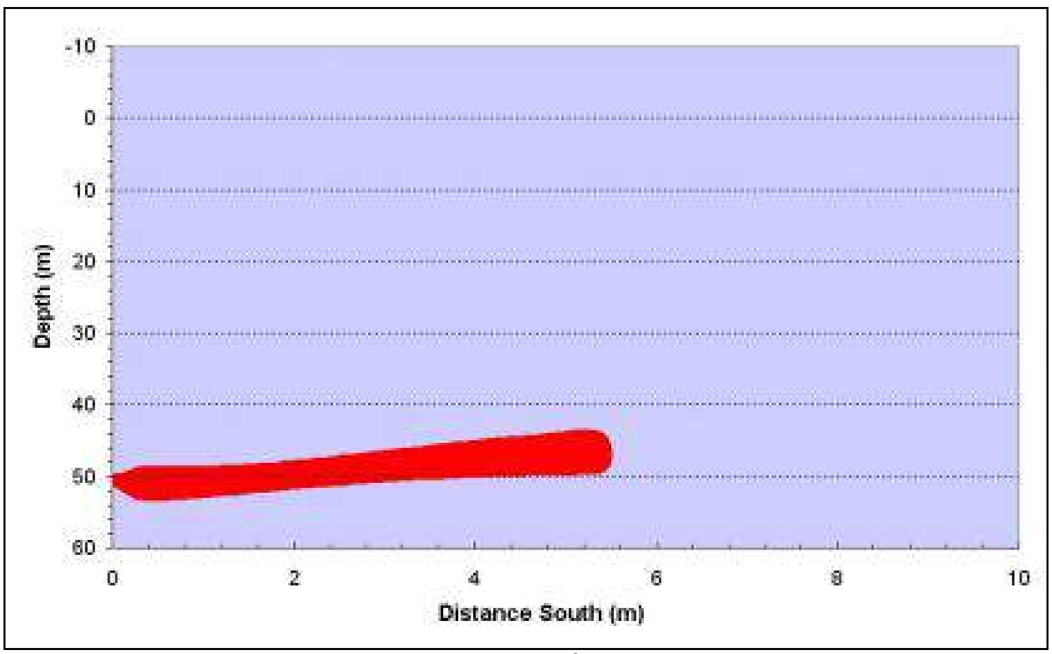


Figure 33: Shows the plume trajectory, to within 1^{o}C of ambient temperature, as a function of distance and depth when released vertically at 10 cm/s from a 50m depth during summer temperature.

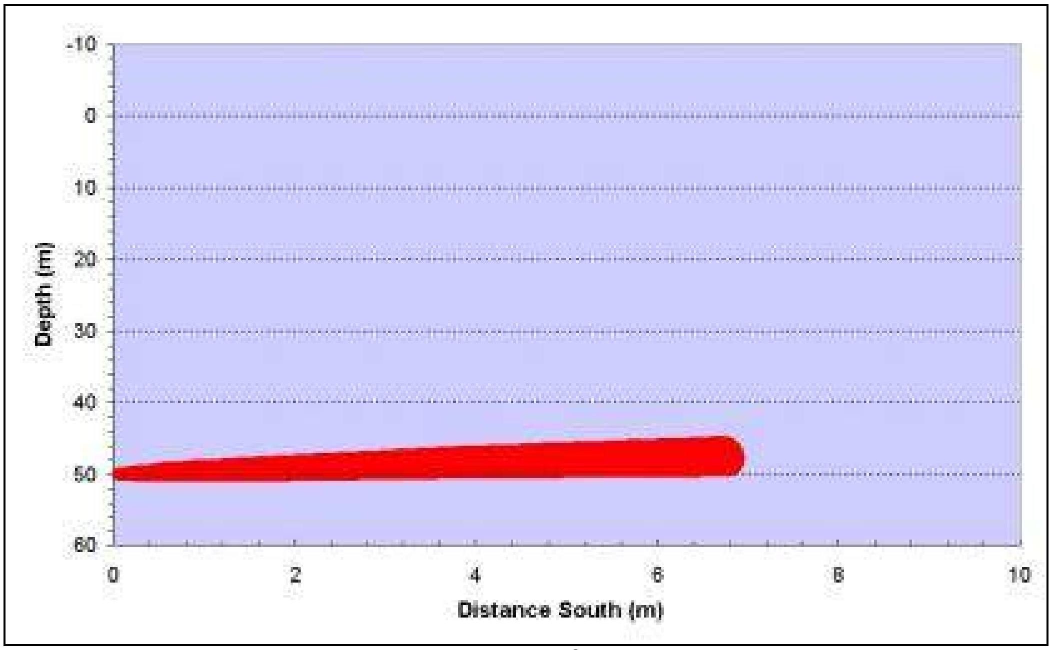


Figure 34: Shows the plume trajectory, to within 1°C of ambient temperature, as a function of distance and depth when released horizontally at 20 cm/s from a 50m depth during summer.

Figure 35: Shows the plume trajectory, to within 1°C of ambient temperature, as a function of distance and depth when released vertically at 20 cm/s from a 50m depth during summer.

6 Drill Cuttings

BP Exploration Ltd is proposing to discharge drill cuttings during drilling of the production wells for the Shah Deniz development. The well design requires drilling of 10 wells, each with a single 28" hole section, using water based mud. The cuttings would be discharged directly to the mudline above each hole.

The primary purpose of this study was to determine the likely spread and deposition pattern for this material over the mudline, with particular concern for the areas under the platform, where the drilling template would be positioned, and around the spud cans at the ends of the platform legs.

BP Exploration Ltd requested that modelling consider discharge of cuttings from a location referred to as slot 9, based on the platform design configurations. Table 12 shows the location of the release site.

Table 12: Location of the proposed discharge point for drill cuttings from Shah Deniz

Name	Latitude and Longitude
Slot 9, production well	39^{o} 53' 48.4' N 50^{o} 26' 44.9 E

6.1 Discharge Characteristics

BP Exploration Ltd provided detailed discharge characteristics used to describe the release (Tables 13). An estimated volume of 302.4 m^3 of cuttings would be produced from each well at a mean production rate of 42 m^3/hr. BP Exploration Ltd also provided the grain size distribution and the equivalent fall velocity for each grain size (Table 14). The model was used to examine the likely dispersal and settling of the drill cuttings, if discharged at 1m, 2m or 3.2m above the mudline as a vertical (facing upwards) discharge.

6.2 Environmental Conditions

Model predictions were carried out for periods when mean currents were relatively low or relatively high, based on the HYDROMAP output. This was to represent the range of likely currents that could affect the spread of cuttings released at the site. Figures 36 & 37 show samples of the currents predicted by HYDROMAP for the release site during summer (January 2000) and winter (August 2000), from which sample periods were chosen. The low energy cases were represented by current speeds <2cm/s. The high energy cases were represented by current speeds >6cm/s. Table 15 shows the start times chosen for the 24 hour simulations.

No data was available to define the general dispersion rate for the waters off the coast of Baku. Thus, conservative estimates of 1.0 m^2/s and 0.00001m^2/s were used for horizontal and vertical dispersion, respectively.

Table 13: Settings used to model the discharge of drill cuttings from Shah Deniz

Discharge Rate	$42m^3$/hr
Discharge duration	24 hours
Duration of simulations	24 hours
Pipe diameter	660mm
Pipe orientation	Vertical - facing upwards
Pipe release depth	1, 2m & 3.2m above the mudline
Cuttings release amount	$302.4m^3$
Density of dry drill cuttings	2550 kg/m^3
Ambient temperature	7 ^oC
Ambient salinity	4 ppt

Table 14: Particle size distribution of the drill cuttings

Nominal Grain Size (microns)	**Percentage of Total Mass**	**Fall Velocity (cm/sec)**
12500	85	71.75
9625	1.25	62.94
6750	1.25	52.72
3875	1.25	39.94
1000	1.25	20.28
74	10	0.31

Table 15: Start time for the 24 hour MUDMAP simulation to represent different levels of current energy during each season.

Summer	
Low energy	7th June 2000
High energy	14th June 2000
Winter	
Low energy	13th January 2000
High energy	28th January 2000

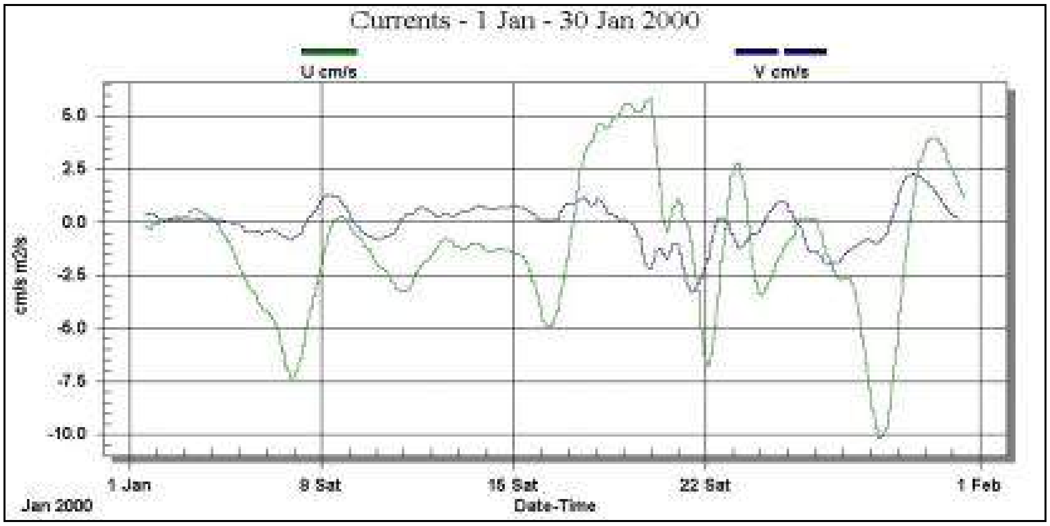


Figure 36. Shows the predicted current speed at the release site during winter (January 2000). Note u is the current east – west component, while v is the north south component.

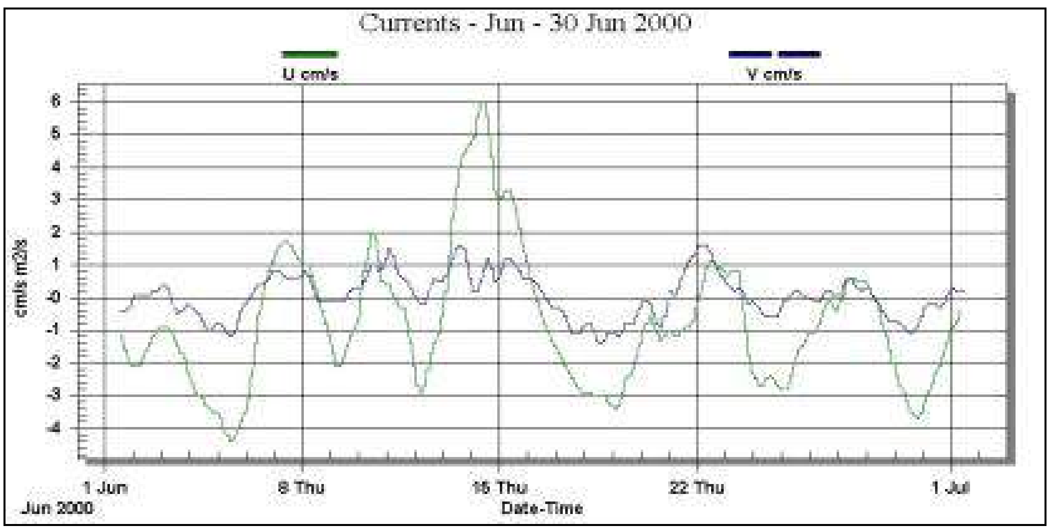


Figure 37. Shows the predicted current speed at the release site during summer (June 2000). Note u is the current east – west component, while v is the north south component.

6.3 Results for cuttings dispersion

Simulations indicated that the distance and area over which cuttings would disperse would be influenced by a number of factors, namely: (a) particle size; (b) environmental conditions and (c) release depth.

Results indicated that the size-distribution of the particles would limit the influences of current speeds and depths. Only the smaller and lighter particle sizes were predicted to remain in the water column for long enough to be sensitive to variations in ambient current velocities and release depth. The settling rates of the larger particles were sufficiently high as to be relatively insensitive to the range of current velocities that were considered.

In general, the cuttings were predicted to form a bell-shaped pile that had the greatest thickness immediately around the discharge and with an exponentially decreasing thickness with distance (Figures 38 to 49). The orientation of the thinner portions, which would be made up of the lighter particles, reflected the prevailing current direction, while the thicker sections were predicted to form uniformly around the discharge irrespective of the prevailing current direction. The latter result reflects the minimal effect of mudline currents upon the heavier particles.

As would be expected, the shortest settling distances and greatest cuttings thicknesses were predicted to occur with release closer to the mudline (Table 16). Under both the summer and winter low energy currents, the lighter cuttings particles were predicted to travel up to 61 m from discharge point and to generate a theoretical thickness around the discharge point of over 8 m. The theoretical load on the mudline at this thickest point was estimated to be approximately 21 Tonnes/m^2. Thicknesses greater than 10 cm were predicted to extend approximately 7.5 m in any direction; covering an area of approximately 45.5 m^2. Raising the discharge point to 2m above the mudline under these same conditions was predicted to result in a 53% reduction in the thickness and load near the centre of the pile and a 26% increase in the total footprint. Thicknesses greater than 10 cm were predicted to extend out to approximately 10.5 m. Thus, the area under thicknesses greater than 10 cm, at approximately 87 m^2, would be 90% larger. Raising the discharge point a further 1.2m, (3.2m above the mudline) under these same conditions, as the 1m release, it was predicted to result in a 72% reduction in the thickness and load near the centre of the pile and a 52% increase in the total footprint. Thicknesses greater than 10 cm were predicted to extend out to approximately 16.4m. Thus, the area under thicknesses greater than 10 cm, at approximately 211.2 m^2, would be 364% larger.

The effect of current speed on the spread of currents was relatively low over the range between the low (< 2 cm/s) and high energy (> 6 cm/s) conditions expected at the site. This can be attributed to the rapid settling time of the mid-weight to heavy particles, which was predicted to limit the influence of increased current speed. It should also be noted that the input currents were depth-averaged and that currents near the mudline will be damped by mudline friction. During both the summer and winter cases, the extent and area of thicknesses greater than 10 cm were predicted to be approximately the same for both the high and low energy cases for a discharge at a given height. However, the lighter materials were predicted to spread out over a larger area. Note that the footprint during each high energy case was predicted to be offset further in the direction of the major current axis in comparison with the equivalent low-energy case. Thus, the footprint was offset further to the east-northeast during summer and to the west during winter. The influence of current speeds on the spread of the lighter particles was predicted to be slightly greater for a higher discharge point. For example, during the winter cases, there was a 32% increase in the distance that particles might travel with a change from the low energy to high energy input currents with discharge at 1 m and a 45% increase with discharge at 2m and a 98% increase with discharge at 3.2m.

Table 16: Predicted dispersal of drill cuttings and mud during summer and winter

Conditions	Release above the mudline (m)	Maximum Bottom Thickness (m)	Maximum Bottom concentration (Tonnes/m^2)	Maximum distance from the release site (m)	Predicted area of coverage (m^2)
Winter – low energy	1.0	8.20	20.9	60.08	7387.25
	2.0	3.81	9.73	73.74	10047.32
	3.2	2.28	5.94	78.62	11259.51
Winter – high energy	1.0	7.83	20.0	78.82	7631.05
	2.0	3.81	9.71	106.83	11749.65
	3.2	2.19	5.83	158.78	11895.80
Summer – low energy	1.0	8.21	20.9	61.36	7681.21
	2.0	3.76	9.58	70.6	9445.49
	3.2	2.57	6.57	80.51	9661.84
Summer – high energy	1.0	8.06	20.06	78.38	7822.60
	2.0	3.90	9.96	89.45	9774.59
	3.2	2.51	6.4	116.4	9984.77

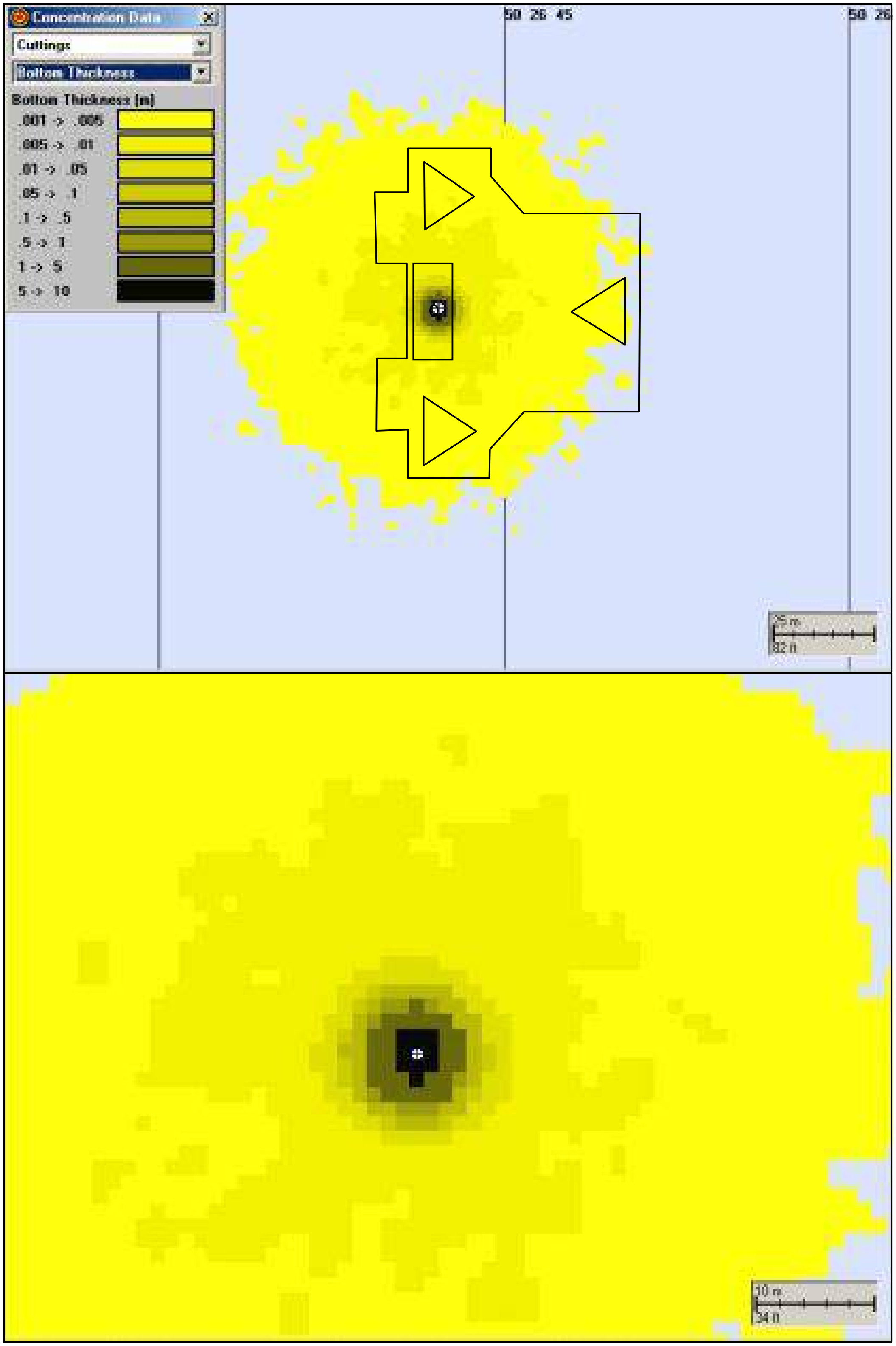


Figure 38: (top) Large scale view and (bottom) close up view of the predicted thickness of the discharged cuttings during low energy winter conditions, with discharge 1m above the mudline.

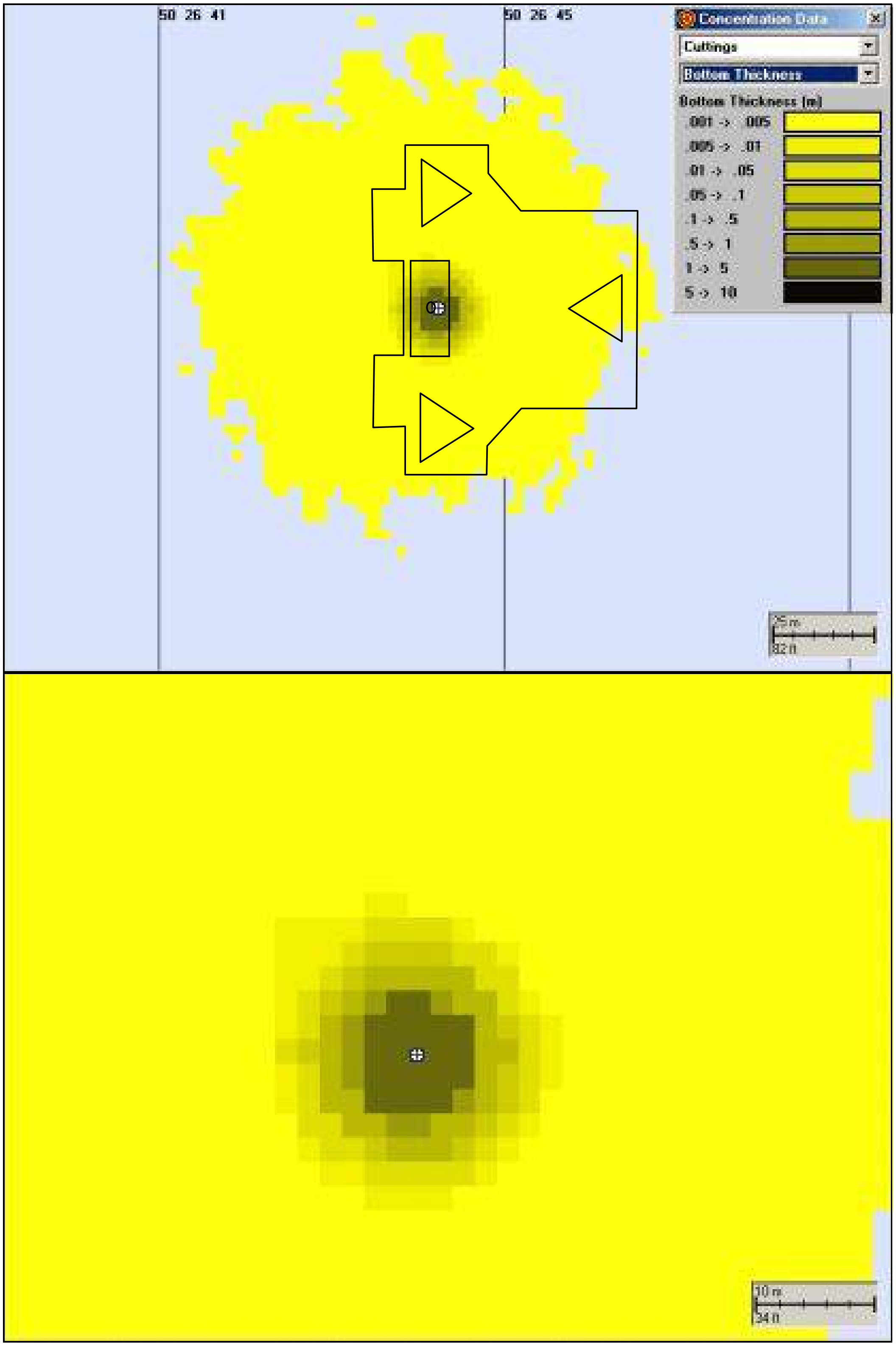


Figure 39: (top) Large scale view and (bottom) close up view of the predicted thickness of the discharged cuttings during low energy winter conditions, with discharge 2m above the mudline.

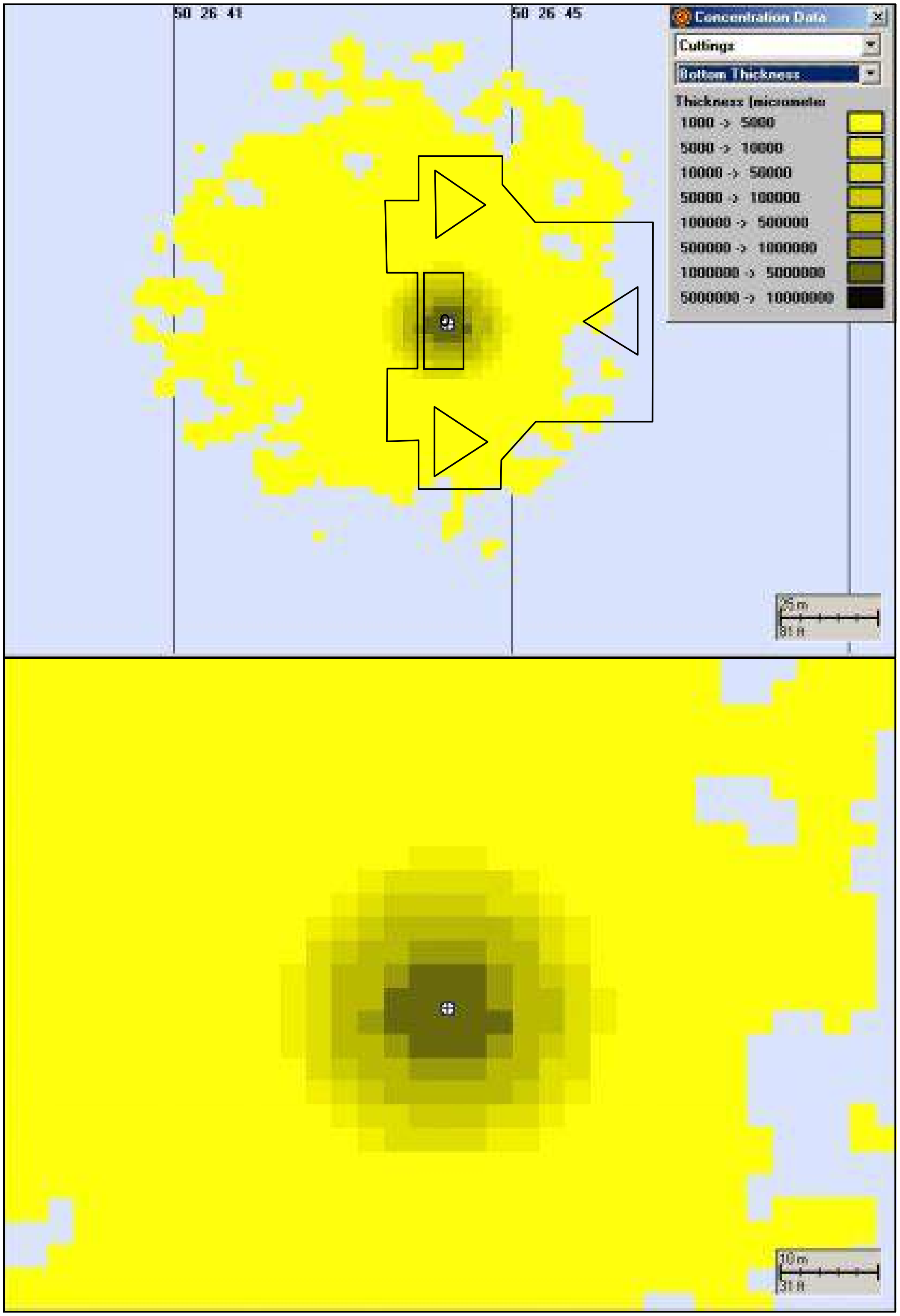


Figure 40: (top) Large scale view and (bottom) close up view of the predicted thickness of the discharged cuttings during low energy winter conditions, with discharge 3.2m above the mudline.

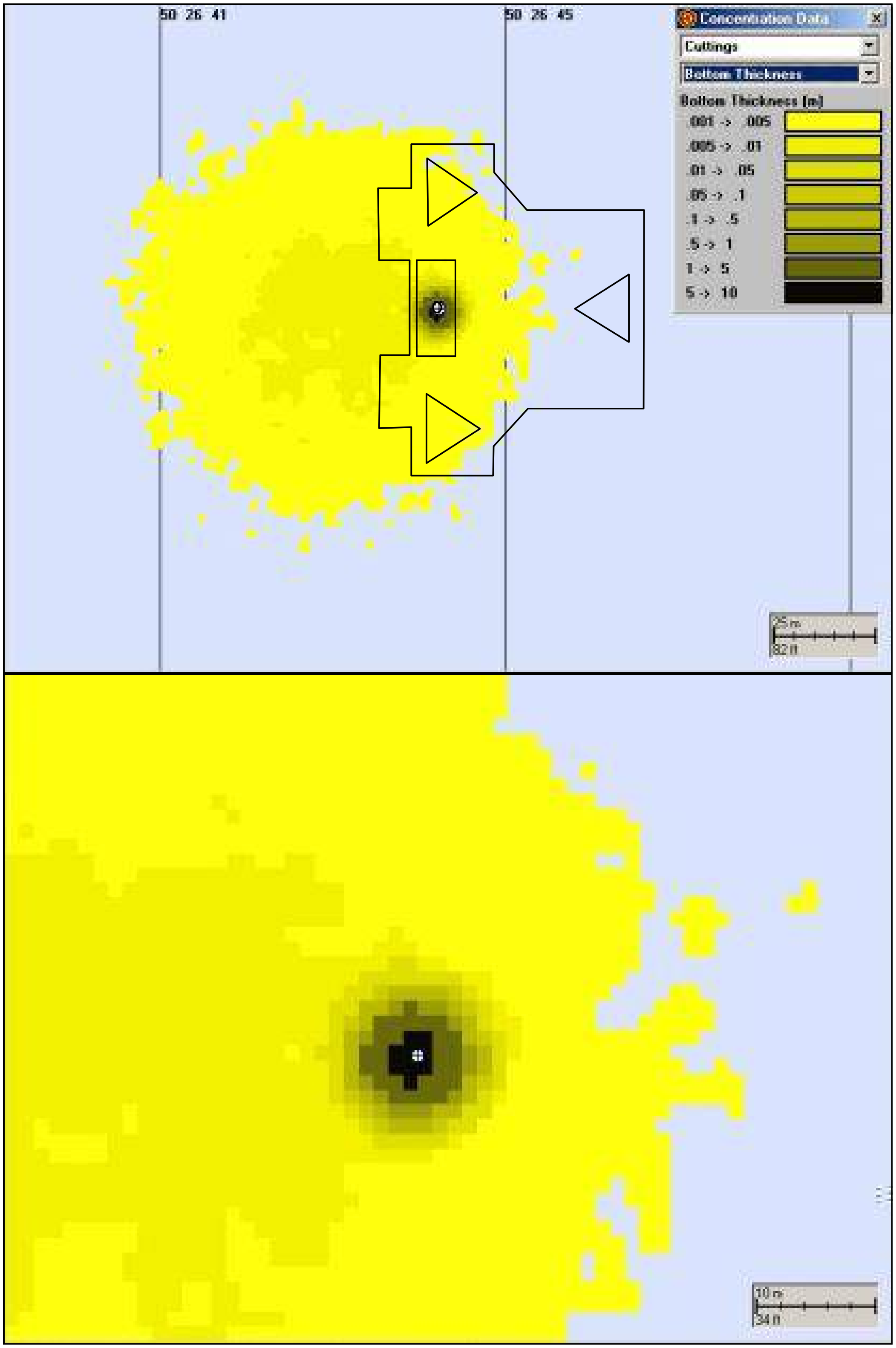


Figure 41: (top) Large scale view and (bottom) close up view of the predicted thickness of the discharged cuttings during high energy winter conditions, with discharge 1m above the mudline.

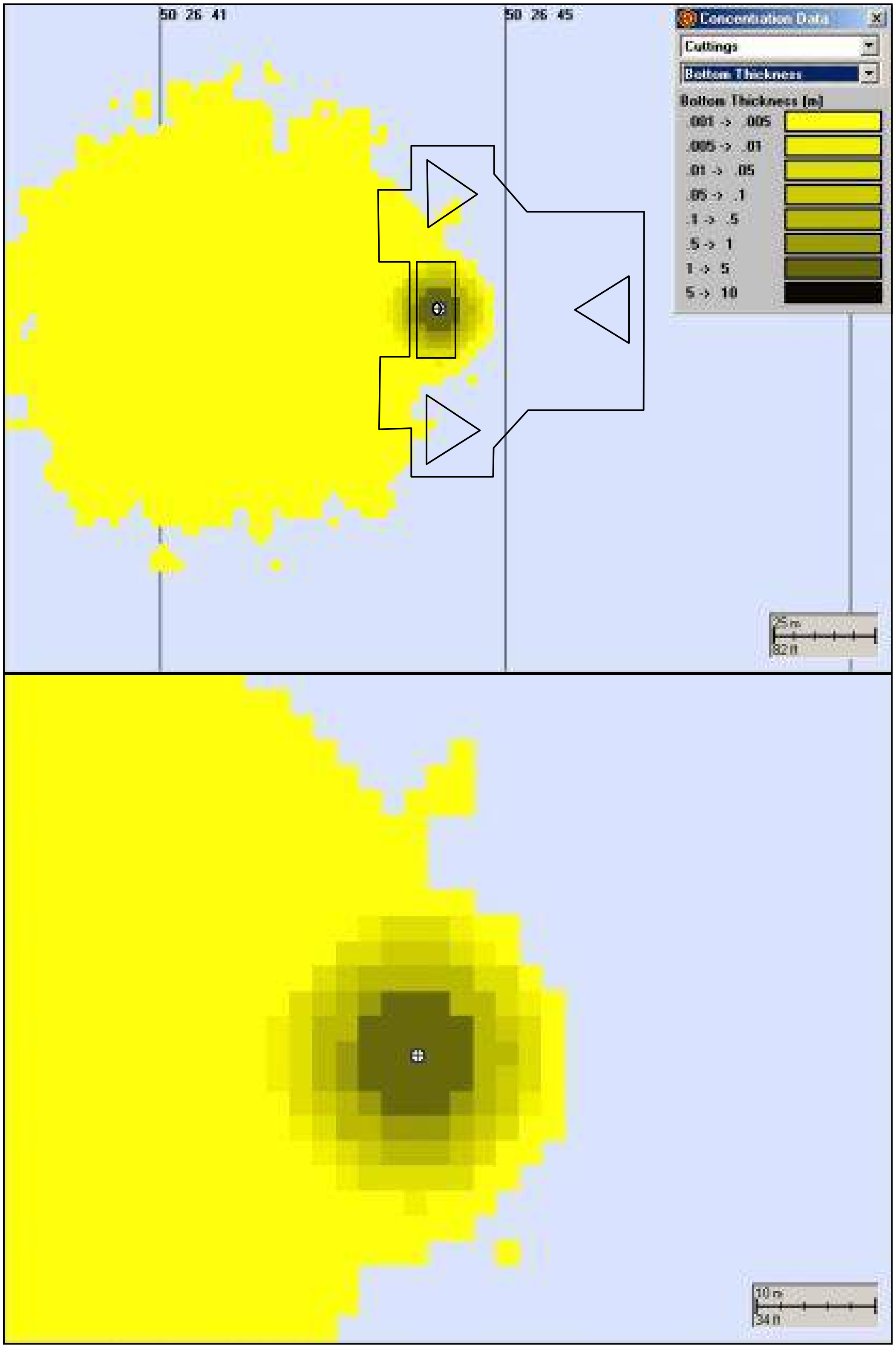
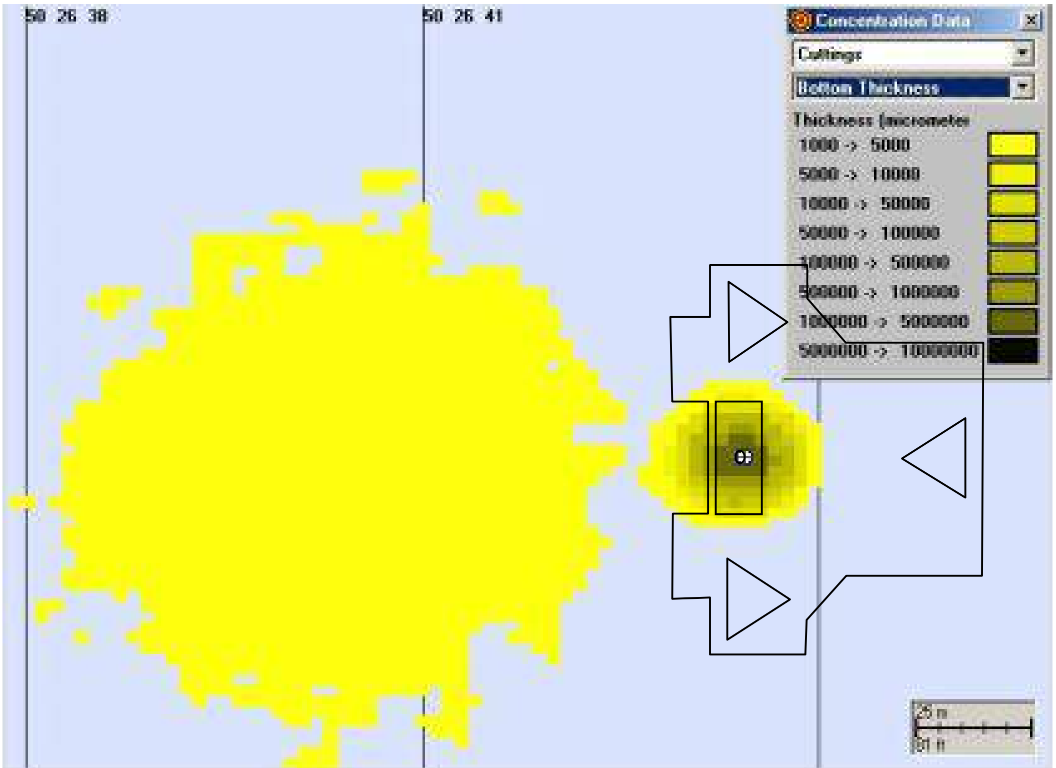


Figure 42: (top) Large scale view and (bottom) close up view of the predicted thickness of the discharged cuttings during high energy winter conditions, with discharge 2m above the mudline.



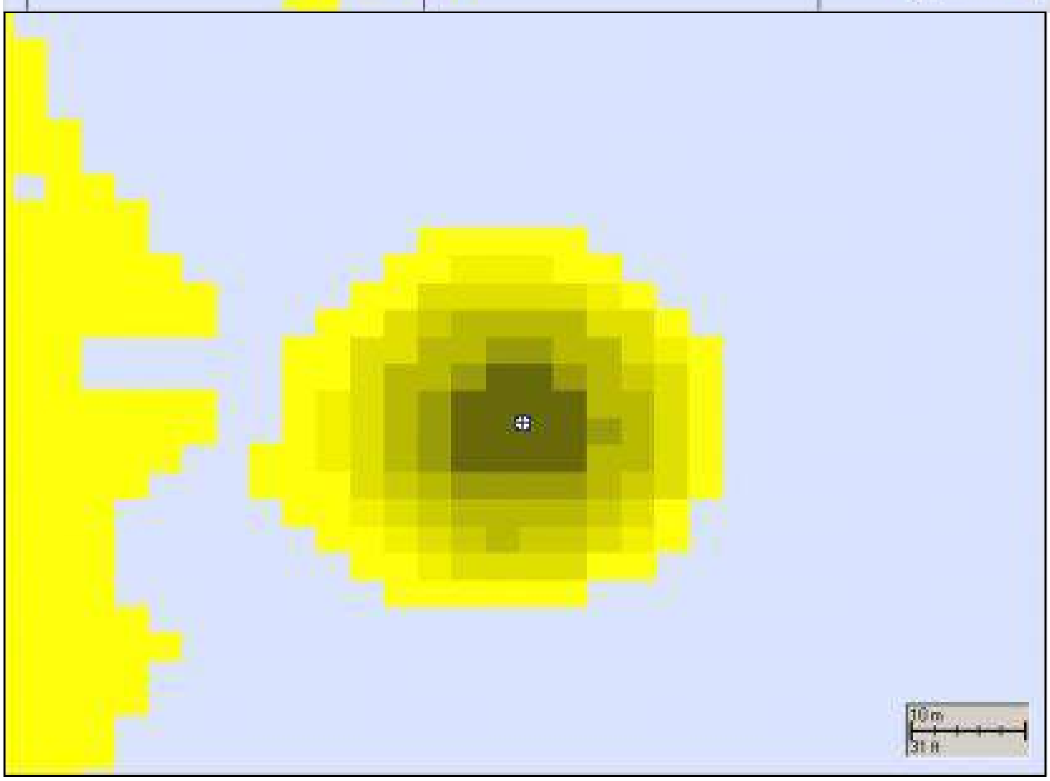


Figure 43: (top) Large scale view and (bottom) close up view of the predicted thickness of the discharged cuttings during high energy winter conditions, with discharge 3.2m above the mudline.

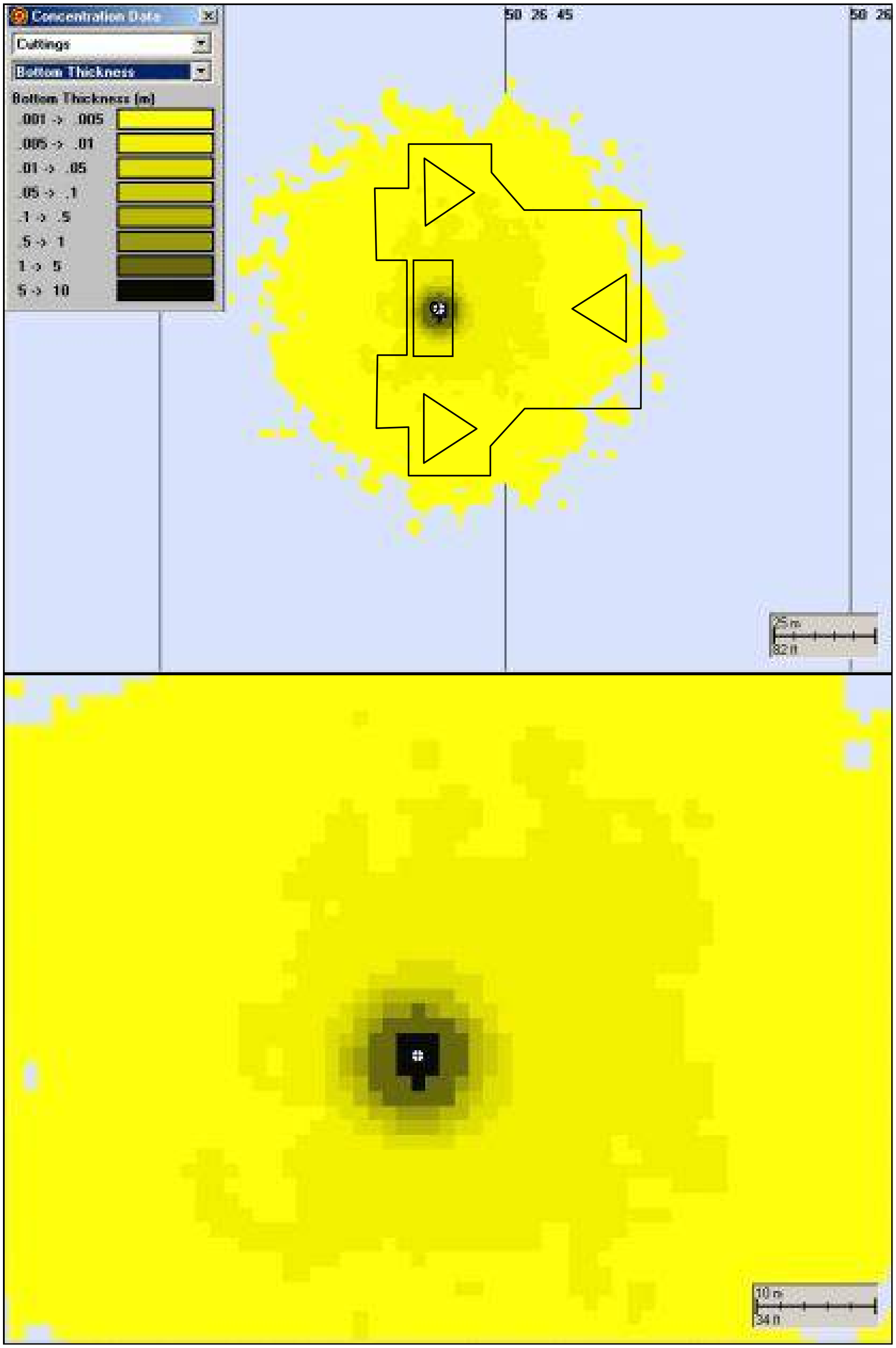


Figure 44: (top) Large scale view and (bottom) close up view of the predicted thickness of the discharged cuttings during low energy summer conditions, with discharge 1m above the mudline.

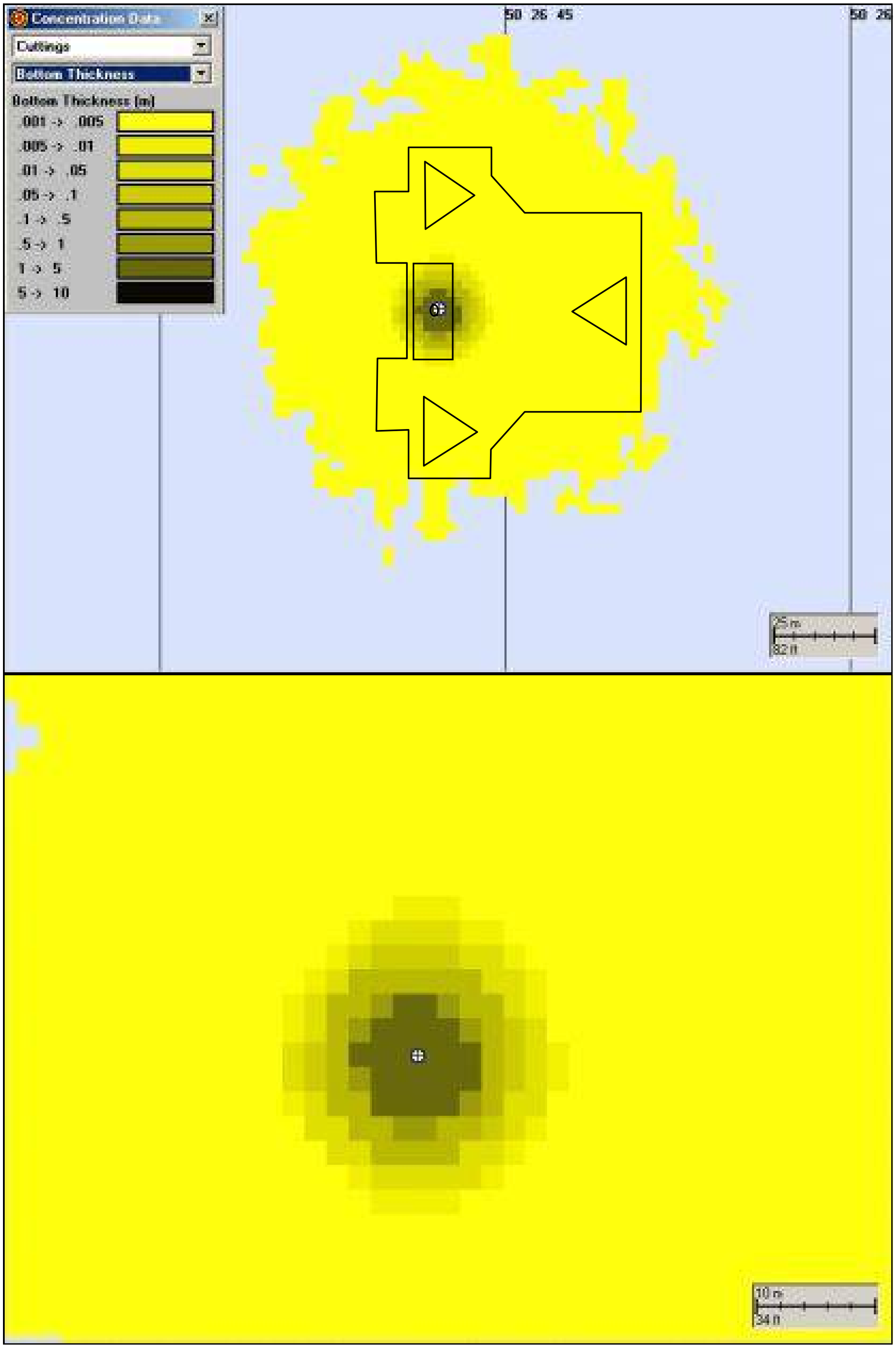


Figure 45: (top) Large scale view and (bottom) close up view of the predicted thickness of the discharged cuttings during low energy summer conditions, with discharge 2m above the mudline.

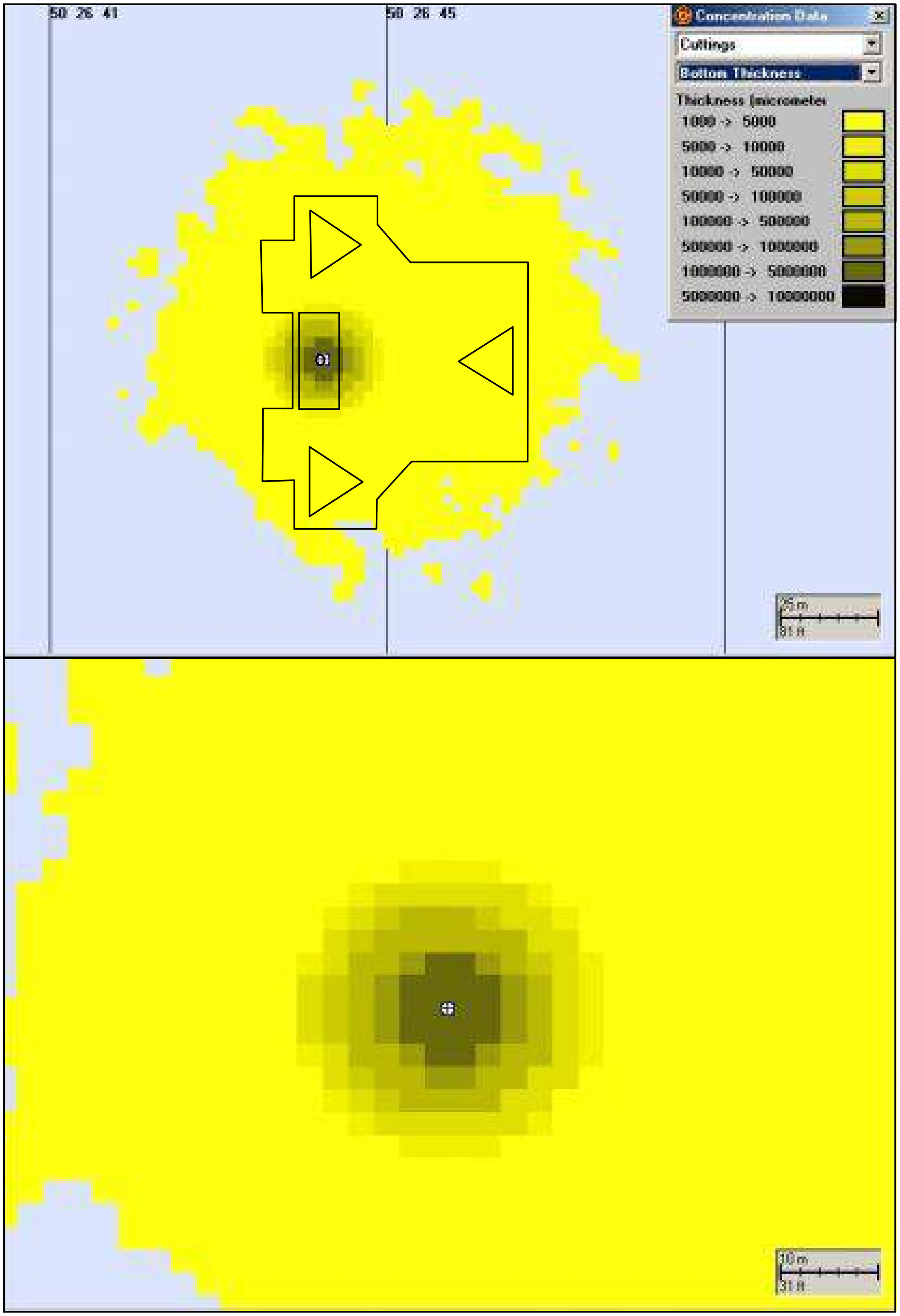


Figure 46: (top) Large scale view and (bottom) close up view of the predicted thickness of the discharged cuttings during low energy summer conditions, with discharge 3.2m above the mudline.

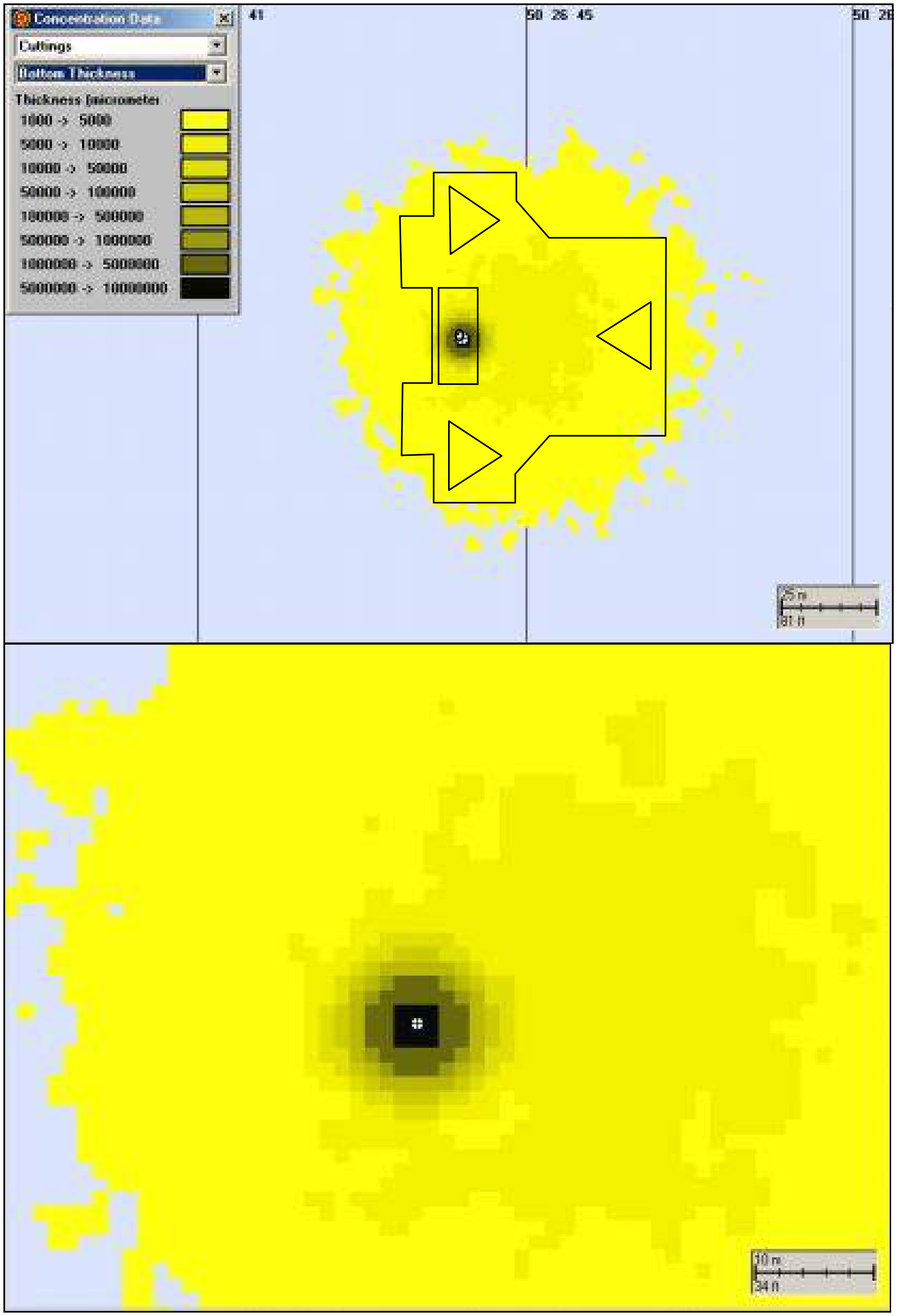


Figure 47: (top) Large scale view and (bottom) close up view of the predicted thickness of the discharged cuttings during high energy summer conditions, with discharge 1m above the mudline.

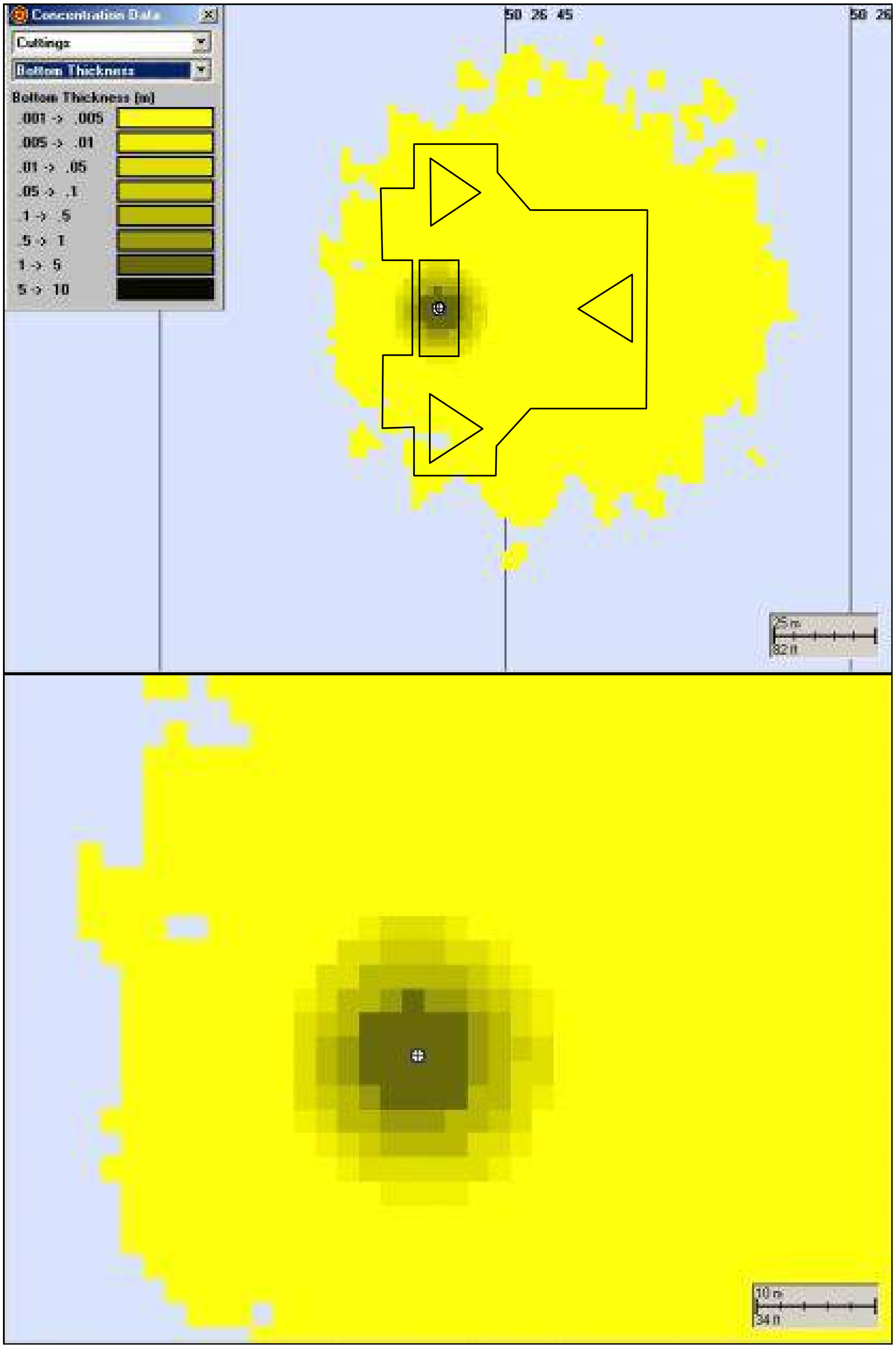


Figure 48: (top) Large scale view and (bottom) close up view of the predicted thickness of the discharged cuttings during high energy summer conditions, with discharge 2m above the mudline.

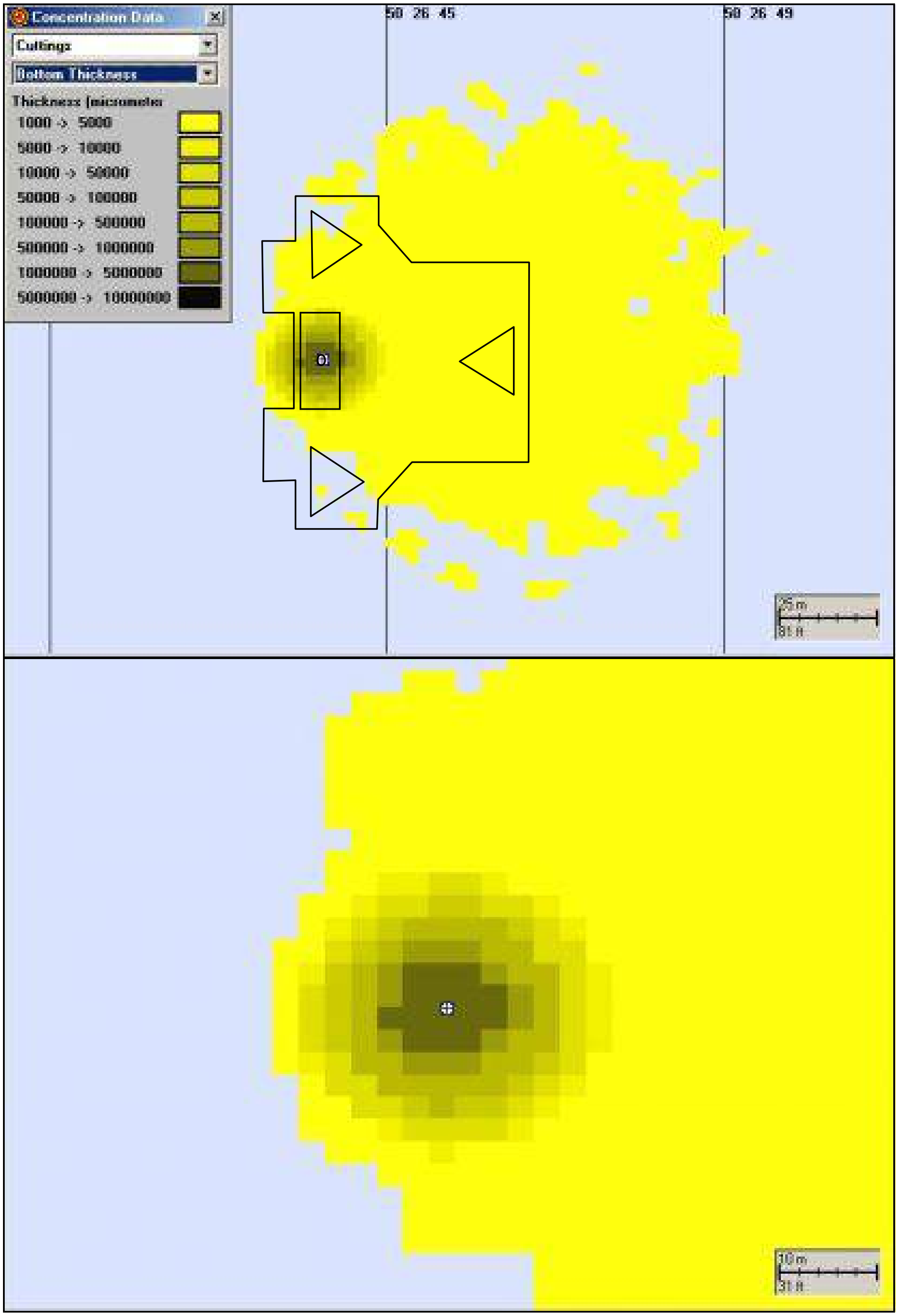


Figure 49: (top) Large scale view and (bottom) close up view of the predicted thickness of the discharged cuttings during high energy summer conditions, with discharge 3.2m above the mudline.

7 Cement Dumping

Cement will be used during the drilling of the Shah Deniz development wells to form the casings for the recirculating drilling-mud system. Under normal circumstances, liquid cement will be contained within the casings and will not be released to the sea. However, it may become necessary to abort the cementing job, in which case up to 100 barrels of mixed cement may be discharged via the cement dump caisson in Leg 3. This discharge would occur over a short period, assumed to be about 2 minutes.

The primary purpose of this study was to determine where the cement would deposit, and at what concentration, with particular emphasis upon loadings on the seabed under the platform, where the drilling template will be located, and around the spud cans supporting the platform legs (BP Exploration, 2002).

7.1 Discharge Characteristics

BP Exploration Ltd provided detailed discharge characteristics for the potential release (Table 17). Table 18 shows the estimated properties of the mixed cement that were used as input to MDFATE. The cement was assumed to clump together with characteristics similar to a typical cohesive sand mixture. A simulation of the cement dumping was carried out in no flow conditions, since the effect of the current on the cement was considered to be minimal.

Table 17: Settings used to model the dumping of cement from Shah Deniz

Discharge Rate	100 barrels
Discharge duration	2 minutes
Pipe diameter	508mm
Pipe orientation	Vertical – facing down
Pipe release depth	15m below sea level
Solid Type	Cohesive Sand clumped
Specific Gravity	2.1
Volume Fraction	0.8 (80% solids)
Median Grain Size	*300mm
Critical shear stress	*4740 N/m^2

*Source: U.S. Army Corps of Engineers

Table 18. Summary of estimated properties of the mixed cement

Temperature	20^oC
Density	2100 Kg/m^3
Dynamic Viscosity	40 cP

7.2 Results of Cement dumping

The simulation of the cement dumping was carried out in no flow conditions, since the effect of the current on the cement was considered to be minimal. After its release, the cement would descend by virtue of its discharge momentum and significant negative buoyancy. As the material moves downward it will push the ambient water around it, experiencing drag as it plunges through the water.

The bulk of the material ultimately hits the bottom and spreads at the bed while the settling of any entrained particles continues. The above process occurs over a very short period of time (tens of seconds), thus preventing any significant horizontal dispersion of the dumped material.

Figures 50 and 51 show plan and section views of the predicted bottom thickness contours for the settlement of the defined cement load if dumped from the Leg 3 caisson.

The cement was predicted to remain in the water column for a very short period of time (seconds), thus reducing the horizontal dispersion of the dumped material. A mound is predicted to form below the discharge site with a predicted peak thickness of 7.5mm at the center point and cover an area of approximately 36 m^2. The mound was predicted to thin uniformly with distance from the center of the mound and have a thickness of between 5.5 and 3.5 mm directly beneath the platform where the well-head and drilling template would be located. The cement was predicted to have a thickness of around 7.5 mm around the spud can on Leg 3 and up to 1.5 mm around the spud can of Leg 1.

Due to the depth of the seabed (100 m), the weakness of the bottom currents, and the cohesive nature of the cement, it is expected that re-suspension of the material would be minimal, and the dumped material would remain in place for some time.

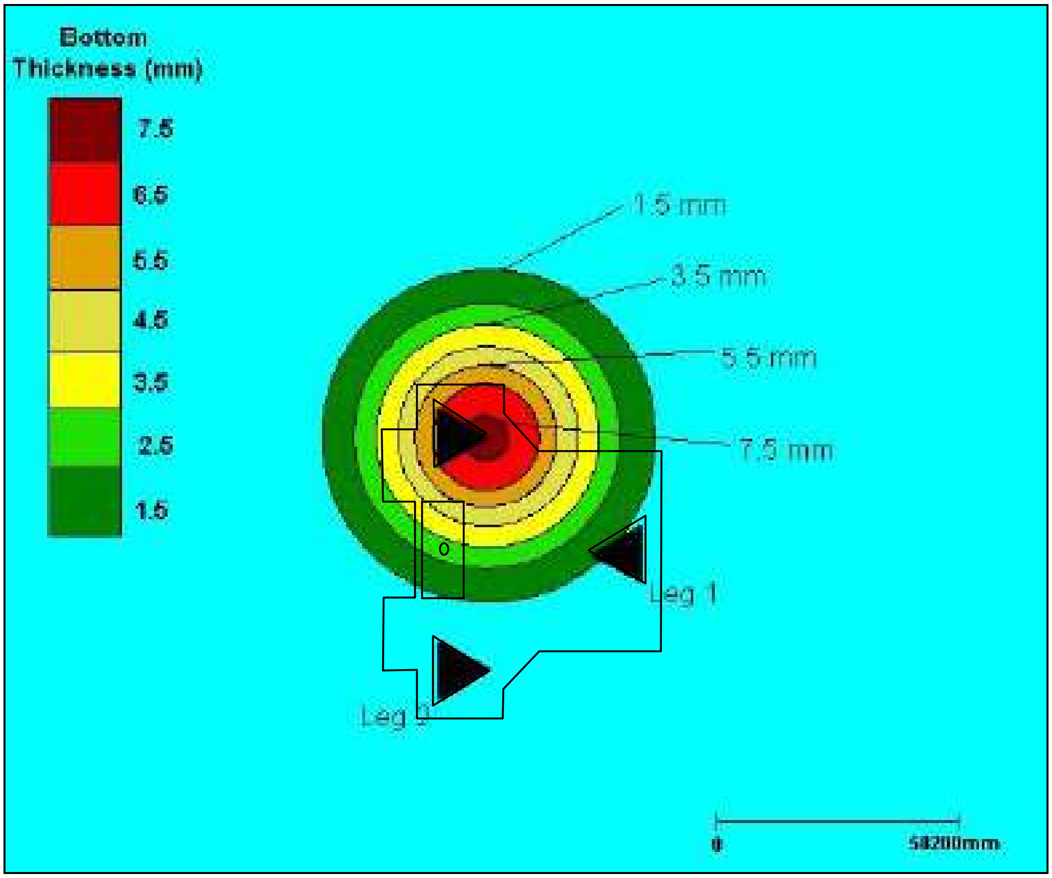


Figure 50. Model predicted bottom thickness contours from 100 barrels of cement dumped from Leg 3 under zero flow conditions.

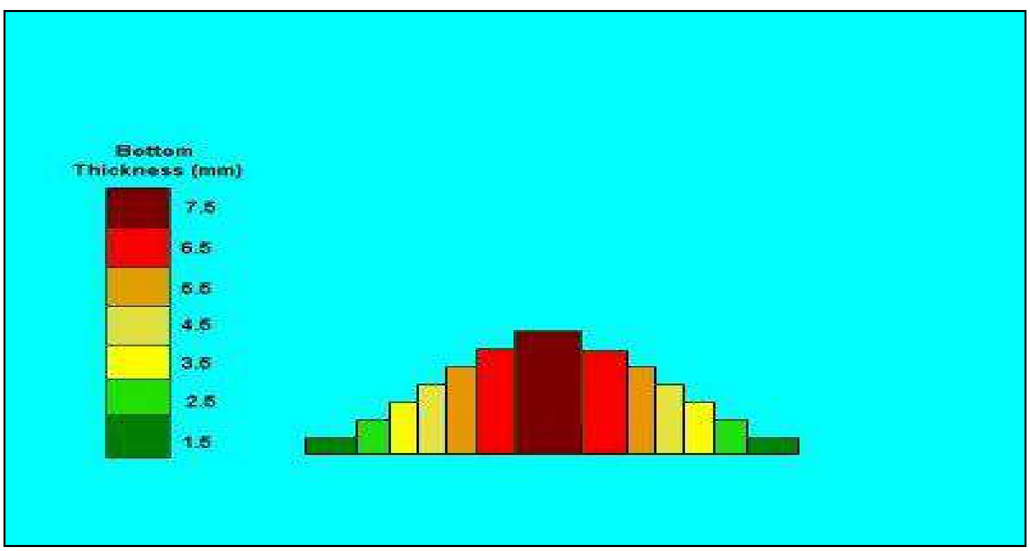


Figure 51. Shows a cross-section view of the predicted bottom thickness contours from 100 barrels of cement dumped from Leg 3, during no flow conditions.

8 References

BP Expoloration (2002) “Dispersion studies scope of work” Internal report No.6531Z 102.

Brandsma, M.G. and T.C. Sauer, Jr. (1983). “The OOC model: prediction of short term fate of drilling mud in the ocean, Part I model description and Part II model results”. Proceedings of Workshop on An Evaluation of Effluent Dispersion and Fate Models for OCS Platforms, Santa Barbara, California, 7-10 February, 1983.

Brandsma, M.G. and J.P. Smith (1997). “Offshore Operators Committee mud and produced water discharge model - Report and user guide. Exxon Production Research Company publication.

Brandsma, M.G. and J.P. Smith (1995). “Dispersion modeling perspectives on the environmental fate of produced water discharges”. Paper presented at the 1995 International Seminar on Produced Water, Trondheim Norway, September 25-28.

Johnson, B.H. (1990). "User's Guide for Models of Dredged Material Disposal in Open Water", Environmental Laboratory TR D-90-5, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Klevtsova, N.D., 1966. Surface Currents in the Middle and South Caspian for various Wind Fields. Okeanologiya. Vol. 6, issue 1, 1966, pp. 82-88.

Koh, R.C.Y. and Y.C. Chang (1973). “Mathematical model for barged ocean disposal of waste”. Environmental Protection Technology Series EPA 660/2-73-029, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Kosarev, A.N., E.A. Yablonskaya, 1994. The Caspian Sea. SPB Academic Publishing, The Hague, 1994.

Lin, J.T., and Pao, Y.H, (1979) “Wakes in Stratified fluids” Ann. Review of Fluid Mechanics, 11: 317.

Moritz, R. H. (1994) “Users Guide for the Multiple Dump Fate Model” U. S. Army Corps of Engineers Waterways Experiment Station - Contract Number DACW39-94-M-1304.

Scheffner, N.W., Tallent, J.R., 1990. "LONGTERM DREDGE – A Personal Computer Based Dredged Material Placement Site Analysis Program", Coastal Engineering Research Center TR DRP-90-00, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Smith, J.P., H.L. Mairs, M.G. Brandsma, R.P. Meek and R.C. Ayers Jr (1994). “Field validation of the Offshore Operators Committee (OOC) produced water discharge model”. In: *The Proceedings of the SPE 69th Annual Technical Conference and Exhibition*. A Society of Petroleum Engineers Publication, pages 519-530, paper #SPE 28350.

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DRAFT

TITLE:

Sewage Discharge Simulations Update and Progress for the Shah Deniz gas export field

AUTHOR(S):

Eric Anderson and Sasha Zigic

CLIENT:

Technip-Coflexip

PROJECT NUMBER:

ASA 01-224

March, 2002

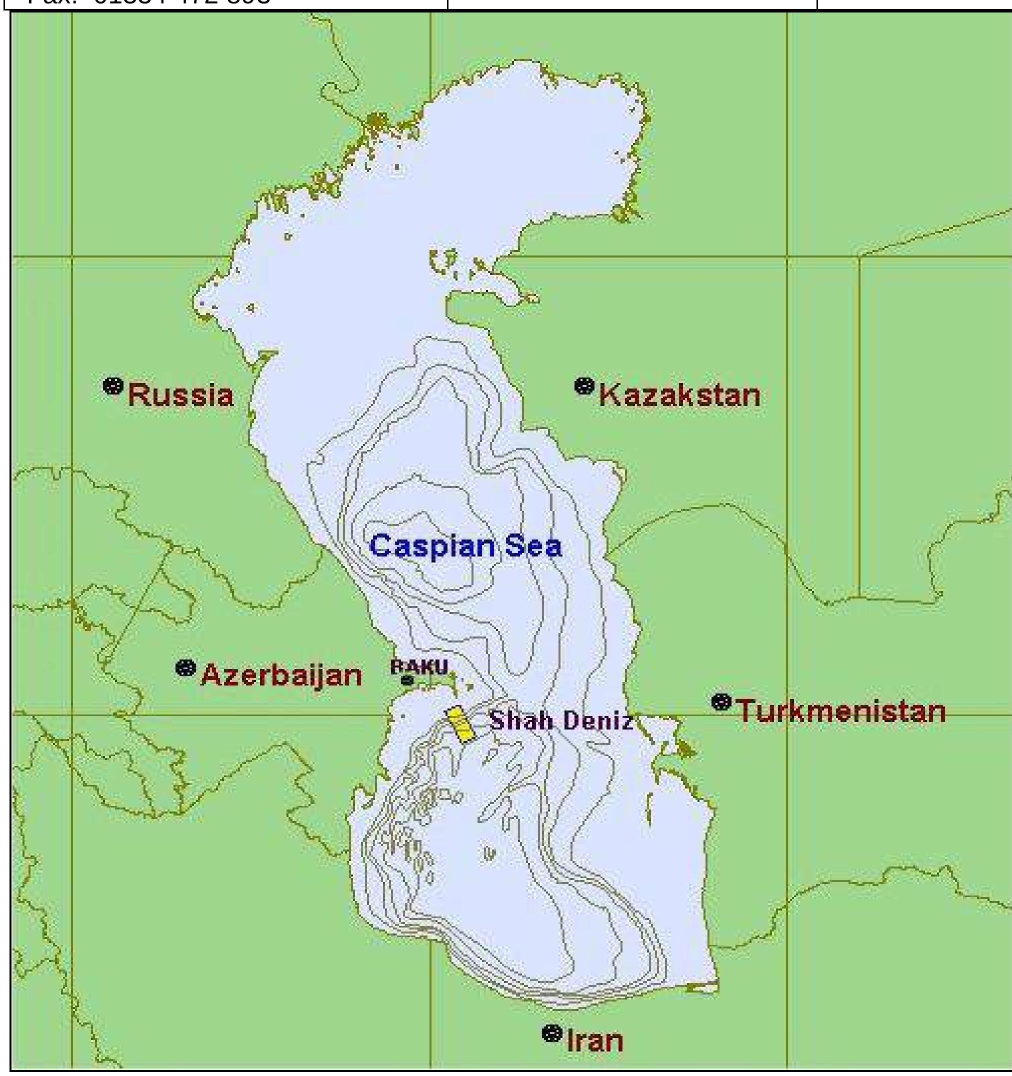

Table of Contents

1 Introduction

BP Exploration Ltd (BP) are proposing to discharge overboard biologically treated sewage from the Shah Deniz platform, which lies approximately 100km south east of Baku in the south Caspian Sea (see Figure 1a). The primary purpose of the study is to establish the potential for the treated sewage discharged from Leg 3 to reach the seawater inlet at Leg 1, as well as determine the likely excursion 75m from the release site (see Figure 1b). ASA's sub-surface model, MUDMAP, was used to examine the likely mixing and dilution of BOD_5, suspended solids and total coliform, which were assumed to be found within the sewage plume. Each constituent was modeled as a conservative tracer (no reaction or decay) constituting a "worst case" scenario. Table 1 shows the location of the release site.

Table 1. Location of the proposed discharge point for sewage outfall from Shah Deniz

Name	Latitude and Longitude
Shah Deniz	39^o 53' 48.4' N 50^o 26' 44.9 E

The following document is a preliminary report detailing the concentrations for each constituent from the Shah Deniz sewage plume.

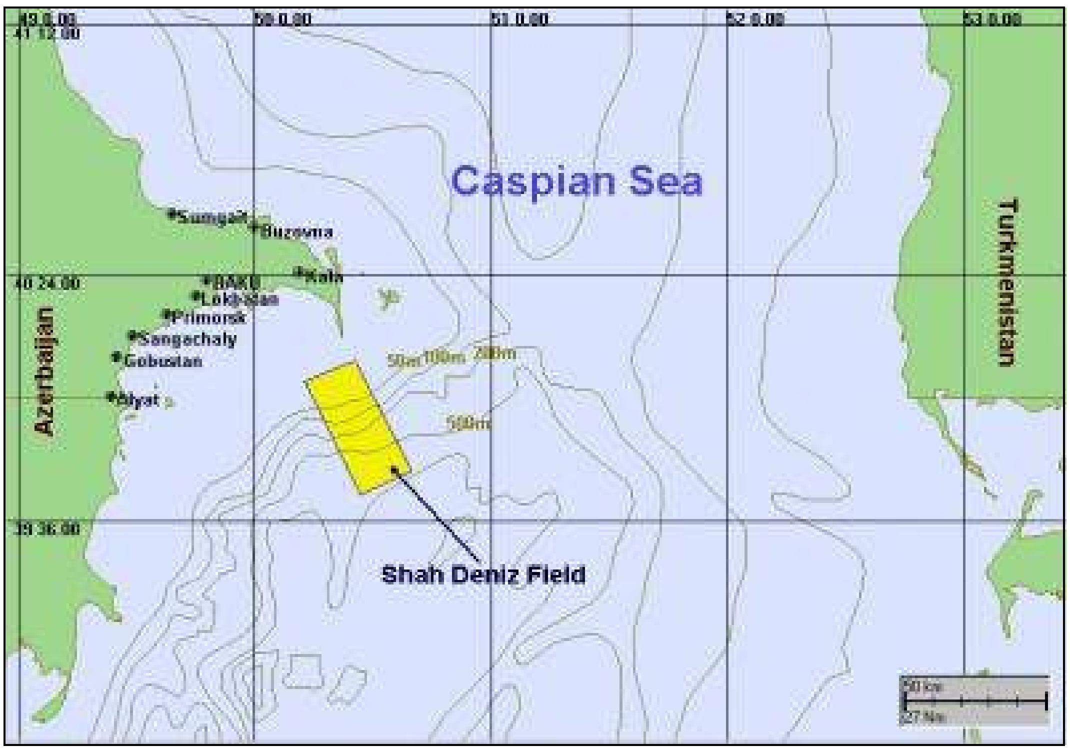

Figure 1a. Shows the location of the Shah Deniz field in the south Caspian sea

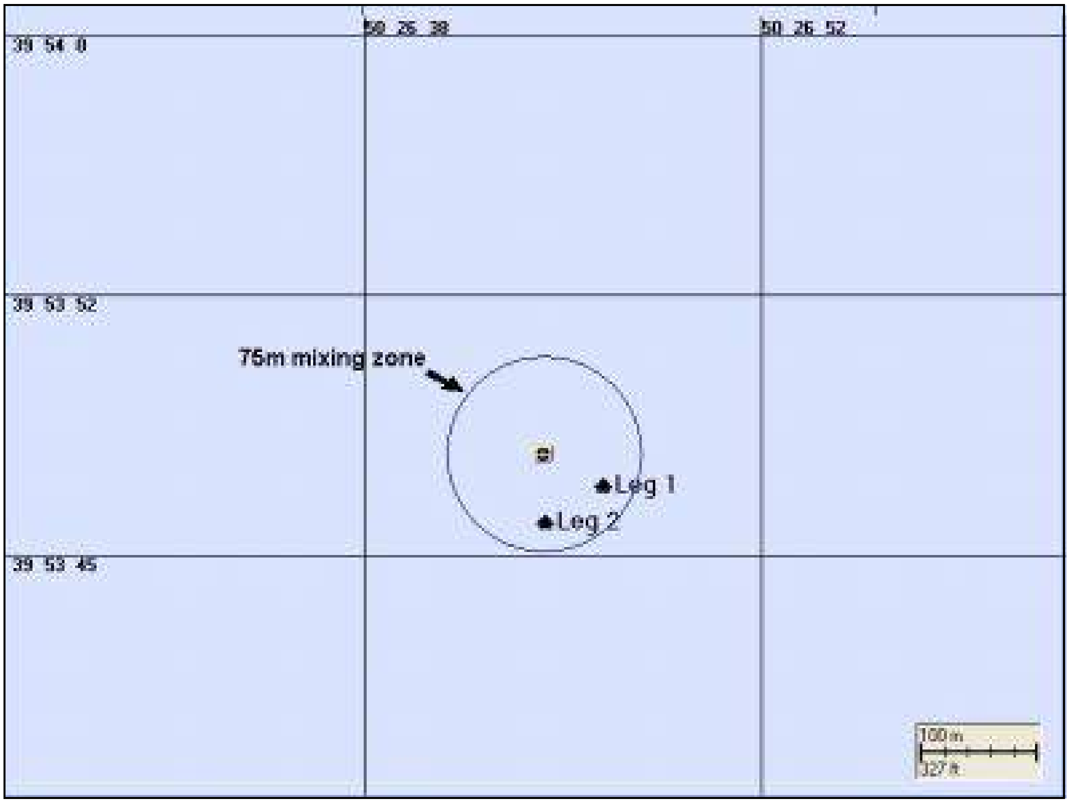

Figure 1b. Shows the 75m mixing zone and the location of Leg 1 in relation to the release site (Leg 3), denoted by the white cross.

2 Modelling Approach

In support of the project objectives, stated in section 1, hydrodynamic simulations were developed for the entire Caspian Sea with high resolution in the area offshore Baku using ASA's HYDROMAP; the likely constituent concentrations were conducted using ASA's MUDMAP.

2.1 HYDROMAP

HYDROMAP, developed by ASA, is a globally re-locatable hydrodynamic model capable of simulating complex circulation patterns due to tidal forcing and wind stress quickly and efficiently anywhere on the globe. HYDROMAP employs a novel step-wise-continuous-variable-rectangular gridding strategy with up to six levels of resolution. The term step-wise continuous implies that the boundaries between successively smaller and larger grids are managed in a consistent integer step.

The hydrodynamic model solves the three-dimensional conservation equations in spherical coordinates for water mass, density, and momentum with the Boussinesq and hydrostatic assumptions applied. These equations are solved subject to the following boundary conditions,

1) At land boundaries the normal component of velocity is set to zero;
2) At the open boundaries the sea surface elevation is specified as a series of temporal sine or cosine waves each with its own amplitude and phase appropriate gradients of the local surface elevation;
3) At the sea surface the applied stress due to the wind is matched to the local stress in the water column and the kinematic boundary condition is satisfied;
4) At the sea floor a quadratic stress law, based on the local bottom velocity, is used to represent frictional dissipation and a friction coefficient parameterizes the loss rate.

2.2 MUDMAP

The likely concentrations for each of the constituents were assessed using ASA's sub-surface model, MUDMAP. MUDMAP is a personal computer-based model developed by ASA to predict the near and far field transport, dispersion, and bottom deposition of drill muds and cuttings and produced water (Spaulding et al; 1994; Spaulding, 1994). In MUDMAP, the equations governing conservation of mass, momentum, buoyancy, and solid particle flux are formulated using integral plume theory and then solved using a Runge Kutta numerical integration technique. The model includes three stages: convective descent/ascent, dynamic collapse and far field dispersion. It allows the transport and fate of the release to be modeled through all stages of its movement. The initial dilution and spreading of the plume release is predicted in the convective descent/ascent stage. The plume descends if the discharged material is more dense than the local water at the point of release and ascends if the density is lower than that of the receiving water. In the dynamic collapse stage, the dilution and dispersion of the discharge is predicted when the release impacts the surface, bottom, or becomes trapped by vertical density gradients in the water column. The far field stage predicts the transport and fate of the discharge caused by the ambient current and turbulence fields.

MUDMAP is based on the theoretical approach initially developed by Koh and Chang (1973) and refined and extended by Brandsma and Sauer (1983) for the convective descent/ascent and dynamic collapse stages. The far field, passive diffusion stage is based on a particle based random walk model. This is the same random walk model used in ASA's OILMAP spill modeling system (ASA, 1999).

MUDMAP uses a color graphics-based user interface and provides an embedded geographic information system, environmental data management tools, and procedures to input data and to animate model output. The system can be readily applied to any location in the world. Application of MUDMAP to predict the transport and deposition of heavy and light drill fluids off Pt Conception, California and the near field plume dynamics of a laboratory experiment for a multi-component mud discharged into a uniform flowing, stratified water column are presented in Spaulding et al. (1994). King and McAllister (1997, 1998) present the application and extensive verification of the model for a produced water discharge on Australia's northwest shelf. GEMS (1998) presents the application of the model to assess the dispersion and deposition of drilling cuttings released off the northwest coast of Australia.

3 Discharge Characteristics

BP Exploration Ltd provided detailed discharge characteristics used to describe the release (see Table 2). Table 2 also shows estimated quantities and properties of various constituents (BOD_5, Suspended Solids and total coliform) assumed to be within the sewage plume.

Table 2: Settings used to model the sewage plume from Shah Deniz

Discharge Rate	33m^3/day
Discharge duration	29 days
Duration of simulations	29 days
Pipe diameter	500mm
Pipe orientation	Vertical – facing down
Pipe release depth	20m below sea level
Sewage release amount	957m^3
Density of sewage	1000 kg/m^3
Constituent	Concentration

BOD_5	40 mg/L (1.32kg/day)
Suspended Solids	50 mg/L (1.65kg/day)
Total Coliforms	200 counts/100ml (6.6 x10^7/day)

The size of the suspended solids was based on Kiely (1995). The grain size, distribution and the equivalent fall velocity are presented in Table 3. Fall velocities for these Settling velocities were derived from empirical data provided by Dyer (1986).

Table 3: Particle size distribution of the suspended solids

Nominal Grain Size (mm)	Percentage of Total Mass	Fall Velocity (cm/sec)
0.1	10	0.8
0.08	5	0.5
0.07	20	0.4
0.06	30	0.3
0.04	25	0.13
0.02	10	0.03

Each constituent was modelled as a conservative tracer (no reaction or decay) constituting a "worst case" scenario. The density for both BOD_5 and Total Coliforms were assumed to be equal to the treated sewage plume (1000 kg/m^3). BOD_5 was assumed to remain suspended within the water column (zero fall velocity), while total coliform was assumed to have a fall velocity of 1m/day based on literature from Thomann and Mueller (1987).

3.1 Environmental conditions

Model predictions were carried out for a 29-day release during winter (January) and summer (June). Figures 2 and 3 shows a sample of the predicted currents around the release site for each season, based on the HYDROMAP output.

Since no data are available regarding the general dispersion rate for the waters off the coast of Baku, conservative estimates of 1.0 m^2/s and 0.00001m^2/s were used for horizontal and vertical dispersion respectively.

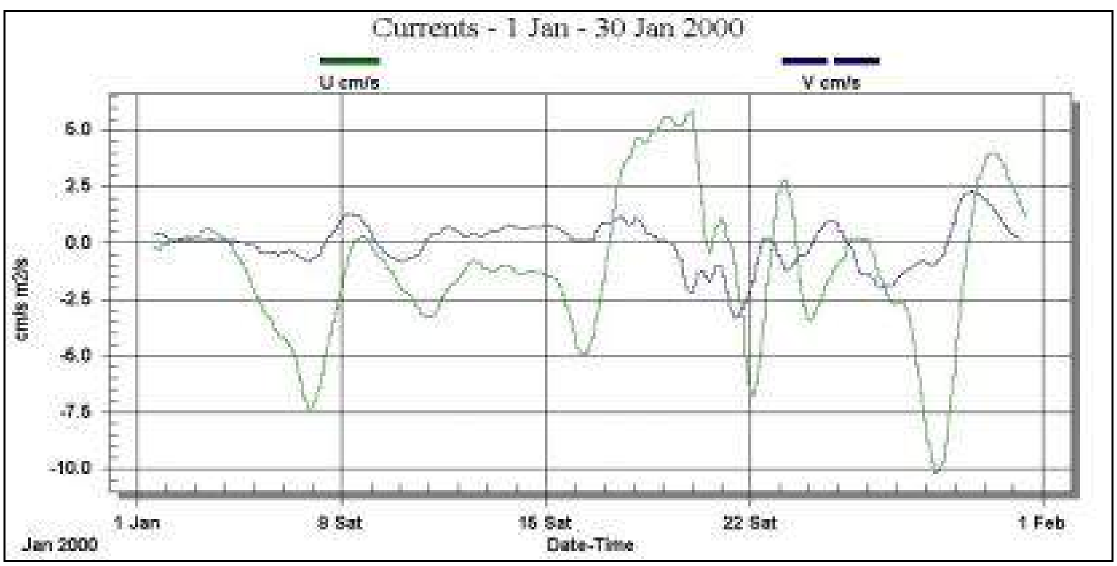

Figure 2. Shows the predicted current speed at the release site during winter (January 2000). Note u is the current east – west component, while v is the north south component.

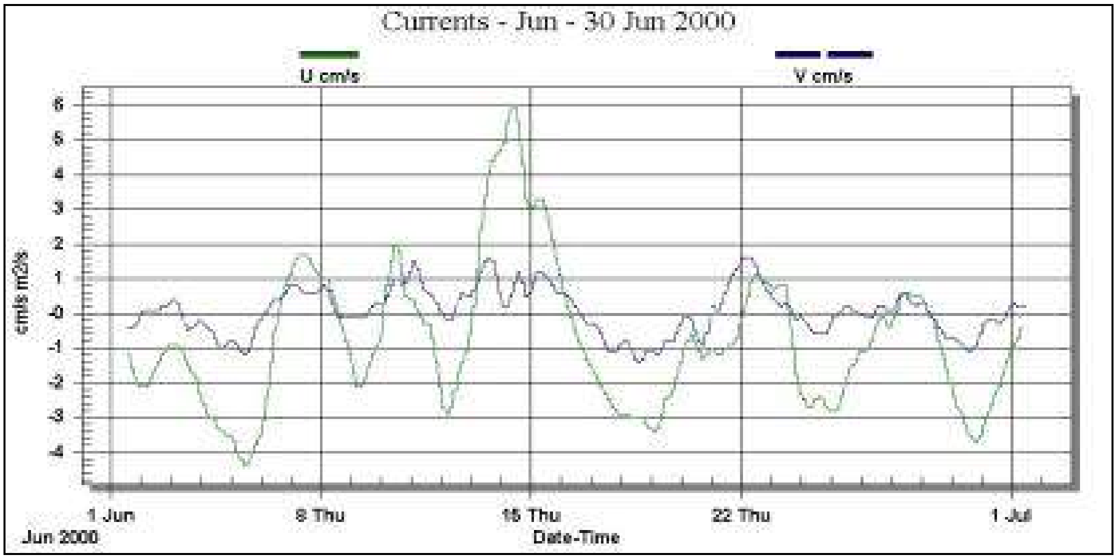

Figure 3. Shows the predicted current speed at the release site during summer (June 2000). Note u is the current east – west component (positive east), while v is the north south component (positive north).

For the simulations reported here, the vertical structure of temperature for each season was developed from data provided by URS Dames and Moore and characteristic temperature profiles of the entire southern Caspian Sea as presented in Kosarev (1994). The summer season is characterized by two dominant thermal layers with surface and bottom temperatures of approximately 25 and 7°C, respectively, with the major thermocline at approximately 40m depth. The winter season is characterized as thermally well mixed with surface to bottom gradients no greater than 1°C. Table 4 presents the vertical structure of temperature used for the sewage dispersion simulations.

Table 4. Seasonal vertical structure of temperature.

Depth (m)	**Summer Temperature (°C)**	**Winter Temperature (°C)**
Surface	25.0	7
10	24.1	7
20	24.0	7
30	24.0	7
50	9.3	7
75	7.9	7
100	7.3	7

4 Results for sewerage dispersion

Predictions indicate that concentrations will be patchy within the plume, caused by variation in the current flows past the discharge point. Concentrations around the discharge point were generally predicted to be low when the winds were stronger (>1.5 cm/s). However, patches of higher concentrations tended to build up with the turning of the wind direction. These patches then moved as a cohesive unit as current speeds increased again. Dispersion of these higher concentrations tended to require a constant wind speed and direction (>6 hours), so that the patches of different sizes, ages and concentrations tended to be present within the wider plume at any one time. Further build-up was predicted to occur when patches coalesced and when current reversals caused the plume to reverse upon itself and consolidate, also known as “second dosing’. This occurred where the sewage plume was moved back under the discharge at some later time due to a sudden change in wind direction (>180 degrees) and speed, and received fresh dosing of the discharge.

These findings are in agreement with the research of King and McAlister (1997, 1998) who also noted that concentrations of produced water plumes generated by the Harriet Alpha platform were patchy, peaking around the changing of the tides.

Highest concentrations at any time step were always found within the grid cell surrounding the discharge point. Table 5 is a summary of the predicted maximum concentration for each constituent in relation to the initial discharge concentrations for summer and winter.

Table 5. Summary of the predicted concentrations for each of the constituents in relation to initial discharge concentrations during summer and winter.

Constituent	Initial concentrations	Highest predicted concentrations	
		Winter	Summer
BOD_5 (g/m^3)	40	0.0225	0.0224
Suspended solids (g/m^3)	50	0.00616	0.00619
Total coliform (counts/100mL)	200	15	13

4.1 Biological Oxygen Demand

Figures 4-7 show time-series graphs of the predicted concentrations of BOD_5 at 75m from the release site and at Leg 1 for both summer and winter discharges. Figures 4 & 5 show the concentrations of the plume as it passes by Leg 1 during summer and winter over the 29 day release. Both figures show that due to the location of the leg the plume makes very little contact. The times that there is contact, the concentrations are short-lived and the concentrations do not exceed 0.006 g/m^3 (mg/L).

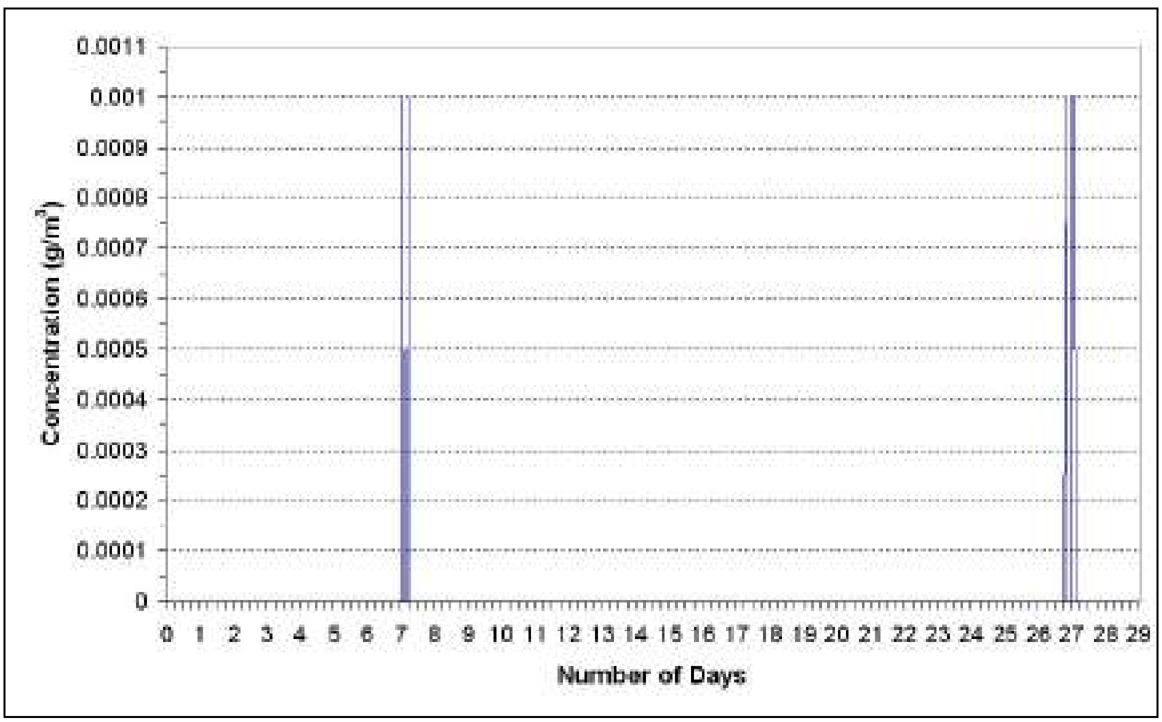

Figure 4. Time series graph of the BOD_5 concentrations predicted at Leg 1 during summer over the 29 day release period.

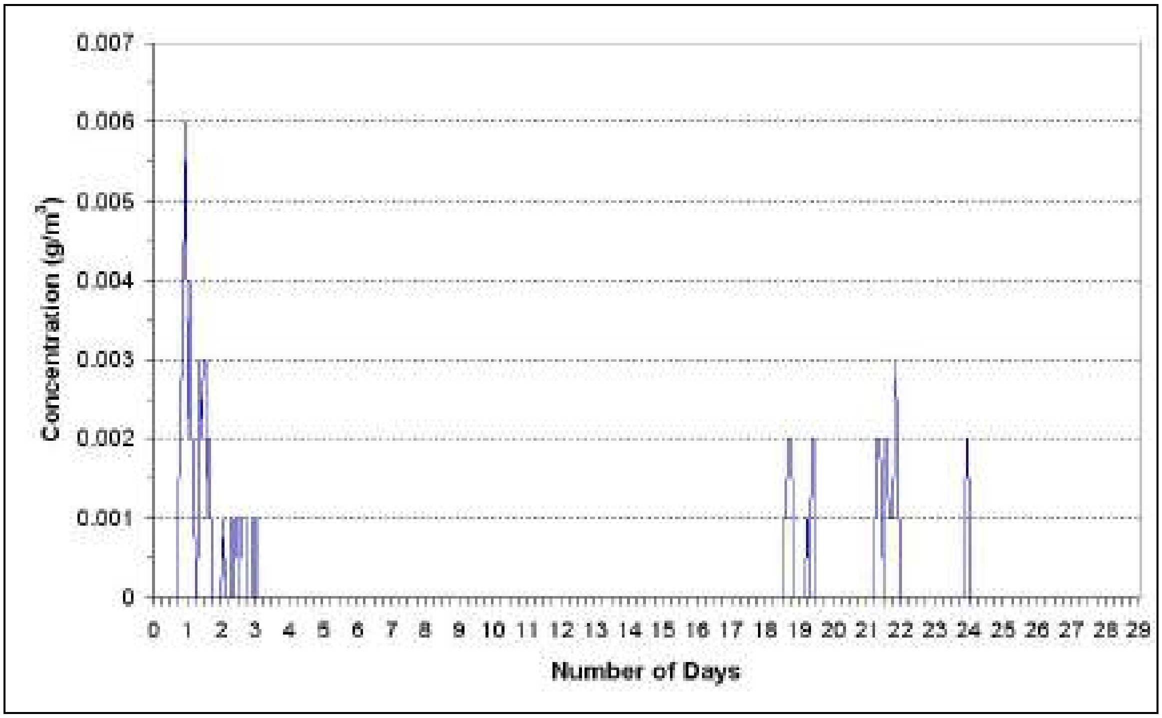

Figure 5. Time series graph of the BOD_5 concentrations predicted at Leg 1 during winter over the 29 day release period.

Due to the predominant wind direction for both seasons being from the north-east for both simulations, the 75m peak concentrations were found to occur south-west from the release site. During the 29 day release the BOD_5 concentrations were found to peak at 0.011 mg/L, which was 0.027% of the initial concentrations. The concentrations (see Figure 6 & 7) 75m away from the release site were found to rapidly diluted.

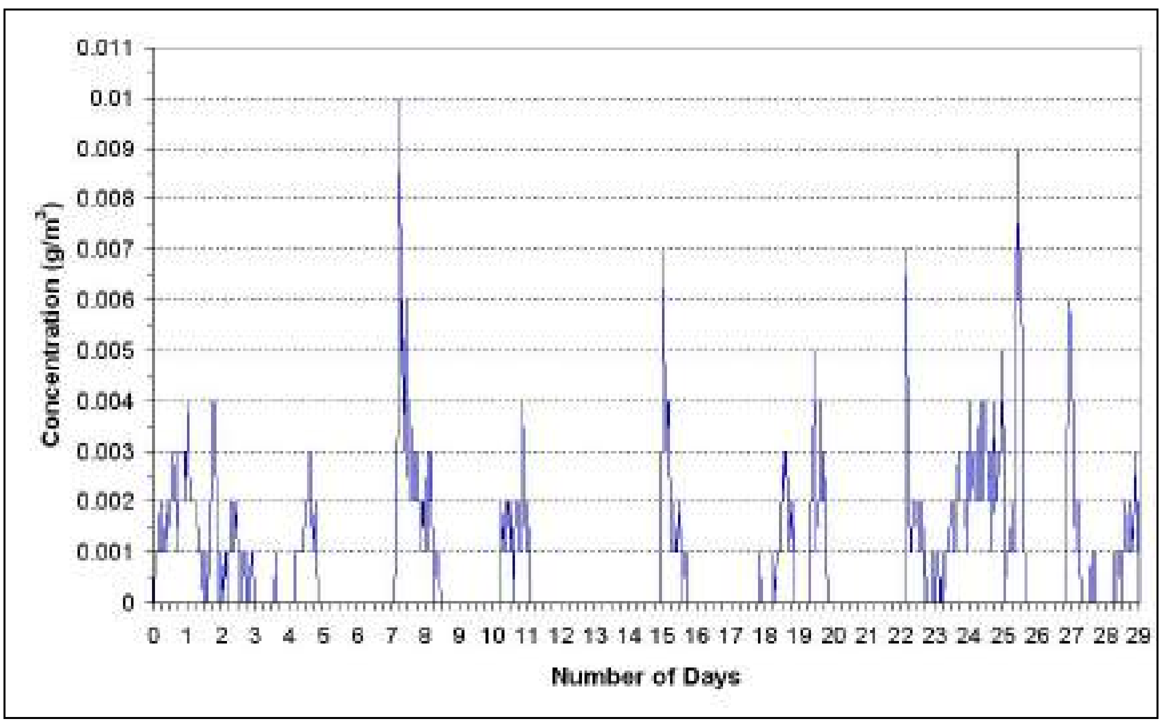

Figure 6. Time series graph of the BOD_5 concentrations predicted 75m from the release site during summer over the 29 day release period.

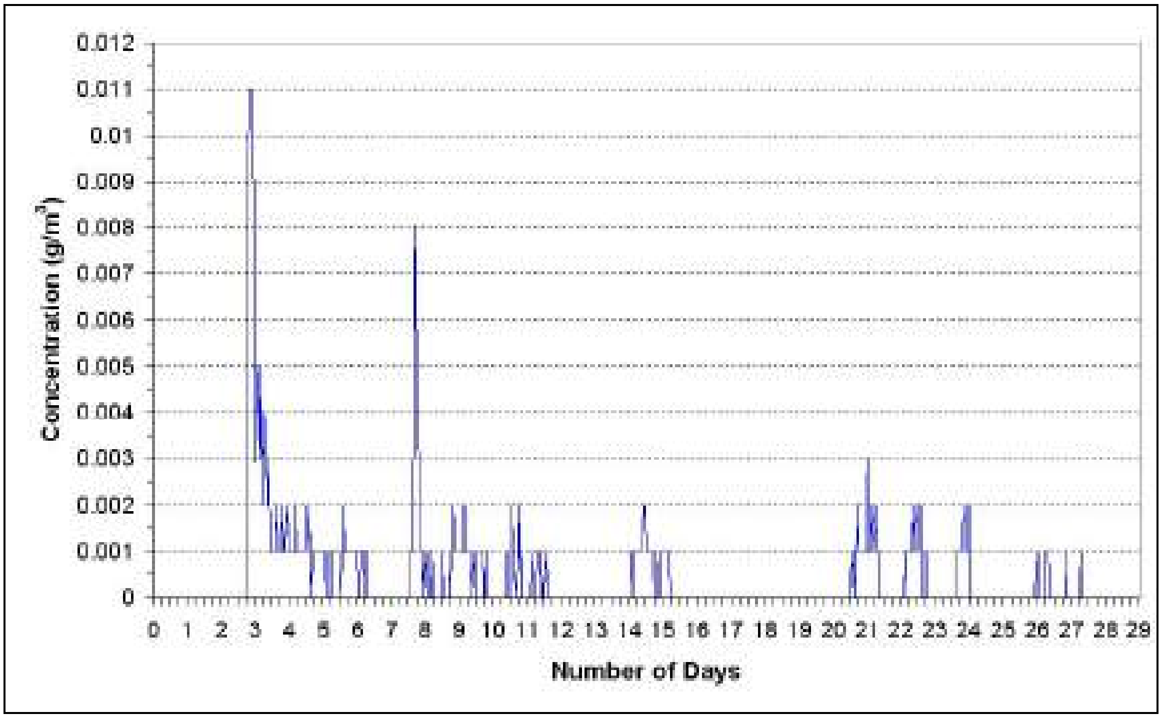

Figure 7. Time series graph of the BOD_5 concentrations predicted 75m from the release site during winter over the 29 day release period.

Figure 8 and 9 show the highest predicted concentrations for BOD_5 during winter and summer, over the 29 day simulation.

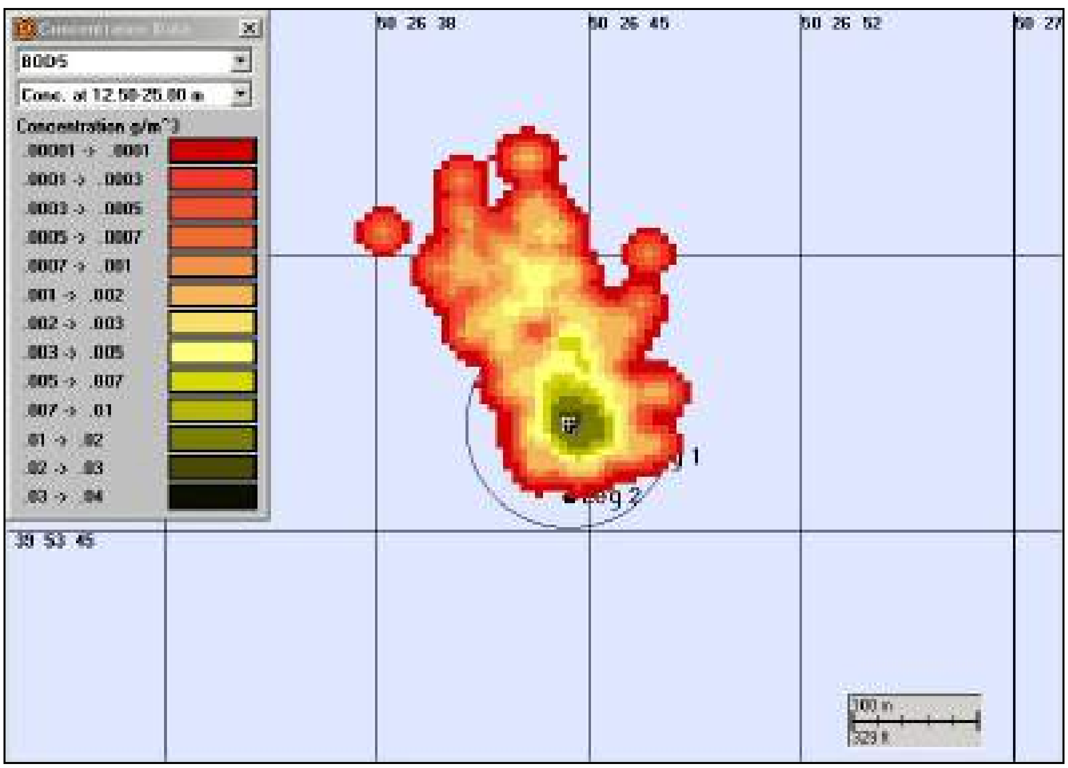

Figure 8. Shows a plan view of the highest BOD_5 concentrations predicted for the 12.5 – 25m layer during winter over the 29 day simulation.

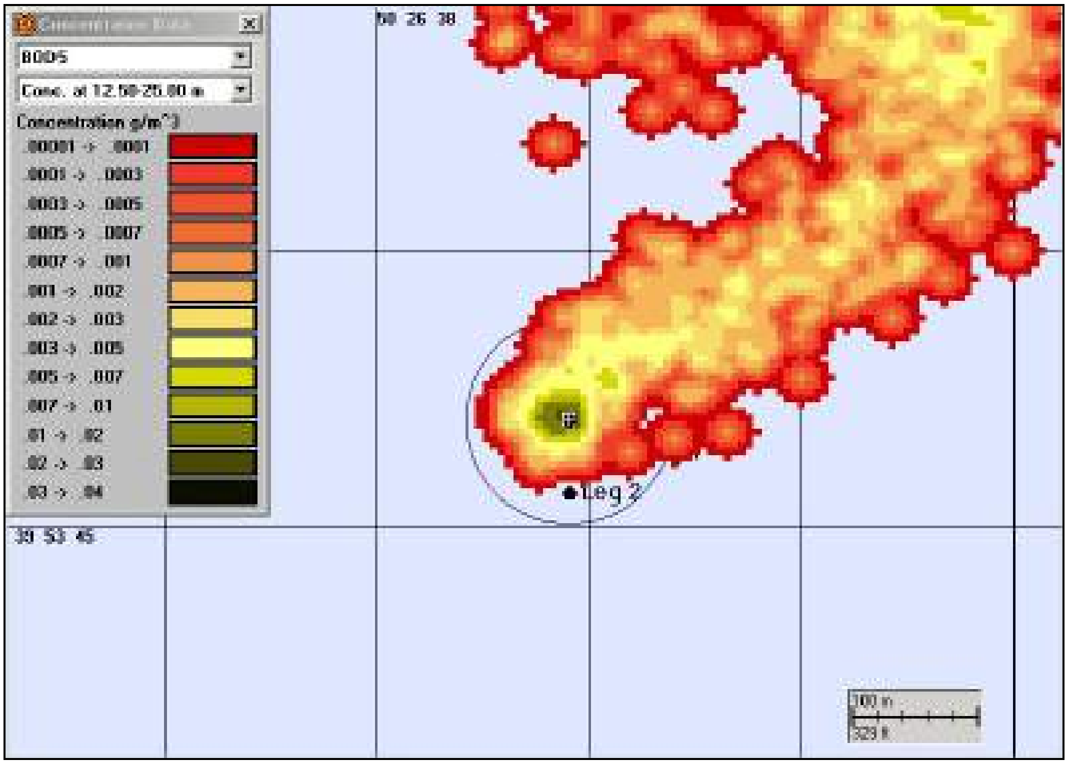

Figure 9. Shows a plan view of the highest BOD_5 concentrations predicted for the 12.5 – 25m layer during summer over the 29 day simulation.

4.2 Suspended Solids

Predicted concentrations of suspended solids within the sewage outfall were found to only be marginally higher during winter (see Table 5), due to the weaker flows. Due to the settling velocities associated with each particles, concentrations at Leg 1 and 75m away were very small. Figures 10 – 13 show a time series of the suspended concentrations at Leg 1 and 75m away from the release site over the 29 day release for each season.

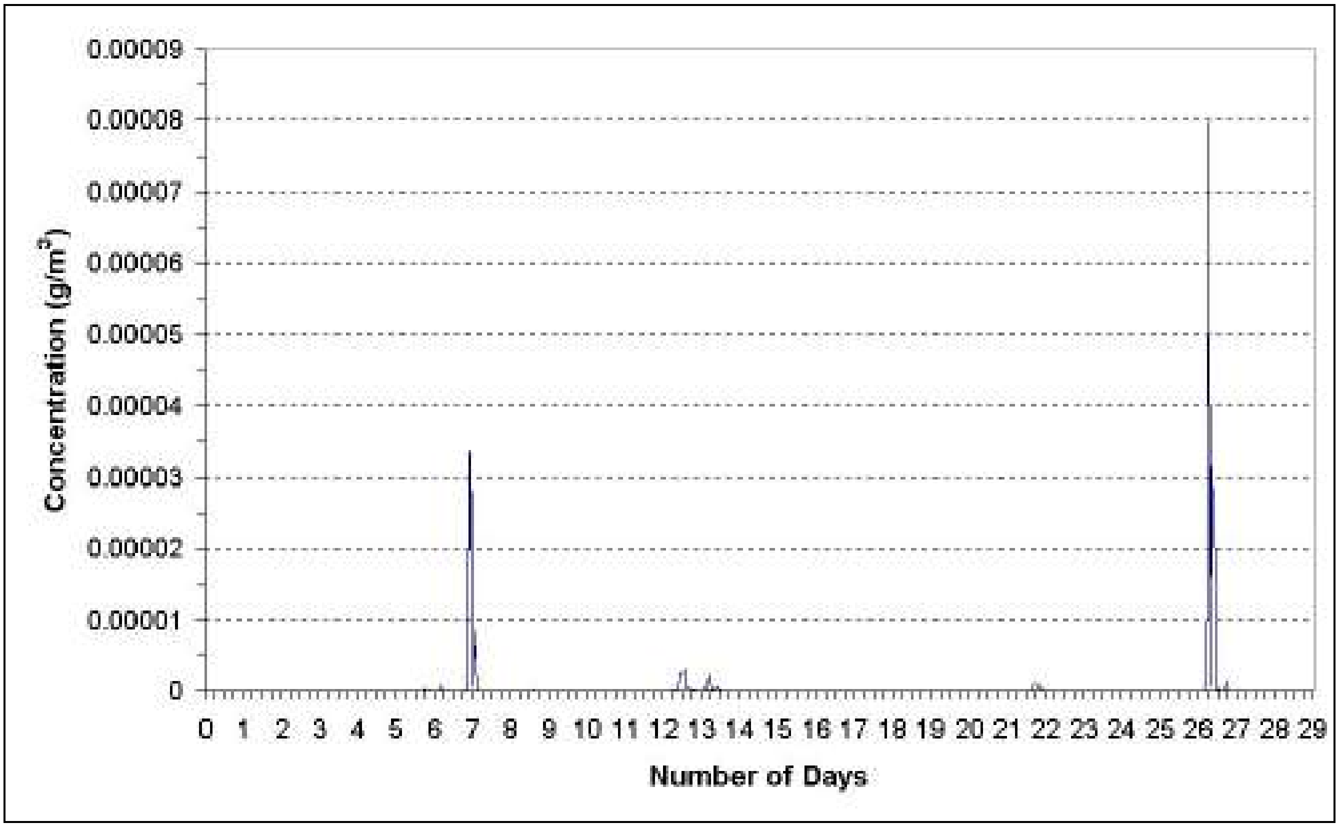

Figure 10. Time series graph of the suspended solids concentrations predicted at Leg 1 during summer over the 29 day release period.

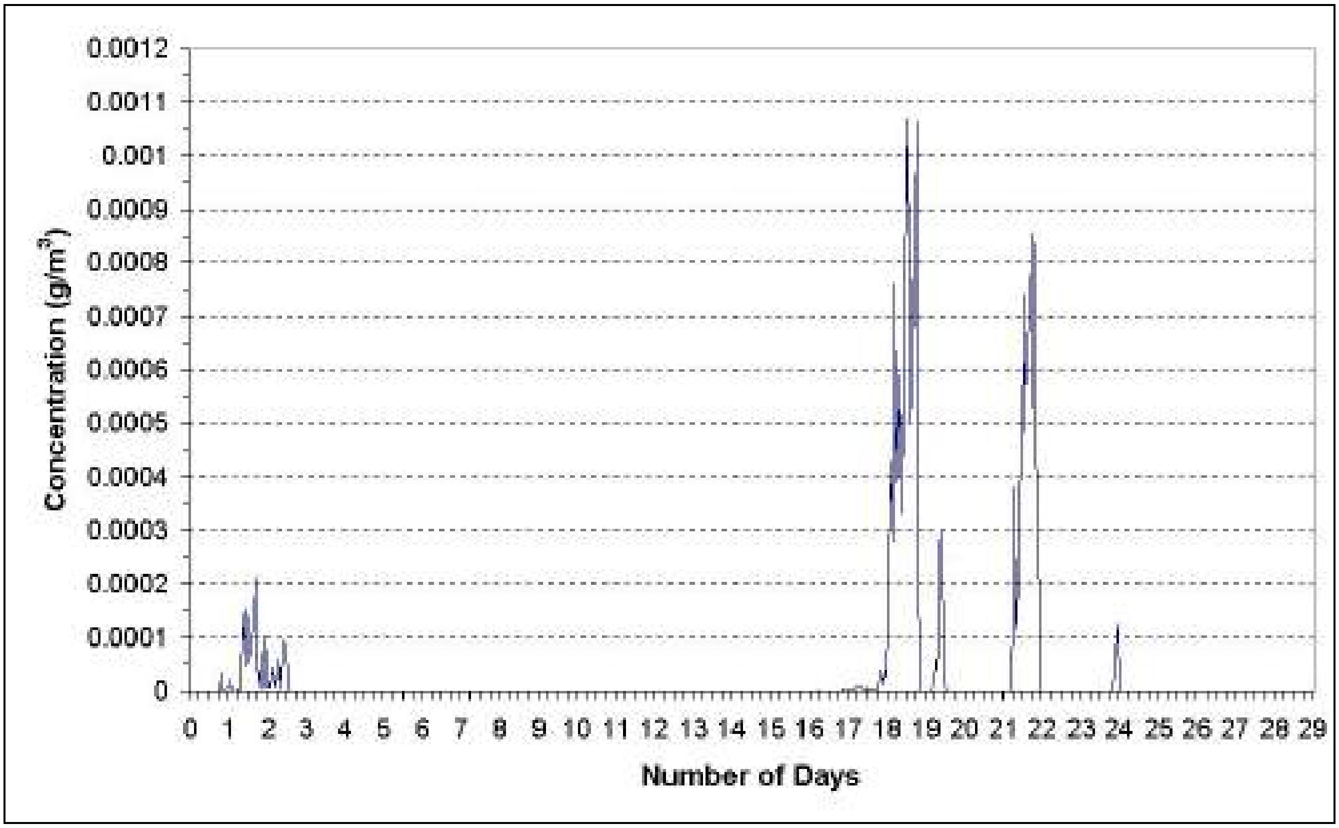

Figure 11. Time series graph of the suspended solids concentrations predicted at Leg during winter over the 29 day release period.

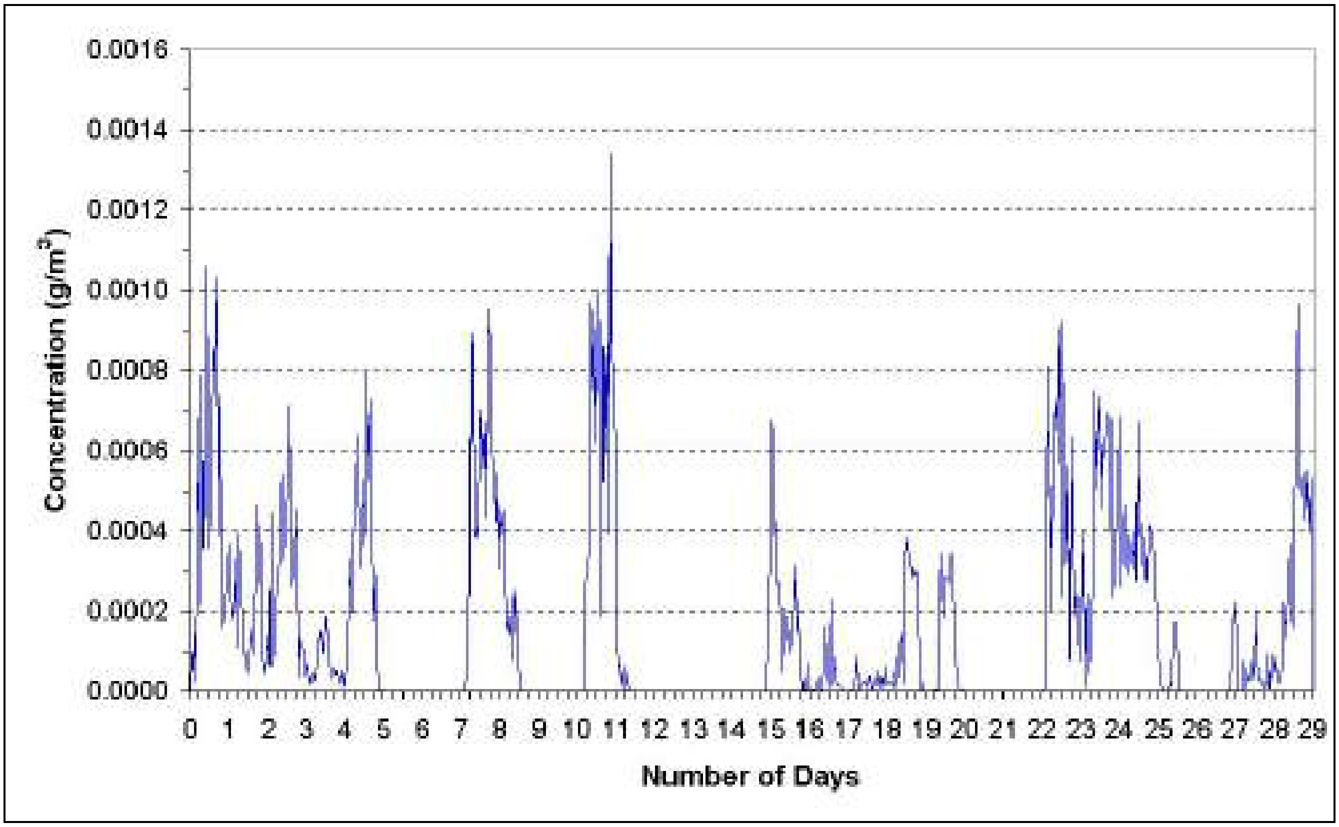

Figure 12. Time series graph of the suspended solids concentrations predicted 75m from the release site during summer over the 29 day release period..

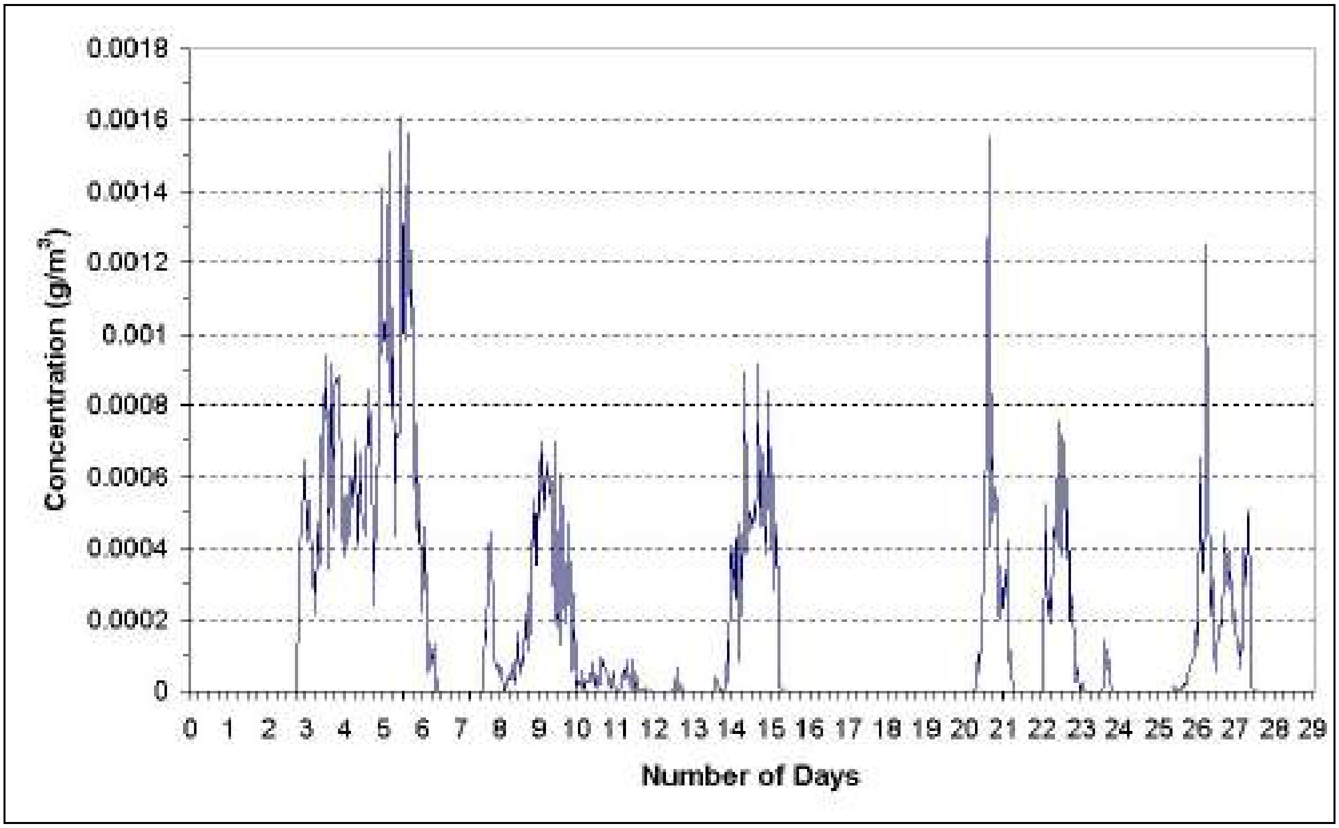

Figure 13. Time series graph of the suspended solids concentrations predicted 75m from the release site during winter over the 29 day release period.

Figure 14 and 15 show the highest predicted concentrations for suspended solids during summer and winter, over the 29 day simulation.

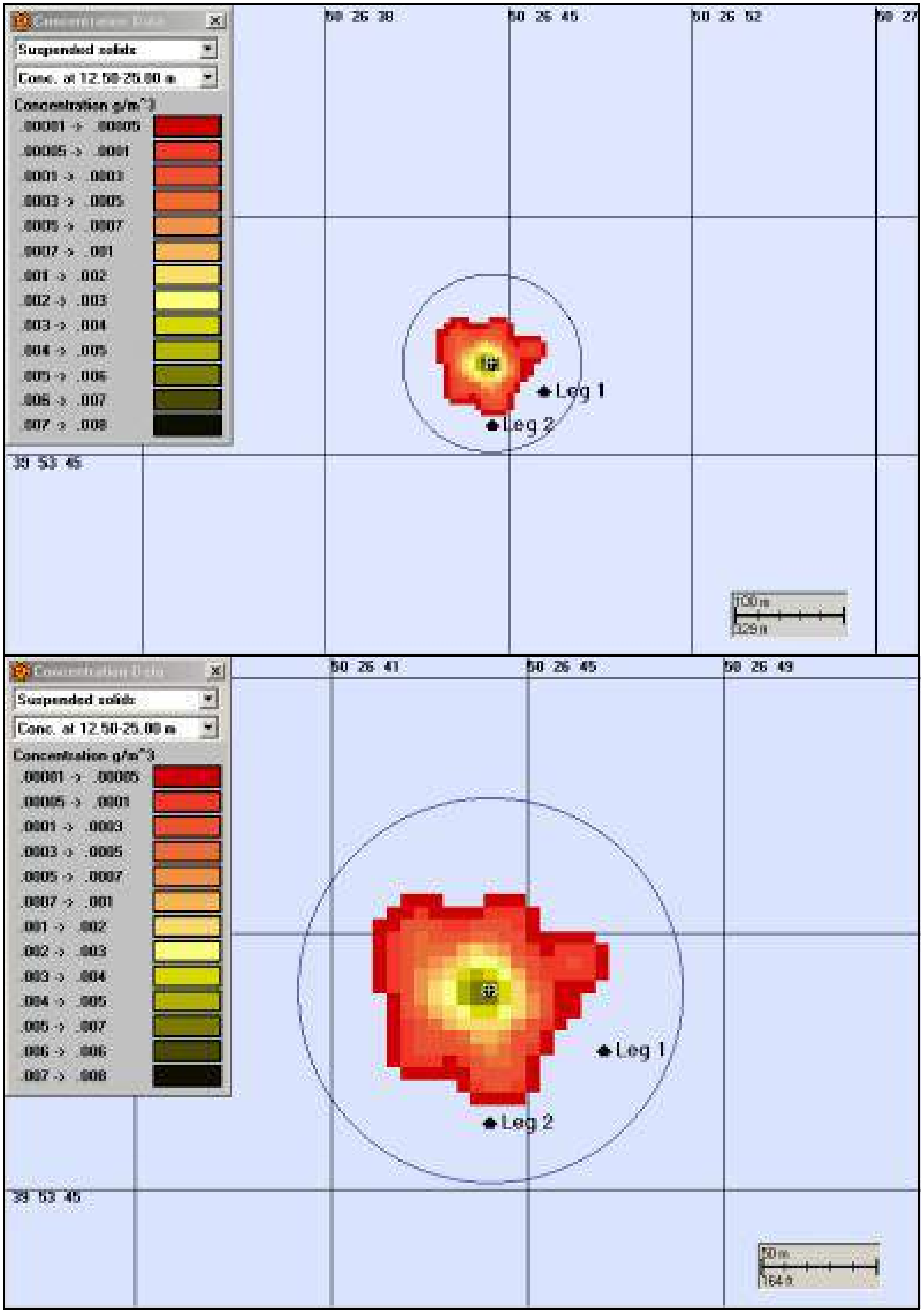

Figure 14. Large scale view (top) and close up view (bottom) of the highest suspended solids concentrations predicted for the 12.5 – 25m layer during summer over the 29 day simulation.

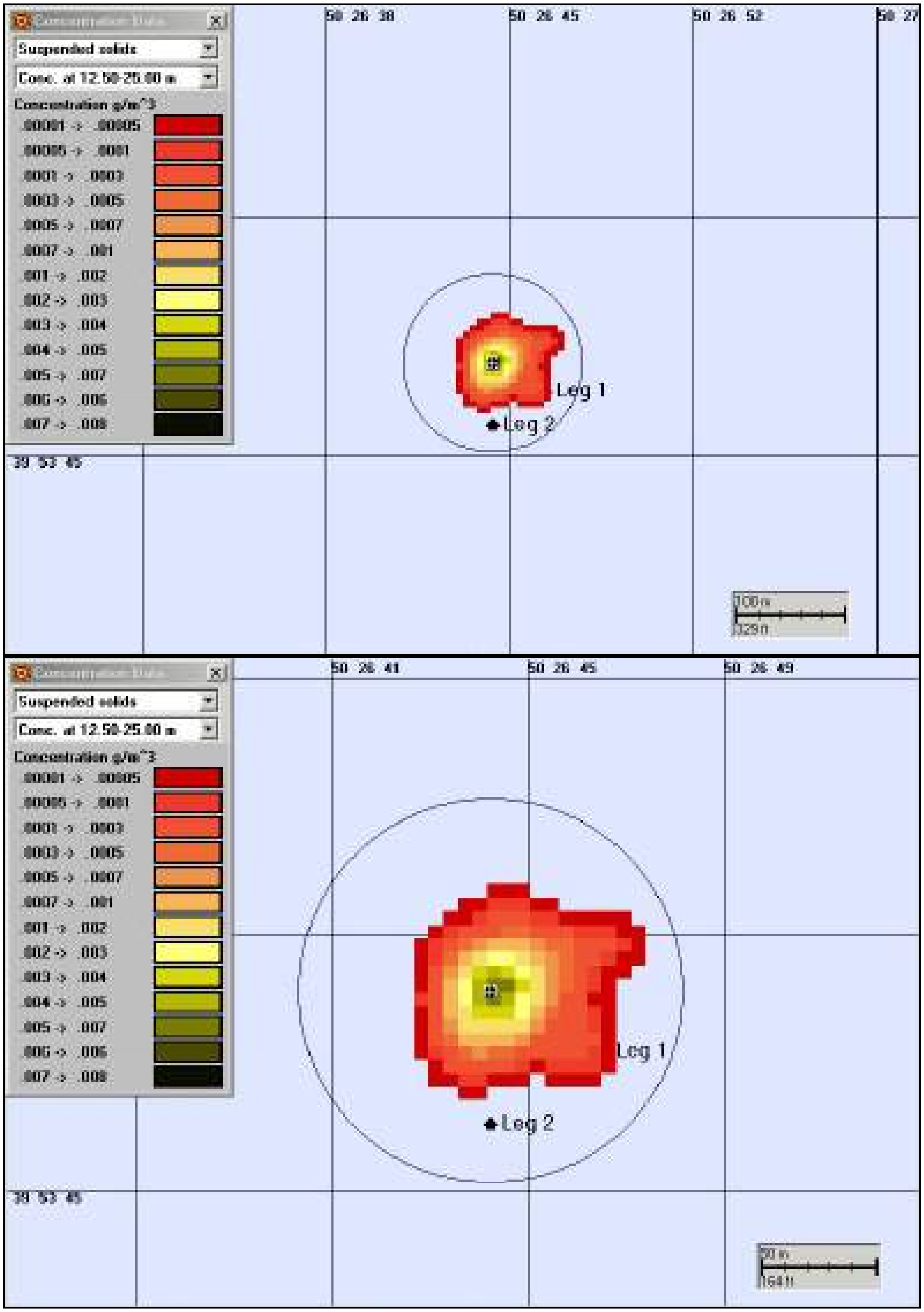

Figure 15. Large scale view (top) and close up view (bottom) of the highest suspended solids concentrations predicted for the 12.5 – 25m layer during winter over the 29 day simulation.

4.3 Total Coliform

Figures 16- 19 show time-series graphs of the predicted concentrations of total coliform at 75m from the release site and at Leg 1 for both summer and winter discharges

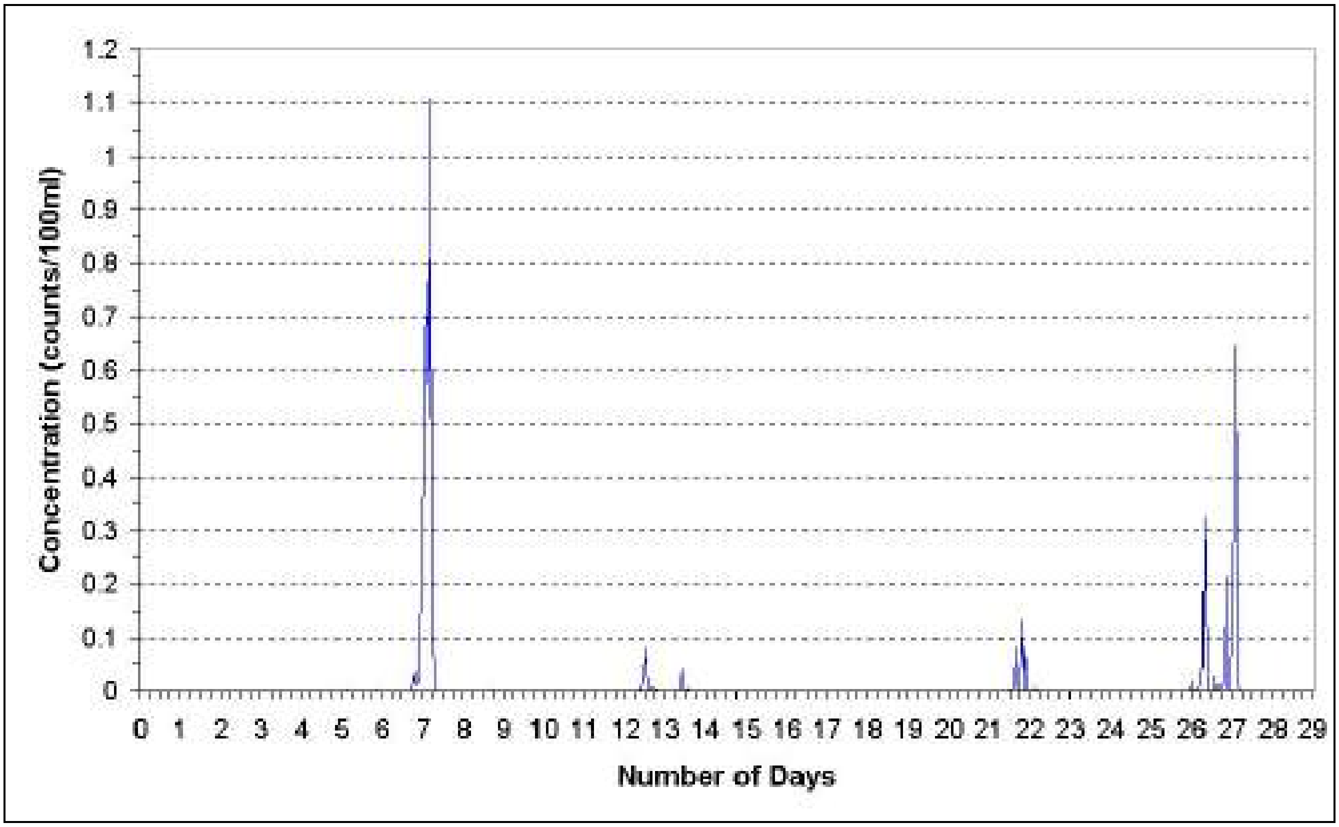

Figure 16. Time series graph of the total coliform concentrations predicted at Leg 1 during summer over the 29 day release period.

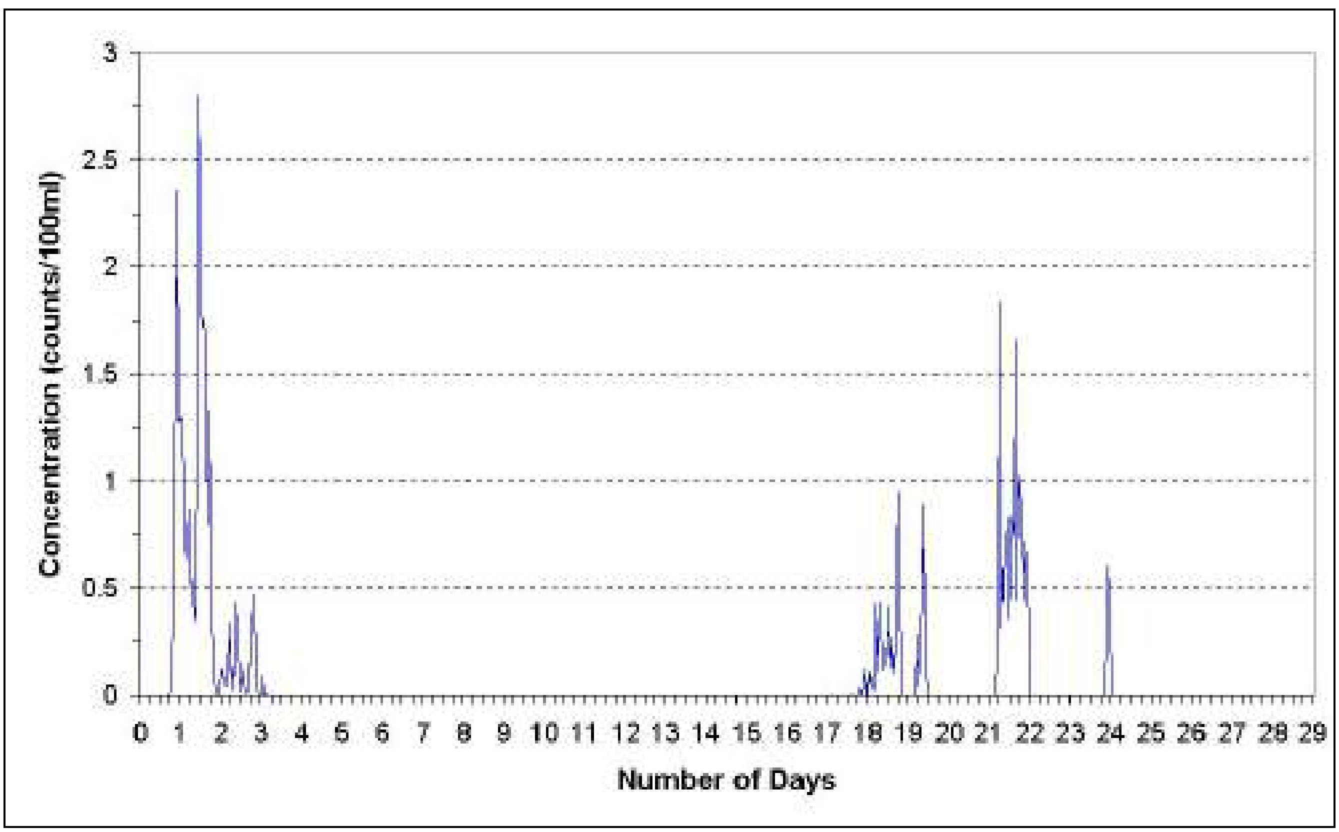

Figure 17. Time series graph of the total coliform concentrations predicted at Leg 1 during winter over the 29 day release period.

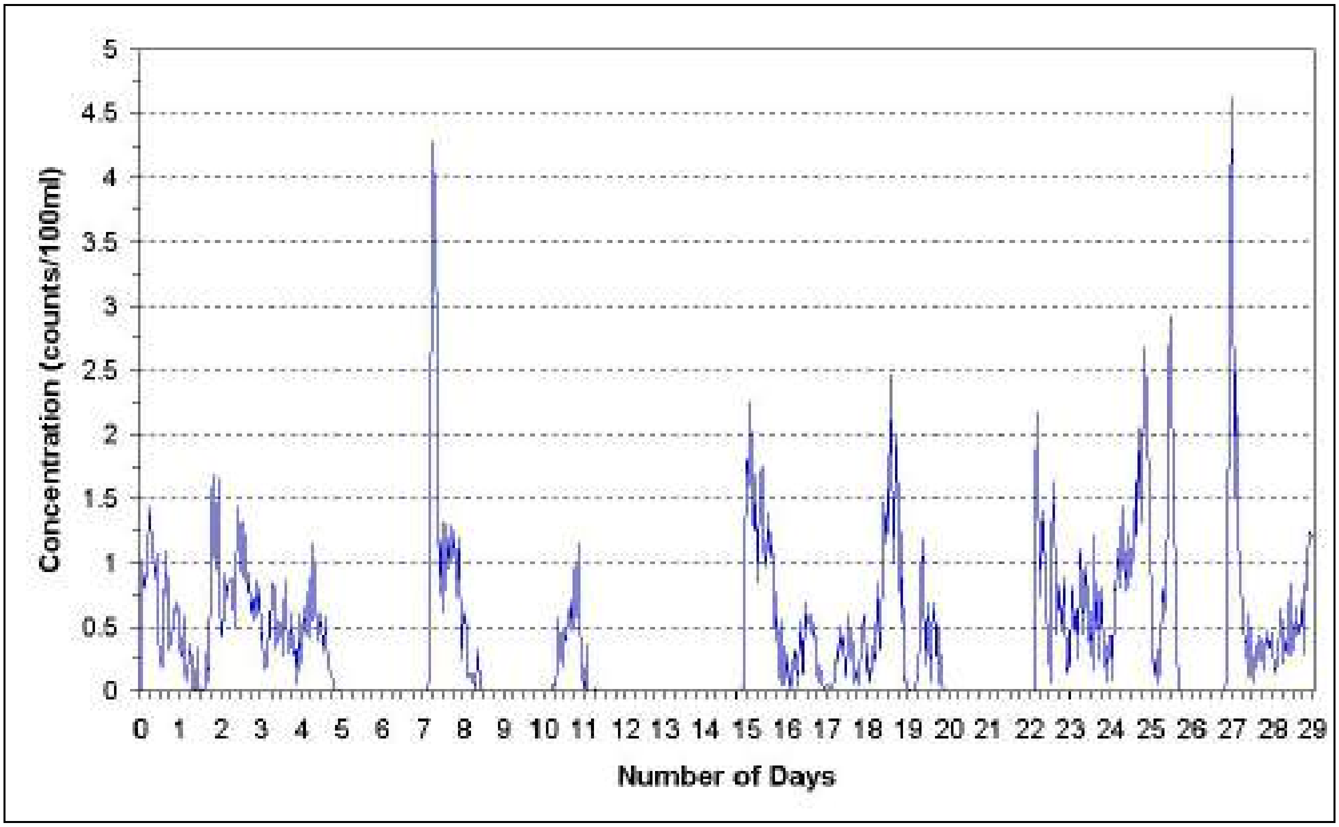

Figure 18. Time series graph of the total coliform concentrations predicted 75m from the release site during summer over the 29 day release period.

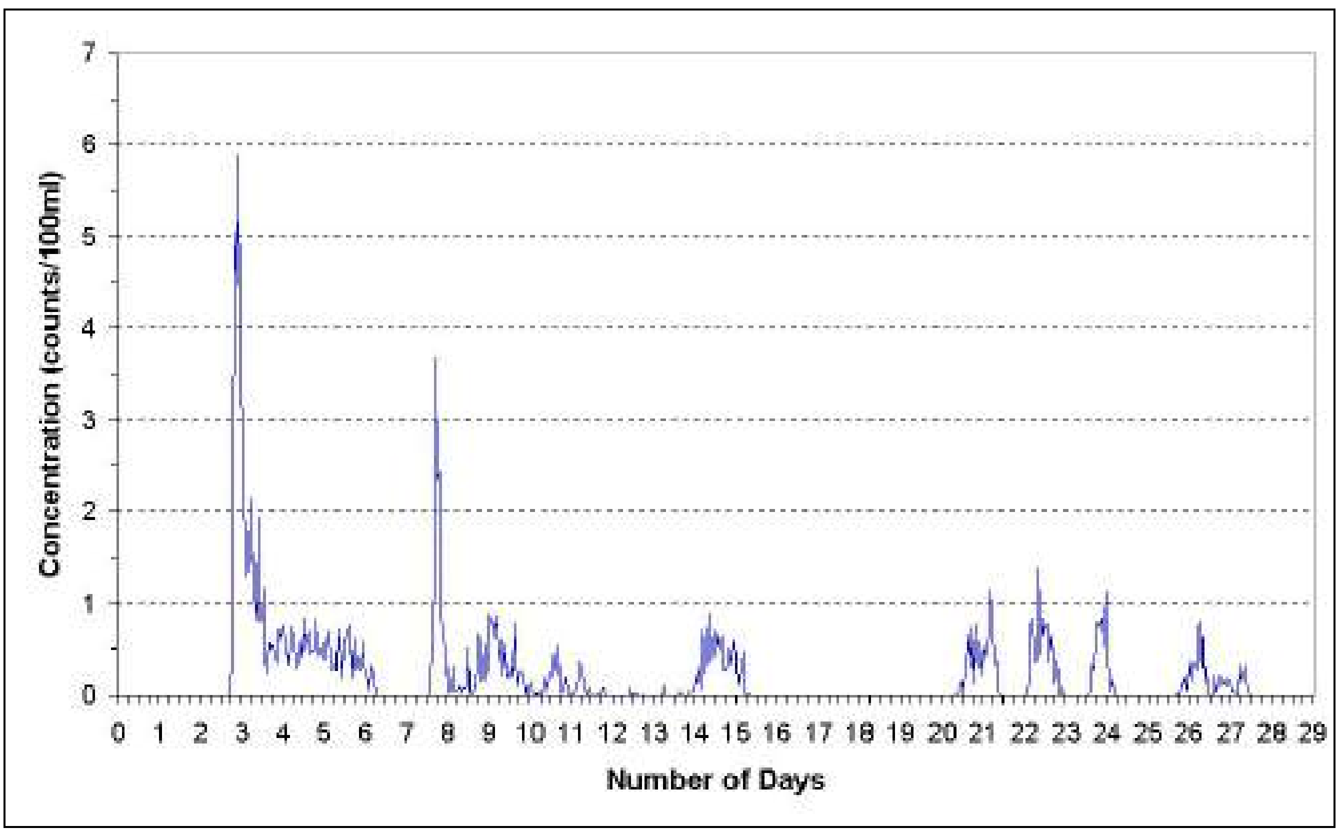

Figure 19. Time series graph of the total coliform concentrations predicted 75m from the release site during winter over the 29 day release period.

Figure 20 and 21 show the highest predicted concentrations for total coliform during summer and winter, over the 29 day simulation.

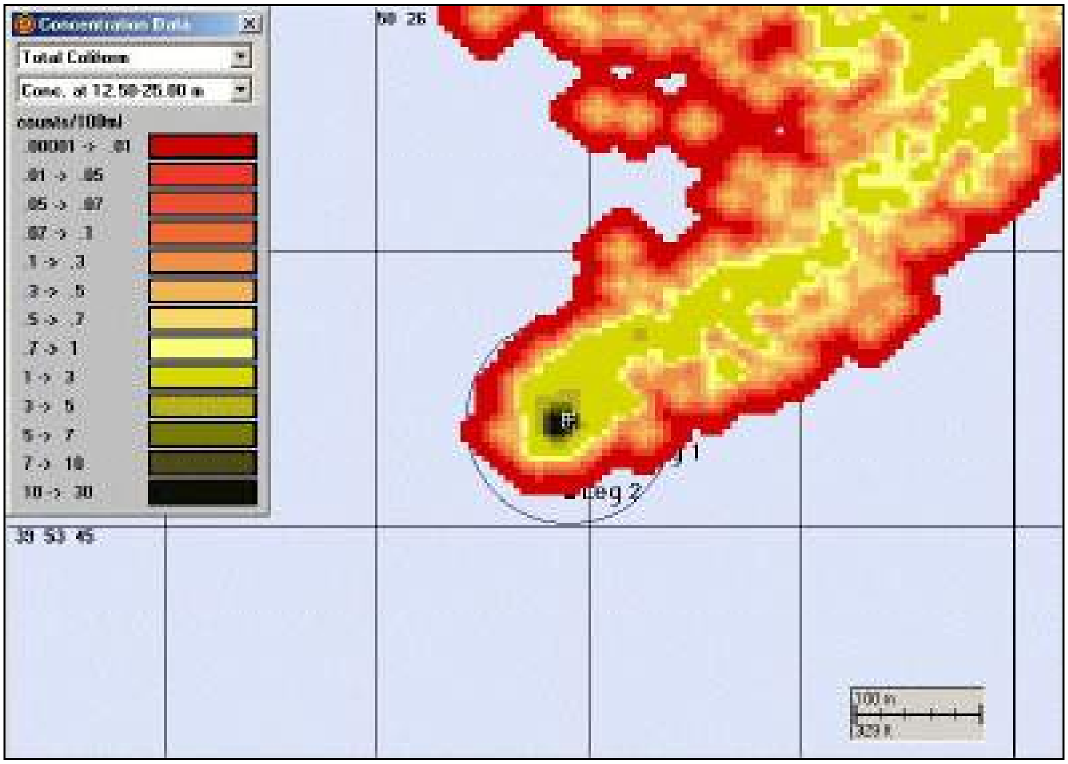

Figure 20. Large scale view (top) and close up view (bottom) of the highest total coliform concentrations predicted for the 12.5 – 25m layer during summer over the 29 day simulation.

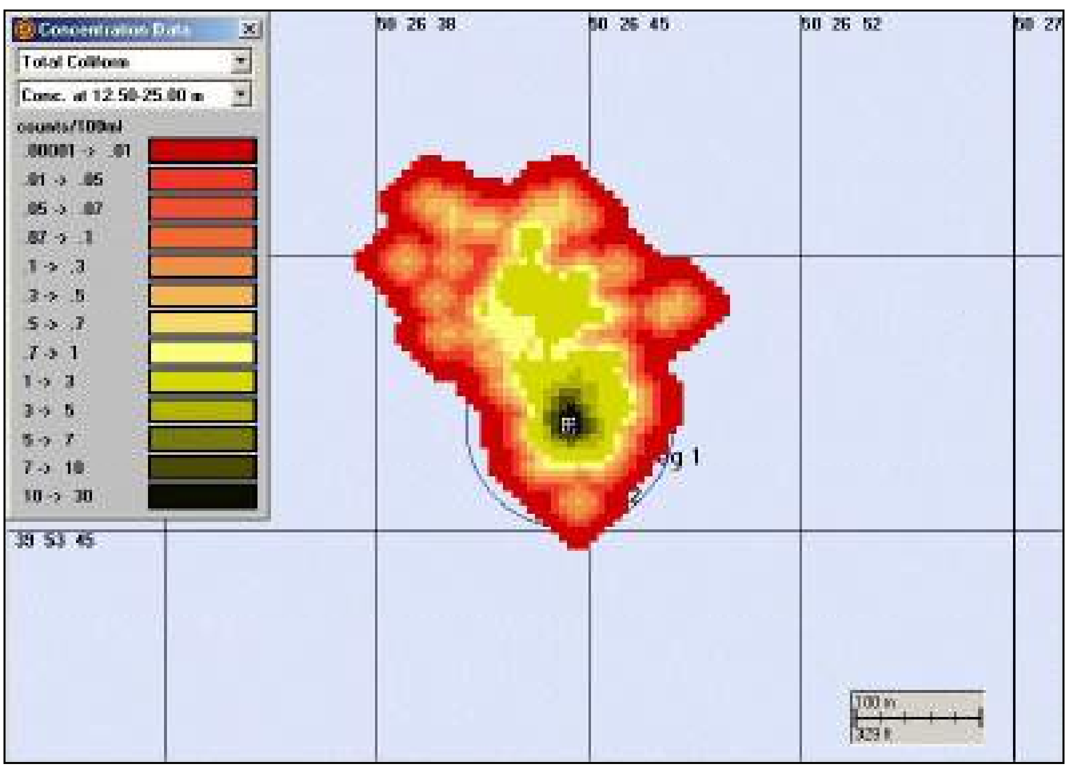

Figure 21. Large scale view (top) and close up view (bottom) of the highest total coliform concentrations predicted for the 12.5 – 25m layer during winter over the 29 day simulation.

5 Conclusions

ASA's sub-surface model, MUDMAP, was used to examine the likely mixing and dilution of BOD_5, suspended solids and total coliform, within the biologically treated sewage plume to be discharged overboard from the Shah Deniz platform, approximately 100km south east of Baku in the south Caspian Sea. Each constituent was modeled as a conservative tracer (no reaction or decay) constituting a "worst case" scenario. The flow field for the study was defined by wind-forced hydrodynamics from ASA's HYDROMAP model. One month of characteristic winter and one month of characteristic summer flow forced advection of the simulations. Vertical structure of the water column was defined by field observations. Predicted patchy concentrations of all three constituents resulted from oscillations in wind forcing and resulting oscillations in the water flowing past the outfall. Thus some patches of water were dosed twice from the continuing discharge of materials. The highest concentrations for any time step were found in the grid cell containing the outfall. These maximum concentrations were: BOD_5 0.0225, 0.0224 (g/m^3) winter and summer; Suspended solids 0.00616, 0.00619 (g/m^3) winter and summer; Total coliform 15, 13(counts/100mL) winter and summer.

The time history of predicted concentrations of BOD_5 75m from the release site over the 29 day release show ephemeral winter and summer maxima of 0.011 and 0.01(g/m^3).

The time history of predicted concentrations of BOD_5 at Leg 1 over the 29 day release show ephemeral winter and summer maxima of 0.006 and 0.001(g/m^3).

The time history of predicted concentrations of suspended solids 75m from the release site over the 29 day release show ephemeral winter and summer maxima of 0.0011 and 0.00008(g/m^3).

The time history of predicted concentrations of suspended solids at Leg 1 over the 29 day release show ephemeral winter and summer maxima of 0.0016 and 0.0014(g/m^3).

The time history of predicted concentrations of total coliform 75m from the release site over the 29 day release show ephemeral winter and summer maxima of 2.9 and 1.1 (counts/100mL).

The time history of predicted concentrations of total coliform at Leg 1 over the 29 day release show ephemeral winter and summer maxima of 6 and 4.5(counts/100mL).

6 References

BP Expoloration (2002) “Dispersion studies scope of work” Internal report No.6531Z 102.

Brandsma, M.G. and T.C. Sauer, Jr. (1983). “The OOC model: prediction of short term fate of drilling mud in the ocean, Part I model description and Part II model results”. Proceedings of Workshop on An Evaluation of Effluent Dispersion and Fate Models for OCS Platforms, Santa Barbara, California, 7-10 February, 1983.

Brandsma, M.G. and J.P. Smith (1997). “Offshore Operators Committee mud and produced water discharge model - Report and user guide. Exxon Production Research Company publication.

Brandsma, M.G. and J.P. Smith (1995). “Dispersion modeling perspectives on the environmental fate of produced water discharges”. Paper presented at the 1995 International Seminar on Produced Water, Trondheim Norway, September 25-28.

Dyer, K.R. (1986). "Coastal and Estuarine Sediment Dynamics". John Wiley & Sons, Great Britain, Chapter 4.

King, B. and F.A. McAllister (1997) "Modeling the Dispersion of Produced Water Discharge in Australia, Volume I and II". Australian Institute of Marine Science report to the APPEA and ERDC, September 1997.

King, B. and F.A. McAllister (1998). Modelling the dispersion of produced water discharges. *APPEA Journal 1998*, pp. 681-691.

Klevtsova, N.D., 1966. Surface Currents in the Middle and South Caspian for various Wind Fields. Okeanologiya. Vol. 6, issue 1, 1966, pp. 82-88.

Koh, R.C.Y. and Y.C. Chang (1973). “Mathematical model for barged ocean disposal of waste”. Environmental Protection Technology Series EPA 660/2-73-029, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Kosarev, A.N., E.A. Yablonskaya, 1994. The Caspian Sea. SPB Academic Publishing, The Hague, 1994.

Smith, J.P., H.L. Mairs, M.G. Brandsma, R.P. Meek and R.C. Ayers Jr (1994). “Field validation of the Offshore Operators Committee (OOC) produced water discharge model”. In: *The Proceedings of the SPE 69th Annual Technical Conference and Exhibition*. A Society of Petroleum Engineers Publication, pages 519-530, paper #SPE 28350.

Spaulding M.L. (1994). “MUDMAP: A numerical model to predict drill mud and produced water dispersion”. *Offshore*, Houston Texas, March 1994 Issue.

Shah Deniz Condensate Spill Risk Assessment

BP Exploration (Caspian Sea) Ltd

Baku

Azerbaijan

Colophon:

Title	:	Shah Deniz Condensate Spill Risk Assessment
Client	:	BP Exploration (Caspian Sea) Ltd
Reference client	:	
Address	:	
Zip code	:	
City	:	Baku
Country	:	Azerbaijan
Project number	:	27527-071
Report number	:	R03PV
Status	:	Final
Number of pages	:	22
Written by	:	Pim Verstappen, Miles Lockwood
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Date	:	18 April 2002

CONTENTS

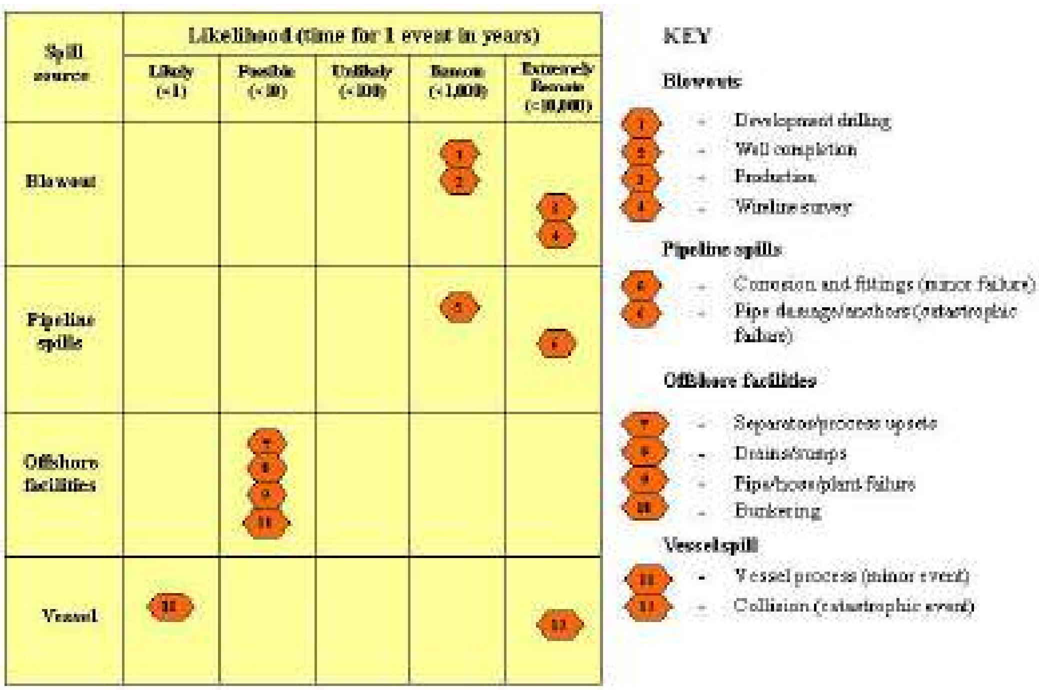
EXECUTIVE SUMMARY

This condensate spill risk assessment report presents a study of the potential accidental condensate spills during the lifetime of the Shah Deniz Gas Export project.

The likelihood of a spill occurring, and the predicted volume of that spill, has been evaluated based on experience of the oil industry internationally and in the Caspian Sea. The identified scenarios have then been modelled using OSIS, a bespoke oil spill mathematical modelling package (Appendix 6).

The risk of an incident occurring during the lifetime of the Shah Deniz Gas Export project resulting in a small spill of condensate or diesel has been found to be almost certain. In summary, the calculated risk of an accidental event resulting in a spill of more than 300 tonnes is unlikely for pipeline spills, remote to extremely remote for blowouts, and extremely remote for vessel spills (Figure ES1).

Figure ES1 Overview of the likelihood (number of years for 1 event to occur)



A number of potential failures that could result in condensate spill have been considered. The results of the spill risk assessment feed into the impact assessment and mitigation sections of the Environmental and Social Impact Assessment as they provide representative spill scenarios which can be simulated using computer models to investigate the potential fate and behaviour of a hydrocarbon spill in the marine environment.

1 INTRODUCTION

All offshore oil and gas production and export operations carry with them some potential for accidental oil spill. BP places considerable emphasis on spill prevention and considers any spill of hydrocarbons undesirable. It is BP policy to strive for a zero spill target using appropriate design standards, equipment, prevention measures and personnel training.

Even with comprehensive prevention measures in place, the residual risk of an oil spill remains and integral to any BP operation is the formulation of detailed and fully tested contingency response plans appropriate to local environmental sensitivities. The Shah Deniz Stage 1 ESIA includes a commitment to develop an oil spill response strategy and oil spill contingency plan.

This study has been conducted by URS on behalf of BP to assess the risks of a condensate spill arising as a result of operations during the Shah Deniz Gas Export Project Stage 1 development (Shah Deniz Stage 1). The study forms part of the wider Environmental and Social Impact Assessment (ESIA) for the Shah Deniz Stage 1, where further details of the proposed development can be found.

The results of the spill risk assessment feed into the impact assessment and mitigation sections of the Environmental and Social Impact Assessment as they provide representative spill scenarios which can be simulated using computer models to investigate the potential fate and behaviour of a hydrocarbon spill in the marine environment. With this respect, Briggs Marine Environmental Services Ltd. used the Oil Spill Information System (OSIS) model (Appendix B) to investigate potential spill scenarios indicated by the risk assessment and assist in the mitigation of impacts from such spills and to provide the platform for hydrocarbon spill contingency planning.

The remaining sections of the report are structured as follows:

Section 2, Spill Sources

Section 3, Conclusion

1.1 Information Sources

In the absence of long-term operational data from offshore oil and gas developments in the Caspian region, data on the frequency and consequence of hydrocarbon spills have been derived from one main source; the historical spill database from hydrocarbon production operations in geographic areas as compiled by the International Offshore Association of Oil & Gas Producers (OGP formerly known as the E&P Forum). The database incorporates real operational occurrences of accidental events to produce spill frequency figures derived from operating fields that have been subject to long term reporting requirements. This source represents a compilation of hydrocarbon spill records from several sources, but concentrates predominantly on U.S. Coast Guard records (Gulf of Mexico) and Department of Trade & Industry (North Sea operations) records. Although the Shah Deniz Project environmental conditions may differ from those associated with some of the operations addressed in this database, the nature and techniques of the operations proposed by BP are consistent with those employed elsewhere and industry design standards and operating practices are expected to be comparable. For this reason, whilst the spill data have been interpolated from a different geographical region, the OGP database is expected to provide the best source for the calculation of condensate spill risks from proposed Shah Deniz operations.

1.2 Frequency and size of spills

When discussing the frequency of possible condensate spills, consistent terminology applied internationally has been employed in this study:

?? Likely, more than one spill per year.

?? Possible, spill every 1-10 year.

?? Unlikely, spill every 11-100 year.

?? Remote, spill every 101-1000 year.

?? Extremely remote, spill every 1001-10,000 year.

For example, if the frequency for a calculated spill is once in the 55 year, then it will be called an *Unlikely* spill.

1.3 Risk assessment

The risk of a hydrocarbon spill occurring was considered for all potential spill sources, events and sizes during the Shah Deniz Gas Export Project. In this assessment, risk was determined through the following steps:

?? Calculations of spill frequency based on the Oil and Gas Producer's (OGP) Oil Spill Datasheet Directory. The OGP were formerly referred to as the Exploration and Production Forum (E&P Forum) and the database is referenced E&P Forum 1996.

?? Determination of the most likely spill frequency associated with each project activity by dividing the number of spills reported in the database by the total amount or duration of activity (known as the computed spill rate).

?? This result was then multiplied by the amount of the specific activity associated with the proposed project to determine the most likely spill frequency (known as the statistically expected value) associated with the Shah Deniz project.

2 Spill sources

Potential sources of hydrocarbon spill from the Shah Deniz Gas Export project were identified as follows:

Blowout (paragraph 2.1)

Pipeline leaks (paragraph 2.2)

Offshore facilities leaks (paragraph 2.3)

Vessel leaks (paragraph 2.4)

These are discussed in the following sections.

2.1 Blowout

2.1.1 Background

A blowout is defined as any uncontrolled flow of formation fluids from the reservoir to the surface. A well blowout can occur when the pressure of the formation exceeds the pressure maintained during drilling operations, resulting in the complete loss of well control and the uncontrolled flow of hydrocarbons from the wellbore. A blowout may occur during a variety of operations and these operations are used to categorise the type of event for incorporation into statistical databases. For development wells, blowouts are classified into those occurring during:

?? Development drilling. Development drilling starts when the well is spudded and includes all operations related to production, injection and observation wells until the production casing is cemented.

?? Well completion. The completion phase includes the final phases of a development well. In the databases used in the risk assessment, it is defined as starting with running the tubing and ending with well hook-up and commissioning, as well as perforation and stimulation in production and injection wells.

?? Production. This includes all offshore wells that produce oil and/or gas, but excludes well intervention, start-up and close-in operations.

?? Workover operations. A workover is defined as a well intervention where the Xmas tree has been removed.

?? Wireline. Well intervention operations where a wireline is used.

A well blowout is mitigated against during drilling by two independent barriers; the weighted mud system and in the event that this is temporarily lost, the blowout preventor. Sudden changes in conditions in the well, such as striking localised high-pressure zones may cause a rapid high-pressure kick, which has a small potential to cause both prevention barriers to fail. Blowout events characteristically occur sub-sea, although it should be noted that for modelling of scenarios identified in the risk assessment, the hydrocarbon spill dispersion model assumes that all of the condensate released reaches the surface (worst case scenario).

Drilling operations will take place from two facilities at the Shah Deniz field. Initially from a Mobile Offshore Drilling Unit (MODU) and then once the facility selected for the offshore location (TPG 500) is installed, drilling will take place from the platform. Whilst the probability of a blowout is extremely unlikely, the consequences represent the worst-case hydrocarbon spill scenario in terms of quantity of condensate released and duration of release and would apply equally to MODU well drilling and TPG-500 platform drilling.

2.1.2 Blowout risk assessment

Statistically blowouts are extremely remote events. However, a total uncontrolled blowout has the potential to result in a significant release of condensate. Tables 1a and 1b present an overview of statistically reported blowouts from the OGP database.

Table 1 **Statistically reported number of blowouts over the period 1980 – 1992 (adapted from the E&P Forum, 1996).**

a) Per well

Scenario	Number of blowouts	Number of wells	Uncontrolled blowout		
			Frequency per 10,000 wells	Frequency per well	Number of wells per incident
Development Drilling	33	9,513	35	3.5×10^{-3}	1,000
Well Completion	7	7,041	10	1×10^{-3}	1,000

b) Per well year

Scenario	Number of blowouts	Number of well years	Uncontrolled blowout		
			Frequency per 10,000 well years	Frequency per well year	Number of years per incident
Production	6	112,720	0.5	5×10^{-5}	100,000
Workovers	19	116,220	1.63	1.63×10^{-4}	10,000
Wireline	4	116,220	0.34	3.4×10^{-5}	100,000

For the Shah Deniz development, the determination of the most likely spill frequency associated with each project activity (development drilling, well completion, production, workovers and wireline) was determined by dividing the related statistical blowout frequency reported in the OGP database, by the total amount of each activity planned for the development. This result (known as the computed spill rate) was then multiplied by the amount of the specific activity associated within the proposed project to give the statistically expected number of events during the programme. The following example equation illustrates the working for the statistically expected number of blowouts from well completions during the Shah Deniz programme.

Example calculation for Well completions:

A = computed spill rate (Table 1): 1×10^{-3}/well

B = number of completions: 15 well completions during the lifetime of this platform

Statistically expected number well completions blowouts <100 tonnes = A x B

Statistically expected number well completions blowouts <100 tonnes = $(1 \times 10^{-3}) \times 15$

Statistically expected number of blowouts during well completion operations = 1.5×10^{-2}

Table 2 presents the calculated statistical frequency of a blowout per activity for the Shah Deniz project lifetime (2001 through 2032). The total calculated statistical expected number of one or more blowouts between 2001 and 2032 is 9.5×10^{-2}.

Table 2 Calculated statistically expected number by activity over the Shah Deniz Stage I project lifetime (assuming all wells at 2005 through 2035)

Spill Source, Blowouts	Statistically expected number over the programme (n)
Development Drilling	5.25×10^{-2}
Well Completion	1.5×10^{-2}
Production	1.65×10^{-2}
Workovers	n.a.
Wireline	1.05×10^{-2}
Subtotal – Blowouts	9.45×10^{-2}

It can be seen from Table 2 that the statistically calculated number of blowouts from Shah Deniz activities indicate that based on historical data, a blowout is not expected during the project lifetime from any of the operations listed.

2.1.3 Blowout prevention

The reservoirs in the Shah Deniz field are deep (6000-7000m Total Vertical Depth (TVD)) with high pressures up to 14,000 psi downhole. Depth, tectonic stresses, narrow pore/fracture pressure windows, wellbore stability and numerous shallow subsurface hazards combine at Shah Deniz to provide one of the most difficult drilling environments that exist anywhere in the world. However, it can be seen from Table 2 that the statistically calculated number of blowouts from Shah Deniz activities indicate that based on historical data, a blowout is not expected during the project lifetime from any of the operations listed.

In addition to this, all of the Shah Deniz wells are designed to be monitored and controlled against unplanned influx. Along with good well management and highly trained personnel, well control is primarily achieved by primary or secondary means:

?? Primary well control against an influx of formation fluid requires the maintenance of sufficient hydrostatic head of weighted drilling mud or completion fluid in the well bore to balance the pressures exerted by fluids in the formation being drilled. This is an inherently safe approach to maintaining well control.

?? Secondary well control is provided by the Blowout Preventer (BOP) stack, which is installed over the well. BOPs consist of a series of hydraulically actuated steel and elastomer rams, which can be rapidly, closed following an influx of formation fluids into the well bore. The BOP immediately closes the annulus between the drill pipe or casing and the well bore, which prevents additional hydrostatic head being lost. The BOP is connected to the choke manifold, and by a combination of hydrostatic head and maintained pressure, the well can be circulated to safely remove the influx and increase the fluid density, if necessary.

    The choke manifold is connected to both the mud system degassers and gas venting system. In an emergency situation, this allows gas to be vented harmlessly at the surface and any condensate to be contained for disposal.

2.1.4 Blowout spill volumes

In order to be able to establish the movement and behaviour of spilled hydrocarbon, the voumes of such a release need to be established. The volume and release rate can then be used in hydrocarbon spill modelling to assess the 'worst case scenario' and assist in contingency planning and emergency planning.

Although the risk of a blowout event resulting in a release of hydrocarbons to the environment is deemed to exist, in terms of the quantity of hydrocarbon that may be released from a blowout scenario, only a few of the historical records in the database have any information on the release rate, with a wide range of values provided. As a result, attempts to derive an average flowrate from a blowout would be misleading, as the number calculated would almost certainly be dominated by a very few large releases. It is therefore concluded that a statistical approach to estimating blowout release rates using historical data is not appropriate. A deterministic approach therefore has to be employed which takes account of:

?? the reservoir;

?? the flowpath to the surface;

?? the properties of the release fluids;

?? the release orifice.

Blowout durations tend to be more accurately recorded, as the primary response is to correct the situation and get the well under control as soon as possible. A summary of some of the results from the available data is provided in Table 3.

Table 3 Recorded release durations from a blowout (E&P Forum, 1996)

Blowout Duration	Percentage frequency
< 1 hr	25%
1 hr - 1 day	15%
> 1 day	60%

Therefore, whilst the probability of a blowout is extremely unlikely, the consequence of such an event represents the largest hydrocarbon spill scenario in terms of quantity of condensate released and duration of release, applying equally to MODU well drilling and TPG-500 platform drilling. If either control of a well was lost either during drilling or during a well completion, then in a worst case scenario, it may be necessary to drill a relief well. In either case, it is possible that the drilling facilities or indeed, all facilities may not be viable for this purpose and thus an intervention well would have to be drilled by another MODU.

When a relief well is drilled, it is drilled from a position at some distance from the blowout location and is designed to intercept the well bore that is out of control. With new casing and well control equipment available to the relief well, it is then possible to kill the well and thus prevent any further loss of hydrocarbon from the well. The blowout volumes calculated below are based on the assumption that any MODU required for intervention drilling would be actively working at the time of the blowout occurring. Thus, there would be a period of time required for the intervention MODU to cease the operation in which it was engaged and make safe those operations. Thereafter the MODU would take some time to be transported to the blowout location and further time would be required to prepare for the intervention operation.

It has been assumed for the worst case, that the time taken for the MODU to suspend drilling operation, mobilise to the blowout location and drill a relief well would amount to a total of 180 days. During this time is also assumed (as a worst case) that the well continues to flow at the full production rate. In reality, the mobilisation and drilling time may be less than that assumed here and furthermore, it is highly likely that some obstructions would occur in the well, either from drilling equipment or well debris and that this would cause some restriction to the flow. It is not possible however to predict to what extent the flow may be restricted or how much faster drilling and intervention might be achieved. In order to allow the modelling of the likely dispersion, trajectory and fate of the spilled condensate to be carried out, the worst case has been assumed.

Table 4 Shah Deniz - blowout spill volumes

Parameter	Notes	Value/quantity
Rate of condensate flow	5,300 m^3/ day	33,334 bbls/day
Shut-in time	Time taken to mobilise another MODU and drill a relief well	180 days
Volume of Condensate (Total) released over 180 days	The pre-identified blowout figure has been estimated at around 953,940m^3 however 52,800m^3 has been used for modelling and is considered representative given the condensate characteristics	52,800 m^3 (**note 1**)

Note 1 It can be seen that the risk assessment indicates that 953,940 m^3 of condensate is released over the 180 day period. In the hydrocarbon dispersion modelling conducted for the blowout scenario, 52,800 m^3 was used as the blowout volume. This is because the model indicated that after release of this quantity of condensate, a 'steady state' was reached where the release of additional volumes of condensate did not result in an increase in the total quantity of hydrocarbon (because of dissolution, evaporation and other losses).

2.2 Pipeline leaks

2.2.1 Background

The release of hydrocarbon from a pipeline may occur through three main pathways:

?? Leaks from poor fitting flanges, damaged or poor fitting seals or vents.

?? From damage to the physical structure of the pipeline as a result of pipeline corrosion,

?? From a breach in the structure resulting from a significant impact and physical damage sufficient to cause a pipeline rupture (eg from vessel grounding or dropped object/anchors).

Two main potential pipeline leak scenarios have been identified based on the above factors, defined as catastrophic and minor pipeline leak. These are discussed below.

2.2.1.1 A Catastrophic pipeline leak

A catastrophic failure of the pipeline and complete loss of inventory represents the worst case for a pipeline leak. This has a low probability for a number of reasons. The pipeline is protected with a concrete coating and is thus resistant to impact damage from a dropped object or dragged anchor. Furthermore, at most points along the pipeline Right Of Way

(ROW), the structure lies on a gradient, as it dips down from the platform and then steadily rises again on route towards the shore. This means that there is a low point at some distance from the platform. For condensate to leak from the pipeline it would have to overcome the hydrostatic head of water in the surrounding waters and thus it is unlikely that all condensate in the pipeline would be discharged.

Continued production following a catastrophic pipeline failure would result in condensate being forced down the line to the rupture. This effect is offset by a drop in pressure that would occur as a result of the rupture, with the effect that the condensate in this section of the pipeline would be subject to the hydrostatic head of water and would thus be more likely to remain in the pipeline.

2.2.1.2 A minor pipeline leak

Minor pipeline leaks are unlikely to lead to any detectable pressure change within a large capacity pipeline and are therefore inherently difficult to detect. This type of spill may continue unnoticed until observed during an intelligent pig survey, a Remote Operated Vehicle (ROV) with onboard camera survey or by a diver performing inspection or maintenance operations. Furthermore, any leaked condensate will move laterally through the water column as it rises, emerging at the surface some distance from the pipeline and the original source of the leak. In addition, there may be some emulsification or dispersion of the condensate as it moves through the water column and thus such leaks can be very difficult to detect.

2.2.2 Pipeline spill risk assessment

Statistically catastrophic pipeline leaks are extremely remote events. Minor pipeline leaks are more likely, particularly in older structures. Available data on failure rates is variable depending upon:

?? geographical location of the pipeline (eg with frequency of loss of containment events caused by anchoring and impact incidents being significantly higher for pipelines in safety zones than for those in deep water);

?? diameter/age of the structures (in the Gulf of Mexico many of the pipelines are small diameter older structures compared to the North Sea which may result in higher expected failure rates in that region).

?? Length of the pipeline (longer pipelines presenting a larger surface area for environmental factors and external factors to influence failure mechanisms).

?? The OGP database contains multiple sources of information (North Sea, Gulf of Mexico) and considering the above limitations is useful in providing an indication of the frequency of these events to assist in engineering design and risk reduction planning. Table 5 provides frequency data for loss of containment reported for pipelines over 5 km in length and for pipeline leakage outside platform safety zones (>500 m). Risk is presented in pipe/km years, for example a 10 km pipeline in place for 10 years representing 100 pipe/km years (10 km x 10 years).

Table 6 provides the calculated statistically expected number of pipeline leaks per activity for the Shah Deniz project lifetime (2005 through 2032) equated to events per year of pipeline activity.

Table 5 Frequency of loss of containment (per 10^4 pipe/km years) for steel pipelines caused by impact incidents, corrosion and material defects for pipelines greater than 5 km in length (adapted from E&P Forum).

Failure mechanism	Period (pipe-km years)			Number of incidents			Frequency/10^4 pipe-km year		
	Pipeline Diameter			Pipeline diameter			Pipeline diameter		
	2-8”	10-16”	26-36”	2-8”	10-16”	26-36”	2-8”	10-16”	26-36”
Anchoring/impact in the platform safety zone (<500 m)	2,334	2,069	1,206	2	4	0	8.57	19.3	5.8
Anchoring/impact in the subsea well safety zone (<500 m)	842	87	0	0	0	0	8.32	80.5	-
Impact incident in the mid line	13,669	15,423	73,371	3	0	0	2.19	0.454	0.095
Corrosion and material defects	78,160			0			0.09		

Note: In the calculation of frequencies it is assumed that the number of incidents follows a Poisson distribution, therefore enabling a frequency to be estimated for the majority of categories where no incidents have been reported for the period.

Table 6 Calculated statistically expected number of one pipeline spill over the Stage 1 Lifetime (2005 through 2035) per year of pipeline activity

Failure mechanism	Statistically expected number over the programme[1]		
	Pipeline diameter		
	2-8”	10-16”	26-36”
Anchoring/impact in the platform safety zone (<500 m)	0.081	0.181	0.055
Anchoring/impact in the subsea well safety zone (<500 m)	0.078	0.76	-
Impact incident in the mid line	0.021	0.004	0.0009
Corrosion and material defects	0.001		

[1]Note all pipelines are 94 km in length and will be in place for 30 years.

It can be seen from Table 6 that the highest statistical frequency of spills associated with the Shah Deniz pipelines occurs from anchoring/impacts in the platform safety zones. Attention should be given to increasing project design and operational safety practices in this area, such as project specific anchoring procedures. These measures must be incorporated in the project schedule.

2.2.3 Pipeline leak spill prevention

Pipeline spill risks are reduced by a combination of planning and design (eg operational standards and practices). There are a number of tools to reduce the possibility of pipeline leaks occurring from pipeline damage through impact from external forces. Nearshore up to water depths of 6 to 7 m (approximately, 2 km from the shoreline) each of the Shah Deniz pipelines will be trenched/buried to provide natural protection against impacts from vessel grounding. Areas of the pipeline will also be provided with rock mattress protection, particularly around the installation. In addition, the Shah Deniz pipelines will be externally coated with concrete to provide mechanical protection against impact and ensure that the structure remains in a stable condition on the seabed. The thickness of the concrete coating or density will vary and will be governed by stability requirements at that section of the pipeline, as well as impact protection requirements.

A number of prevention and mitigation measures will be in place on the Shah Deniz pipelines to reduce or remove the probability of leaks from corrosion:

?? Use of proven pipeline design and appropriate design codes;

?? Inclusion of planned losses for corrosion along the full length of the pipeline, based on worst case anticipated corrosion rates close to the platform;

?? Use of a cathodic protection system

?? The use of corrosion inhibitor;

?? Use of an external anti-corrosion coating on the pipeline;

?? Regular pigging operations to remove water, wax and any other debris;

?? Establishment and enforcement of an exclusion zone to prevent vessel movement over areas of reduced draught;

?? Ongoing inspection programme, including:

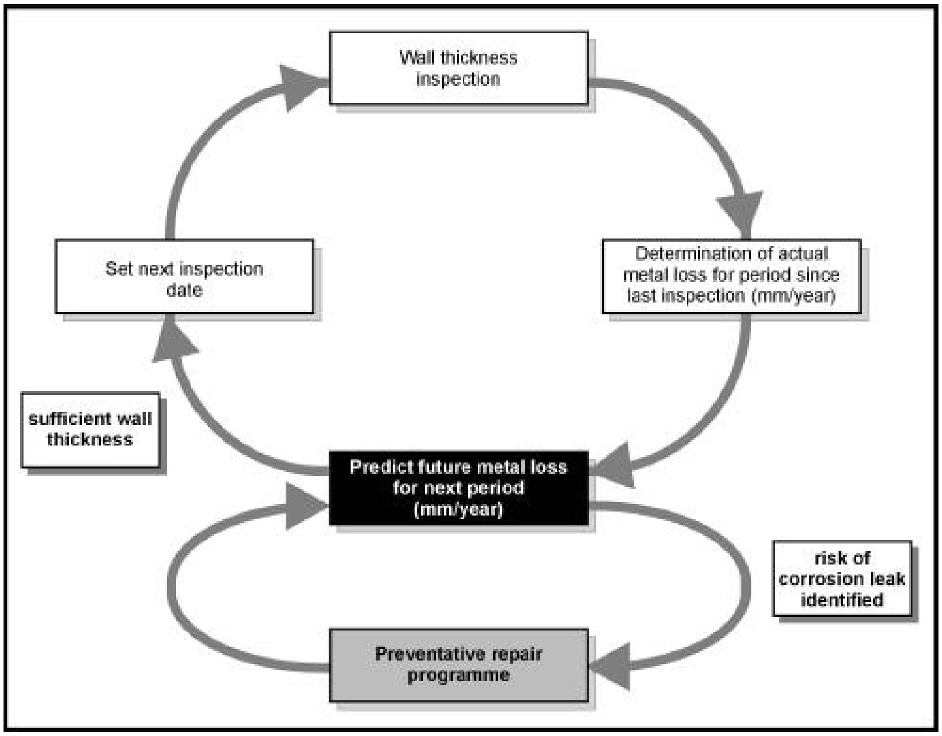
- Internal intelligence pig surveys;
- Corrosion monitoring;
- Side scan sonar surveys; and;
- Visual inspection surveys by ROV with onboard camera.

?? Regular maintenance programme, including:

- Span correction; and
- Corrosion defect repairs.

These aspects are incorporated into BP's goal setting and risk based Pipeline Integrity Management Scheme (PIMS) for its Caspian Sea Business Unit. These schemes are in-line with best industry practice. A project specific PIMS has been developed for the Early Oil Project (EOP) and will be expanded for other BP operated developments including the Shah Deniz Gas Export Project. The Shah Deniz PIMS will include a detailed pipeline risk assessment process to identify potential failure modes and mechanisms, probability and time dependence of failure, consequences of failure and overall risk of pipeline failure. This information is used to develop appropriate inspection, monitoring, maintenance and repair procedures during detailed design. The results of inspections are subsequently used to reassess the probability of failure and the feedback cycle is repeated (Figure 1).

Figure 1: Pipeline corrosion monitoring and mitigation cycle



Pipeline leak detection systems depend primarily on the detection of drops in pressure along the pipeline and the effectiveness of the systems therefore depends on the size of the release:

?? Minor leak. Low release rates (<0.1 m^3/hr) are unlikely to lead to any detectable change in pipeline pressure and may not result in a visible surface sheen. As a result, such leaks are difficult to detect and may persist for an extended period before the effects are noticed.

?? Major leak. The rate of hydrocarbon loss would be sufficient to produce a pressure drop that would be readily detectable and may be expected to be of a short duration.

2.2.4 Pipeline leak spill volumes

As with the simulation of a release from a blowout event, it is also necessary to conduct modelling of any potential releases from the Shah Deniz pipelines. In terms of volumes of hydrocarbon released from an accidental event from the pipelines, the modelling is concerned with condensate release. In event, that catastrophic or a minor pipeline leak were to happen the volumes that may be released are discussed below.

2.2.4.1 Catastrophic pipeline failure

It is estimated that a pressure drop in the major export pipeline will be detected within an hour followed by production shut-in. This is the estimated time taken to detect the pressure drop, confirm its extent and subsequently cease export from the installation, and in the case of a catastrophic failure, this represents the worst case. In fact the amount of condensate that would be discharged through one hour's continued production following a catastrophic pipeline failure would amount to approximately 220 m^3 or approximately 3% of the total worst case volume. Thus, for the purpose of modelling, the exact time to detect a leak is of low significance since in all likelihood the increased condensate discharged is likely to amount to less that 5% of the total spill. Therefore, the worst case for a pipeline failure is based on the release of the inventory of the pipeline plus one hours production.

2.2.4.2 Minor pipeline leak (pinhole leak)

As stated earlier, a small scale release of $1m^3$/hour is unlikely to be detected by pressure drop and thus detection would rely on a visual sighting of the condensate. Based on water depth at the Shah Deniz location, it is likely that the condensate will be carried some distance from the pipeline (assuming the release occurred at the platform location) by water currents as it rises up through the water column and may be detected on the sea surface outside of normal platform helicopter flights and supply boat routings.

Using industry experience, hole sizes associated with minor leaks range between 0.25 – 0.5 mm resulting in spill release rates between 0.02 – 0.09 m^3/hr. Assuming that visual detection of a surface release would be required, it is assumed that a loss of approximately 720 m^3 (taking a period of 30 days) would be sufficient to alert the operator to the existence of a leak.

Table 7 Shah Deniz – Catastrophic and Minor pipeline spill volumes

Scale of Leak	Parameter	Value/quantity	Notes
Catastrophic	Production rate (Shah Deniz)	357.72 m^3/hr	357.72 m^3/ Hour
	Shut in time	1 Hour	Released at above rate.
	Total Volume	6,899 m^3	This is the inventory plus the pipeline flow for 1 hour.
Minor	Leak rate	1 m^3/hour	Note this has been assumed as not detectable by pressure drops.
	Shut in time	30 days	Assumed time frame to spot from the air very small leak
	Total Volume	720 m^3	30 days at $1m^3$/hour

2.3 Offshore facilities leaks

2.3.1 Background

There are a number of potential sources of hydrocarbon spill from the offshore facilities; these could result from a mechanical failure, operational failure or human error during normal operations, through activities such as bunkering, hose operations, through equipment leaks (eg separator), or from overflow of sumps and drains. Although, most spills from installations are expected to be small, The worst-case spill scenario from an offshore platform would be the loss of one of the two separators present on the platform. It is assumed in such an event offshore production would be shutdown promptly if not immediately. However, an example scenario would be a leak of the contents of one the largest of the separators on the platform.

Diesel spills are by far the most common type of hydrocarbon spill to occur through offshore operations. There are number of potential causes, such as the failure of transfer hoses, failure to secure tankage valves or attempts to fill an already full storage tank. In a worst-case scenario, the maximum possible loss of diesel is equal to the storage tank inventory on the facility.

In calculating probability of spills from fixed platforms, oil spill reports from the North Sea submitted to the Department of Trade and Industry for the UKCS (United Kingdom Continental Shelf) between 1993 and 1997 were used. This data set period was selected as most appropriate to this analysis due to changes in operational practices in recent years and an increased requirement for reporting of all spills to the DTI making these a more accurate representation of current spill frequency and therefore probability. However, in analysing the probability for larger spills, the number of reports of these spill sizes were zero during the data set period selected, therefore for larger spills, a wider period (1973-1997) was considered in order to receive representable data.

Of all spills, the majority in this period were less than 1 tonne (90%) with 58% of this size of spill being less than 0.1 tonnes. No spills of >50 tonnes were recorded from fixed installations during the period 1993-1997, however since 1980 there have been eight spills of over 50 tonnes recorded from fixed platform installations on the UKCS with the largest of these being 3,000 tonnes.

Table 8 provides probabilities of spills from fixed platforms by source and size of spill based on generic North Sea data.

Table 8 Computed spill rates for offshore facilities leaks (North Sea 1973-1997)

Offshore Facilities	Spill frequencies			Risk period
	<0.1 tonnes	<1 tonnes	< 25 tonnes	
Drains/Sumps	5.3×10^{-1}	2.9×10^{-1}	1.4×10^{-2}	Number /installation-year
Pipe/Hose/Plant failures	2.6×10^{-1}	1.6×10^{-1}	1.9×10^{-2}	Number /installation-year
Bunkering	2.0×10^{-1}	9.4×10^{-1}	3.3×10^{-2}	Number /installation-year
All	2.0	1.3	1.1	Number /installation-year

Table 9 provides the calculated statistically expected number of offshore facility leak per activity for the Shah Deniz project lifetime (2005 through 2035) equated to events per year of vessel activity.

Table 9 Calculated statistically expected number of offshore facilities leaks over the Stage 1 Lifetime (2005 through 2035) equated to events per year of vessel activity

Offshore Facilities	**Statistically expected number over the programme**[1]		
	Spill size		
	<0.1	**<1**	**<25**
Drains/Sumps	0.53	0.29	0.014
Pipe/Hose/Plant failures	0.26	0.16	1.9
Bunkering	0.2	0.94	0.033

[1]Note all pipelines are 94 km in length and will be in place for 30 years.

As can be seen from Table 9, the main sources of spills from offshore facilities during the Shah Deniz project are expected to be and small spills (<1 tonne) from bunkering. Effort should be focussed to reduce the risk of these events occurring.

2.3.2 Offshore facilities leak spill prevention

The Shah Deniz Platform has been designed to minimise potential leak sources and to provide secondary containment and processing systems for residual leak sources and spill pathways, through the following measures:

?? Minimisation of the number of potential leak sources (small bore fittings, flanges etc.) from hydrocarbon process systems;

?? Containment of potential spills of condensate, drilling mud and chemicals;

?? Containment of likely spill sources from flow lines, manifolds and HP production separators (e.g. sample connections, level instrumentation) into the drains system via skidpans and piped connections.

?? Regular inspection for corrosion and leaks, of all storage tanks, pipe work and separators.

?? Training of personnel.

2.3.3 Offshore facilities leak spill volumes

2.3.3.1 Offshore Separator Leak

The worst-case spill scenario for the offshore platforms is the loss of one of the two separators on the platform. It is assumed the offshore shutdown and detection system for production process would be highly reliable and offshore production would be shutdown promptly if not immediately. However, the most credible scenario would be a leak of the contents of one the largest of the separators on the platform, amounting to 20 m^3 assuming no containment of the spilled condensate. In fact, the probability of total inventory loss into the sea from a separator is low since much of any condensate spilled would be contained within the drainage system on the platform.

2.3.3.2 Loss of Storage Inventory

The worst case is the inventory of one storage tank and not the total inventory of the platform, equating to 20 m^3 of condensate may spill.

2.4 Vessel spills

2.4.1 Background

Potential hydrocarbon spills from vessels may include:

?? accidental operational events, such as spills resulting from:

- Upsets in bilge treatment systems;
- Storage tank failure for lubricating oils, fuel oil (diesel), oil based muds, base oil and chemicals;
- during maintenance activities including equipment removal and lubrication;
- during refuelling, bunkering etc; or

?? those from physical damage to the vessel resulting in loss of containment from grounding, collision and fire/explosion.

In terms of potential sizes of spill, the most frequently reported spills from vessels are those associated with upsets in bilge treatment systems and are usually small (< 1 tonne). The probability of vessel spills will be greater during periods of high vessel activity. During pipelay and installation operations there may be up to a maximum of 8 vessels in the area at any one time. Vessel numbers during operations will be restricted to one standby vessel (on site at the Shah Deniz platform all year round) and seven supply vessels trips to the platform every week.

The activities that are associated with catastrophic events are those that result in an impact on the physical structure of the vessel. Statistically catastrophic events resulting in uncontrolled releases of more than 300 tonnes are extremely remote events (Table 10)

Table 10 Recorded spill rates for vessel spills (E&P Forum, 1996)

Vessel leaks	Spill frequencies			Risk period
	<100 tonnes	100-300 tonnes	>300 tonnes	
Vessel Collision/Impact Damage Spills	-	-	1.4×10^{-6}	/installation-year

2.4.2 Vessel leak spill prevention

A number of measures will be implemented to reduce the risk of oil spills from supply and standby vessels associated with the Shah Deniz project, including:

?? Selection of vessels that comply with IMO/MCA codes for prevention of oil pollution;

- Documented inspection of hydrocarbon hose integrity and condition;
- Drums and storage tanks for hydrocarbons to be secured and stored in burned areas;

- All vessels to comply with MARPOL requirements including onboard Shipboard Oil Pollution Emergency Plans (SOPEP).

?? A Vessel Management Plan will be in place to reduce collision risk, both vessel–vessel and platform–vessel and will address the following:

- Mandatory 500 m safety zone around platform;
- Operational restrictions on visiting vessels in bad weather;
- Defined vessel no-go areas within safety zone;
- Agreed approach procedures to platform by supply and safety vessels;

?? Vessel personnel will be given full training in spill prevention and actions to be taken in the event of a spill. A system will be in place for the reporting of all spills.

2.4.3 Vessel leak spill volumes

A worst-case spill volume of 242 m^3 diesel has been modelled as representative of the amount of hydrocarbon that would be spilled from the loss of storage integrity from a vessel.

3 Conclusion

Based on the information available and the calculations performed the following conclusion can be derived.

The risk of an incident occurring during the lifetime of the Shah Deniz Gas Export project resulting in a spill of condensate or diesel has been found to be remote to extremely remote for large spills, although the statistics for small spills, such as those from vessels and offshore processes show that these releases are common in other operational areas. Due to the lifetime of the Shah Deniz project, these statistics show that such spills are likely to occur. In summary, the risk of an accidental event resulting in a spill of more than 300 tonnes is unlikely for pipeline spills, remote/extreme remote for blowouts, and extremely remote for vessel spills. These are detailed below and an overview of the calculated risk per activity during the lifetime of the project is presented in Figure 2 and the spill volumes proposed for modelling summarised in Table 11.

3.1 Blowout

The statistically expected number of blowouts show that the event is remote (1/1000 years) during drilling years and extremely remote (1/10,000-100,000 years) for all other operations. In terms of potential spill volume, in the remote/extremely remote event that a blowout occurs, 953,940 m^3 may be released in worst case.

3.2 Pipeline spill

3.2.1 Catastrophic pipeline failure

The risk on a catastrophic pipeline spill is extremely remote (1/1001-10,000 years) during the lifetime of the Shah Deniz project. If a catastrophic spill occurs, 6,899 m^3 may be released.

3.2.2 Minor pipeline failure

The risk on a minor pipeline spill is remote (1/100-1,000 years) during the lifetime of this project. In such an event, 720 m^3 may be released.

3.3 Facility spill

The risk of an offshore facility spill is possible (1/1-10 years) during the lifetime of this project, although statistical analysis of the volumes of these spills show that these are predicted to be low <25 tonnes.

3.4 Vessel spill

The risk of a small spill <1 tonne is likely. The risk of a large scale spill occurring from a vessel during the lifetime of the project is extremely remote (1/1,000-10,000 years). Should a spill occur, the volume of diesel released has been estimated to be 242 m^3 (inventory of the vessel) in a worst-case scenario.

Figure 2 Overview of the likelihood (number of years for 1 event to occur)

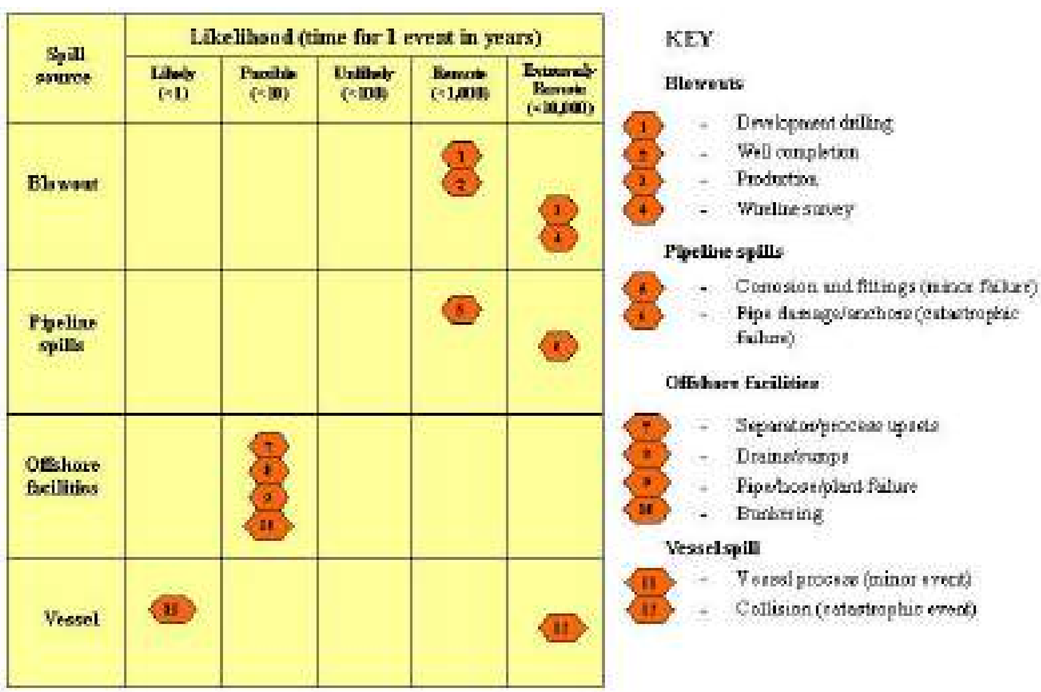


Table 11 Summary of spill volumes for hydrocarbon dispersion modelling

Event	Evaporated	Dispersed	Beached
	m^3	m^3	m^3
Blowout	32,882	16,381	3,536
Catastrophic offshore pipeline spill	4,727	1,703	1,163
Catastrophic nearshore pipeline spill	3,718	831	2,350
Minor pinhole offshore pipeline spill	480	230	8.5
Minor pinhole nearshore pipeline spill	454	252	13
Vessel spill (diesel)	98	144	0

4 References

E&P Forum. 1996. E&P Forum QRA Datasheet Directory.

Weathering and Dispersibility of Azeri Condensate

A report produced for Dames & Moore Group by AEA Technology plc

August 2001

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Executive Summary

The National Chemical Emergency Centre (NCEC) of AEA Technology Environment has undertaken an environmental behaviour and dispersibility study of the Azeri condensate. This study provides an understanding of changes in the physical properties of the condensate that would occur in the event of a surface spill and gives an indication of the fate of any spilled condensate. This information is of vital importance for contingency planning prior to any incident, as it is key information in determining the most appropriate response actions in the event of a spill. The environmental behaviour study has provided OSIS constants that are specific for the condensate, and enable them to be added to the oil database of the OSIS oil spill simulation model.

The Azeri condensate exhibited unusual weathering behaviour, which will have a significant influence on the selected spill response strategy. The Azeri condensate rapidly loses a high proportion of light ends, but in cold temperatures it then forms a viscous, highly persistent residue.

Laboratory investigations on the Azeri condensate suggest that it will rapidly lose approximately 39% by volume from the sea surface by evaporation immediately following a spill at sea. A total of 58% by volume will eventually be lost by evaporation. The characteristics of the condensate are similar to the crude. The condensate is of similar viscosity ranging from 210-6 mPas at 6°C to 27°C when fresh. The viscosity of the condensate at 6°C is significantly higher than at 27°C. For example after the first few hours at sea (39% evaporate loss by volume) the viscosity increases to only 20 mPas at 27°C, but to 5,550 mPas at 6°C. After 24-48 hours at sea (58% evaporative loss) the viscosity increases to 180 mPas at 27°C, but to 12,000 mPas at 6°C. This significant increase in viscosity at 6°C is due to a visible precipitation of waxes in the condensate, giving it the consistency of a thick paste.

At 6°C, the condensate forms loose, unstable emulsions. In these emulsions, the water droplets are fairly large and held in the condensate primarily by the precipitated waxes. The formation of these weak emulsions mobilised the condensate, thereby decreasing the viscosity significantly (to 70-100 mPas). Whilst these weak emulsions may be formed if the condensate is spilt at sea at this temperature, the condensate is unlikely to emulsify unless there is high energy sea conditions and even then, the condensate emulsions are very likely to break back to condensate and water once energy levels reduce. At 27°C, even after weathering the condensate remains a light fluid oil, thereby preventing it from emulsifying.

The weathering and emulsification behaviour of the Azeri condensate is unusual and it has not been possible to derive constants that reflect the measured properties over the range of temperatures examined. The OSIS constants finally selected reproduce the change in viscosity with temperature, but do not allow for emulsification. The laboratory studies indicate that emulsions will only be formed during cold conditions and during high energy sea conditions. These emulsions will be of lower viscosity than predicted by the OSIS model. However the emulsions formed would be very weak so are likely to break back to condensate and water rapidly. Therefore the condensate is unlikely to emulsify in the majority of conditions.

The dispersibility results indicate that Finasol OSR51 would be effective on a spill of weathered Azeri condensate at 27°C and emulsified condensate at 6°C. This indicates that at

27^{o}C the condensate is amenable to dispersants once it has lost a large fraction of its light oil fraction. However, at 6^{o}C, the weathered condensate is very viscous therefore rapidly becomes ineffective to dispersant treatment. Therefore, at 6^{o}C the condensate will only be amenable to dispersants once it has emulsified, which lowers the viscosity of the condensate considerably.

In summary, a spill of the condensate would result in the loss of a large volume of the spill by evaporation. In warm temperatures, the residue is of low viscosity therefore would not persist for long periods of time at sea. However in cold temperatures, the condensate forms a viscous waxy residue, and at low wind speeds, these waxy residues may persist for some time.

Dispersant treatment is an option for the condensate in warm temperatures and if the weathered condensate becomes emulsified in cold temperatures. However in high wind speeds, when the condensate in only likely to persist for 1-2 days, the preferred response method may be to 'leave alone' depending on the specific conditions of the spill, which avoids the unnecessary use of dispersants. If a 'leave alone' response is to be considered as part of the contingency plan for the condensate, it is important to undertake a Net Environmental Benefits Analysis (NEBA) for the areas that may be affected. This will enable BP Amoco to determine whether a 'leave alone' response is acceptable for the areas that may be affected by a spill of the condensate.

Contents

1 Introduction

Crude oils spilt on the sea surface undergo evaporation and emulsification processes that change the physical properties of the oil. These changes are important as the physical properties of the oil determine the choice of clean-up techniques and the long-term persistence of the oil. Some oils, particularly those that do not form stable water-in-oil emulsions, are relatively non-persistent and, in the event of spillage, might be expected to disperse naturally within a short period of time as a result of wind and wave action. Other oils, that form viscous emulsions, are likely to be very persistent and may also be resistant to treatment by dispersants (unless treated rapidly before emulsions can form). Since the behaviour of the oil is so important in determining a response strategy, it is essential that oil contingency plans should take account of the particular properties of the oil and how these might change with time. Thus, any understanding of the environmental behaviour of an oil requires not only information on the physical properties of the fresh crude, but also information about the physical properties of the weathered oils and emulsions.

AEA Technology Environment has undertaken studies on the weathering and emulsification behaviour of numerous crude oils around the world. The work entails measurement of changes of properties of the oil in simulated weathering experiments and the derivation of algorithms to predict surface spill behaviour for incorporation into the oil spill model, OSIS, (Oil Spill Information System); the effects of dispersant treatment on the oils was also investigated.

Dames & Moore have commissioned AEA Technology to characterise the behaviour of the Azeri condensate in a similar manner on behalf of BP Amoco.

2 Crude Oil Weathering

When a crude oil is spilled on the surface of the sea it is subjected to several processes and the combined effect of all of these processes is commonly referred to as 'weathering'. These processes are:

- spreading
- evaporation
- dissolution
- emulsification
- natural dispersion
- photo-oxidation
- sedimentation
- biodegradation.

These various processes can occur simultaneously, although at very different rates. The rate at which they occur and the extent to which they proceed depends on:

- The chemical and physical properties of the original crude oil.
- The prevailing environmental conditions.
- The release conditions.

The relative importance of each of the processes varies during the time after a spill, although they are interrelated, and it is their combination that causes different crude oils to behave in different ways at different oil spills. Consequently, crude oil weathering studies should always be an integral part of all oil spill contingency planning. These studies enable the potential environmental consequences of an oil spill to be assessed and they can help to determine the most effective oil spill response strategy.

The various processes are briefly outlined in the following sections.

2.1 SPREADING

As soon as crude oil is spilled onto the surface of the sea it will normally spread out rapidly to form a thin layer, or slick, of oil and this will drift under the influence of wind and currents. The general appearance of a surface slick of oil is of two distinct areas:

- a relatively small area of thick oil, containing the majority of the oil volume (especially if the oil has formed a stable water-in-oil emulsion
- a much larger area of very thin oil, or sheen, trailing behind the thick area.

The area of thicker oil is always downwind of the sheen as the thick oil is more influenced by the wind than the sheen. Sheen is created by temporary natural dispersion of oil and is created as the larger droplets of oil re-surface some distance away from the main body of the slick. The temporarily dispersed oil droplets are transported by the current while they are submerged.

The oil slick will drift under the influence of currents with a contribution, approximately 3% of wind speed, in direction and speed from the wind. Under certain circumstances the distribution of spilled oil on the sea surface may be modified by oil release conditions.

2.2 EVAPORATION

Evaporation is the primary cause of rapid volume reduction of spilled oil. The loss of ‘light ends’ by evaporation causes an increase in the viscosity and density of the oil residue that remains. Evaporative loss can also cause more subtle changes in the oil properties such as the precipitation of wax and asphaltenes which will alter the flow properties of the residue and help to stabilise water-in-oil (w/o) emulsions.

2.3 DISSOLUTION

The vast majority of crude oil components are not soluble in water to any appreciable degree. However, some of the lower molecular weight aromatic components (the so-called “BTEX” compounds - benzene, toluene, ethylbenzene and xylenes, plus some of the lower molecular weight alkanes) are water-soluble to a limited extent and will dissolve out of the oil into the water column. The volume loss of spilled oil by dissolution is negligible for any practical purposes, but the environmental consequences of dissolution can be significant. Although the concentration of these compounds in water will rapidly be diluted to very low levels, they can exert a toxic effect on marine organisms.

2.4 WATER-IN-OIL EMULSIFICATION

Water-in-oil (w/o) emulsification is the incorporation of small water droplets into the spilled oil. W/o emulsification is the major process that causes spilled oil to be persistent on the sea surface. Emulsification causes an increase in the volume of pollutant, typically by a factor of three or four compared to that of the original oil and this more than offsets the volume reduction caused by the evaporative loss of the 'light ends'. The viscosity of emulsified crude oil is much greater, up to several orders of magnitude (a factor of 100, or even 1000 or more) than that of the original oil and of the residue left after evaporative loss of 'light ends'. W/o emulsions formed rapidly after the oil is spilled can be unstable and amenable to treatment by dispersants, but eventually, extremely high viscosity 'chocolate mousse' may be formed by some oils.

2.5 NATURAL DISPERSION

Natural dispersion is the conversion by wave action of some small proportion of the spilled oil into droplets that are small enough to be retained in the water column by the turbulence of the sea. The rate of natural dispersion is influenced by sea state (breaking waves are needed for a significant rate of natural dispersion) and is resisted by the viscosity of the oil. In the initial stages of weathering the rate of natural dispersion can be relatively high, but the viscosity increase caused by evaporation and w/o emulsification rapidly reduces the rate of natural dispersion to almost zero under typical conditions.

2.6 PHOTO-OXIDATION

Crude oils are generally dark-coloured and can absorb UV (ultra-violet) radiation from the sun. In some oils, in very sunny conditions, this can cause significant changes in the chemical composition and this can affect emulsification properties.

2.7 SEDIMENTATION

If there is a sufficient amount of suspended sediment in the water column, typically in shallow water with a silt sea bed or in deeper water in very rough seas, the oil droplets that have been created by natural dispersion may adhere to the sediment and eventually sink to the sea bed.

2.8 BIODEGRADATION

The ultimate fate of the majority of crude oil components in dispersed oil is to be biodegraded by naturally occurring micro-organisms. These micro-organisms exist in low concentrations and biodegrade naturally occurring oils in the sea that are liberated when marine flora and fauna die and decompose. In the event of an oil spill, the concentrations of oil degrading micro-organisms rapidly increases in the location of a slick.

2.9 CONSEQUENCES OF CRUDE OIL WEATHERING

The consequences of crude oil weathering are that the physical and chemical properties of the crude oil alter very rapidly once it has been spilled on the sea. Different crude oils weather in different ways; under some conditions the spilled crude oil will be naturally dispersed at a rapid rate, while in other cases the oil will be converted into a high viscosity emulsion which will drift on the sea surface for a prolonged period and may contaminate the coastline at locations far from the spill site.

The potential for environmental damage caused by an oil spill varies with different areas of the marine environment. Oil spills, being infrequent and relatively short-term events, rarely cause much damage to organisms in deep water, but there can be severe and long-term impacts on organisms living in shallow water near the shore. The weathering behaviour of spilled crude oil influences the potential environmental impact of an oil spill.

The weathering behaviour of a crude oil also has a large influence on the effectiveness of any oil spill response that could be undertaken:

- a crude oil that naturally disperses rapidly is unlikely to be amenable to any active countermeasure; it will disperse before it can be contained and recovered by booms and skimmers, burnt or dispersed by oil spill dispersants. The potential environmental impacts of a rapidly dispersing crude oil will not be mitigated by any response measure, although there is unlikely to be any significant lasting effect if the oil disperses in deep water
- a crude oil that forms a high viscosity emulsion that persists on the sea surface for a long time has the potential to be recovered, although this is very difficult in practice. The emulsified oil may be amenable to treatment with oil spill dispersants, although highly emulsified oil cannot be treated successfully after long periods at sea.

3 Objectives of Study

The objectives of the work programme were to:

- Obtain data on the properties of the condensate that are relevant to surface weathering after a spill. This includes information on evaporation, emulsification and changes in viscosity
- Determine the OSIS constants for the condensate
- Undertake dispersibility testing on both fresh condensate and weathered emulsions
- Determine the time window for dispersant use with OSIS V3

4 Work Programme

The work programme consisted of the following activities for the condensate:

4.1 LABORATORY WEATHERING STUDIES

Laboratory weathering studies were undertaken to simulate both evaporation and emulsification. Evaporation was simulated by two approaches; gas stripping and distillation. The physical properties of the original condensate and the various products of weathering were also determined. All of these are discussed in the following sections.

4.1.1 Gas Stripping

Previous investigations have shown that the degree of weathering of crude oil during gas stripping can be related to the evaporation of oil at sea (Walker et al., 1992). Consequently, gas stripping of the condensate was undertaken to obtain information on the rate of evaporation. Gas stripping involves bubbling air at a rate of 2 litres per minute for about 50 hours through a given weight of oil at a constant temperature. The weight of oil remaining is recorded at regular intervals.

4.1.2 Distillation

Previous investigations have shown that distillation of crude oils can produce oils similar to those occurring at sea as a result of weathering. During experimental spills of crude oils it has been noted that oils typically lose 20-30 % by weight after about one hour and 40-50 % by weight after several days, depending on the composition and environmental conditions (Walker et al, 1992; Buchanan and Hurford, 1988). Typically all alkanes to hexadecane are eventually lost by evaporation. Distillation to 175^{o}C produces a topped oil similar to that produced on the sea surface after about one hour, while distillation to 250^{o}C produces oils similar to those at sea after 24-48 hours. Consequently, known weights of the condensate were to be subjected to two separate distillations to 175^{o}C and 250^{o}C, to produce residues resembling weathered products of different ages.

4.1.3 Emulsification

The exact form of the water-in-oil emulsion depends to a great extent on the sea conditions at the time of the spill. In addition, the emulsification of an oil slick at sea does not result in homogenous emulsion properties throughout the slick. Thus, there is no such thing as a "typical emulsion" even for a single oil type.

From comparison with field trial data a standard method has been developed which represents emulsions typically formed in the thickest most emulsified parts of the slick. The emulsions were prepared at 6^{o}C and 27^{o}C by placing the residue and synthetic sea water (35 ppt) in a Kilner jar and mixing vigorously with a high shear mixer. The ratio of water to oil was such that an excess of water existed once emulsification was complete. Mixing was stopped when specific end points were reached (Walker et al., 1992).

Emulsions were made from the 175°C and 250°C distillation condensate residues using this emulsification method. These emulsions were used to assess the dispersibility of the condensate in the standard weathering and dispersibility test.

4.1.4 Physical Property Determination

Viscosity measurements were undertaken using a Haake VT 550 instrument. Commencing with the lowest shear rate, viscosity data were obtained up through the shear rate range (usually 1 - 100 s^{-1}). Where possible, replicate measurements were made. As different cup and bob geometries are used for the various oils and emulsions, results were recorded at different shear rates and the viscosity (η) reported at a standard shear rate ($\dot{\gamma}$) of 10 s^{-1}. (10 s^{-1} is thought to be typical of the shear rate at the surface of the sea and is therefore the shear rate at which dispersant effectiveness is commonly related to viscosity (Institute of Petroleum, 1986).)

Density measurements were determined by the Institute of Petroleum standard specified in IP59 (Institute of Petroleum, 1983).

Water contents of the emulsions were determined by the Dean and Stark technique specified in IP74 (Institute of Petroleum, 1983).

Table 2 provides a summary of the physical measurements undertaken the oil during the experimental work.

Table 2. Summary of Physical Measurements Undertaken

Product	Viscosity			Density	Water Content
	6°C	16°C	27°C		
Fresh crude	x	x	x	x	
175°C distillation residue	x		x	x	
175°C distillation residue 6°C emulsion	x				x
175°C distillation residue 27°C emulsion			x		x
250°C distillation residue	x		x	x	
250°C distillation residue 6°C emulsion	x				x
250°C distillation residue 28°C emulsion			x		x
Gas stripping residue				x	

4.2 DISPERSIBILITY TESTING

The dispersibility (i.e. dispersant effectiveness) of the condensate and emulsions was measured against a commercial dispersant using the Warren Spring Laboratory LR 448 protocol.

The test consisted of adding a known quantity of oil or emulsion (about 5g) to 35 ppt artificial sea water (250 ml) contained in a 250 ml separating funnel. Dispersant (200 µl) was added dropwise to the oil from a syringe. The funnel was stoppered, left to stand for 1 minute then rotated at 33 rpm in a motor driven rack for 2 minutes. The rotation was stopped, the funnel unstoppered and allowed to stand for 1 minute before 50 ml of oily water was run-off. The oil was extracted from the sample with chloroform, dried with sodium sulphate and diluted with chloroform to 100 ml in a volumetric flask. The UV absorbance of the solution was measured at 580 nm and by comparison to a calibration curve the amount of oil dispersed was determined. For emulsions, the absorbance calibration curve of the parent topped crude was used.

The degree of dispersibility (%) was calculated as:

% Dispersibility = $\frac{\text{Mass of Oil Dispersed into Water}}{\text{Mass of Oil Used in Test}} \times 100$

With emulsions the amount of oil is always less than the mass of emulsion so the equation above was corrected using the known water content of the oil.

Dispersibility tests were carried out in a temperature controlled cabinet at 6 C and 27 C. The dispersant tested on the crude was Finasol OSR51.

It should be noted that laboratory dispersant tests were designed to rank the relative effectiveness of different dispersants and not to provide quantitative estimates of how effective they might be at sea. Only field trials can provide a truly quantitative estimate of dispersant effectiveness at sea (Lunel 1995).

4.3 TIME WINDOW ANALYSIS AND BEHAVIOUR MODELLING

Dispersant time window analysis and oil behaviour modelling was undertaken on OSIS V3 using the constants derived from the laboratory studies and the dispersibility data determined using the methods described in Section 4.2.

A 1000 m^3 instantaneous surface spill of the oil was modelled under the range of scenarios indicated in Table 3.

Table 3. Scenarios Used for Time Windows and Behaviour Modelling of the Azeri Condensate

Sea Temperature °C	Sea State	Wind Speed m/s
6	Calm	2
6	Slight	5
6	Moderate	10
6	Rough	15
6	Very Rough	20
28	Calm	2
28	Slight	5
28	Moderate	10
28	Rough	15
28	Very Rough	20

5 Azeri Condensate Results

The results of the weathering and dispersibility studies on the condensate are detailed as follows.

5.1 LABORATORY WEATHERING STUDIES

5.1.1 Gas Stripping and Distillation

The measured weight loss and calculated volume loss of the condensate as a result of gas stripping and distillation are indicated in Table 4. The distillation characteristics are shown in Table 5.

Table 4. Weight and Volume Loss of Condensate Resulting from Gas Stripping and Distillation

Product	Weight Loss %	Volume Loss %
175°C distillation residue	36%	39%
250°C distillation residue	55%	58%
Gas stripped residue	36%	39%

The Azeri condensate contains a relatively high light oil fraction. The distillations represent a loss of 39% by volume in the initial stages of a spill and a total loss of 58% by volume.

Table 5. Condensate Distillation Characteristics

Vapour Temperature °C	Fraction Evaporated % weight
101	10
148	26
175	34
200	40
225	46
250	53

5.1.2 Emulsification

The preparation of maximum water content emulsions was attempted with the 175°C and 250°C distillation residues at 6°C and 27°C. A very loose, unstable emulsion was formed at 6°C, however, at 27°C the residues did not emulsify.

The properties of the emulsion produced are indicated in Table 6. Further analysis was only possible on the emulsions formed at 6°C.

Table 6. Properties of the Emulsions

Emulsion	Formation Temperature ^oC	Water Content % w/w	Colour	Flow Property
175^{o}C distillation residue emulsion	6	81	Yellow	Mobile, Unstable
250^{o}C distillation residue emulsion	6	83	Yellow/White	Mobile, Unstable
175^{o}C distillation residue emulsion	27	Did not emulsify		
250^{o}C distillation residue emulsion	27	Did not emulsify		

5.1.3 Physical Properties

The results of the different physical property measurements undertaken on the various products are indicated in Table 7. The physical properties of the condensate are significantly different at the low temperature of 6^{o}C than at the higher temperature of 27^{o}C.

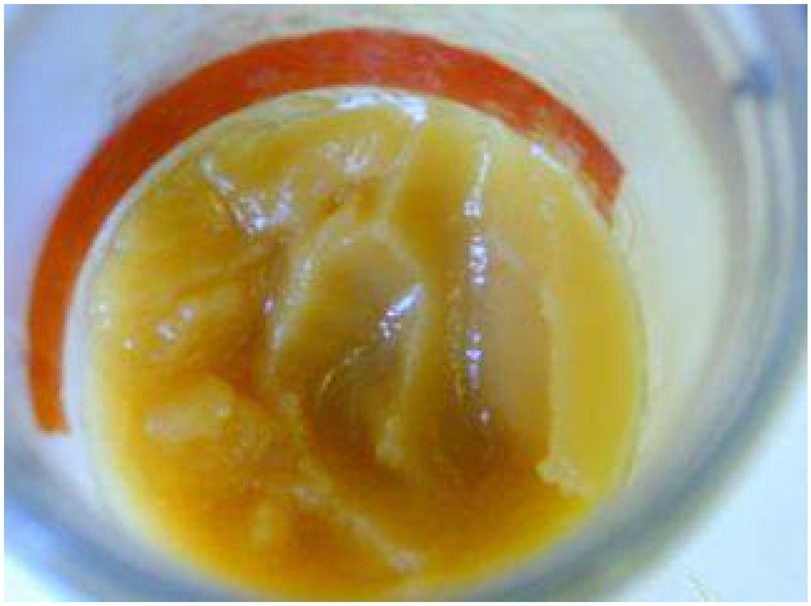
Table 7. Results of Physical Measurements Undertaken on the Condensate

Product	Viscosity mPa s at 10 s^{-1}			Density	Water Content
	6^{o}C	16^{o}C	27^{o}C		% w/w
Fresh crude	210	15	6	793.8	-
175^{o}C distillation residue	5,550	-	20	831.2	-
175^{o}C distillation residue 6^{o}C emulsion	70	-	-	-	81
175^{o}C distillation residue 27^{o}C emulsion	-	-	N/F	-	-
250^{o}C distillation residue	12,000	-	180	845.6	-
250^{o}C distillation residue 6^{o}C emulsion	100	-	-	-	83
250^{o}C distillation residue 27^{o}C emulsion	-	-	N/F	-	-
Gas stripping residue	-	-	-	826.8	-

At 27^{o}C, the condensate is a light, fluid oil. The viscosity of the fresh condensate is only 6 mPas and this does not increase significantly as the condensate weathers, for example after 39% evaporate loss (by volume) the viscosity increases only to 20 mPas and after 58% evaporate loss the viscosity of the residue is 180 mPas. This suggests that on weathering of the condensate and evaporation of a large volume of light oil, at 27^{o}C the condensate remains a light, fluid oil. This prevents the condensate from emulsifying.

At 6^{o}C, the viscosity of the fresh condensate is higher at 210 mPas. The viscosity of the condensate continues to increase considerably as the condensate weathers; after 39% evaporate loss (by volume) the viscosity increases to 5,550 mPas and after 58% evaporate loss the viscosity of the residue is 12,000 mPas. This increase in viscosity is due to the precipitation of waxes from the condensate, giving it the consistency of a thick paste. The change in consistency is shown in the photograph in Figure 1.

Figure 1. Weathered Azeri Condensate at 6°C



At 6°C, the condensate residues formed loose, unstable emulsions. In these emulsions, the water droplets were fairly large and were held in the condensate primarily by the waxes. The emulsions were very unstable, therefore easily broke back to water and condensate – and would not reform. The formation of these weak emulsions mobilised the condensate, thereby decreasing the viscosity significantly (to 70-100 mPas). Whilst these weak emulsions may be formed if the condensate is spilt at sea at this temperature, the condensate is unlikely to emulsify unless there is high energy sea conditions and even then, the condensate emulsions are very likely to break back to condensate and water once energy levels reduce. Therefore the condensate is only likely to emulsify in certain conditions, which should be taken into account in the event of a spill.

5.2 DERIVATION OF OSIS CONSTANTS

The OSIS v3 constants specific for the condensate are indicated in Table 8. These constants can be incorporated into the OSIS v3 spill simulation models.

Table 8. OSIS V3 Constants for the Azeri Condensate

Constant	Value
Density, rho	793.78
Distillation, ec1	128.71
Distillation, ec2	54.54
Density change, ec3	75.65
Viscosity, a	8.77
Viscosity, b	37.40
Gas stripping, gs1	5.90
Gas stripping, gs2	12.15
Water visc	1.00
Vis exp	7.42
Max water	0
Asp	0
Pour	0
Waxy	0

The weathering and emulsification behaviour of the Azeri condensate is unusual and it has not been possible to derive constants that reflect the measured properties over the range of temperatures examined. The OSIS constants finally selected reproduce the change in viscosity with temperature, but do not allow for emulsification. The laboratory studies indicate that emulsions will only be formed during cold conditions and during high energy sea conditions. These emulsions will be of lower viscosity than predicted by the OSIS model. However the emulsions formed would be very weak so are likely to break back to condensate and water rapidly. Therefore the condensate is unlikely to emulsify in the majority of conditions.

The OSIS constants have been developed to predict the most probable behaviour of the condensate in a range of temperatures, so will not predict the condensate to emulsify. So when modelling the condensate in cold temperatures, it is important to consider the potential for the condensate to emulsify. Emulsification will change the properties of the condensate to be a more fluid oil, so may require a different response approach than would be applied to the weathered condensate residue.

5.3 DISPERSIBILITY TESTING

Dispersibility testing was undertaken on:

- Fresh condensate at 6°C and 27°C
- 175°C residue emulsion (representative of the first few hours at sea) and 250°C residue emulsion (representative of 24-48 hours at sea) formed at 6°C
- 175°C residue (representative of the first few hours at sea) and 250°C residue (representative of 24-48 hours at sea) formed at 6°C and 27°C

The dispersibility of the oil and emulsions was determined using one dispersant; Finasol OSR51. The dispersibility testing was undertaken with a dispersant application rate at a 1:25 dispersant to oil ratio. Table 9 shows the measured effectiveness of the dispersant.

Table 9. Effectiveness of dispersants on Azeri Condensate

Oil	Dispersibility (%) with Finasol OSR51	
	6°C	27°C
Fresh Crude	5	4
175°C Residue	7	29
250°C Residue	3	34
175°C Residue Emulsion	18	-
250°C Residue Emulsion	36	-

The threshold for the LR448 efficacy test is based upon previous work where laboratory tests have been correlated against field data to set the threshold value at 15%. The effectiveness values that pass this threshold are indicated in the tables by grey shading.

The results indicate that Finasol OSR51 would be effective on a spill of weathered Azeri condensate at 27°C and emulsified condensate at 6°C. This indicates that at 27°C, the condensate is amenable to dispersants once it has lost a large fraction of its light oil fraction. However, at 6°C, the weathered condensate is very viscous therefore rapidly becomes ineffective to dispersant treatment. Therefore, at 6°C the condensate will only be amenable to dispersants once it has emulsified, which lowers the viscosity of the condensate considerably.

5.4 BEHAVIOUR MODELLING AND TIME WINDOW ANALYSIS

As a validation of the OSIS constants derived from the laboratory simulation, behaviour modelling was undertaken on OSIS V3. The behaviour of a 1000 m^3 instantaneous surface spill of the condensate was predicted at various sea conditions at 6°C and 27°C. The results are shown graphically in Figures 2-15.

5.4.1 Winter Conditions (6°C)

Figures 2-3 indicate the changes in oil properties, over the time period of the spill in different wind conditions. Figures 4-8 show the changes in mass balances for the scenarios modelled. The various physical properties and changes in mass balance are discussed below.

5.4.2 Viscosity Changes

Figure 2 demonstrates the change in viscosity over time at a temperature of 6°C. The rate of increase in viscosity becomes more rapid with increasing wind speed (associated with rougher sea conditions) reflecting a faster loss by evaporation.

At 6°C OSIS will predict the condensate to weather to a waxy, viscous residue. At wind speeds of 10-20 m/s, the increase in viscosity is significantly faster than at wind speeds of 2-5 m/s. This is demonstrated in the following table, which shows the approximate predicted viscosities after 24 hours in all the conditions modelled in OSIS V3.

Table 10. Predicted Viscosity after 24 hours at sea

Sea State	Wind Speed m/s	Viscosity prediction mPas
Calm	2	1,540
Slight	5	2,870
Moderate	10	8,140
Rough	15	10,980
Very Rough	20	10,090

The maximum viscosity measured in the laboratory (12,000 mPas) is likely to be reached within 24-48 hours even at the higher wind speeds.

The OSIS constants generated for the condensate predict the oil to weather over time. However it was observed in the laboratory that the weathered condensate may emulsify. This leads to a reduction in viscosity as the incorporation of water mobilises the waxy weathered condensate residue. The laboratory studies suggested that emulsification is only likely to occur in high energy sea conditions, and the emulsions formed would be very weak so are likely to break back to condensate and water rapidly. Therefore, at higher wind speeds of 10-20 m/s, the viscosity of the condensate may be significantly less than predicted if emulsification has occurred.

Water Content Changes

OSIS will not predict the condensate to emulsify, therefore OSIS does not predict the condensate to incorporate water in this scenario. However in some conditions the condensate may emulsify to a water content of 81%-83%, although forming a very weak emulsion.

Flash Point Changes

Figure 3 indicates the change in flash point over time at a temperature of 6^oC. There will be a rapid increase in flash point of any spilled oil with over time and the rate of change will increase with increasing wind speed.

Mass Balance

Figures 4-8 indicate the mass balance of oil occurring during the different scenarios modelled at a temperature of 6^oC.

In all the scenarios, the volume of condensate on the sea surface steadily declines over time. The amount lost through evaporation is high due to the 58% light oil fraction in the condensate. The rate of evaporated increases with increasing wind speed. After the light oil fraction has evaporated, at 6^oC a viscous residue remains, which is persistent at sea. This residue is slowly removed from the sea surface through natural dispersion.

The modelling indicates that in a 1000 tonne spill at low wind speeds of 2 m/s, the residue will persist for up to 12 days at sea. At 5 m/s, this decreases to 6 days, but at higher wind speeds he condensate is still expected to persist for 2-4 days. The persistence of the condensate on the sea surface is longer at low wind speeds than at higher wind speeds. This is because dispersion will be more rapid in rougher seas, causing a faster reduction in the volume of oil remaining on the sea surface.

Figure 2. Changes in viscosity of Azeri Condensate with different wind speeds (6°C)

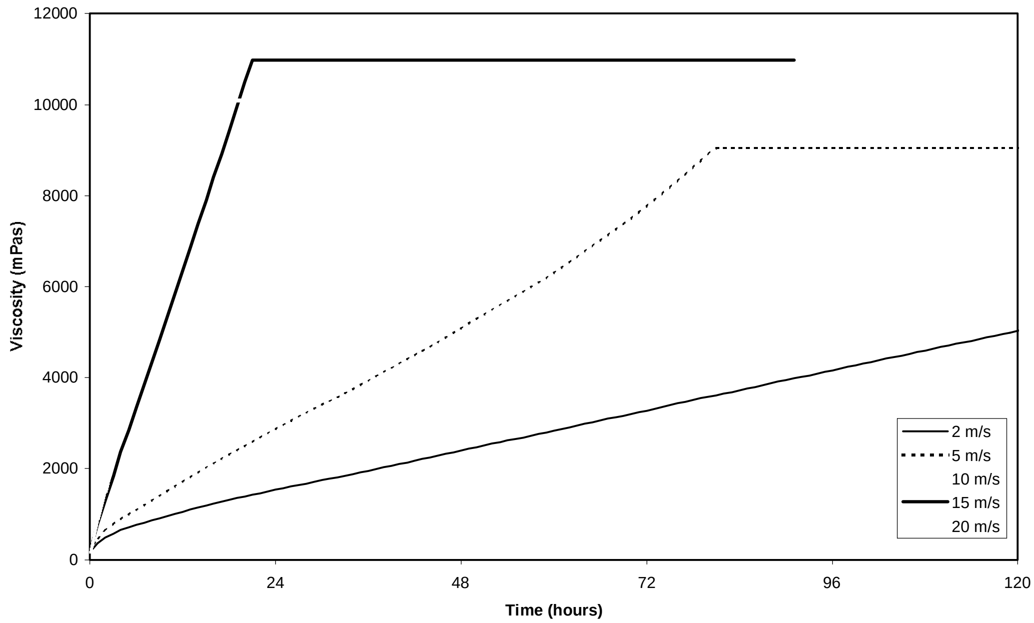


Figure 3. Changes in flash point of Azeri Condensate at different wind speeds (6°C)

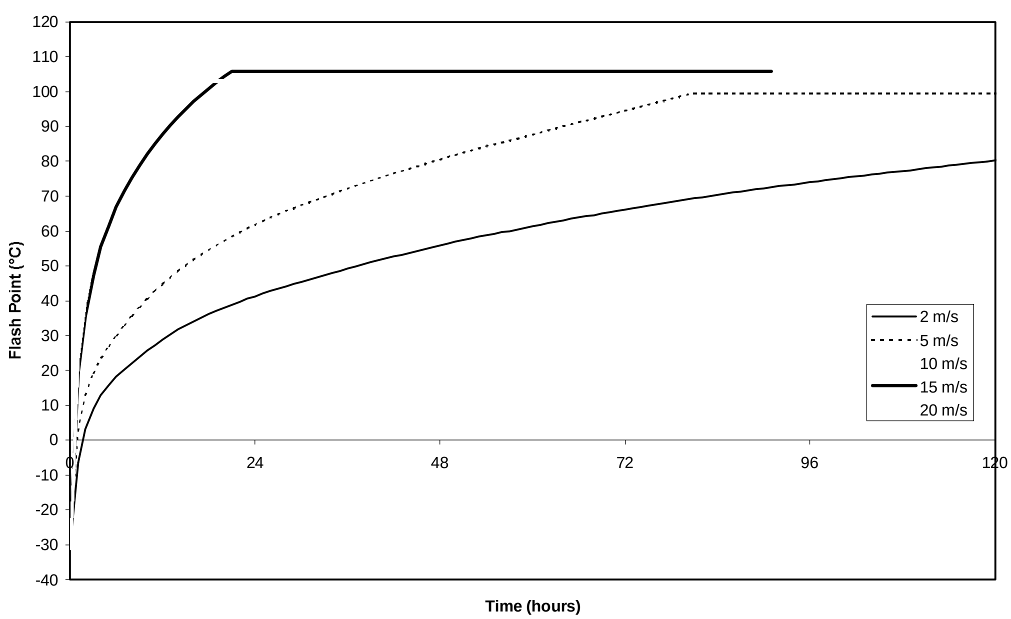


Figure 4. Mass Balance of Azeri Condensate at 2 m/s (6°C)

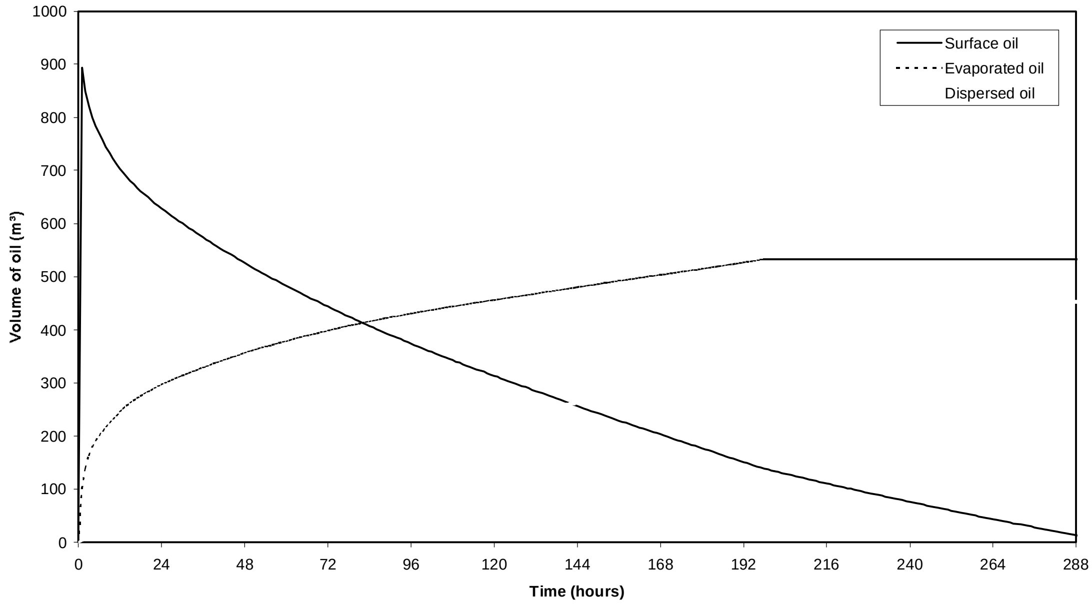


Figure 5. Mass Balance of Azeri Condensate at 5 m/s (6°C)

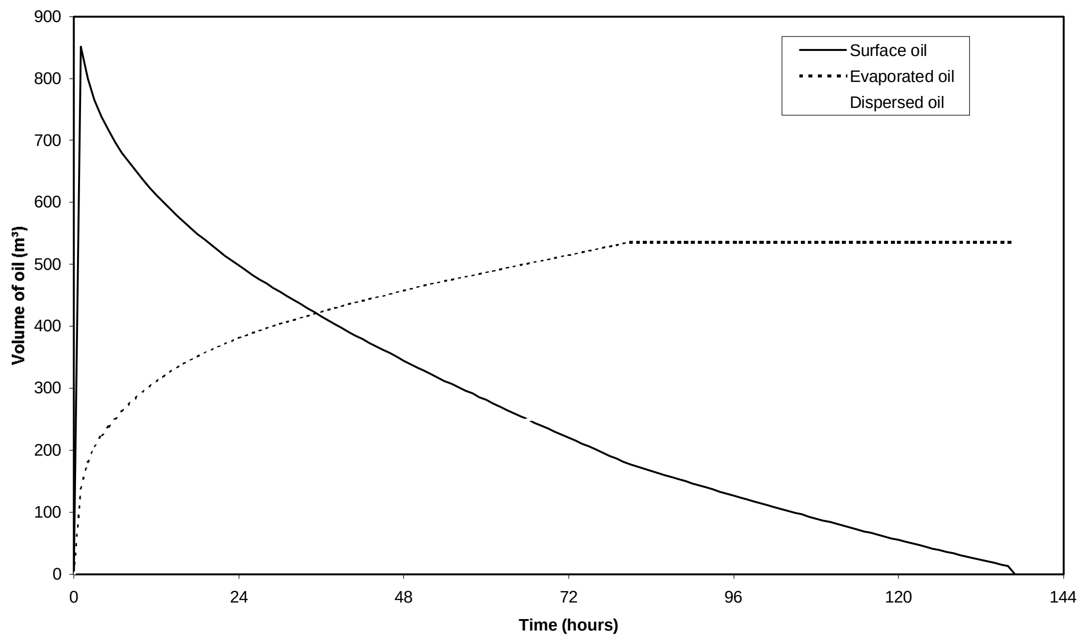


Figure 6. Mass Balance of Azeri Condensate at 10 m/s (6°C)

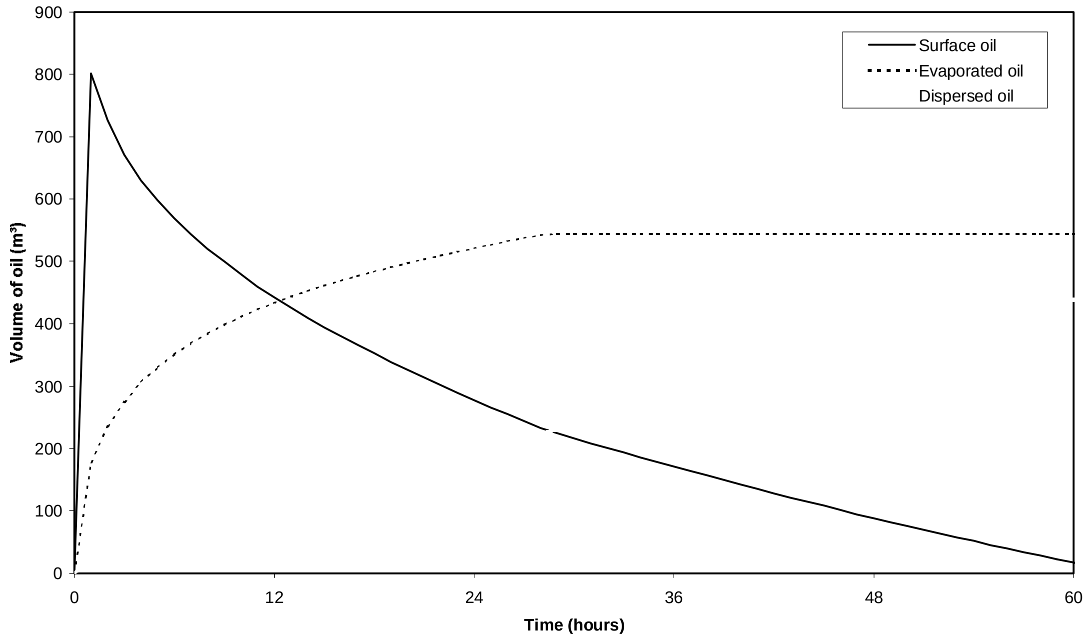


Figure 7. Mass Balance of Azeri Condensate at 15 m/s (6°C)

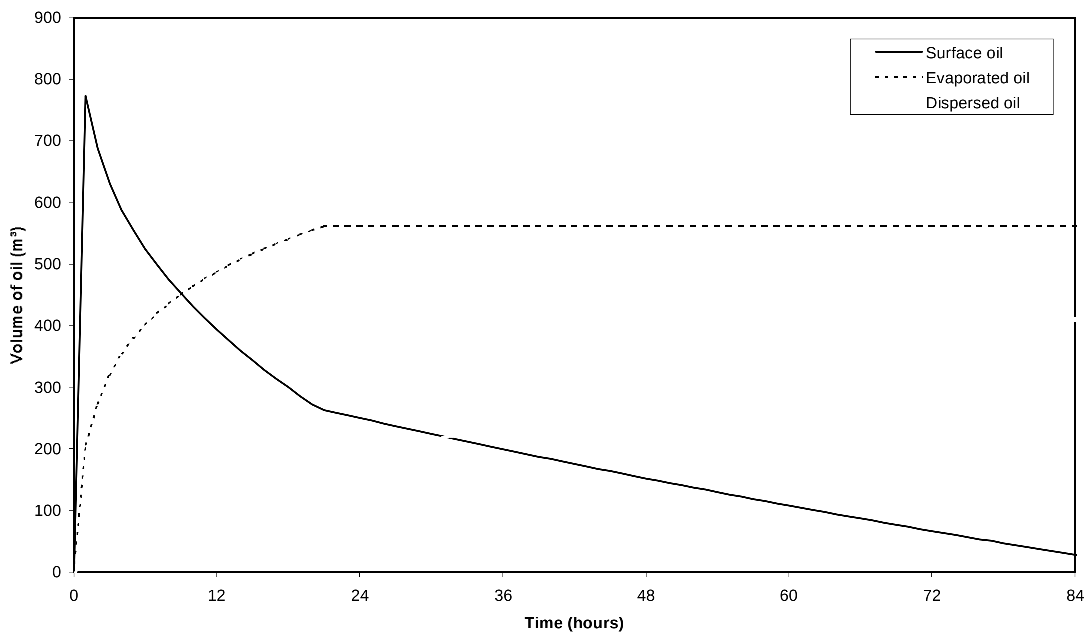
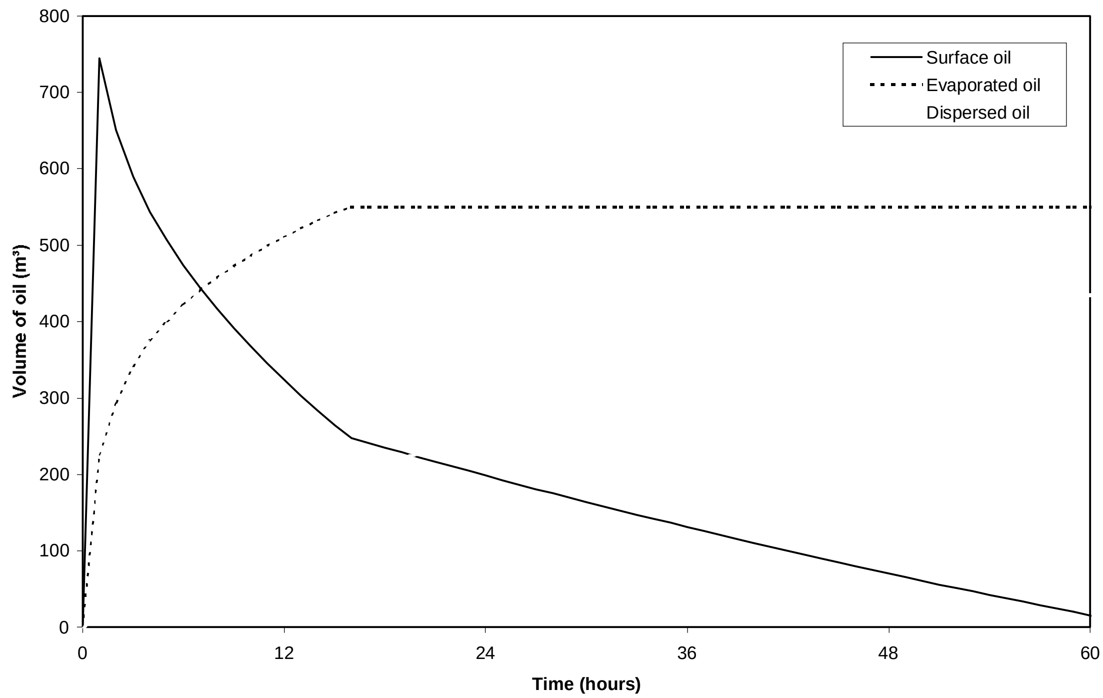


Figure 8. Mass Balance of Azeri Condensate at 20 m/s (6°C)



5.4.3 Summer Conditions (27°C)

Figures 9-10 indicate the changes in oil properties, over the time period of the spill in different wind conditions. Figures 11-15 show the changes in mass balances for the scenarios modelled. The various physical properties and changes in mass balance are discussed below.

Viscosity Changes
Figure 9 demonstrates the change in viscosity over time at a temperature of 27°C. The rate of increase in viscosity becomes more rapid with increasing wind speed (associated with rougher sea conditions) reflecting a faster loss by evaporation. However there is only a small increase in viscosity as the condensate weathers at sea (maximum viscosity increase is 6-330 mPas). At high wind speeds (10-20 m/s the condensate reaches maximum viscosity within 12 hours of a spill. At lower wind speeds (2-5 m/s) this may take up to 1-3 days.

Water Content Changes
The condensate did not emulsify in the laboratory, therefore it did not incorporate water. The modelling reflects this by assuming that no emulsification takes place.

Flash Point Changes
Figure 10 indicates the change in flash point over time at a temperature of 27°C. There will be a rapid increase in flash point of any spilled oil with over time and the rate of change will increase with increasing wind speed.

Mass Balance
Figures 11-15 indicates the mass balance of oil occurring during the different scenarios modelled at a temperature of 27^{o}C.

In all the scenarios, the volume of condensate on the sea surface steadily declines over time. The amount lost through evaporation is high due to the 58% light oil fraction in the condensate. This fraction evaporated increases with increasing wind speed. Natural dispersion is the other main route of removal of condensate from the sea surface.

The modelling indicates that the condensate will not persist for long periods of time at sea at higher wind speeds (10-20 m/s). However it may persist for 2-5 days at lower wind speeds. The persistence of the condensate on the sea surface is longer at low wind speeds than at higher wind speeds. This is because dispersion will be more rapid in rougher seas, causing a faster reduction in the volume of oil remaining on the sea surface. The following table summarises the persistence of a surface slick from a 1000 tonne spill in the absence of a response.

Table 11. Persistence of 100 tonne spill of Azeri condensate

Wind Speed (m/s)	Persistence (days)
2	5
5	2.5
10	1
15	1
20	<1

Figure 9. Changes in viscosity of Azeri Condensate with different wind speeds (27°C)

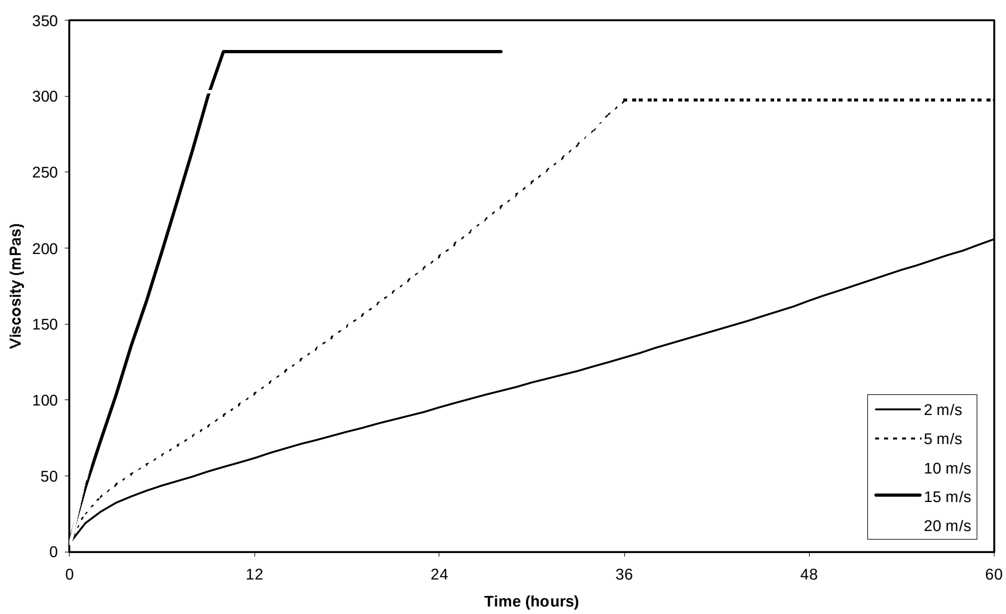


Figure 10. Changes in flash point of Azeri Condensate at different wind speeds (27°C)

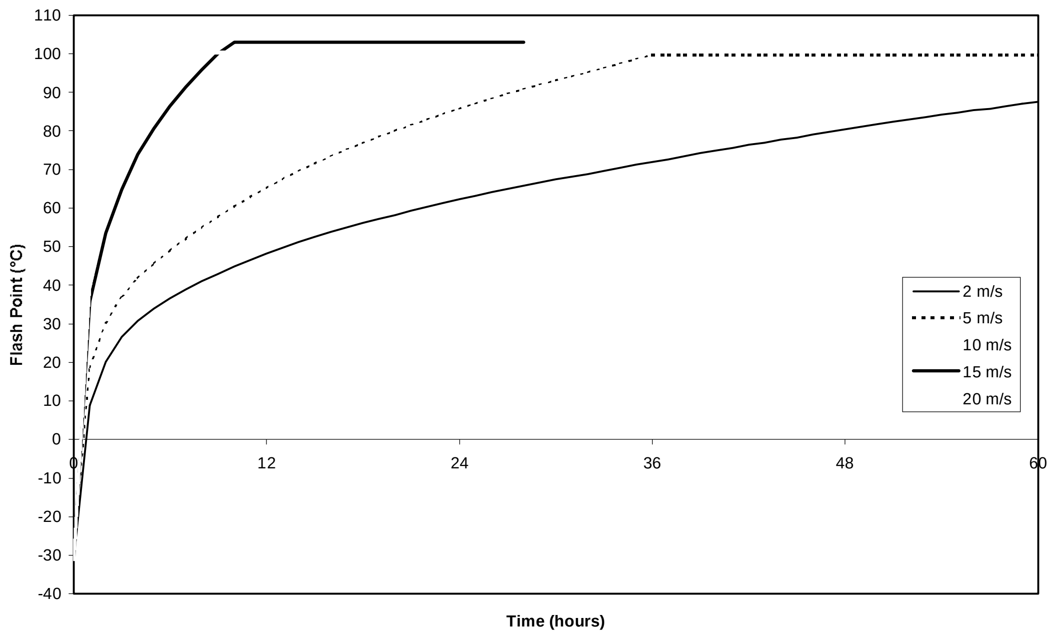


Figure 11. Mass Balance of Azeri Condensate at 2 m/s (27°C)

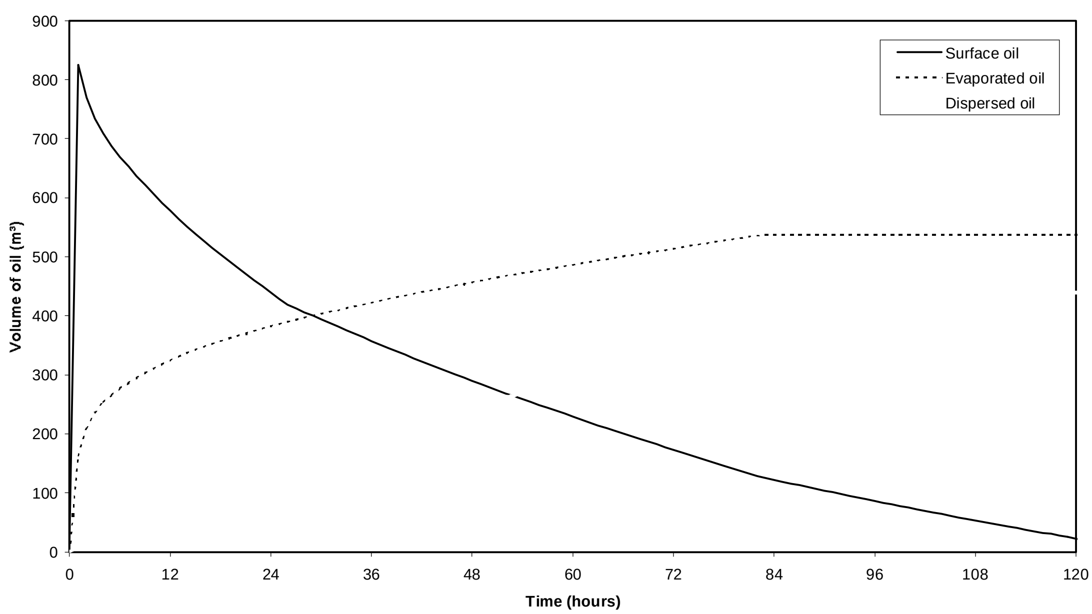


Figure 12. Mass Balance of Azeri Condensate at 5 m/s (27°C)

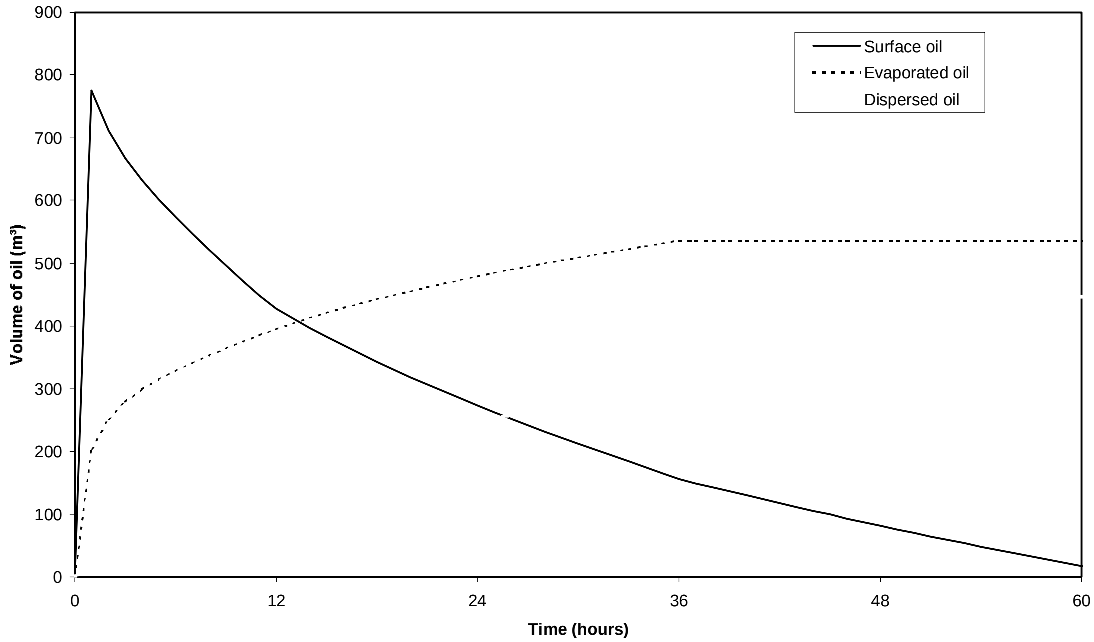


Figure 13. Mass Balance of Azeri Condensate at 10 m/s (27°C)

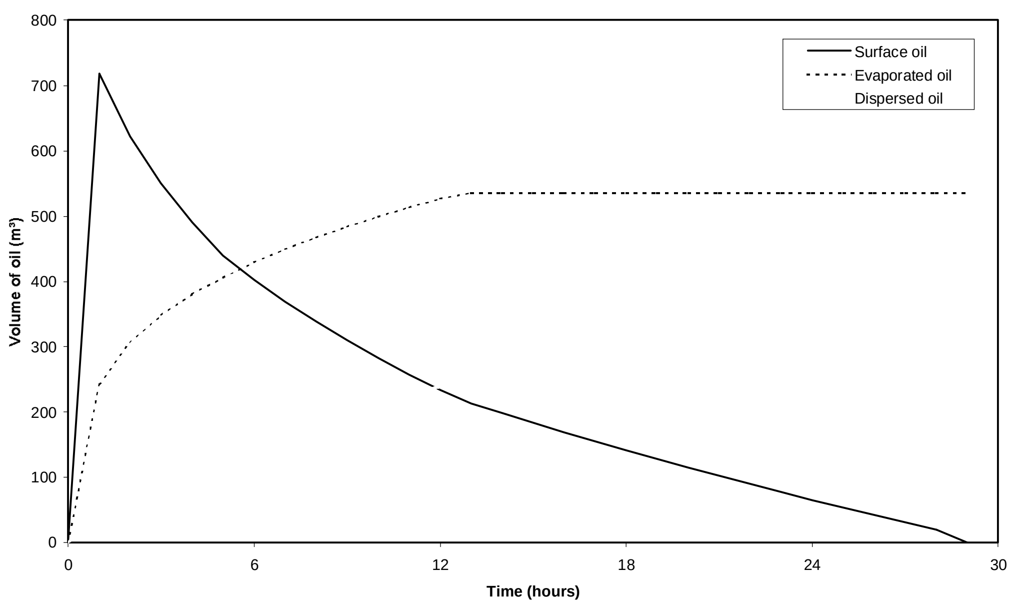
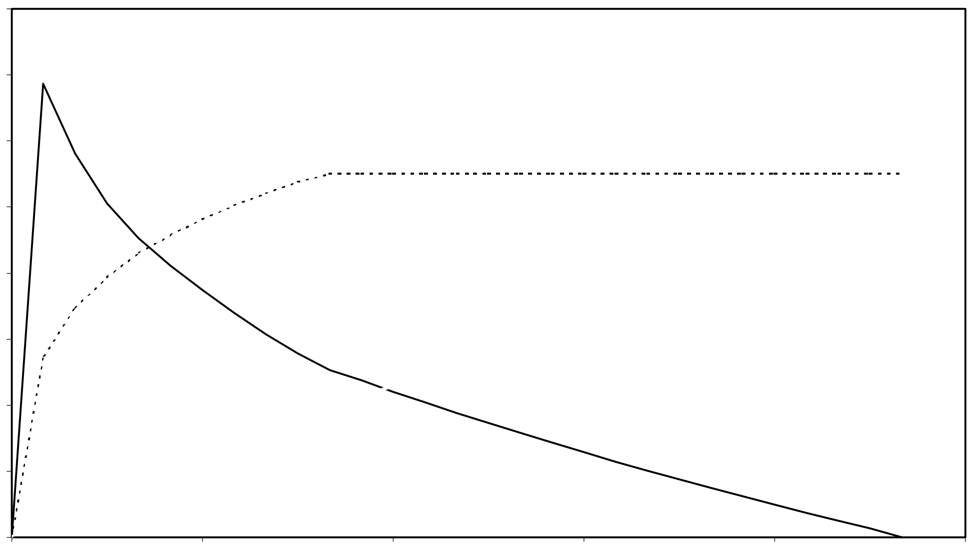


Figure 14. Mass Balance of Azeri Condensate at 15 m/s (27°C)



Time Windows for dispersant use

OSIS V3 allows an assessment to be made on the time window available for dispersant use in the event of an oil spill. This assessment is based on dispersibility of the oil at specific viscosities determined in the dispersant testing phase. The length of the time window changes according to different wind speeds/sea conditions as this affects the behaviour of the oil. Therefore, the time window is assessed at a range of wind speeds to account for a range of conditions that are likely to be encountered in an oil spill.

Table 12 consists of the dispersant time window constants as derived for OSIS V3.

Table 12. Dispersant Time Window Constants for the Azeri Condensate

Dispersants	Max Readily Dispersible	Dispersible	Reduced Dispersibility
Finasol OSR51	0	180	210

At 6°C, OSIS predicts the time window for dispersant use to be less than one hour at all wind speeds (2-20 m/s). However as suggested previously, if the weathered condensate emulsifies the viscosity of the condensate will be significantly reduced. The condensate may then be amenable to dispersants, thereby extending the time window for dispersant treatment. If possible, during a spill the state of the condensate should be assessed and taken into consideration when deciding on the most appropriate response method.

At warmer temperatures, the condensate is more dispersible. Table 13 indicates the time window for dispersant use at 27°C for a range of wind speeds.

Table 13. Time Window for Dispersant Use for Azeri Condensate at 27°C with OSR51

Wind Speed (m/s)	Dispersant Spraying Effective (hours)	Dispersant Spraying possibly Effective (hours)	Dispersant Spraying may not be Effective (hours)
2	0-52	52-61	>61
5	0-22	22-26	>26
10	0-8	8-9	>9
15	0-5	5-6	>6
20	0-4	4-5	>5

The table indicates the time period over which the dispersant is effective. This is determined by taking the viscosity of the oil that was effectively dispersed in the laboratory and relating it to the expected viscosity of the oil over time (as predicted by OSIS).

The dispersant efficiency tests indicated that the condensate was amenable to dispersant at warmer temperatures due to the lower viscosity. This is reflected in the time window for dispersant use. OSIS predicts that the dispersant will be effective for 1-2 days following a spill at low wind speeds (2-5 m/s). This time period is significantly reduced at higher wind speeds (10-20 m/s), however the condensate is also unlikely to persist for long periods of time at these higher wind speeds so dispersants may not be the most appropriate response option.

6 Conclusions

Laboratory investigations on the Azeri condensate suggest that it will rapidly lose approximately 39% by volume from the sea surface by evaporation immediately following a spill at sea. A total of 58% by volume will eventually be lost by evaporation. The characteristics of the condensate are similar to the crude. The condensate is of similar viscosity ranging from 210-6 mPas at $6^{o}C$ to $27^{o}C$ when fresh. The viscosity of the condensate at $6^{o}C$ is significantly higher than at $27^{o}C$. For example after the first few hours at sea (39% evaporate loss by volume) the viscosity increases to only 20 mPas at $27^{o}C$, but to 5,550 mPas at $6^{o}C$. After 24-48 hours at sea (58% evaporative loss) the viscosity increases to 180 mPas at $27^{o}C$, but to 12,000 mPas at $6^{o}C$. This significant increase in viscosity at $6^{o}C$ is due to a visible precipitation of waxes in the condensate, giving it the consistency of a thick paste.

At $6^{o}C$, the condensate forms loose, unstable emulsions. In these emulsions, the water droplets are fairly large and held in the condensate primarily by the precipitated waxes. The formation of these weak emulsions mobilised the condensate, thereby decreasing the viscosity significantly (to 70-100 mPas). Whilst these weak emulsions may be formed if the condensate is spilt at sea at this temperature, the condensate is unlikely to emulsify unless there is high energy sea conditions and even then, the condensate emulsions are very likely to break back to condensate and water once energy levels reduce. At $27^{o}C$, even after weathering the condensate remains a light fluid oil, thereby preventing it from emulsifying.

The weathering and emulsification behaviour of the Azeri condensate is unusual and it has not been possible to derive constants that reflect the measured properties over the range of temperatures examined. The OSIS constants finally selected reproduce the change in viscosity with temperature, but do not allow for emulsification. The laboratory studies indicate that emulsions will only be formed during cold conditions and during high energy sea conditions. These emulsions will be of lower viscosity than predicted by the OSIS model. However the emulsions formed would be very weak so are likely to break back to condensate and water rapidly. Therefore the condensate is unlikely to emulsify in the majority of conditions.

The dispersibility results indicate that Finasol OSR51 would be effective on a spill of weathered Azeri condensate at $27^{o}C$ and emulsified condensate at $6^{o}C$. This indicates that at $27^{o}C$ the condensate is amenable to dispersants once it has lost a large fraction of its light oil fraction. However, at $6^{o}C$, the weathered condensate is very viscous therefore rapidly becomes ineffective to dispersant treatment. Therefore, at $6^{o}C$ the condensate will only be amenable to dispersants once it has emulsified, which lowers the viscosity of the condensate considerably.

In summary, a spill of the condensate would result in the loss of a large volume of the spill by evaporation. In warm temperatures, the residue is of low viscosity therefore would not persist for long periods of time at sea. However in cold temperatures, the condensate forms a viscous waxy residue, and at low wind speeds, these waxy residues may persist for some time.

Dispersant treatment is an option for the condensate in warm temperatures and if the weathered condensate becomes emulsified in cold temperatures. However in high wind speeds, when the condensate in only likely to persist for 1-2 days, the preferred response method may be to 'leave alone' depending on the specific conditions of the spill, which avoids the unnecessary use of dispersants. If a 'leave alone' response is to be considered as part of the contingency plan for the condensate, it is important to undertake a Net Environmental Benefits Analysis (NEBA) for the areas that may be affected. This will enable BP Amoco to determine whether a 'leave alone' response is acceptable for the areas that may be affected by a spill of the condensate.

7 References

Buchanan, I and Hurford, N. *Report of the Forties Fate Trial*, July 1987. Stevenage: Warren Spring Laboratory. Report No LR 671 (OP). 1988

Daling, P.S., Brandvik, P.J., Mackay, D. and Johanson, O. *Characterisation of Condensates for Environmental Purposes*. Oil and Chemical Pollution, 7, 199-224. 1990

Hokstad, J. N., Daling, P. S., Lewis, A., Strom-Kristiansen, T. 1993: Methodology for testing water-in-oil emulsions and demulsifiers Description of laboratory procedures. In: Proceedings Workshop on Formation and Breaking of W/O Emulsions. MSRC, Alberta June 14-15 24p.

Hurford, N. *Report of the Flotta Fate Trial, August 1988*. Stevenage: Warren Spring Laboratory. Report No LR 725 (MPBM). 1990

Lunel, T. Dispersant Effectiveness at Sea. *Proceedings 1995 Oil Spill Conference*, pp 147-155. 1995

Lunel T. & Davies L. Dispersant effectiveness in the field on fresh oils and emulsions. Proc. 1996 Arctic and Marine Oil Spill Programme (AMOP), 1355-1394, 1996.

The Institute of Petroleum. *Methods for Analysis and Testing*. Chichester, John Wiley. 1983

The Institute of Petroleum. *Guidelines on the Use of Oil Spill Dispersants*. London, Institute of Petroleum. 1986

Walker, M.I., Albone, D.J., McDonagh, M., Wilkinson, A.O., Baron, G.R. and Grigson, S.J.W. *Final Report on the Joint Programme of Research on Source Identification, Behaviour and Modelling of North Sea Crudes at Sea*. Stevenage: Warren Spring Laboratory. Report CR 3698. 1992

URS Corporation

SD Condensate Release

OSIS Modelling Results Report

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Contents

Abstract

Briggs Environmental Services Limited have been commissioned to undertaken Oil Spill Modelling using the OSIS Oil Spill Information System to determine the fate and trajectory of SD Condensate in summer and winter and worst case conditions using pre-identified spill scenarios and actual statistical wind speed/direction frequency data.

The modelling results from both offshore and nearshore locations illustrate that the condensate is more persistent then expected and does pose a small potential risk to shoreline impact. For very large offshore spills the condensate shows a 5% probability of beaching to the West of Baku during winter and a 5% probability of beaching along the southern shoreline of the Caspian Sea during summer months. Beaching times in worse case weather conditions ranges between 10 to 38 hours depending on location, but in all runs the amount of oil beaching is low die to the amount of evaporation and dispersion.

1 Introduction

The risk of an oil spill into the marine environment is an unfortunate consequence of the increasing demand for petroleum products. In many region, production and storage facilities are close to coastal zones where oil spills can have significant environmental and economic effects. Fundamental to implementing a successful response to an oil spill is the ability to mobilise the appropriate resources to the area at risk before the oil impacts the coastline. In order to achieve this, it is essential to know the time taken for oil to reach the coastline, the location of oil beaching, the likely extent of the oiling and the physical state of the oil when it beaches. Oil spill modelling provides a tool to support oil spill response operations by predicting the trajectory and fate of spilt oil, the area of impact and the oil properties.

The operation requiring assessment is an offshore production platform situated in the Caspian Sea at latitude and longitude 39^0 53" 94'N and 50^0 26" 45' E. The platform is producing SD Condensate which is then exported via pipeline to the AIOC Sangachal Terminal Integrated Plant situated just to the west of Baku city on the west coastline of the Caspian Sea. The condensate is considered a fairly heavy product in terms of condensates with an expected durability if released in the environment. A full weathering and dispersibility study has been undertaken by Dames and Moore and certain elements will be mentioned in the discussion section.

It is essential that any oil spill modelling tool accurately represents the environment into which the oil may be spilt, in terms of the topographic, oceanographic and meteorological conditions of the surrounding environment. In addition the model needs to accurately predict the fate, trajectory and probable impact of a spill. Therefore a number of spill scenarios based around this operation have been identified and have been modelled through the OSIS Oil Spill Information System Stochastic and Single trajectory model modes.

2 Methodology

2.1 Scope

The OSIS Oil Spill Information System uses a series of complex spatial and time series datasets, real-time data, data visualisation and knowledge-based capabilities to predict the fate and behaviour of spilt oil. OSIS is a Microsoft Windows based package, therefore the model is presented in a way that is directly applicable to most users requirements.

The model attempts to predict the dispersion of complex pollutants in a highly dynamic and complex environment, clearly the model will be restricted by our own limited understanding of the mechanisms involved. Nevertheless the model represents the main processes, of which science has a good grasp, at work in the marine environment, and converts them into model code and provides an indication, in quantifiable terms, of the likely behaviour of an oil spill. The accuracy of any model relies on the resolution and accuracy of the databases from which the model is driven.

2.2 Summary of Method

<u>Scenarios</u>

The following oil spill scenarios have been determined by URS Corporation, where single trajectory and stochastic modelling have been applied using the OSIS Oil Spill Information System.

Stochastic Modelling			
Scenario & No.	**Location / Season**	**Spill Size**	**Oil Type**
Blowout - 4a	Platform / Summer	52,800m^3 * (220m^3 p/hr over 240 hrs)	Azeri Condensate
Blowout - 4b	Platform / Winter	52,800m^3 * (220m^3 p/hr over 240 hrs)	Azeri Condensate
Pipeline leak - 5a	Nearshore Pipeline / Summer	6899m^3 (357.72m^3 over 19 hrs)	Azeri Condensate
Pipeline leak - 5b	Nearshore Pipeline / Winter	6899m^3 (357.72m^3 over 19 hrs)	Azeri Condensate
Pipeline leak - 6a	Offshore Pipeline / Summer	6899m^3 (357.72m^3 over 19 hrs)	Azeri Condensate
Pipeline leak – 5b	Offshore Pipeline / Winter	6899m^3 (357.72m^3 over 19 hrs)	Azeri Condensate
Single Trajectory			
Scenario & No.	**Location / Season**	**Spill Size**	**Oil Type**
Blowout – 4c	Platform / Winter	52,800m^3 * (220m^3 p/hr over 240 hrs)	Azeri Condensate
Tank Rupture - 4d	Platform / Winter	242m^3	Diesel
Pipeline leak - 5c	Nearshore Pipeline / Winter	6899m^3 (357.72m^3 over 19 hrs)	Azeri Condensate
Pipeline leak - 5d	Nearshore Pipeline / Winter	720m^3 (1m^3 over 720 hrs)	Azeri Condensate
Pipeline leak - 6c	Offshore Pipeline / Winter	6899m^3 (357.72m^3 over 19 hrs)	Azeri Condensate
Pipeline leak - 6d	Offshore Pipeline / Winter	720m^3 (1m^3 over 720 hrs)	Azeri Condensate

** The pre-identified blow out figure has been estimated at around 953,940m^3 however 52,800m^3 has been used for modelling and is considered representative given the condensates characteristics*

Stochastic Modelling

Stochastic Modelling takes its input data in the form of identified spill scenarios and actual statistical wind speed/direction frequency data. This is then calculated to provide a probability range of sea surface oiling representative of the prevailing conditions.

Single Trajectory

Single trajectory modelling investigates the shortest beaching time, excluding prevailing weather conditions, to deduce the worst case scenario.

Modelled Oil

Following the recent characterisation of Azeri Condensate by AEA, as featured in the Dames and Moore Weathering and Dispersibility report, the OSIS constants have been derived and made available for input into the OSIS package. These constants allow for more accurate calculations to be made by the model when predicting the oils behaviour and fate over time therefore providing more realistic results.

It is important to mention that during characterisation the condensate illustrated a complex behaviour pattern centred around temperature and sea conditions. This has an influence on the ultimate fate of the oil within the environment but will be discussed in context later in this report.

Constants

There are certain environmental parameters that have an influence on oils behaviour at sea and need to be addressed before running the OSIS programme, therefore a number of Caspian specific constants were assumed based on factual metocean data.

- Winter spill runs: air temperature 5^0C. Sea temperature 10^0C.
- Summer spill runs: air temperature 35^0C. Sea temperature was 25^0C.
- A worst case scenario for single trajectory would be in winter conditions using a 20 knot onshore wind, this has been calculated by examining the annual wind data.

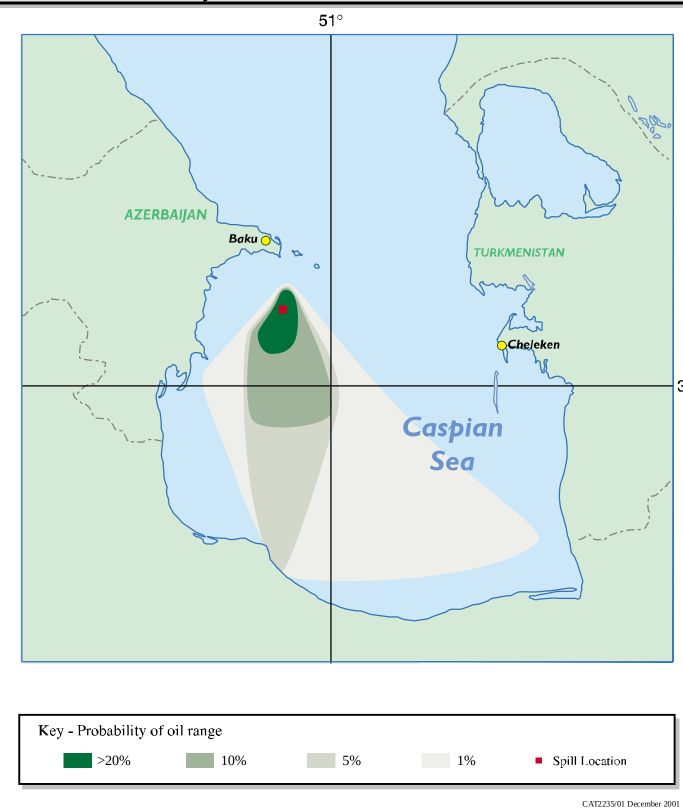
3 Results

Scenario 4: Blow out from SD Platform

Release Location: 39^0 53” 94’ N 50^0 26” 45’ E

Stochastic modelling has been carried out to represent a blow out from the platform for both winter and summer conditions. Although it has been calculated that the true spill size would be expected to in the region of 953,940 m^3 it was decided, after reviewing the condensate characteristics that the 52,800m3 released over 240 hours would be representative.

Figure 4a: 52,800m^3 SD Condensate (220 m^3 per hour for 240 hours resulting from a Well Blow Out) in Summer conditions

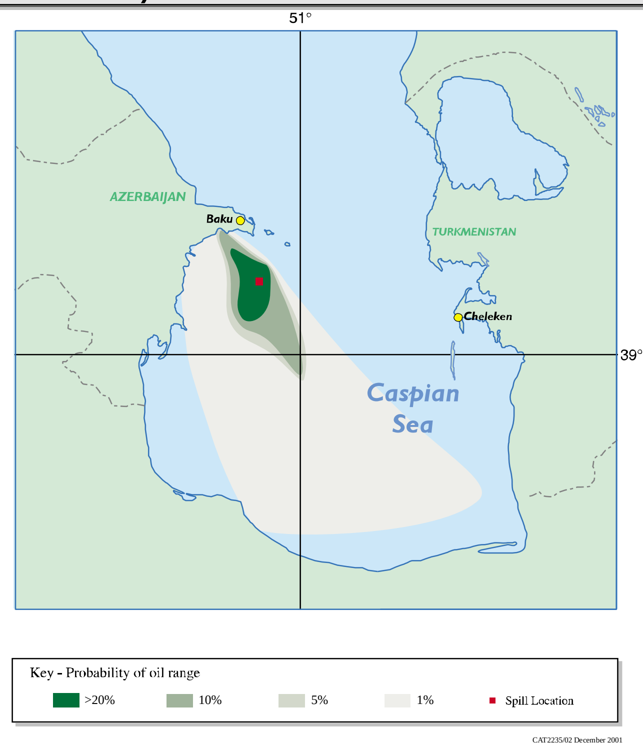


Results

The prevailing Metocean Data indicates that the oil will be transported predominantly to the south and south east of the field into the Southern Central Caspian Sea area, with the heaviest area of oiling directly to the south of the release location.

There is a 5% probability of oil heading south and beaching around the southern Caspian. There is a 1 % probability of oil reaching the Cheleken Peninsula in the east.

Figure 4b: 52,800m^3 SD Condensate (220 m^3 per hour for 240 hours resulting from a Well Blow Out) in Winter conditions

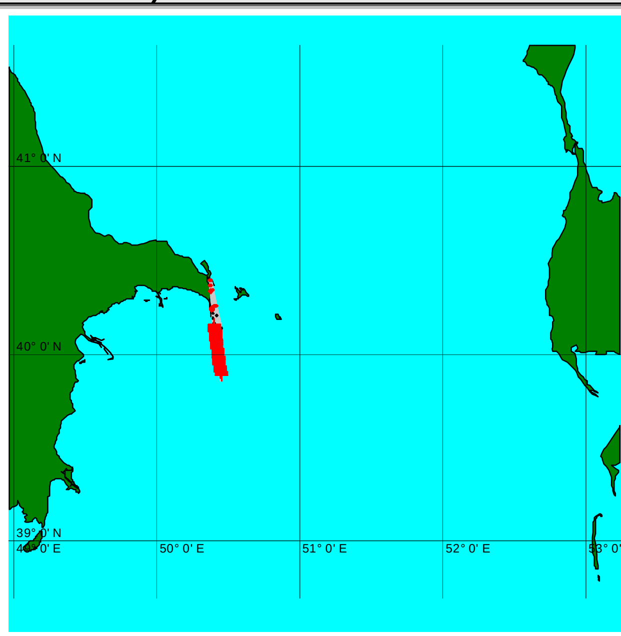


Results

The prevailing Metocean Data indicates that the oil will be transported predominantly in a SE and NW direction with the heaviest area of oiling directly to the south east of the release location.

The spread of the oil is very much localised with only a 1% probability of oil impacting the southern shoreline of the Caspian. However due to its reluctance to readily spread the oil has travelled to the NW indicating a 5% probability of impact along the shoreline just to the east of Baku and a 1% probability of impact stretching down the east coast.

Figure 4c: 52,800m^3 SD Condensate (220 m^3 per hour for 240 hours resulting from a Well Blow Out) in Worst Case conditions



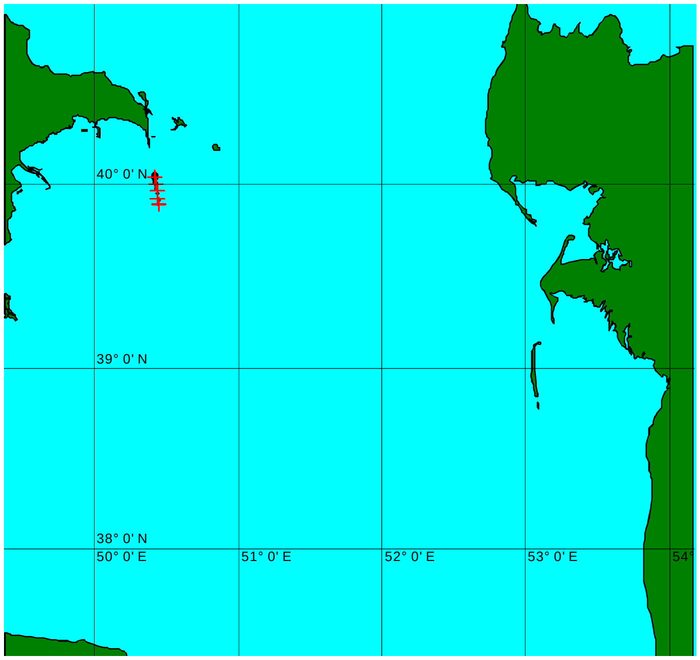
Results

Upon release the oil immediately began to evaporate and disperse into the water column accounting for a great deal of the oils volume. The oil was persistent enough to beach at the nearest landfall after 34 hrs.

Note: surface slick volume peaked at 2088 tonnes after 26 hours.

The resultant fate of the oil in terms of volumes were as follows:
32,882m^3 Evaporated
16,381m^3 Dispersed
3,536m^3 Beached

Figure 4d: 242m^3 Diesel (Instantaneous release from loss of Diesel storage tank) in Worst case conditions



Results

Upon release the diesel evaporated quickly. After 8 hours the surface slick at sea became insignificant.

The resultant fate of the oil in terms of volumes were as follows:
98m^3 Evaporated
144m^3 Dispersed.

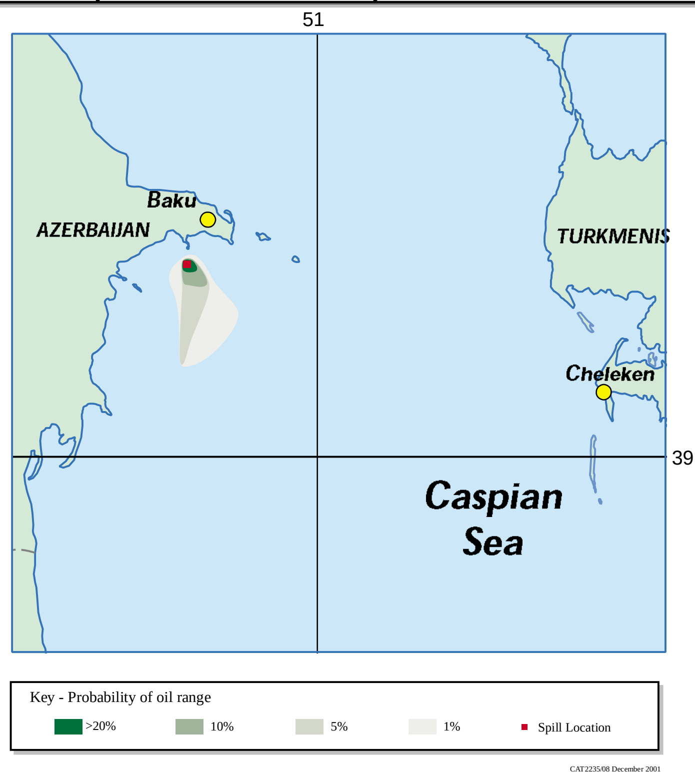
Scenario 5: Spills from SD Pipeline Nearshore

Release Location: 40^0 21”53’ N 51^0 06” 44’ E

Stochastic modelling has been carried out for a pipeline spill estimated at 6899m^3 of Azeri Condensate released over a period of 19 hours for both winter and summer conditions.

In addition single trajectory modelling was carried out for the same spill scenario but in a worst case conditions plus a slow leak scenario of 1m^3 over 720 hours.

Figure 5a: Nearshore Pipeline Leak 6899m^3 Azeri Condensate - Summer Conditions (357.72m^3 per hour for 19 hours).



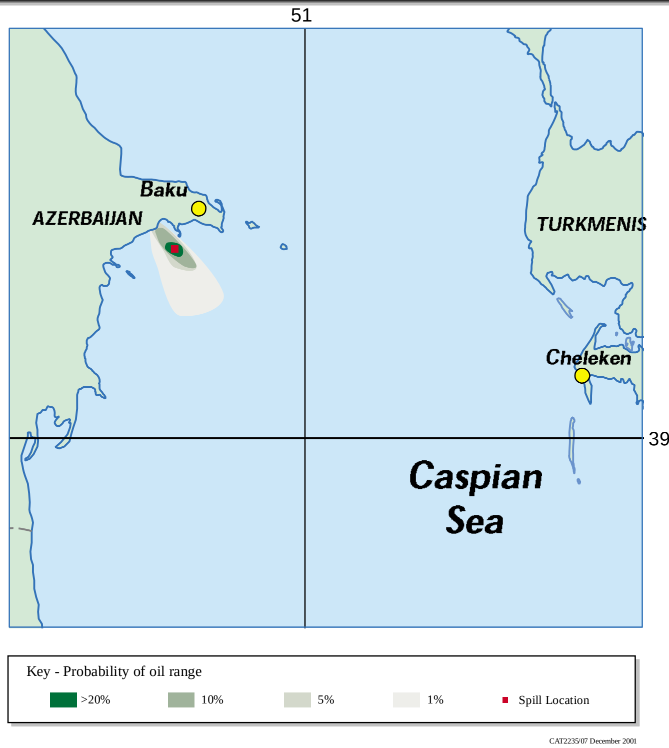
Results

The prevailing Metocean Data indicates that the oil will be transported predominantly to the south of the field into the Southern Central Caspian Sea area. The heaviest area of oiling directly to the south of the release location with no condensate travelling north of the spill location.

From the spill location the total length of the slick to the 1% probability contour is approximately 38 Nautical Miles.

The summer weather pattern and light characteristics ensure that there is a less than 1% probability of oil beaching anywhere along the Caspian shoreline.

Figure 5b: Nearshore Pipeline Leak 6899m^3 Azeri Condensate - Winter Conditions (357.72m3 per hour for 19 hours).

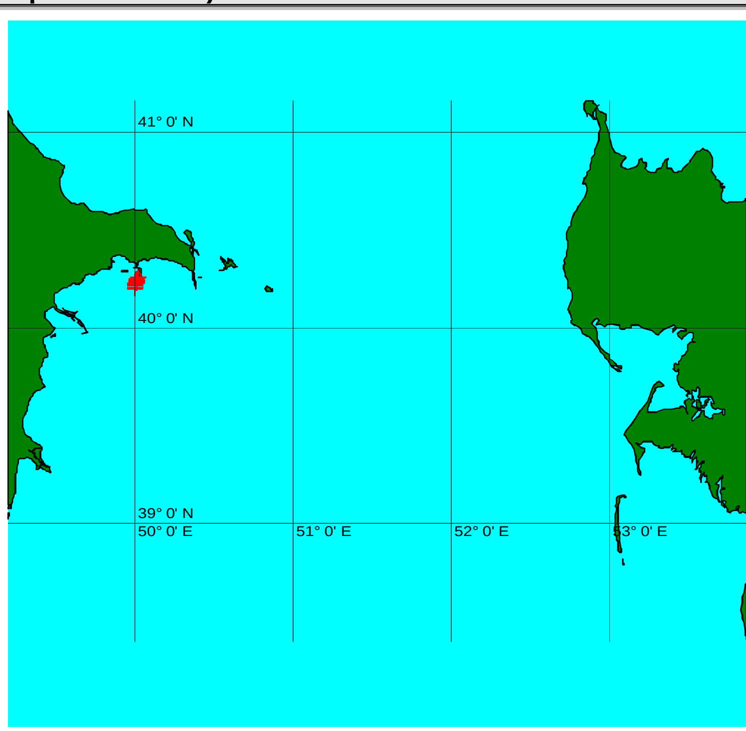


Results

The prevailing winter Metocean Data indicates that the main body of the slick will be transported along a SE and NW axis with some oil transgressing to the south.

There is a 5% probability that oil will beach to the NW of the spill source impacting to the west of Baku city. Although amounts cannot be determined it could be suggested from the size of the contour rings that quantities would be relatively small.

Figure 5c: 6899m^3 SD Condensate (357.72 m^3 per hour for 19 hours resulting from a Pipeline Failure) in Worst Case conditions



Results

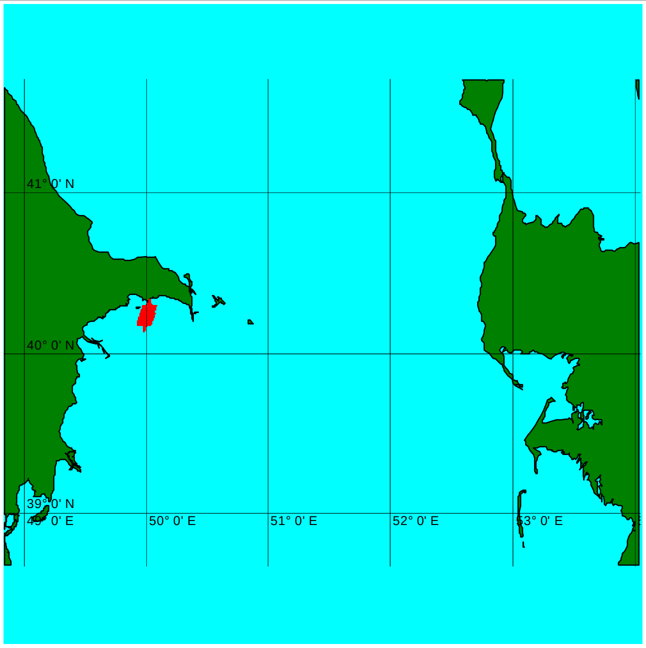
Upon release the oil began to evaporate and disperse into the water column accounting for much of the overall volume.

The oil was persistent enough to beach at the point of nearest landfall after 10 hrs.

Surface slick volume peaked at 1652m^3 after 9 hours.

The resultant fate of the oil in terms of volumes were as follows:
3,718 m^3 Evaporated
831 m^3 Dispersed
2,350 m^3 Beached

Figure 5d: 720m^3 Condensate (1 m^3 per hour for 720 hours resulting from a pipeline failure) in Worst case conditions



Results

Upon release the oil evaporated and dispersed into the water column at a steady rate reducing the risk of oil beaching. However, enough oil was released over time to become persistent and beached after 17 hours. The condensate was persistent enough to beach at the point of nearest landfall after 14 hrs.

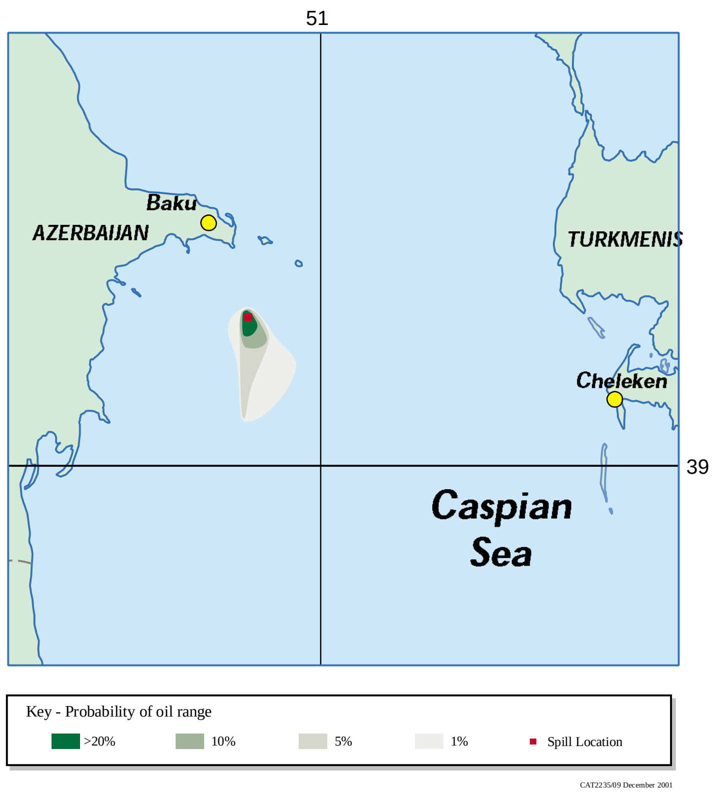
The resultant fate of the oil in terms of volumes were as follows:
454 m^3 Evaporated
252 m^3 Dispersed
13 m^3 Beached

Scenario 6: Spills from SD Pipeline Offshore Location

Release Location: 39^0 53” 94’ N 50^0 26” 45’ E

Stochastic modelling has been carried out for a pipeline spill offshore estimated at 6899m^3 of Azeri Condensate released over a period of 19 hours for both winter and summer conditions.

Figure 6a: Offshore Pipeline Leak 6899m^3 Azeri Condensate - Summer Conditions (357.72m^3 per hour for 19 hours).



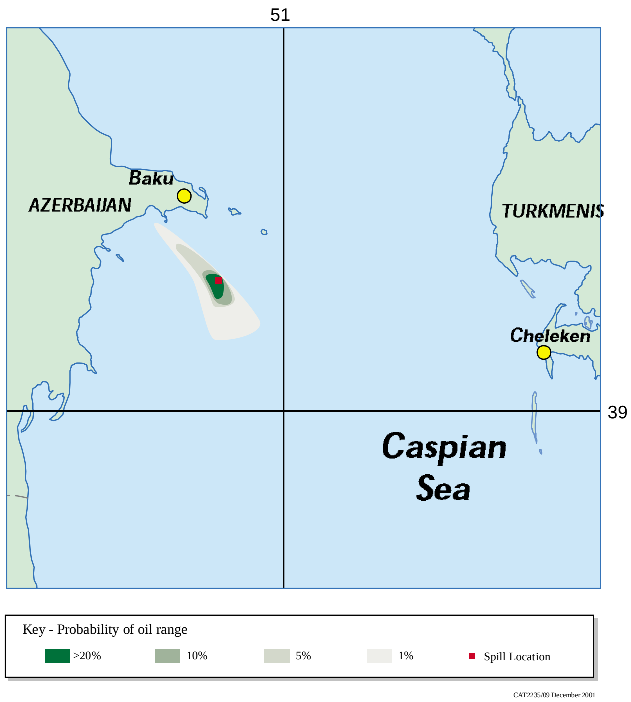
Results

The prevailing summer Metocean Data indicates that the oil will be transported predominantly to the south of the field into the Southern Central Caspian Sea area. The heaviest area of oiling directly to the south of the release location with no condensate travelling north of the spill location.

From the spill location the total length of the slick to the 1% probability contour is approximately 35 Nautical Miles.

The summer weather pattern and light characteristics ensure that there is a less than 0% probability of oil beaching anywhere along the Caspian shoreline.

Figure 6b: Offshore Pipeline Leak 6899m^3 Azeri Condensate - Winter Conditions (357.72m^3 per hour for 19 hours).



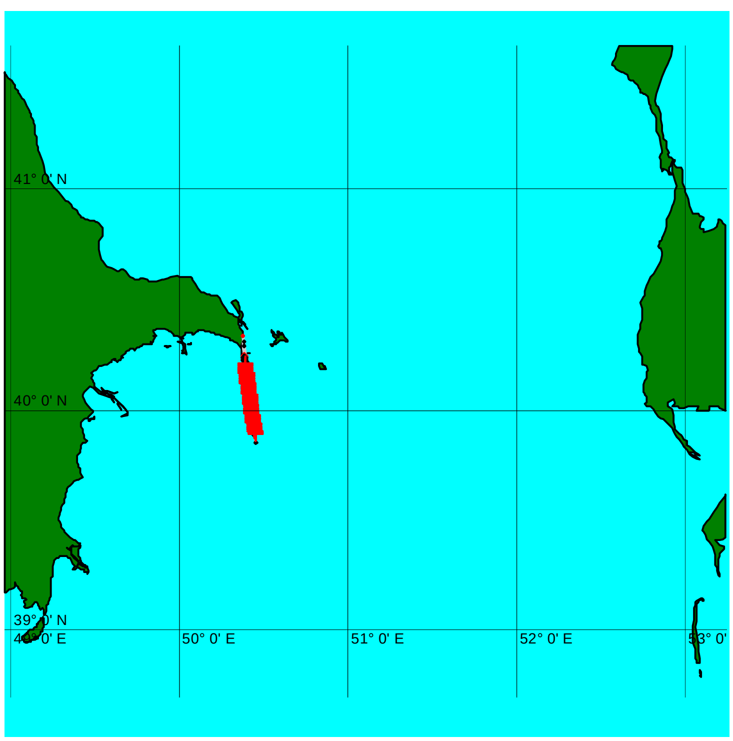
Results

The prevailing winter Metocean Data indicates that the main body of the slick will be transported along a predominantly NW but also SE axis with some oil transgressing to the south.

The slick transgressing to the NW is 33 Nautical miles in length from the spill epicentre to the 1% contour line.

The most likely area for shoreline impact is to the West of Baku city with the model calculating a less than 1% probability.

Figure 6c: 6899m^3 SD Condensate (357.72 m^3 per hour for 19 hours resulting from a Pipeline Failure) in Worst Case conditions

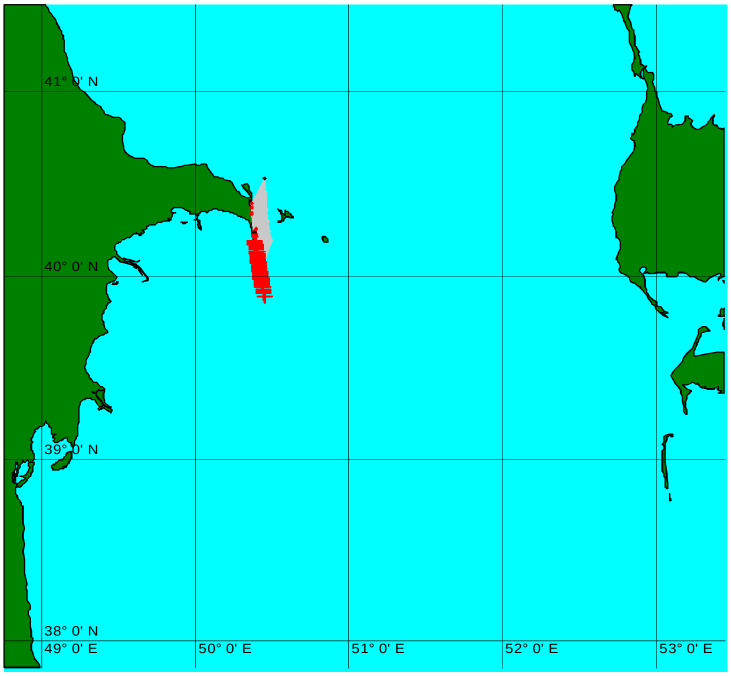


Results

Upon release the condensate began to disperse and evaporate but remained persistent enough to reach landfall after 32 hours.

The surface slick volume peaked at 2897m^3 after 20 hours.

The resultant fate of the oil in terms of volumes were as follows:
4,727 m^3 Evaporated
1,703 m^3 Dispersed
1,163 m^3 Beached

Figure 6d: 720m^3 Condensate (1 m^3 per hour for 720 hours resulting from a pipeline failure) in Worst case conditions	
	**Results** Upon release the oil evaporated and dispersed into the water column at a steady rate reducing the risk of oil beaching. However, enough oil was released over time to become persistent and beached after 38 hours. The resultant fate of the oil in terms of volumes were as follows: 480 m^3 Evaporated 230 m^3 Dispersed 8.5 m^3 Beached

4 Discussion

Oil Behaviour and OSIS limitation

One of the significant results is the difference in the condensate's area of impact, which appears greater for the summer warmer months as opposed to the cooler winter months. This would normally be contrary as condensate is usually considered a very light oil evaporating and dispersing rapidly upon release assisted further by rough seas. The explanation for this observation is a result of the condensate's characteristics and OSIS modelling constraints.

The laboratory investigations suggest that the condensate exhibits unusual weathering behaviour based around its viscosity. In warm summer temperatures the Azeri condensate rapidly loses a high proportion of light ends accounting for much of its fate but in cool winter conditions it forms a viscous mass which is highly persistent.

This change in viscosity 180mPas at 27^0c to 12,00mPas at 6^0c has a serious influence on the oils ability to readily flow across the sea surface especially under the 3% influence of the wind. More viscous oils are more resistant to wind sheer then less viscous oils.

In addition the report establishes that at 6^0c the condensate forms loose unstable emulsions, especially in rough sea conditions, resulting in an increase in the volume of the spill and subsequent persistence within the environment. This being the case then the winter runs should have shown a greater impact then the summer results as the oil is more persistent. However, due to unusual complex weathering behaviour of the condensate it has not been possible to derive the OSIS constants to reflect the measured properties over a range of temperatures therefor although the OSIS constants selected reproduce the change in viscosity with temperature it does bot allow for emulsification.

It is stated that emulsions are only likely to be formed in cold rough conditions and emulsions that do form would be very weak and therefore prone to break back to condensate and water rapidly.

In conclusion it can be stated that if weak emulsions are the bi-product of rough cold seas then the modelling results determined from this report are likely to be fairly accurate.

Scenario 4: Blow out

The largest modelled scenario representing the worst case scenario. The Stochastic results (4a and 4b) illustrate that during the summer months the oil is transported in a southerly direction with a 5% probability of the condensate impacting the southern shoreline of the Caspian Sea. Winter results show the oil being transported along a NW and SE axis with a 5% probability of oil impacting the shoreline to the west of Baku City and a 1% probability of the oil impacting the southern shoreline. The modelling clearly demonstrates the influence of the seasonal winds suggesting that winter conditions may present more likelihood of oil impacting the shoreline in a shorter space of time.

The single trajectory results (4c) provides a better indication as the fate of the oil. Despite large amounts of evaporation and dispersion into the water column there was still enough oil to impact the shoreline after 34 hours in a 20 knot wind. Beached volume for a 52, 800m^3 spill was 3,536m^3.

A diesel run (4d) of 242 m^3 was modelled in a 20 knot wind to the nearest shoreline. Evaporation and dispersion were rapid enough to record the amount of oil at sea after 8 hours as insignificant, presenting little or no risk to the receiving environment.

Scenario 5: Nearshore Pipeline Spill.

The Stochastic runs illustrated in Figures 5a and 5b again demonstrate the influence of the winds between winter and summer. During the summer the oil transported to the south with a less than 1% probability of oil impacting the shoreline, given the release amount. During the winter the oil is transported to the NW and being persistent enough to propose a 5% probability of beaching just to the west of Baku City. The remaining oil is transported in a SE direction into open water. Although the quantity of oil cannot be established we can suggest that it would be small given the size of the impacting probability ring.

The Single Trajectory results detailed in figure 5c illustrate that in a worse case scenario a spill of 6899m^3 released over 19 hours would be persistent enough to impact the shoreline after 10 hours with an approximate 2,350m^3 of oil beaching. A slow release of condensate over a long time period was modelled in figure 5d and showed that the oils light characteristics ensures that 98.2% of the condensate either evaporates or disperses into he water column allowing only 13m^3 to beach.

Scenario 6: Offshore Pipeline Spill

The Stochastic results in figures 6a and 6b indicate that although the oil moves in different directions (south during the summer and NW during the winter) the distance from the land is far enough to ensure that the 6899m^3 released over 19 hours oil is unlikely to impact the shoreline.

However, in worse case conditions (20 knot onshore wind) as illustrated in the Single Trajectory results figure 6c, the oil was persistent enough to impact the shoreline after 32 hours at its nearest point (Apsheron Peninsula) depositing 16% of the 6899m3 released. The Single Trajectory results in figure 6d also illustrate that a slow release of oil condensate from the pipeline over 720 hours will result in 8.5m^3 of 720m^3 of oil will impact the shoreline after 38 hours at sea.

5 Conclusion

The modelling results clearly show the seasonal influence of the winds with the winter winds moving the condensate in a NW, SE axis and the summer winds moving the condensate in a southerly direction. The condensate appears persistent enough to impact the shoreline either for very large spill amounts under prevailing weather conditions or under worse case weather conditions from both offshore and nearshore locations.

From all the Stochastic scenarios the highest probability of oil impacting the shoreline under winter conditions was 5% beaching to the west of Baku City and under summer conditions 5% along a small stretch of the southern Caspian shoreline.

Single trajectory results indicate that oil released either in large quantities over a short space or small quantities released over a long period of time are likely to beach (between 10 – 38 hours), but only in small amounts as the most of the condensate evaporates or disperses into the water column.

There is some question as the validity of the winter results because OSIS does not mimic the condensate's ability to form unstable emulsions therefore this should be taken into account when determining how much oil may beach.

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Sangachal seabed mapping survey

ERT 1610 – Draft 4

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Contents

1 Introduction

The potential impact of existing and future operations at the Sangachal terminal on the presence of seagrass and red algae in the nearshore waters of Sangachal has raised concerns from a number stakeholders including the former Ministry of Environment and Natural Resources (MENR) and several NGO's. In order to address these concerns a study was carried out to map the distribution of seagrass, macroalgae and sediment types of the nearshore waters of Sangachal. Samples of seagrass and algae were collected for taxonomic identification and information provided on their general biology. The objectives of the survey were to:

- Identify the types of sub-littoral flora (marine plants) present in Sangachal Bay;
- Assess the abundance and distribution of the sub-littoral flora;
- Improve the understanding of the ecological importance of the sub-littoral flora;
- Provide information for the ACG Phase 1 Full Field Development ESIA to gain an understanding of the role of the sub-littoral flora in the maintenance of physical habitats and biological communities, and issues such as vulnerability and levels of contamination.

The field survey of the nearshore waters was completed between the 13 June 2001 and 21 June 2001. An Acoustic Ground Discrimination System (AGDS) was used to map seabed features. Simultaneous acquisition of ground truthing information using drop-down video and grab samples facilitated the mapping process. SeaMap, a research group affiliated with the Newcastle University in the UK, were responsible for the mapping and data interpretation. Samples of seagrass and algae were sent to Dr. Christine A. Maggs at Queen's University Belfast for identification.

2 Survey and data interpretation methods

The acoustic survey of the sea floor extended out a distance of approximately 4km. The tracks were variably spaced, but rarely greater than 200m apart. A ground-truthing sampling program using videography and grab samples was also undertaken over the area so that the AGDS data could be interpreted in terms of habitats and sediment types. In addition to the ground truth data collected during the 2001 survey, sediment data (PSA analysis) collected on previous surveys were also available for interpretation.

2.1 Data acquisition

Acoustic ground discrimination systems (AGDS) are based on single beam echo sounders and, apart from determining depth, are designed to detect different substrata by their acoustic reflectance properties. Hard surfaces produce strong echoes, whilst soft surfaces result in a weak signal. Additionally, rough surfaces will produce an echo that decays slowly, whilst flat surfaces result in a rapid decay of the signal. SeaMap use the RoxAnn™ AGDS together with an echo sounder operating at 200kHz. The system is portable and the transponder is strapped to the side of the survey vessel on the end of a steel pole. The RoxAnn data is logged, together with position from a global positioning system (GPS). RoxAnn uses analogue signal processing hardware to select two elements from the echo that relate to roughness/smoothness and hardness/softness. The strength of the decaying echo is termed Echo 1 (E1) and is taken to be a measure of roughness of the ground whilst strength of the first multiple echo is termed Echo 2 (E2) and is a measure of hardness. The raw data can be quite variable in quality due to environmental factors and the data is checked and edited prior to data analysis.

2.2 Data processing

After quality control procedures, there are two main stages in AGDS data processing:

1. Interpolation: The AGDS data are point data saved at set time intervals along the survey vessel's tracks. Track point data, however, are both problematic to work with and produce maps that are difficult to appreciate and interpret by eye. The point data need to be transformed into a continuous digital image through a mathematical process termed interpolation. Interpolation works well when the track spacing is close and the ground relatively homogeneous (as was the case in Sangachal Bay);
2. Classification: The images of depth, E1 and E2 need to be processed together to derive classes attributable to specific sediments or biological communities. This can involve finding clusters of values within the data to derive acoustic classes and then attributing these to sediment type or community type (a process termed 'unsupervised classification'). Alternatively the ground truth data can be used to derive acoustic signatures typical of the main ground types which can then be used to interpret the whole image (a process termed 'supervised classification'). Both types of classification were employed in this survey.

2.3 Preliminary data treatment and quality control

The purpose of this stage was to ensure that the data were of sufficient quality to allow further analysis through data exploration and the removal of dubious data. Bad data is often typified by zero depths and depths greater than the maximum known depth in the survey area. These were removed. The data were then imported into *MapInfo* and displayed to show depth against time in non-earth co-ordinates to search for spurious jumps in depth records. These records were also removed. E1 and E2 were plotted against each other to check for outliers. Lastly the track data were plotted showing the three variables separately (E1, E2 and depth) to visually check for obvious values that did not conform to surrounding data. If it seemed appropriate, these data were also removed. In all about 4.5% of the data were removed from the data set. This is an acceptable percentage and many of the data that were removed came from a small number of tracks that were close inshore. The majority of the tracks required no data to be removed.

A video record was made at each sampling station, and grab samples were collected at a number of ground truthing stations to assess the main habitat/biota types and sediment types. BGS (British Geological Survey) and MNCR (Marine Nature Conservation Review) based classification schemes were used to characterise the video footage and make a qualitative assessment of the sediment types.

Representative frame grabs from the videotapes were taken to aid analysis and provide a reference to the commonly encountered habitats. The video footage required some manipulation in order to create successful ground truth points for image processing. Since the sea grass and algae could exist on a range of substrate types, it is clear that biotope categories and sediment types were not mutually exclusive and, when processed together, lead to a confused classification of the images. For this reason two ground truth data sets were created; one concentrated on the biotopes and the other on sediment types.

The biotope ground truth records were categorised into four classes (sea grass; algae; sea grass and algae; non-macro flora) whilst the sediments were categorised into 15 classes (see Figure 3.2).

A more complete description of the survey methodology is provided by Chivers *et al* (1990).

2.4 Seagrass and macroalgae identification

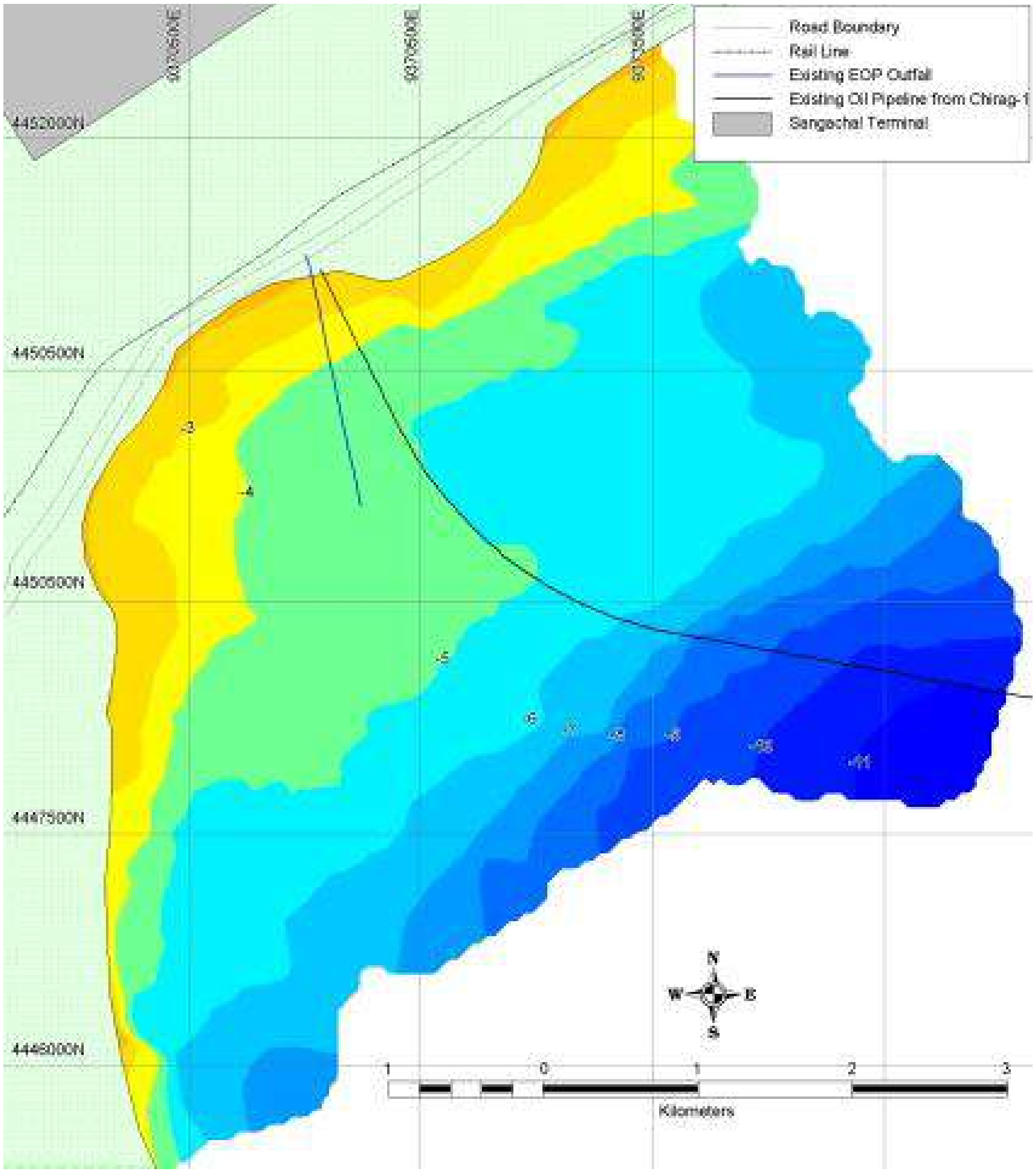
Seagrass and macroalgae were sorted from grab samples taken at 16 stations and either preserved in formalin-seawater (algae and seagrass) or transported live to Belfast (seagrass only). Samples were sorted under a dissecting microscope. All macroalgae samples were made into stained slide preparations for examination with a compound microscope. Identifications were made by reference to appropriate literature. Molecular taxonomy was used to confirm the identity of seagrass as *Zostera noltii* (dwarf seagrass). To achieve this, DNA was extracted from 12 seagrass samples and part of the chloroplast genome was amplified using the polymerase chain reaction with universal plant chloroplast primers and cut into species-specific fragments using restriction enzymes.

3 Seabed biotopes in Sangachal nearshore area

3.1 Bathymetry

Sangachal Bay is a shallow bay that gradually slopes away from the shore reaching a depth of 10 m approximately 3 km offshore. In the centre of the bay on the western side of the existing sub sea pipeline there is an accumulation of soft sediment. The recent acoustic survey of Sangachal Bay has provided the bathymetry chart shown in Figure 3.1.

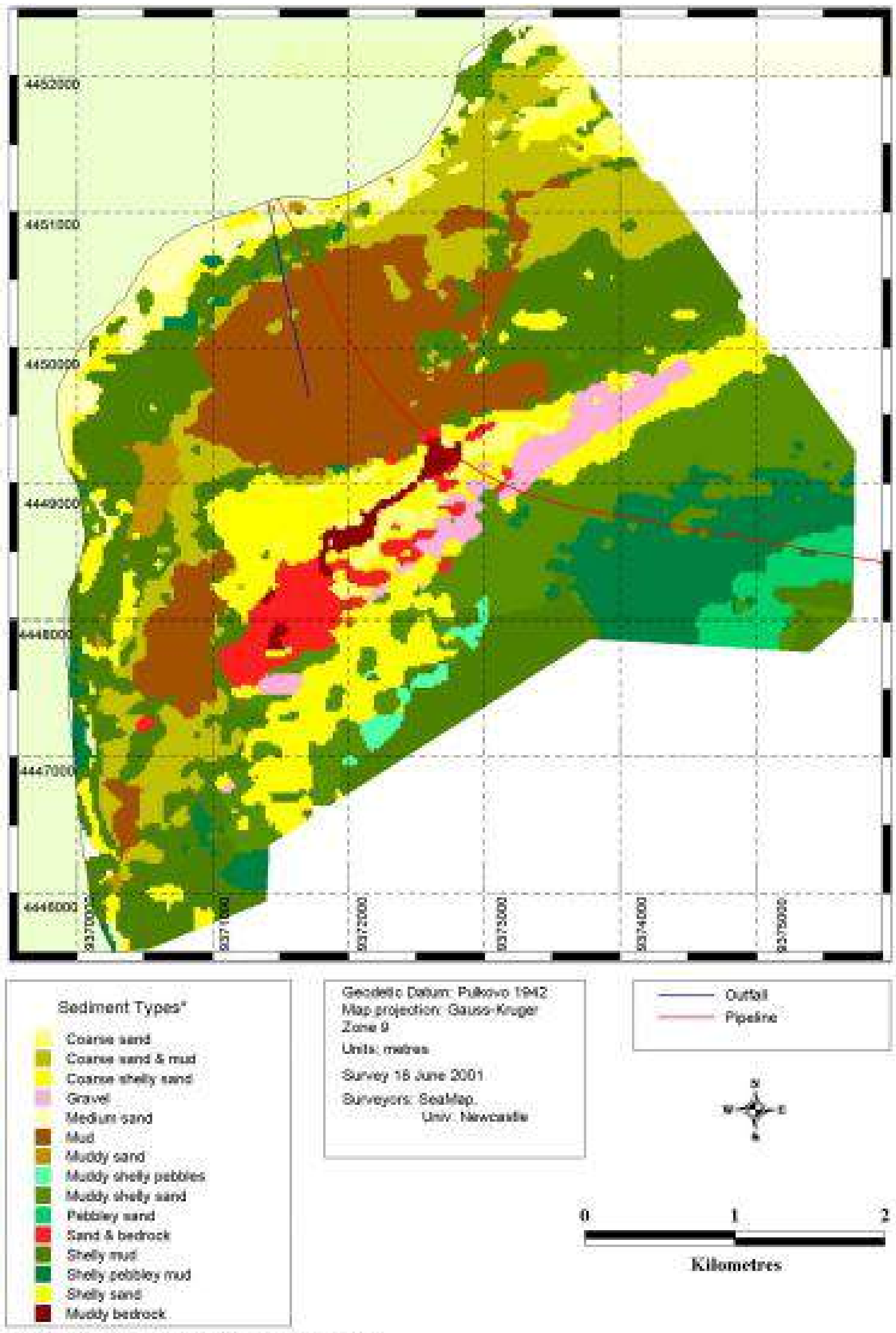
Figure 3.1 Bathymetry of Sangachal Bay (depths in metres)



3.2 Seabed sediments

The nearshore sediments of Sangachal display a patchy mosaic of different sediment types ranging from hard concretions to very soft and mobile silty muds (Figure 3.2). The most common sediment type is a poorly sorted mixture of silt, clay, sand and shell fragments. This type of sediment is found close to the shoreline, around the perimeter of the whole of the bay, and in the deeper water areas. The central area in the immediate vicinity of the terminal outfall is composed of very mobile soft silt and mud. In deeper water (greater than 5m) rock outcrops and hard concretions are present as well as coarse sands and gravel.

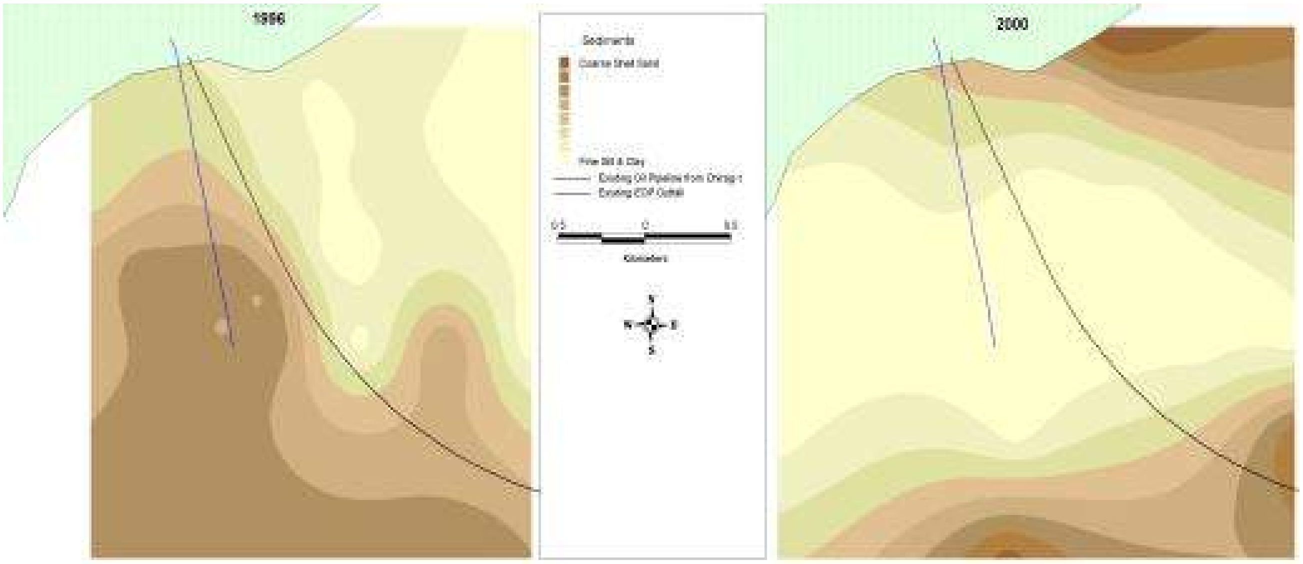
Figure 3.2 Seabed sediment types



* based on BGS and MNCR clasification scheme

Sediment types and distributions identified in the 2001 survey are similar to those found in the 2000 survey. A comparison of mean sediment particle size between 1996 and 2000 indicated a change in sediment distribution during this time (Figure 3.3). In 2000, a band of fine sediments existed in the centre of the bay, with coarser, poorly sorted sediments close to the shore and in deeper waters to the south. In contrast to this, in 1996, the finest sediments were located closer to the shore with particle size increasing with distance from the shore.

Figure 3.3 Comparison of sediment mean particle diameter between 1996 and 2000



In both surveys, however, the same relationships were observed between particle size, carbonate, silt/clay, and organic content. It is thus reasonable to conclude that the sediments of the shallow Sangachal area are highly mobile, and may regularly be re-distributed by wave action.

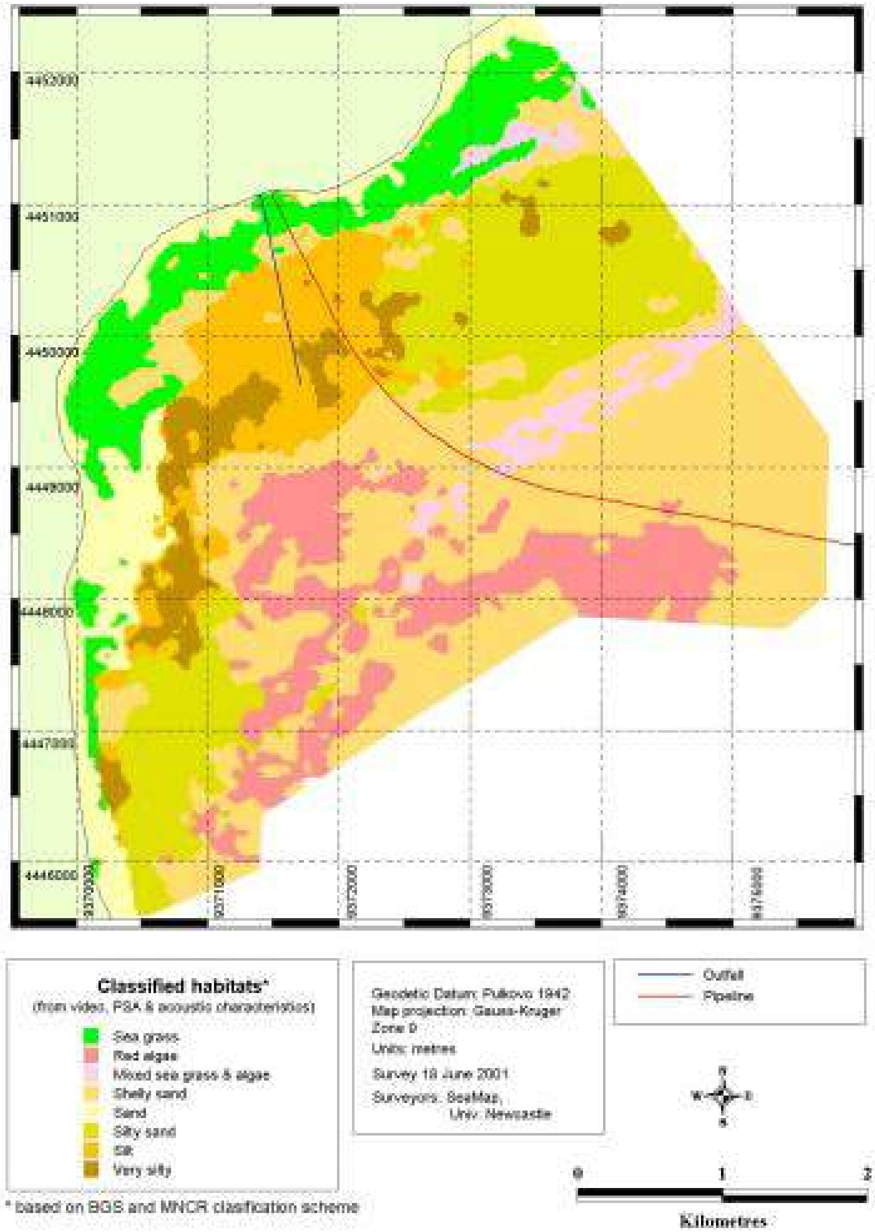
3.3 Marine flora

3.3.1 Seagrass

Presence and distribution

A single species of seagrass (*Zostera noltii*) was recorded during the recent seabed mapping survey. *Z. noltii* was found growing on a number of different sediment types, that included shelly mud, coarse shelly sand as well as gravel (Figure 3.4). Dense beds of seagrass were present close to the shoreline in water depths of less than 4 metres. A narrow band of seagrass was also found in deeper water (6-7m) nearly 2 km from the shoreline, in an area of gravel. Seagrass was not present in areas of fine-grained soft muds and silts or growing on rock outcrops. The results from the survey suggest that at Sangachal neither type of substratum allows the development of *Z. noltii* root networks.

Figure 3.4 Distribution of seagrass and red algae



General biological and ecological information

Seagrass is an angiosperm (flowering plant) that requires a particular light regime to photosynthesise and grow. The majority of growth takes place in the spring and summer, and established patches can enlarge at 0.5 m per year (C. Maggs pers com.). *Zostera* species form continuous mats, of varying size, which extend marginally by growth of stolons. During periods of low light intensity in the autumn the leaves are shed (Brown, 1990). They are also removed by grazing or wave action during the winter. *Z. noltii* over- winters as a rhizome and shoot fragments, which enable recruitment and re-growth in the spring (Marta et al 1996). Seeds probably do not play a major role in the life history of *Z. noltii*, although they could permit survival during extremely adverse periods (C. Maggs pers com.).

Seagrass plays a diverse range of roles in the maintenance of physical habitats and also biological communities. These include:

- The roots of seagrass bind the sediment, promoting sediment accumulation and stabilisation. This provides protection against wave disturbance which can aid natural coastal defence (Davison & Hughes, 1998; Orth, 1992);
- Leaves of seagrass slow water movement under the canopy and encourage the settlement of fine sediments, detritus and larvae (Orth, 1992).
- Seagrass supports numerous species of algae growing on the leaves as well as diverse benthic fauna in the sediment (Davison & Hughes, 1998; Connor *et al.,*1997b);
- Seagrass provides shelter and refuge from predation for fish and invertebrates.
- Oxygen penetration into the sediment is increased by the transport of oxygen to the roots and rhizomes of seagrass;
- Intertidal seagrass beds in Europe are an important food source for wildfowl. It is possible that submerged beds in the Caspian may also be an important grazing area for migratory and overwintering birds (Burton, 1961;Percival & Evans, 1997);
- Dead seagrass provides a source of organic detritus which is used as a food source for micro-organisms such as bacteria and protozoa (Davison & Hughes, 1998).

Overall, sea grass beds are characterised by high productivity and biodiversity and are considered to be of great ecological and economic importance (Davison & Hughes, 1998; Asmus & Asmus 2000b). The relative importance of the seagrass in the nearshore waters of Sangachal is discussed in Section 3.3.3.

3.3.2 Macroalgae

Presence and distribution

A total of six species of red algae, five species of green algae and one species of yellow-green algae were recorded during the 2001 survey (Table 3.1). The number of algal species recorded was low in comparison to other brackish-water areas such as the northern Baltic, where over 40 species of macroalgae have been recorded (Middelboe *et al.* 1997). The largest red algae in the samples collected was an endemic species *Osmundea caspica*, and the majority of the other red algae were growing epiphytically on it. Species of the genera *Ceramium* and *Polysiphonia* were the most commonly-occurring red algae.

Table 3.1 Algae types identified during the 2001 survey

Red Algae – Rhodophyta:
Callithamnion sp. *cf. corymbosum* *Ceramium sp. cf. tenuicorne* *Osmundea caspica* *Polysiphonia denudata* *Polysiphonia stricta* *Acrochaetium/Audouinella* sp
Green Algae - Chlorophyta:
Chaetomorpha sp. *Cladophora* sp. *Enteromorpha* sp. *Rhizoclonium* sp. *Spongomorpha* sp
Yellow-green Algae - Xanthophyta:
Vaucheria sp

Macroalgae were present on a range of substrates from coarse sand to rock outcrops as well as on living mussels and barnacles and dead shells. Samples of macroalgae were not retrieved in areas composed of fine-grained soft muds and silts. Only a limited number of samples of macroalgae were retrieved from the areas of rock outcrops. This is probably associated with the limitations of the sampling technique rather than the actual distribution of macroalgae. In areas of rock outcrops the grab sampler had a low success rate of retrieving macroalgae samples. Macroalgae (unlike seagrass) was not found in abundance in shallow water areas, but was primarily present in water depths between 4-11m (Figure 3.1). This pattern of distribution is probably strongly influenced by the presence/absence of suitable substrata rather than depth. The types of macroalgae found require solid substrata for attachment, which were largely absent in the shallow water areas. The most distinctive zones of red algae were located more than 1 km from shore, in regions defined as shelly mud, although a limited area of mixed seagrass and macro-algae was identified close to shore in the north of the survey area (Figure 3.1).

General biological/ecological information

Either light penetration or substratum availability may influence the lower depth limits of the red algae. The upper depth limit of approximately 5m is most likely determined by the substratum availability, as rock outcrops for red algae to fix themselves to were not found in the shallow water areas below 5m. The maximum depth at which red algae were recorded in the present survey was 10-11 m. During the seabed mapping survey high levels of water turbidity were experienced across the whole survey area. As previously mentioned the quality and usefulness of the video footage was compromised by high levels of water turbidity. Therefore it could be assumed that macroalgae are light-limited at depth.

All the red algae recorded were of a filamentous morphology and were predominantly members of the Ceramiales. This is probably due to the sedimentary substratum and high natural turbidity of the water, which would select against morphologies (e.g. foliose, crustose) which are more likely to accumulate silt and hinder photosynthesis. The red algae observed fall into two life history categories:

- Annual or ephemeral species, with one to several life histories being completed during the spring, summer and autumn. These include *Callithamnion* sp., *Ceramium* cf. *tenuicorne*, *Polysiphonia denudata* and *Acrochaetium* sp.;
- Perennial species include *Osmundea caspica* and *Polysiphonia stricta*, perennating as mature thalli; either as entire thalli or holdfasts. Both grow fastest in the spring, occur as large thalli in the summer, and overwinter as perennating bases. The basal parts of both species contain large amounts of storage material, and they can survive reduced light availability or even total darkness for several months.

The perennial nature of *Osmundea* is probably important in determining the structure and persistence of the macro-algal community, since (as noted above) many of the other species were observed to be growing on *Osmundea*.

3.3.3 Summary of seagrass and macroalgae importance

Results from a year long fish monitoring program of the nearshore waters in Sangachal (carried out between July 2000 and June 2001) have shown that shallow water areas support seasonal juvenile fish populations of roach (vobla and kutum), mullet, sprat and kilka. The nearshore region also supports permanent populations of sandsmelt and several species of goby. Several of the fish sampling sites were adjacent to the most extensive areas of seagrass coverage (Figure 3.5). Substantial numbers of small fish (typically 5-10 cm in length) are present in the shallow margins at most times of the year, indicating that the Sangachal area is used as a nursery and foraging site for several species. No information is available on the diurnal behaviour patterns of these local populations, but it is possible that they occasionally or regularly use the adjacent seagrass beds as refuge. If this is the case, then it is also possible that the abundant presence of small fish in shallow waters is directly dependent on the close availability of such a refuge.

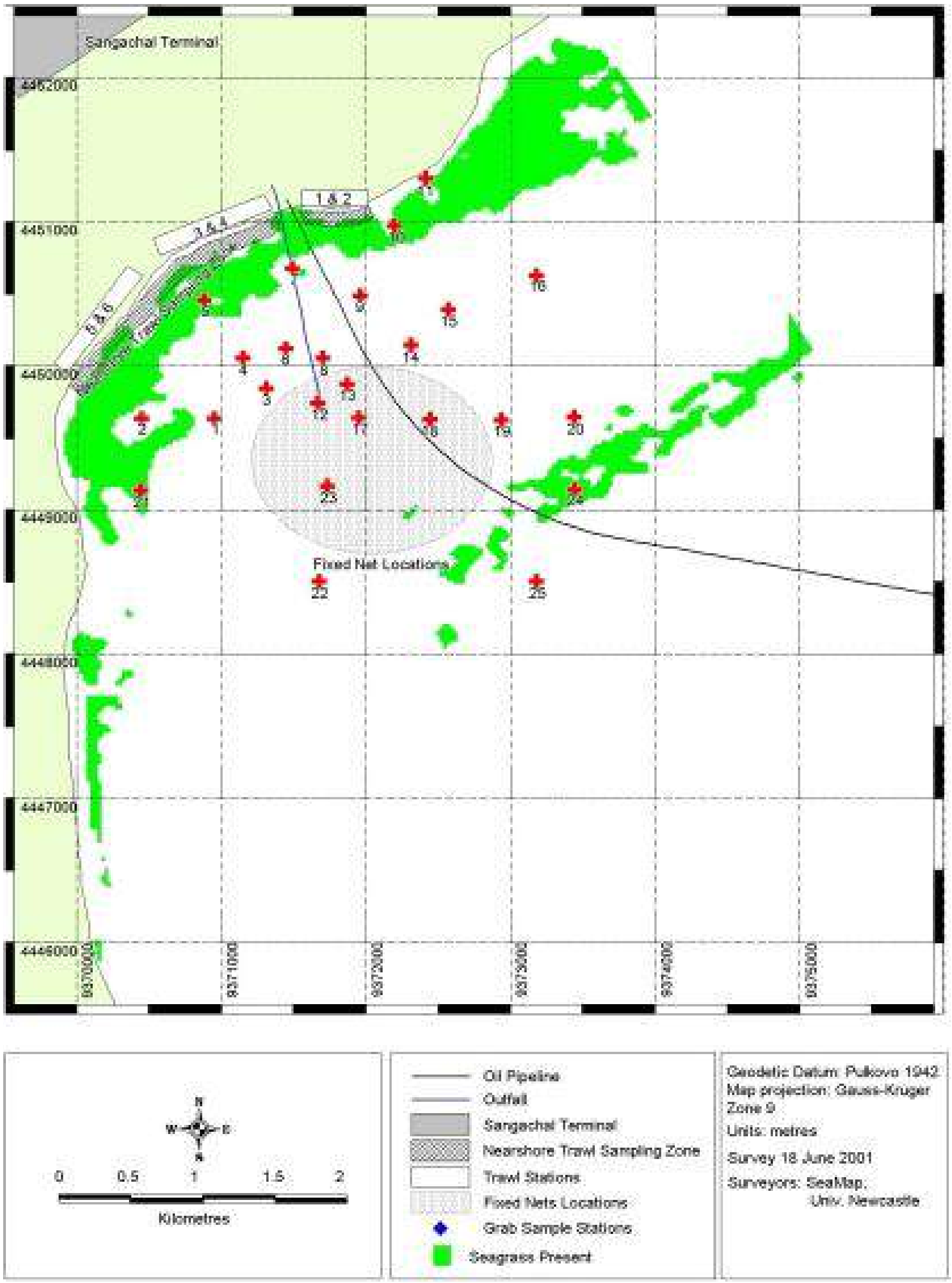
A seabed survey of the Sangachal area was conducted in 2000. Seagrass was observed in grab samples at six stations (10, 13, 15, 19, 21, 22 – Figure 3.5), and five stations coincide with the nearshore seagrass beds delineated in the current seagrass mapping survey (5, 10, 11, 21 and 24). Red algae were not observed in any of the 2000 survey samples; however, this could be a combination of the distribution of station locations, and of the difficulty of obtaining good grab samples from some of the hard substrata with which the red algae are associated. The observations below should be considered as tentative, since:

a) the presence of seagrass in grab samples in 2000 is not firm evidence that the sample was taken within the limits of a seagrass bed (substantial amounts of fresh detached seagrass fronds are regularly encountered in the area);
b) the coincidence of location of 2000 station locations and 2001 seagrass bed location does not mean that seagrass present in 2001 was present at the same locations one year earlier.

The macrobenthic species present in the four 2000 survey stations which coincide with the mapped distribution of seagrass are listed in Table 3.2, which also indicates their relative abundance. As is generally the case for the whole Sangachal bay area, the macrobenthos most closely associated with the seagrass beds is dominated by bivalves (*Abra, Mytilaster, Cerastoderma*). These samples are also dominated by introduced (alien) species (*Nereis, Mytilaster, Abra, Rhithropanopeus, Balanus*) which appear to have replaced the native communities. Apart from *Cerastoderma*, native invertebrates are poorly represented by the occasional presence of one or two oligochaete and polychaete species. The dominant components at the stations summarised in Table 3.2 are dominant across the whole Sangachal area, and it does not therefore appear that the seagrass beds are likely to support entirely distinctive macrobenthic communities. It is also worth noting that many taxa characteristic of native Caspian fauna (especially amphipods and gastropods) were rare or absent in Sangachal samples. However, it is also worth noting that three taxa of native amphipods were present at station 11, and that a range of native fauna (sabellid and ampharetid polychaetes, cumaceans and a gastropod were present at station 5 – both of these stations are close to shore, and presumably close to the inshore limit of the seagrass beds, and it is possible that the presence of seagrass at these locations has assisted in the maintenance of local populations of native invertebrates.

The sampling methods used in 2000 will not have been effective for some mobile epibenthic species, or for invertebrates which swim within the seagrass canopy, so it is not possible, from the available data, to provide a definitive characterisation of the communities associated with the seagrass beds. However, the available data indicate that the dominant species are either filter-feeders or omnivores which are also found in abundance in the absence of seagrass, and this would suggest that the macrobenthic community would not be highly sensitive to damage to the seagrass beds.

Figure 3.5 Sampling stations (2000 seabed environmental survey, 2000/2001 fish sampling locations) and distribution of seagrass from 2001 seabed mapping survey



The seagrass beds in the nearshore waters of Sangachal are relatively limited in their spatial coverage, as they are only primarily found occupying a narrow strip of the seabed close to the shoreline. Their role in stabilising and maintaining the environment could be quite significant, but it is currently difficult to establish with a high degree of confidence

Table 3.2 Macrobenthic taxa present (and relative abundance) at Sangachal 2000 survey stations located within areas of seagrass distribution mapped in 2001

Species	Stations				
	11	24	10	5	21
Gammaridae indet.	5				
Niphargoides sp.	3				
Niphargoides carausui	5				
Turricaspia spp				3	
Ampharetidae sp				5	
Manayunkia caspica				5	
Pterocuma pectinata				2	
Nereis diversicolor	5	5	5	5	
Hypania invalida		2	5	5	
Hypania kowalewski				5	5
Balanus improvisus		5	4	3	
Rhithropanopeus		5	2	5	
Mytilaster lineatus	5	5	5		
Tubificidae spp			3		
Cerastoderma lamarcki	3	5	5	5	
Tubificidae sp BPSD38#30	5	5		5	3
Abra ovata	5	5	5	5	2
Isochaetides michaelseni	3	4			

Key to numbering:

2 = 1-10 individuals per m^2
3 = 11-100 individuals per m^2
4= 101-1000 individuals per m^2
5 = 1001-10,000 individuals per m^2

4 Seagrass and algae sensitivity to Phase 1 construction activities

Although current site specific information on the role and ecological importance of seagrass is limited, a preliminary assessment is required of the sensitivity of the plant communities themselves to the construction of pipelines associated with the Phase 1 project and later phases of the Full Field Development project. In order to address the issue of seagrass and algae sensitivity, a number of issues need to be considered:

- Changes to the existing features of the nearshore Sangachal environment need to be identified;
- The potential for, and rates of, recovery of the affected areas;
- The importance of the seagrass and red algae communities or biotopes, in terms of their role in providing a habitat for other species and maintaining biodiversity.

Activities associated with pipeline construction work in the nearshore waters of Sangachal include:

- Trenching/dredging;
- Construction of shoreline jetties;
- Increased vessel traffic.

These activities have the potential to affect the environment in a number of ways:

- Direct temporary losses and permanent alterations in the seabed substrata;
- Increased water turbidity and higher levels of suspended sediment through the resuspension of mobile sediments;
- Smothering caused by the settlement of suspended material;
- Long term changes to sediment movement and associated alterations to seabed substrata;
- Changes to land drainage patterns may also occur as a result of onshore civil engineering work.

Of primary concern to the health and stability of the seagrass and macroalgae populations are changes in the sediment type distribution and increases in turbidity and suspended sediment.

4.1 Seagrass sensitivity

In Western Europe and North America, there has been a great deal of research focused on *Zostera marina* and disturbance arising from activities such as pipeline laying. It has been found that rhizomes of Zostera elongate at variable rates depending on the environmental conditions. Growth rates with a mean of 0.6 m per annum have been recorded (Hemminga and Duarte, 2000). New beds and new individuals that initially suffer high mortality and can take 5 years to establish and stabilise (C. Maggs pers com.). Destruction of even small areas of large seagrass beds by pipelaying activities could result could result in long-term consequences due to the fragmentation of seagrass beds. As mentioned previously small patches of seagrass experience higher rates of mortality than extensive beds. Changes to the distribution of seagrass may also affect sediment movement and cause further losses of seagrass as the sediment types change to those that do not support seagrass growth.

The majority of growth takes place in the spring and summer, and established patches can enlarge at a rate of 0.5 m per year (C. Maggs pers com.). Thus a trench only 3 metres wide would be expected to take at least 3 years to fill in, growing from both sides. The majority of the re-growth will be through vegetative growth as seeds probably do not play a major role in the life history of *Z. noltii*, although they could permit survival during extremely adverse periods (C. Maggs pers com.). Severe damage caused by Zostera dieback in the 1930s has still not been overcome in the British Isles. In the US particularly, mitigation by transplantation has been attempted, with mixed results (Davison, 1997; Hemminga & Duarte, 2000).

4.2 Macroalgae sensitivity

Losses of macroalgae associated with construction activities through direct substrata alterations and increased turbidity are likely to affect nearshore population dynamics. However, the implications to macroalgae are not as significant in comparison to seagrass as:

- Macroalgae density were found to be lower than that of seagrass;
- Macroalgae are less sensitive to fragmentation in comparison to seagrass;
- Macroalgae plays a less significant role in sediment stabilisation and movement when compared to seagrass.

The sensitivity of macroalgae to temporarily increased water turbidity depends on the factor that sets the lower depth limits (either light penetration or substratum availability). Assuming that lower depths limits are dependent on light penetration then the effects of increased water turbidity would depend on the macroalgae life history:

- Annual or ephemeral species will more readily adapt to periods of increased turbidity than perennial species, as one to several life histories are completed each season. During periods of increased turbidity the distribution of these species will be restricted to shallow water areas with suitable substrata. Rapid reproduction rates would enable them to recolonise deep areas as water turbidity decreased. Increased sedimentation could reduce recruitment as red algae spores cannot settle on silt;
- Perennial species are capable of surviving longer periods of increased turbidity as they contain larger amounts of storage material in comparison to annual or ephemeral species. Short term increases in sedimentation rates would not impact the algae severely, but long term changes could prevent recruitment if surfaces were entirely sediment covered.

5 Summary

The 2001 seabed mapping survey was successful in establishing the current distribution of sediment types, seagrass and macroalgae in Sangachal Bay. Sampling success in areas of hard substrata such as rock outcrops was limited and as a result these areas are underrepresented. This may account for the low number of macroalgae species recorded.

Zostera noltii was the only species of seagrass found in the bay. *Z. noltii* was found inhabiting relatively coarse sediment types with a varying sand and mud content. The densest areas of seagrass were found within a few tens of metres from the shoreline almost across the entire perimeter of the bay in water depths of less than 4 metres. Several species of macroalgae were identified, including six species of red algae. The majority of the macroalgae were found growing on hard substrata such as areas of rock outcrops, mussels, barnacles and dead shell fragments, in water depths of between 5-11 metres.

Recent available scientific literature regarding the distribution of seagrass along the coast of Azerbaijan is limited. Surveys completed in the 1950's and 1960's found seagrass (*Zostera noltii*) to be abundant in the nearshore water between Sangachal and Kizil Agach Bay (E. B. Zaberzinskaya 1968a, 1968b, M. S. Kireeva 1957). Seagrass was found on a mixture of sandy sediment types, within relatively shallow water of less than 4.5 metres. Numerous species of macroalgae were also recorded during these surveys. The highest abundance of macroalgae was found in the vicinity of the Apsheron peninsula growing in areas of rocky outcrops. Dead seagrass and red algae is commonly found washed up across large parts of the shore south of Sangachal especially between Sangachal and Banka, suggesting that seagrass is common in the nearshore waters (W. Boulton pers com 2000).

The current survey provides valuable information on the sediment types and spatial distribution of the seagrass and macroalgae in the nearshore waters of Sangachal. However, additional information is required to enable the potential environment changes caused by pipelaying activities to be put into context of natural variations in seagrass and macroalgae population dynamics.

Options available to address these existing data gaps include:

- The collection of baseline photon irradiance data prior to and during pipeline installation work. This will provide results on the existing levels of turbidity and the actual affects of construction activities. In-situ measurements could be collected using fixed moorings;
- Use of sediment traps that are retrieved on a regular basis prior to and during pipeline installation work. This will provide information on sediment mobility and rates of sediment deposition;
- Repeat surveys using similar methodologies with improved sampling techniques in areas of hard substrata. Repeat surveys will provide information on overall changes

in sediment type distribution, seagrass and red algae coverage and density on an annual or seasonal basis;

- Targeted seabed sampling of the benthic communities in areas where seagrass is present. This information could be used to provide detailed information on the biological communities that live in areas covered by seagrass.

Ideally a combination including all of the above would provide detailed information on the changes to seagrass and red algae distribution as well as vital supporting information on the influential environmental factors.

6 References

Brown, R.A., (1990). Strangford Lough. The widlife of an Irish sea lough. The Institute of Irish Studies, Queens University of Belfast.

Burton, P.J.K., (1961). The brent goose and its winter food supply in Essex. Wildfowl, 12, 104-112. Percival, S.M. & Evans, P.R., (1997). Brent geese (*Branta bernicla*) and *Zostera*; factors affecting the exploitation of a seasonally declining food resource. Ibis, 139, 121-128.

Chivers, R.C., Emerson, N. and Burnus D.R. (1990). New acoustic processing for underway surveying. The Hydrographic Journal 56, 9-17.

Connor, D.W., Dalkin, M.J., Hill, T.O., Holt, R.H.F. & Sanderson, W.G., (1997b). Marine biotope classification for Britain and Ireland. Vol.1. Littoral biotopes. Joint Nature Conservation Committee, Peterborough, JNCC Report no.299, Version 97.06.

Davison, D.M. (1997). The genus Zostera in the UK: a literature review, identifying key conservation, management and monitoring requirements. Environment and Heritage Sevice, Belfast.; Hemminga, M.A. & Duarte, C.M. (2000). Seagrass Ecology. Cambridge University Press, Cambridge.

Davidson, D.M. & Hughes, D.J., (1998). Zostera Biotopes: An overview of dynamics and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science, (UK Marine SACs Project), Vol.1.;

Davidson, D.M. & Hughes, D.J., (1998). Zostera Biotopes: An overview of dynamics and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science, (UK Marine SACs Project), Vol.1.;

Hemminga, M.A. & Duarte, C.M. (2000). Seagrass Ecology. Cambridge University Press, Cambridge.

Marta, N., Cebrian, J., Enriquez, S. & Duarte, C.M., (1996). Growth patterns of western Mediterranean seagrasses: species specific responses to seasonal forcing. Marine Ecology Progress Series, 133, 203-215.

Middelboe, A.L., Sand-Jensen, K. & Brodersen, K. (1997). Patterns of macroalgal distribution in the Kattegat-Baltic region. Phycologia 36: 208-219.

Orth, R.J.,(1992). A perspective on plant-animal interactions in seagrass: physical and biological determinations influencing plant and animal abundance. In Plant-Animal Interactions in the Marine Benthos, Systematics Association Special Volume no 46, (ed. D.M.John, S.J. Hawkins, & Price, J.H.), pp. 147-164. Oxford: Clarendon Press.

Zaberzinskaya, E.B., (1968a). New species of red algae in the Caspian. New of classification of unicellular. L: Nauyka, Leningrad.; Zaberzinskaya, E.B., (1968b). Flora of macrophyte algae of the Caspian Sea. Report. Dissertation – Baku.; Kireeva, M.S., Schchapova,T.F., Species distribution and biomass of algae and seagrass in the Caspian sea. Institute of Oceonology, AS of USSR, v.XXIII, (1957)

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F I N A L   R E P O R T

NEARSHORE ASSESSMENT OF SANGACHAL BAY

Prepared for:

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Figures

1.1 BACKGROUND

The development programme for Shah Deniz Gas Export Stage 1 and ACG Phase 1 includes significant pipeline installation operations and pipeline landfall at Sangachal Bay. Pipeline installation along with construction of the pipeline landfall may effect the transport of sediment along the Sangachal Bay shoreline.

URS mobilised Mr. Louis Armstrong, a senior oceanographer, to visit London and Baku. In London he met with the pipeline engineers to discuss their views of solving problem of bringing pipelines ashore through an active sediment transport zone. In Baku, he familiarised himself with the site and local environmental conditions as well as assessed engineering implications of the sediment transport regime. During the Baku visit, he performed a simple drifter study and used simple photo survey techniques to characterize sediment transport in the bay. In addition, an evaluation of the need for a field monitoring progamme to evaluate the sediment transport regime for later use in pipeline-to-shore transition design was performed.

1.2 CONTENT AND FORMAT OF REPORT

This technical report presents the observations and findings of the Sangachal Bay assessment. Given that a great deal of observational data was collected by previous studies, this report represents only a summary of such data as it relates to the SD Stage 1 development programme, and a description of new information collected as part of the field visit.

The remainder of this report is divided into the following sections:

- Description of the Environment
- Conclusions and Recommendations
- References

1.3 LIMITATIONS OF STUDY

The services were performed, within the limits prescribed by our client, with the customary thoroughness and competence of consulting professionals in the relevant disciplines, in accordance with the standard for professional services at the time and location those services were rendered. The subject study was limited in scope and performed as an initial assessment of Sangachal Bay. As such, the study was not aimed at providing a comprehensive assessment of potential impacts.

2.1 METEOROLOGY

2.1.1 Air Temperature and Humidity

The closest operational weather station which is representative of the type of conditions found at the site is in Alyat over 30 km to the south. The climate of the area is classified as being warm temperate semi-arid dry steppe. Summers are warm with typical maximum air temperatures in the order of 35 to 40 ^{0}C. Rainfall is extremely limited, humidity is low and evapotranspiration rates are high.

Alyat is in one of the warmest parts of Azerbaijan with an average air temperature of 14.6 ^{0}C. July is the warmest month when the average air temperature is 26.4 ^{0}C. The maximum recorded temperature is 41 ^{0}C (recorded in July). The lowest recorded air temperature at Alyat is -16 ^{0}C (recorded in January). The average minimum air temperature in January is 0 ^{0}C.

2.1.2 Precipitation

The region is one of the driest areas in Azerbaijan, the mean annual average precipitation is less than 150 mm. The majority of the rain falls between September and April. The driest months are July and August when rainfall is typically 7 to 8 mm. Snowfall in this area on average occurs for 10 days per annum. Snow rarely settles on the ground for long periods of time. Historical data from a decommissioned weather station at Puta indicated an average annual rainfall of 104 mm, with the driest recorded months being July and August, having an average rainfall of between 2 to 3 mm.

2.1.3 Wind Regime

The wind regime of Sangachal Bay is consistent with that of the rest of the Apsherson Peninsula although there is a local thermally driven wind system. This produces a slight (1 to2 ms^{-1}) offshore wind during the early hours of the morning, which then drops and becomes a stronger onshore wind as the land heats. This thermal wind coupled with the meteorological dynamics of the region can result in strong winds occurring with little forewarning.

Winds in the bay are predominantly from the northeast (ERT, undated). An analysis of wind records for the period 1980 to 1989 undertaken for this ESIA, concluded that northeasterly winds blow for approximately 50% of the time and southeasterlies for approximately 17% of the time. For the remaining time, winds are variable.

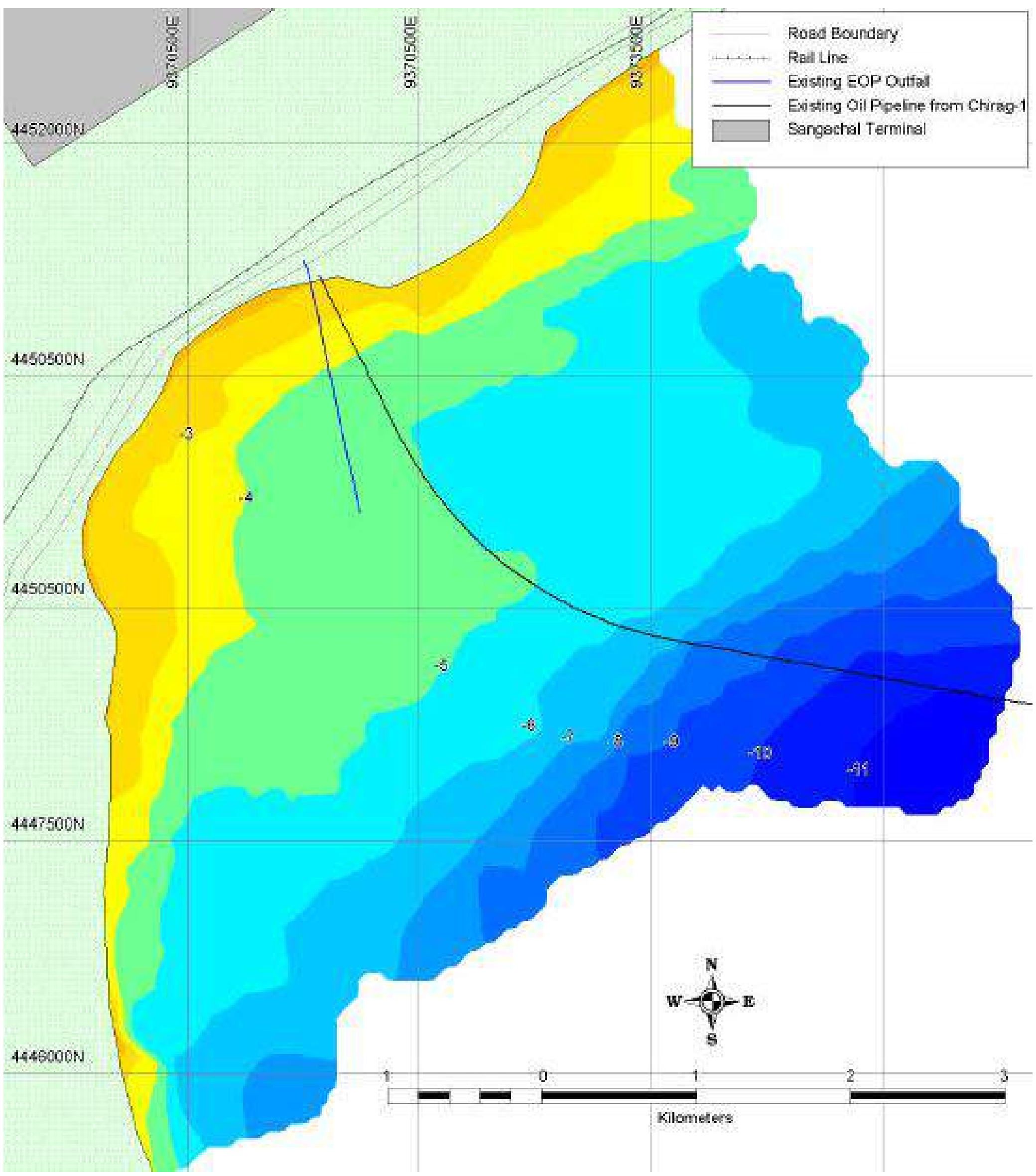
In the Apsheron region as a whole winds greater than 5 ms^{-1} blow approximately 37% of the time and winds greater than 10 ms^{-1}, 18% of the time (ERT, undated). At Alyat, some 15 km south of Sangachal, the average wind speed is 3.6 ms^{-1} and for up to 100 days a year, wind speed exceeds 15 ms^{-1}. Under storm conditions, wind speeds of greater than 25 ms^{-1} have been recorded.

2.2 OCEANOGRAPHY

2.2.1 Bathymetry

Sangachal Bay is a shallow bay that slopes from the shore gradually and reaches a depth of 10 m approximately 3 km offshore. In the centre of the bay is a slight depression that acts as a sediment sink. The recent acoustic survey of Sanagchal Bay has provided the bathymetry chart shown in Figure 1. A detailed description of the sediment types, metal and hydrocarbon contaminants and the associated biological communities is provided below.

Figure 1 Bathymetry of Sangachal Bay (depths in metres)

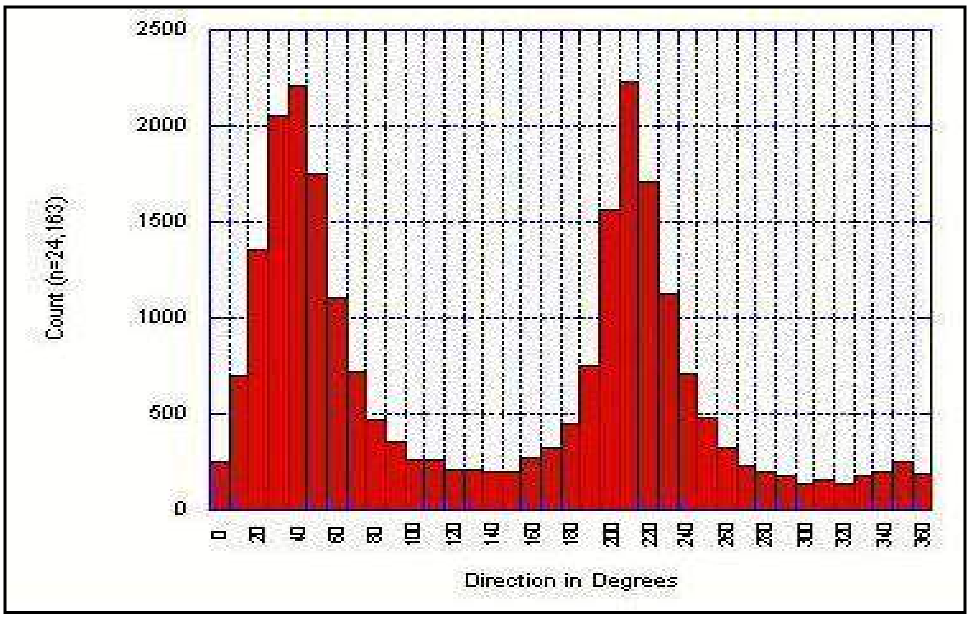


2.2.2 Currents and Water Circulation

The Caspian Sea is effectively non-tidal and water currents are mainly wind generated. Measurements of currents in the Bay were recorded by NeSA BV in two periods; 13 October 1999 to 15 December 1999 and 28 January 2000 to 11 May 2000. The data was collected from an Aanderaa RCM9 current meter deployed approximately 3 m above the seafloor in approximately 6 m depth of water at approximately 2.5 km offshore. This data was analysed as part of this ESIA in order to develop an understanding of the nearshore oceanographic conditions of Sangachal Bay. As no seasonality was observed in the data, the two data sets were combined for analysis.

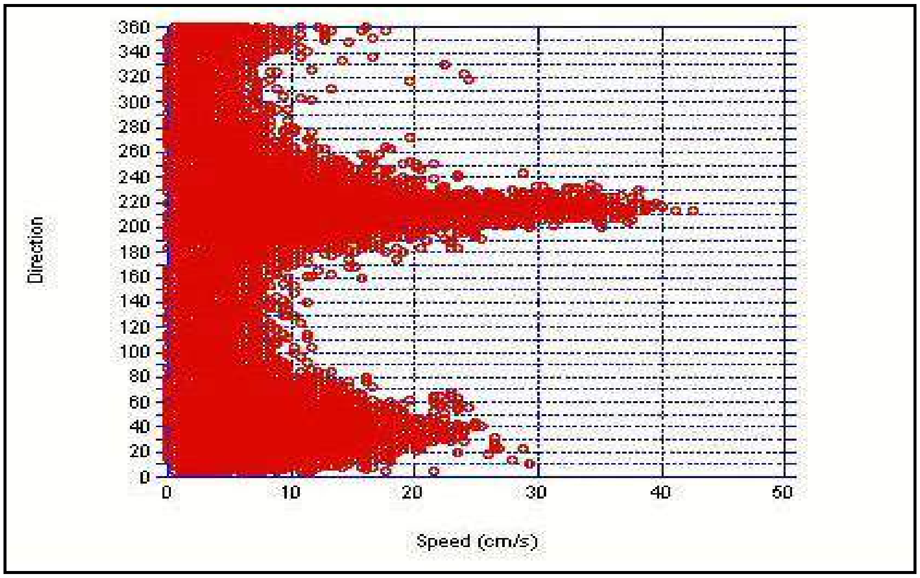
The NeSA BV data showed that the minimum current speed was 0.0 cms^{-1} and the maximum, approximately 42.5 cms^{-1} (Figure 2).

Figure 2 Distribution of current direction over complete NESA by record



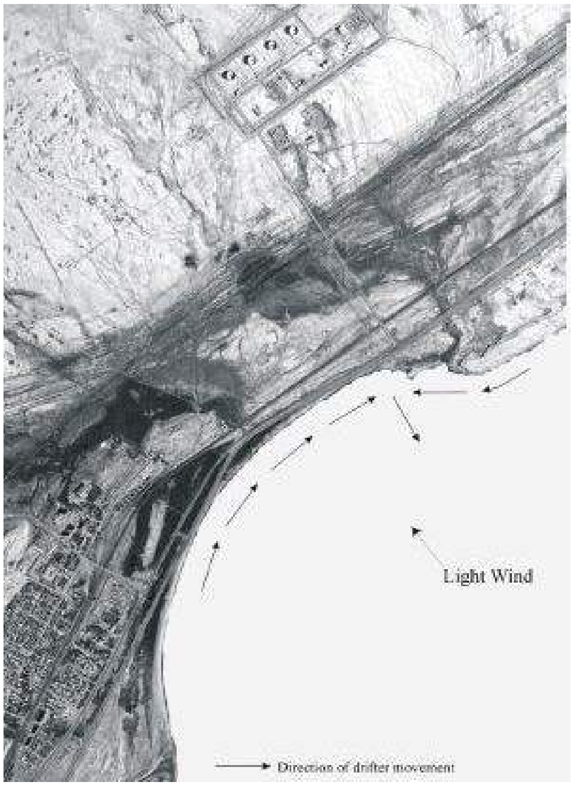
The mean current speed was approximately 7.9 cms^{-1}. Current direction was evenly distributed between flowing in a southwesterly direction and a northeasterly direction; that is, down coast and up coast respectively (Figure 3). Higher current speeds are associated with the southwesterly direction currents.

Figure 3 Distribution of current speeds per direction



To develop a better appreciation of the oceanographic regime in the coastal area (i.e. that area where water depths are in the order of a few meters), two drifter studies were completed at seven and four (repeat) locations along the Sangachal Bay coast on separate days in June 2001. Conditions during the first day were light southeast winds with wave height of approximately 20 cm. On the second day, two days later, winds were strong from the northeast and little or no wave action was observed.

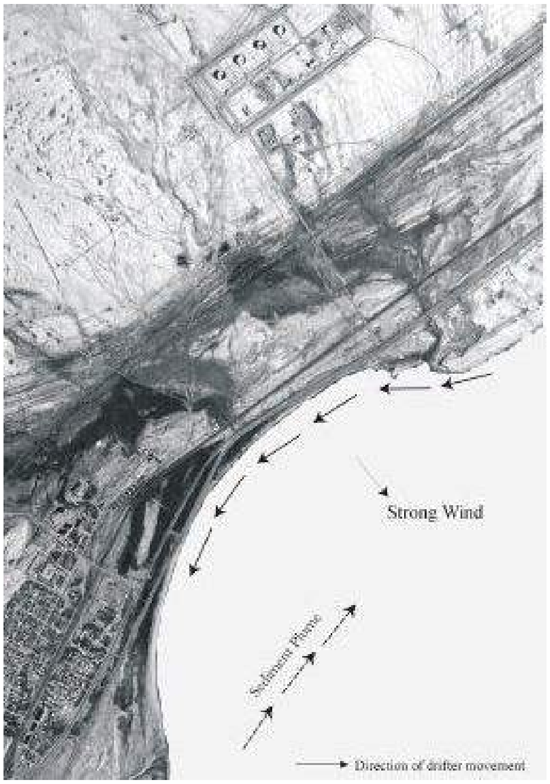
Figure 4 Inferred current direction – light southeast winds



The results of the first drifter exercise indicate that a complex nearshore circulation pattern operates in the limited space of Sangachal Bay. The direction of drift was unexpected in that drifters released in the northern part of the Bay moved southwards while those released in the southern part of the Bay, northwards (Figure 4).

Drifter speeds varied from 1 to 6 cms^{-1}. Two drifters left in the wave break area northeast of the jetty showed a slow residual current to the northeast concluded to be most likely associated with the waves.

Figure 5 Inferred current direction – strong northeast winds



The second drifter exercise showed that southerly currents with speeds varying from 17 to 22 cms^{-1} were operating (Figure 5). A large sediment plume approximately 100 to 200 m offshore was however, observed to be moving in a northerly direction.

A large sediment plume approximately 100 to 200m offshore was however, observed to be moving in a northerly direction.

It is concluded from the drifter work that a complex nearshore current regime exists in Sangachal Bay. Currents have been observed to be moving in opposite directions over distances of a few kilometres. Currents are primarily wind driven but are also influenced and generated by waves. Shoreline configuration (i.e. shape and make-up) contributes to the behaviour of currents in the very nearshore zone and is itself shaped by the currents.

2.2.3 Waves

Due to the enclosed nature of the Caspian Sea the predominant waves are wind-blown rather than swells. Waves are a strong feature of this part of the Caspian Sea and wave heights can exceed 10 m in offshore waters during severe storm conditions. Longer time scale internal waves within the water column can give rise to short term sea level fluctuations; the most marked of these arise from onshore and offshore winds which cause surges and withdrawals of water along the coast, including the coastal water adjacent to the existing terminal.

2.2.4 Sea Temperature

Sea surface temperatures measured during a recent annual fish monitoring study of the nearshore waters adjacent to the Sangachal terminal recorded a temperature range of between 6 and 30°C between January and July.

2.2.5 Salinity

Seawater salinity of nearshore waters adjacent to the terminal recorded by ERT during the 1996 baseline survey were lower than those commonly quoted in published literature from the Caspian Sea (11.2-11.6 ‰, rather than 12-13 ‰), but are consistent with those recorded from surface waters in other recent surveys offshore (ERT, unpublished data). Limited measurements of ionic concentrations in Sangachal Bay indicated the salt content to be fairly typical of open waters of the Middle and South Caspian, although slightly reduced chloride ion concentrations at the surface suggested effects of fresh water run-off from the land.

2.3 BIOLOGICAL COMMUNITIES

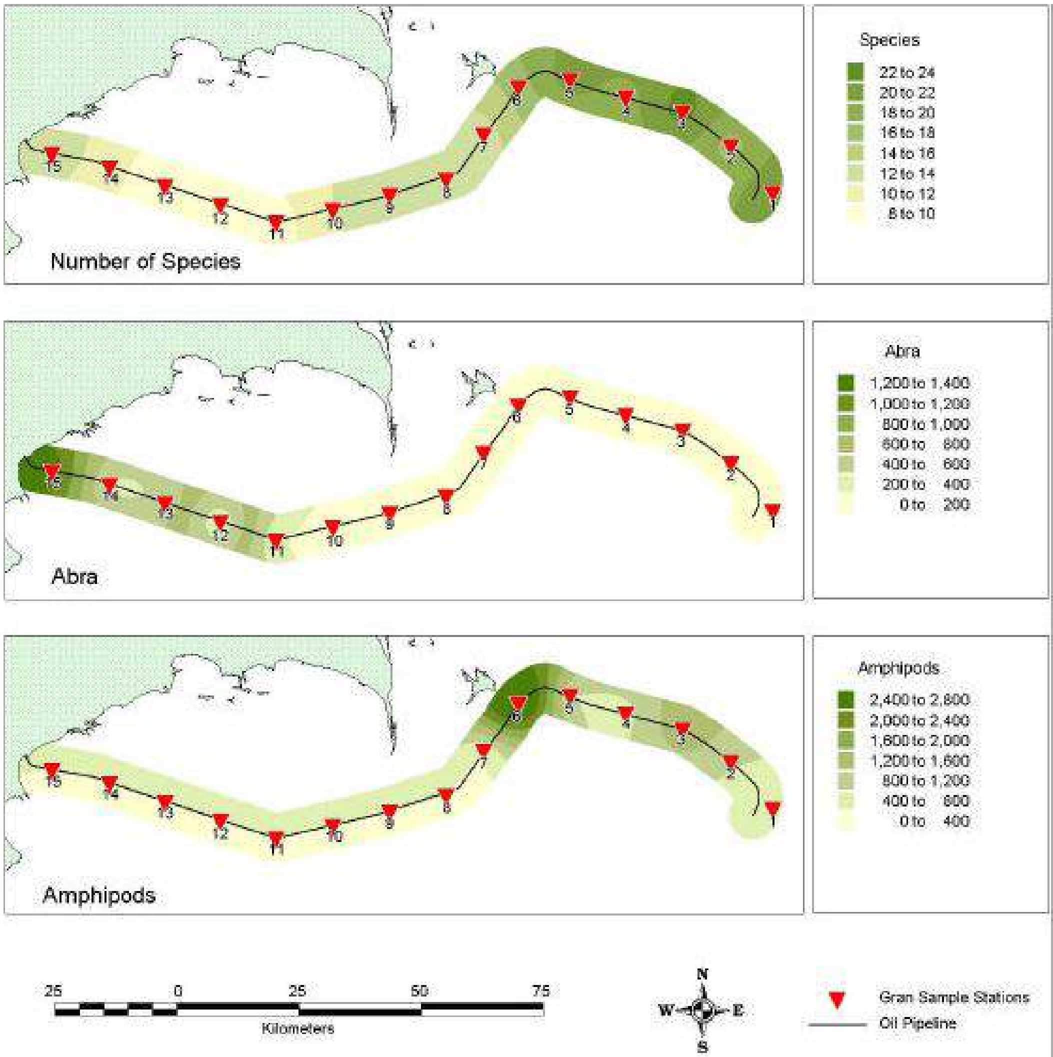
This section provides a general description of the biological communities in the nearshore area of Sangachal Bay based on a survey of part of the pipeline route that was carried out in November 2000 and visual observations during the June 2001 site visit.

2.3.1 Macrobentic Communities

There were distinctive biological gradients along the pipeline route (Figure 6). Amphipods were abundant at stations in the deeper water to the east, but were absent from stations in shallower water (approximately along the 20 m depth contour). The alien polychaete *Nereis* exhibited a complementary pattern of distribution to that of the oligochaetes and amphipods being absent from stations in deeper water and more consistently present in shallower stations to the west of the survey area. The distribution of the alien bivalve *Abra* was similar to that of *Nereis*, but exhibited a stronger bias towards stations closer to Sangachal.

Overall, the macrobenthic data indicates a transition from a native community in the east of the survey area (dominated by endemic gastropods and amphipods) to a community in the west dominated by alien species (polychaetes and bivalves).

Figure 6 Marcobenthic gradients along the pipeline route (in number of individuals)



2.3.2 Other Communities

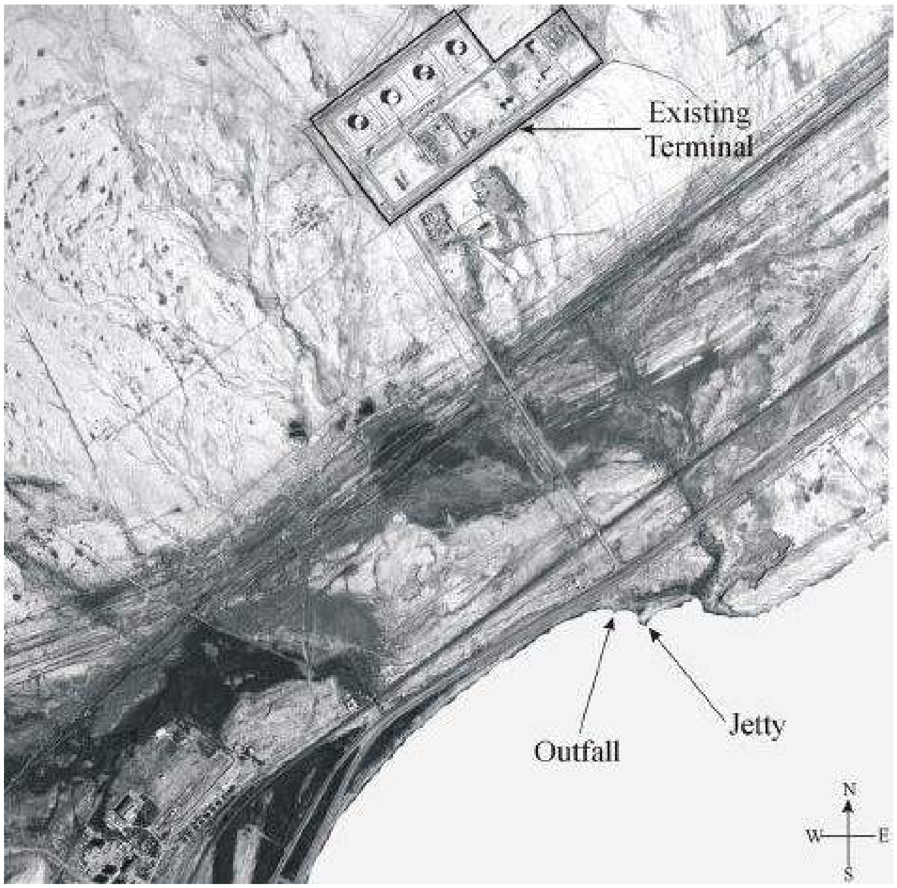
During the June 2001 site visit, seagrass communities were observed from the existing jetty. Also, artisinal fishers were observed collecting small shrimp within a few metres of the shoreline, as well as fishing from the jetty.

2.4 COASTAL ASSESSMENT

Changes in the coastline profile of Sangachal Bay was based on observations made during field investigations. A series of historical photographs believed to have been taken in January-February 2001 were used as a basis for comparison of present conditions as observed during the June field investigation.

The field investigation area was centred around the rock groyne jetty and concrete sewerage outfall structures on the Sangachal Bay coastline southeast of the existing Early Oil Project terminal. The location of jetty and outfall structure are shown in Figure 7.

Figure 7 Location of jetty and outfall structure in relation to existing terminal



The jetty location was chosen as it was widely reported that considerable change to the coastal configuration had occurred as a result of the construction of the two structures.

By investigating the existing coastal configuration and analysing the pattern of sediment redistribution in the beach areas adjacent and near to the jetty and outfall, following construction of the structures, an insight can be gained into the nearshore dynamics of the area. This insight can be used as a basis from which predictions can be made in regards to the possible affects the subsea pipelines will have both in the short and long term.

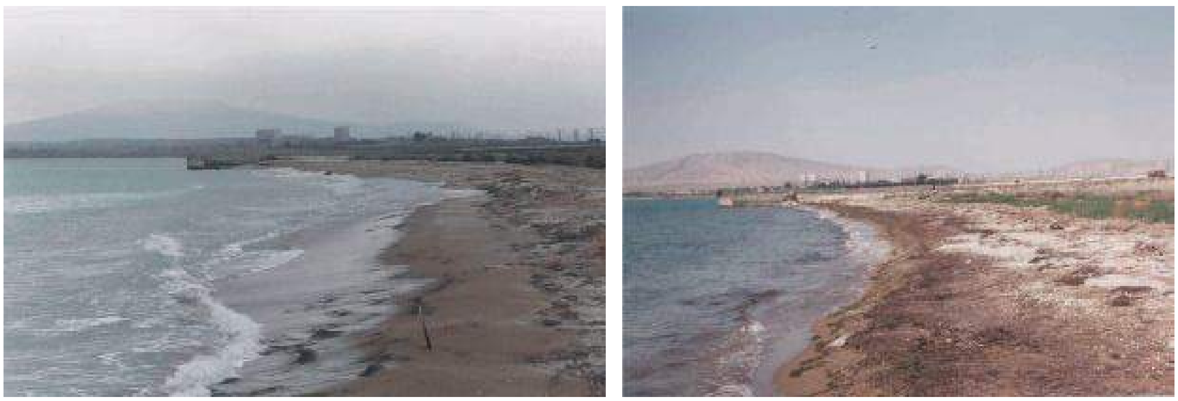
It should be noted that the sea level in Sangachal Bay was higher during the June field investigation than that observable in the January-February 2001 photos (Figures 8-12). The exact cause of this rise is unknown.

Due to the higher water line, the lower section of the beach profile visible in some of the January-February 2001 photos was inundated during the June investigations thus making interpretation and comparison of past conditions with present conditions, in some instances, more difficult.

2.4.1 East of Jetty

Fine sands with shells characterise the beach make-up northeast of the jetty. The beach sediments higher up the beach profile, showed at least four layers of sediments and seagrass that had been deposited over time. Figure 8 shows a comparison of the beach area looking west towards the jetty from its eastern side between January-February 2001 conditions to June 2001 conditions. Figure 9 shows a comparison of the beach area looking northeast away from jetty. In both figures the accumulation of seagrass can be seen in the June photo.

Figure 8 Sangachal coastline east of jetty looking west (at jetty)



January-February 2001 June 2001

Figure 9 Sangachal coastline east of jetty looking east (away from jetty)

January-February 2001 June 2001

During the June survey, the coast directly adjacent to the jetty consisted solely of shells with little or no sand. Figure 10 shows the difference in the beach profile near the jetty between January-February and June 2001.

Figure 10 Shoreline adjacent to jetty – eastern side

January-February 2001 June 2001

There are three main changes in the coastal configuration that can be discerned through the comparison of the two photos as follows:

- it appears that there has been erosion behind the berm crest (or landward ridge); and
- sediment has been accumulated along the landward ridge.
- There has also been erosion below the bottom of the jetty as shown in Figure 11.

Figure 11 Erosion at base of jetty – eastern side

January-February 2001 June 2001

Recent sedimentation around the jetty is limited to the an area of 10 to 20 meters near its tip on the eastern side. Further inland there appears to be older deposits that were redistributed by earthmoving equipment. The redistribution of sediment potentially was undertaken to reclaim some of the coast. This observation is supported by the 1999 AIOC document *Review of research and monitoring activities in Sangachal Bay and the AIOC Contract Area* which hypothesizes that:

> *"…it seems likely that some structure existed prior to 1997, and this structure was extended or improved in October 1997."*

2.4.2 West of the Jetty

The area adjacent to the jetty to the west is being eroded. The area that is currently the edge of the coast consists of fine sediment placed by earthmoving equipment. Figure 12 show the increased erosion and effect of sea level rise on the coast on the west side of the jetty. It should be noted however, that the earlier photos show a different shoreline near the jetty. It is possible that some of the historical photos may be older than January/February 2001.

Figure 12 Erosion at base of jetty – western side

January-February 2001 June 2001

Slightly further west there is some accretion of sediment east of the outfall structure. Figure 12 also shows the erosion that is occurring along the coast. Again, much of the existing coastline has been disturbed by earth moving equipment. This observation is supported by the 1999 AIOC document *Review of research and monitoring activities in Sangachal Bay and the AIOC Contract Area* which states that:

> *"…the situation is complicated by the major disturbance caused by the construction associated with the landfalls of the outfall and oil pipelines…."*

2.4.3 South of the Jetty and Outfall Structure

The coastline south of the jetty and outfall pipe consists of fine sediment and sand mixed with some seagrass. There are also rocky outcrops areas. In general, these areas do not appear to have undergone significant changes due to the construction of the jetty or the outfall structure.

2.5 NEARSHORE SEDIMENTS

A variety of sediment samples have been taken near the coast since 1995. The stations used for this sediment grain size assessment are listed in table below. These sediment samples show that the sediments that could be disturbed during pipeline trenching vary from fine muds to medium sands. Many of the sediments contain shell fragments. Results of a sediment surveys in Sangachal Bay in 1996 and 2000 were compared by ERT (Unpublished ERT report, Section 9). This comparison shows significant changes in the sediment grain size distribution offshore.

Station	Year	Description	Reference
AIPL895-9	1995	Clay, Very silty, sandy, very soft, greyish olive with many shell fragments and inclusion of peat.	Fugro Report N3252/040
AIPL895-5	1995	Shells and shell fragments, in a matrix of Clay, very silty, sandy, dark olive to grey.	Fugro Report N3252/040
AIPL895-10	1995	Clay, Very silty, very soft, greyish olive with shell fragments.	Fugro Report N3252/040
ERT28	1996	Gravelly mud (Folk); Glutinous grey mud.	ERT 96/200
ERT27	1996	Gravelly muddy sand (F) Muddy shell gravel; brown sediment surface grading to dark grey beneath. Seagrass in all grabs. Extremely poorly sorted.	ERT 96/200
F55	1998	Shell debris, clayey, becoming clay, very soft, greenish grey, with many shells and shell fragments.	Fugro Report N3652/01
ERT10	2000	Medium Sand, less than 1% silt/clay	ERT 2001 (draft)
ERT7	2000	Fine Sand, 32.24% Silt/Clay	ERT 2001 (draft)
ERT5	2000	Fine Silt, 82.07% silt/clay	ERT 2001 (draft)

2.6 NEARSHORE SEDIMENT TRANSPORT ASSESSMENT

Conclusions regarding sediment movement in Sangachal Bay are based on three main areas of evidence as follows:

- an observed sediment plume and nearshore eddy;

- a beach sediment and profile comparison – January-February 2001 and June 2001; and
- a critical shear velocity to grain size analysis.

2.6.1 Sediment Plume and Nearshore Eddy

A recent aerial photo of the Bay (Figure 13) shows a northward travelling sediment plume emanating from the southern part of the Bay. A northward moving sediment plume was also observed during the June 2001 field investigation. This phenomenon suggests that a northerly direction current flow occurs in the southern part of the Bay close to shore. The current is evidently strong enough to mobilise sediment.

The photo also shows an eddy in the southern part of the Bay that may potentially be associated with a shear zone caused by a current running in a southerly direction interacting with the northward flowing current responsible for the movement of the sediment plume.

Figure 13 Sediment plume in Sangachal Bay

2.6.2 Beach Sediment and Profile Comparison – January-February 2001 and June 2001

The comparison of sediment analyses undertaken between 1996 and 2000 (see Section 2.4) indicates that a significant change in sediment distribution has occurred in Sangachal Bay over the last few years. This change strongly suggests that there is a dynamic sediment movement regime in Sangachal Bay.

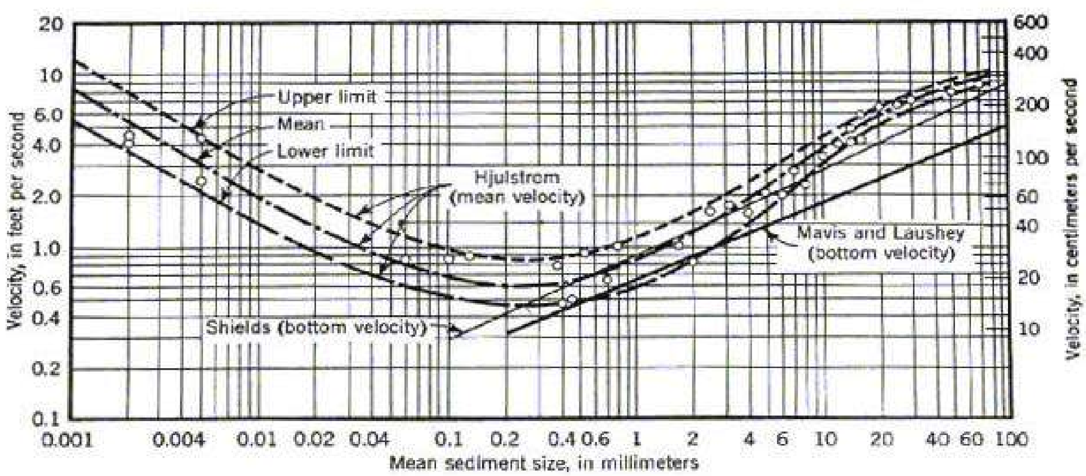
A comparison of evidence from historical photos (January-February 2001) to the results of the June 2001 field investigation into beach profiles and shoreline sediment distribution indicates that considerable change has occurred to the shoreline's configuration over a short period of time. Some of this change results from deliberate earthmoving works but much of it is also the result of natural processes including sea level rise and nearshore currents. These latter contributing factors in particular, suggest that the nearshore sediment movement regime is dynamic and that the sediments themselves are relatively mobile.

2.6.3 Critical Shear Velocity to Grain Size

Critical shear velocity to grain size can be used to determine sediment transport potential. Figure 14 presents the critical velocities for quartz sediments as a function of mean grain size.

If a maximum current speed of approximately 40 cms^{-1}, as observed at the current meter station, is used it can be shown that currents operating in Sangachal Bay are sufficient to move many of the grain sizes found there. In fact, Figure 14 shows that a current speed of approximately 12 cms^{-1} should be sufficient to transport some of the sediments found in Sangachal Bay. It should also be noted that wave induced orbital velocities have not been considered in this analysis. These orbital velocities, which have been estimated at over $1ms^{-1}$ at the seabed for a 2 meter wave with a 5 second period (ERT, undated), can be very important in the movement of larger diameter particles.

Figure 14 Critical velocities for quartz sediments as a function of grain size



3.1 POTENTIAL IMPACTS

The project is proposing to construct one or more jetties to assist with pipeline haul onto the shore. These jetties would be rock groynes and could either be permanent or temporary. The following table provides a summary of the engineering and environmental issues associated with each of the pipeline landfall options.

Option	Engineering Issues	Environmental Issues
Construct permanent jetties	Least expensive, easiest option	Potential negative impacts to shoreline and coastal sediment transport; Jetties could provide positive social impact for local fishermen and recreational users
Construct temporary jetties	More expensive, however most construction material most likely available in country	Short term impact to shoreline and coastal sediment transport. Construction related impacts include increased suspended sediment during demolition

Based on the complex nature of the currents in Sangachal Bay and the changes associated with the existing jetty, it is recommended that onshore pipe pulling operations consider using one of the temporary options which can be removed to avoid significantly altering the coastline. Though these temporary options will cause a short term impact to the coastal sediment transport in Sangachal Bay, there removal would help mitigate against any longer term downstream erosion, particularly at the base of the existing road.

The negative aspect of removing the temporary jetties is the resuspension of sediment, which could impact the biological community. This includes the macrobenthic community, as well as observed seagrass and shrimp associated with local artisinal fishers. Of particular concern is the seagrass communities, which are very susceptable to increased suspended sediment (Kennish 1996). Therefore, demolition and removal of the jetties should be done in a manner to minimize sediment resuspension.

With respect to trenching, additional analysis on the impact of the trenching and associated suspended sediment plume on the biota of the Bay should be performed. However, the trenches that are formed should refill over time given the dynamic nature of the sediments in the Bay.

3.2 MONITORING PROGRAMME

Lastly, a long term monitoring programme of the coastal oceanographic and sedimentation regimes should be considered. This monitoring programme does not need to be overly complicated or expensive. However, it should be implemented both before and after any additional construction in the Bay. The following minimal monitoring should be considered:

Develop a series of locations along the beach from which photographs can be taken on a regular interval (monthly) to develop a visual record of the beach. The photographs should be taken from the same location, using the same camera settings and orientation each time.

Install permanent staff gauge to measure sea level along the coast. A simple staff gauge should be installed in the Bay such that a record of water level can be recorded monthly during the above photo sessions.

Collect meteorological data at Sangachal Terminal. It is our understanding that the Sangachal Terminal already has a met station on site, however data are not recorded. We recommend that the met station record at a minimum hourly wind speed and direction for the week that the photo sessions are being performed.

Additional monitoring that would be useful but requires more logistics includes:

Collect nearshore current speed and direction and wind speed and direction in the Bay for a minimum of one month during each season. Given the complex nature of the currents in the Bay measurements should be considered for the north, middle, and south bay. Given the relatively shallow nature of the Bay, it may be possible to collect surface currents using a radar system thereby increasing the extent of coverage with minimal equipment.

4.1 REFERENCES

American Society of Civil Engineers, 1975. Manuals and Reports on Engineering Practice – No. 54: Sedimentation Engineering. V. Vanoni, editor. American Society of Civil Engineers. New York.

ERT, 1996. Environmental Issues Related to the Sangachal Terminal Outfall: Volume 3 – Baseline Environmental Survey, September October 1996. Report ERT96/200

ERT, 1999. Review of Institute of Geography Proposal for Current Measurement and Hydrodynamic Modelling of the Sangachal Bay Area. Report E/99/9609

ERT, No Date. Sanagachal Terminal: Review of Nearshore and Coastal Impacts. Report E/4019

Fugro Report N3252/040

Fugro Report N3652/01

Kennish, M.J., 1996. Practical Handbook of Estuarine and Marine Pollution. CRC Press.

Murray, I. 2000. Sangachal Inshore Surveys, 24" Oil Line Approach (Fugro and Racal Integrated Data) Scale 1:5000. August.

NeSA, 2000. Metocean Monitoring Along the Proposed Chirag to Sangachal Pipeline Route, Summary Report. June. Report Reference 706600.

Pethick, J., 1984. An Introduction to Coastal Geomorphology. Edward Arnold Publishers. London.

Ritchie, No Date. Scoping: Requirments for Environmental Impact Assessment of Pipeline Landfalls in Sangachal Bay, Azerbaijan. Letter.

Woodward-Clyde, 1996. Shoreline Survey: Oil Spill Sensitivity. Preliminary Report prepared for AIOC.

BOREHOLE NUMBER: **BHURS1**	PAGE **1** OF **2**
DRILLING DATES: 26/05/2001	DRILLING METHOD: Continuous Flight H.S Auger
DRILLER: Tekar	BOREHOLE DIAMETER: 200mm
LOGGED BY: ED	SCREEN TYPE & DIAMETER: 50mm PVC
CHECKED BY:	SCREEN SLOT SIZE: 1mm & Geowrap

BOREHOLE CONSTRUCTION | SAMPLE (NUMBER, TYPE) | SOIL VAPOUR (ppm) | GROUNDWATER | DEPTH (m) | GEOLOGY

Depth (m)	Sample number	Soil vapour (ppm)	Description	Comments
0		*	Dry, loose, light brown very silty fine SAND,	NVO
1.0	TPH, Metals	0 SPT 1 n=10	increasing density with depth.	
2.0		0		
2.5		SPT 2 n=12	Dry, medium dense, light brown, very silty CLAY, occasional crystals- probably gypsum ($CaSO_4$)	NVO
3.0		0		
4.0	TPH, Metals, BTEX, PAH	0 SPT 3 n=16		
5.0		0		
5.5		SPT 4 n=53	Dry, very dense, grey-brown, poorly cemented fine SANDSTONE (probably gypsum cement).	NVO
6.0		0	Dry, very dense, clayey silty, fine to medium SAND, occasional small sandstone nodules and crystals - probably gypsum.	NVO
7.0		0 SPT 5 n=>50		
7.4			Slightly moist, very dense, brown, silty fine to medium SAND, occasional shell fragments.	NVO
8.0		0		
8.5		SPT 6 n=>50	Slightly moist, very dense, brown, clayey silty fine SAND, occasional grey-brown clay laminations.	Moisture at 8.5mbgl.
9.0		0		Perched water standing at 9.1mbgl, (2 June 2001)
10.0		0		

LOCATION / NOTES:

NVO - No Visual or Olfactory evidence of contamination.

GPS Location - 9370966.2
4454059.6

LEGEND

- Disturbed Sample
- Undisturbed Sample
- * Headspace Analysis
- Down Borehole Analysis
- Groundwater Table
- Perched Water Table

BOREHOLE LOG

Job Title	Terrestrial Soil and Groundwater Survey
Location	SANGACHAL, AZERBAIJAN
Client	BP

URS
Dames & Moore
O'Brien Kreitzberg
Thorburn Colquhoun

App'd:	Drawn:	Date:
ED	DH	JUNE 2001
		Ref: ED/DH/LON
Scale: AS SHOWN		Job No: 27527-064-401
Drg. Size: A4		BOREHOLE LOG

BOREHOLE NUMBER: **BHURS1**	PAGE **2** OF **2**
DRILLING DATES: 26/05/2001	DRILLING METHOD: Continuous Flight H.S Auger
DRILLER: Tekar	BOREHOLE DIAMETER: 200mm
LOGGED BY: ED	SCREEN TYPE & DIAMETER: 50mm PVC
CHECKED BY:	SCREEN SLOT SIZE: 1mm & Geowrap

Sample Number	Sample Type	Soil Vapour (ppm)	Depth (m)	Description	Comments
		0	10.0	Moist, very stiff, grey silty CLAY intercalated with very grey-brown, fine to medium, very dense sand, occasional shell fragments.	NVO
		0 SPT 7 n=67			
TPH, Metals	Disturbed	0	13.0	Dry, very stiff, grey silty CLAY (intact), occasional thin, fine sand laminations - intact.	NVO
		SPT 8 n=>50	16.0		
		SPT 9 n=>50	17.5	Dry, very stiff, grey silty CLAY (intact) with much black organic carbon nodules.	NVO
			20.0	Borehole terminated at 20.0mbgl.	

LOCATION / NOTES:

NVO - No Visual or Olfactory evidence of contamination.

GPS Location - 9370966.2
4454059.6

LEGEND

- Disturbed Sample
- Undisturbed Sample
- * Headspace Analysis
- Down Borehole Analysis
- Groundwater Table
- Perched Water Table

BOREHOLE LOG

Job Title: Terrestrial Soil and Groundwater Survey

Location: SANGACHAL, AZERBAIJAN

Client: BP

URS

Dames & Moore
O'Brien Kreitzberg
Thorburn Colquhoun

App'd: ED	Drawn: DH	Date: JUNE 2001
		Ref: ED/DH/LON
Scale: AS SHOWN		Job No: 27527-064-401
Drg. Size: A4		BOREHOLE LOG

BOREHOLE NUMBER: **BHURS2**	PAGE **1** OF **2**
DRILLING DATES: 27-28/05/2001	DRILLING METHOD: Continuous Flight H.S Auger
DRILLER: Tekar	BOREHOLE DIAMETER: 200mm
LOGGED BY: ED	SCREEN TYPE & DIAMETER: 50mm PVC
CHECKED BY:	SCREEN SLOT SIZE: 1mm & Geowrap

BOREHOLE CONSTRUCTION	SAMPLE NUMBER	SAMPLE TYPE	SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	DESCRIPTION	COMMENTS
					0		Dry, loose, light brown silt.(MADE GROUND)	NVO
			0*					
							Dry, medium density (non-plastic), light brown, slightly fine sandy clayey SILT.	NVO
	TPH, Metals	☒	0*					
			SPT 1 n=28		1.0			
			0*		2.0			
			SPT 2 n=13				Dry, non-plastic, medium dense, brown slightly sandy, very clayey SILT.	
			0*		3.0			
	TPH, Metals, BTEX, PAH	☒	0*					
			SPT 3 n=11		4.0			
			0*		5.0			
							Dry, very dense, grey-brown, poorly cemented fine SANDSTONE (probably gypsum cement).	NVO
			SPT 4 n=44					
			0*		6.0		Dry, very stiff, light brown silty thinly laminated CLAY, some crystals - probably gypsum.	NVO
			0*		7.0		Dry, very stiff-dense, light brown very silty fine SAND.	NVO
			SPT 5 n=44					
			0*		8.0			
			SPT 6 n=>50				Dry, very stiff brown with orange and grey mottling, fine sandy, silty CLAY. Laminated - Crystals and powder form (probably gypsum) and occasional bands of iron oxide, up to 5mm.	NVO
			0*		9.0		Dry, very stiff light brown-brown with orange and grey mottling, thinly laminated, fine sandy silty CLAY. Some crystal laminations (probably gypsum) up to 2mm. Some organic carbons.	NVO
			0*		10.0			

LOCATION / NOTES:

NVO - No Visual or Olfactory evidence of contamination.

GPS Location - 9370177
4453494

Situated in vicinity of former oil well (50m to NE of borehole). Evidence of fire - Ashy silt 50m NE, 50m SW of borehole.

LEGEND

- ☒ Disturbed Sample
- ■ Undisturbed Sample
- * Headspace Analysis
- † Down Borehole Analysis
- ▼ Groundwater Table
- ▽ Perched Water Table

BOREHOLE LOG

Job Title: Terrestrial Soil and Groundwater Survey
Location: SANGACHAL, AZERBAIJAN
Client: BP

URS
Dames & Moore
O'Brien Kreitzberg
Thorburn Colquhoun

App'd:	Drawn:	Date:
ED	DH	JUNE 2001
		Ref: ED/DH/LON
Scale: AS SHOWN		Job No: 27527-064-401
Drg. Size: A4		BOREHOLE LOG

BOREHOLE NUMBER: **BHURS2**		PAGE **2** OF **2**	
DRILLING DATES: 27-28/05/2001		DRILLING METHOD: Continuous Flight H.S Auger	
DRILLER: Tekar		BOREHOLE DIAMETER: 200mm	
LOGGED BY: ED		SCREEN TYPE & DIAMETER: 50mm PVC	
CHECKED BY:		SCREEN SLOT SIZE: 1mm & Geowrap	

Depth (m)	Sample Number	Sample Type	Soil Vapour (ppm)	Groundwater	Description	Comments
10.0			0*		CLAY intact, occasional seams of shell fragments.	NVO
11.0						
11.5			SPT 7 n=>50		Dry, very stiff to hard, greyish brown mottled grey thinly laminated, very silty CLAY with occasional fine SAND. Some organic carbon and occasional shell fragments intact.	NVO
13.0			0*			
14.0	TPH, Metals	Disturbed	SPT 8 n=>50		Dry, very stiff to hard, greenish brown-brown mottled dark grey fine sandy, slightly thinly laminated CLAY, intact.	NVO
15.0			0*			
16.5			SPT 9 n=>50		Dry, very stiff to hard, dark grey, silty CLAY - intact. Occasional thin fine sand lamination with iron oxide staining.	NVO
18.8				Dry		
19.0			SPT 10 n=>50		Dry, very stiff to hard dark grey, mottled green-grey slightly silty CLAY intact. Occasional crystals (probably gypsum) and shell fragments.	NVO Dry, groundwater not encountered.
20.0					Borehole terminated at 20.0mbgl.	

LOCATION / NOTES:

NVO - No Visual or Olfactory evidence of contamination.

GPS Location - 9370177
4453494

Situated in vicinity of former oil well (50m to NE of borehole). Evidence of fire - Ashy silt 50m NE, 50m SW of borehole.

LEGEND

- ⊠ Disturbed Sample
- ■ Undisturbed Sample
- * Headspace Analysis
- † Down Borehole Analysis
- ▼ Groundwater Table
- ▽ Perched Water Table

BOREHOLE LOG

Job Title: Terrestrial Soil and Groundwater Survey
Location: SANGACHAL, AZERBAIJAN
Client: BP

URS
Dames & Moore
O'Brien Kreitzberg
Thorburn Colquhoun

App'd:	Drawn:	Date:
ED	DH	JUNE 2001
		Ref: ED/DH/LON
Scale: AS SHOWN		Job No: 27527-064-401
Drg. Size: A4		BOREHOLE LOG

BOREHOLE NUMBER: **BHURS3**	PAGE **1** OF **2**
DRILLING DATES: 30/05/2001	DRILLING METHOD: Continuous Flight H.S Auger
DRILLER: Tekar	BOREHOLE DIAMETER: 200mm
LOGGED BY: ED	SCREEN TYPE & DIAMETER: 50mm PVC
CHECKED BY:	SCREEN SLOT SIZE: 1mm & Geowrap

SAMPLE NUMBER	SAMPLE TYPE	SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	DESCRIPTION	COMMENTS
				0	Dry, loose, light brown SILT.	NVO
					Dry, very stiff to hard, light brown-brown slightly sandy, very clayey SILT (slightly fissured). Some crystals probably gypsum.	
TPH, Metals	Disturbed	0		1.0		
		SPT 1 n=26				
		0		2.0		
		SPT 2 n=23				
		0		3.0	Dry, medium dense, non-plastic-friable, light brown-brown, clayey SILTSTONE, many voids up to 1mm (porous).	NVO Void possibly, related to gypsum dissolution.
		SPT 3 n=20				
TPH, Metals, BTEX, PAH	Disturbed	0		4.0		
		SPT 4 n=20				
		0		5.0		
		SPT 5 n=54				
		0		6.0		
		SPT 6 n=>50			Dry, very stiff to hard, brown, slightly fine sandy, clayey SILT with fine to coarse SAND laminations (up to 5mm), occasional shell fragments in sand layers, occasional black organic carbon.	NVO
		0		7.0		
		0		8.0		
		0		9.0		
		0		10.0		

LOCATION / NOTES:

NVO - No Visual or Olfactory evidence of contamination.

GPS Location - 9369272.7
4452584.6

LEGEND

- Disturbed Sample
- Undisturbed Sample
- * Headspace Analysis
- Down Borehole Analysis
- Groundwater Table
- Perched Water Table

BOREHOLE LOG

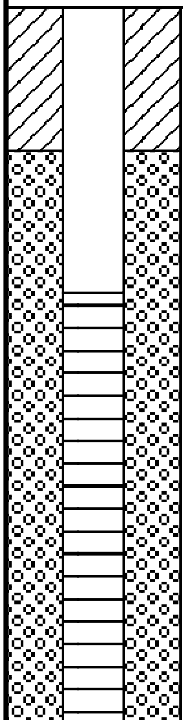
Job Title: Terrestrial Soil and Groundwater Survey
Location: SANGACHAL, AZERBAIJAN
Client: BP

URS
Dames & Moore
O'Brien Kreitzberg
Thorburn Colquhoun

App'd:	Drawn:	Date:
ED	DH	JUNE 2001
		Ref: ED/DH/LON
Scale: AS SHOWN		Job No: 27527-064-401
Drg. Size: A4		BOREHOLE LOG

BOREHOLE NUMBER: **BHURS3**	PAGE **2** OF **2**
DRILLING DATES: 30/05/2001	DRILLING METHOD: Continuous Flight H.S Auger
DRILLER: Tekar	BOREHOLE DIAMETER: 200mm
LOGGED BY: ED	SCREEN TYPE & DIAMETER: 50mm PVC
CHECKED BY:	SCREEN SLOT SIZE: 1mm & Geowrap

Sample Number	Sample Type	Soil Vapour (ppm)	Groundwater	Depth (m)	Description	Comments
		SPT 7 n=43		10	Dry, stiff-very stiff, brown-greyish brown laminated, slightly fine sandy, clayey SILT, intercalated with bands of fine to medium SAND,	NVO
TPH, Metals	Disturbed					
		0		11.0		
		SPT 8 n=59				
				12.0	occasional well rounded gravel up to 2.5mm,	
					occasional bivalve shell fragments and whole shells up to 20mm (pelecypoda)	
				13.0	occasional organic carbon, occasional orange (iron oxide) staining on upper sand surfaces.	
		SPT 9 n=64				
		0		14.0		
			Dry		Dry, very stiff to hard grey CLAY, occasional shell fragments.	NVO Dry, groundwater not encountered.
				15.0	Borehole terminated at 15.0mbgl.	
				16.0		
				17.0		
				18.0		
				19.0		
				20.0		



LOCATION / NOTES:

NVO - No Visual or Olfactory evidence of contamination.

GPS Location - 9369272.7
4452584.6

LEGEND

- Disturbed Sample
- Undisturbed Sample
- * Headspace Analysis
- Down Borehole Analysis
- Groundwater Table
- Perched Water Table

BOREHOLE LOG

Job Title	Terrestrial Soil and Groundwater Survey
Location	SANGACHAL, AZERBAIJAN
Client	BP

URS
Dames & Moore
O'Brien Kreitzberg
Thorburn Colquhoun

App'd:	Drawn:	Date:
ED	DH	JUNE 2001
	Ref:	ED/DH/LON
Scale: AS SHOWN	Job No:	27527-064-401
Drg. Size: A4		BOREHOLE LOG

BOREHOLE LOG

BOREHOLE NUMBER: **BHURS4**	PAGE **1** OF **2**
DRILLING DATES: 29/05/2001	DRILLING METHOD: Continuous Flight H.S Auger
DRILLER: Tekar	BOREHOLE DIAMETER: 200mm
LOGGED BY: ED	SCREEN TYPE & DIAMETER: 50mm PVC
CHECKED BY:	SCREEN SLOT SIZE: 1mm & Geowrap

Sample Number	Type	Soil Vapour (ppm)	Depth (m)	Description	Comments
		*	0	Dry, loose to medium dense (increasing with depth) slightly fine sandy, very clayey SILT.	NVO
		0			
		0	1.0		
TPH, Metals, BTEX, PAH	Disturbed	0	2.0	Dry, very stiff, light brown-brown slightly fine sandy, silty CLAY, occasional shell fragments,	NVO
		0	3.0	occasional silty CLAY.	
TPH, Metals, BTEX, PAH	Disturbed	0	4.0		
		0	5.0		
		0	6.0	Dry, light brown-greenish brown, silty CLAY (intact) with very fine SAND laminations,	NVO
		0	7.0		
TPH, Metals	Disturbed	0	8.0	some organic carbon, occasional orange (iron oxide) staining on upper surface of sand laminations.	
		0	9.0		
		0	10.0		

LOCATION / NOTES:

NVO - No Visual or Olfactory evidence of contamination.

GPS Location - 9370438.5
4453301.3

No Geotech testing undertaken on BHURS4

LEGEND

- Disturbed Sample
- Undisturbed Sample
- * Headspace Analysis
- Down Borehole Analysis
- Groundwater Table
- Perched Water Table

Job Title	Terrestrial Soil and Groundwater Survey
Location	SANGACHAL, AZERBAIJAN
Client	BP

URS
Dames & Moore
O'Brien Kreitzberg
Thorburn Colquhoun

App'd:	Drawn:	Date:
ED	DH	JUNE 2001
		Ref: ED/DH/LON
Scale: AS SHOWN		Job No: 27527-064-401
Drg. Size: A4		BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE NUMBER	SAMPLE TYPE	SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: **BHURS3**	PAGE **2** OF **2**
							DRILLING DATES: 29/05/2001	DRILLING METHOD: Continuous Flight H.S Auger
							DRILLER: Tekar	BOREHOLE DIAMETER: 200mm
							LOGGED BY: ED	SCREEN TYPE & DIAMETER: 50mm PVC
							CHECKED BY:	SCREEN SLOT SIZE: 1mm & Geowrap

Depth (m)	Sample	Type	Soil Vapour (ppm)	Groundwater	DESCRIPTION	COMMENTS
10			0			
11.0					Dry, very stiff to hard, light brown-greenish brown, very silty CLAY (intact) laminated with fine SAND,	NVO
12.0					occasional crystals - probably gypsum,	
13.0					occasional carbon, orange (iron oxide) staining on upper surface of sand.	
14.0				Dry		
15.0	TPH, Metals	☒			Borehole terminated at 15.0mbgl.	
16.0						
17.0						
18.0						
19.0						
20.0						

LOCATION / NOTES:

NVO - No Visual or Olfactory evidence of contamination.

GPS Location - 9370438.5
4453301.3

No Geotech testing undertaken on BHURS4

LEGEND

- ☒ Disturbed Sample
- ■ Undisturbed Sample
- * Headspace Analysis
- † Down Borehole Analysis
- ▼ Groundwater Table
- ▽ Perched Water Table

BOREHOLE LOG

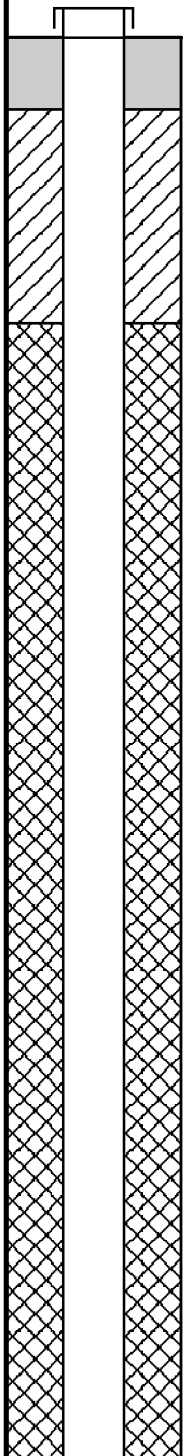
Job Title: Terrestrial Soil and Groundwater Survey
Location: SANGACHAL, AZERBAIJAN
Client: BP

URS
Dames & Moore
O'Brien Kreitzberg
Thorburn Colquhoun

App'd:	Drawn:	Date:
ED	DH	JUNE 2001
		Ref: ED/DH/LON
Scale: AS SHOWN		Job No: 27527-064-401
Drg. Size: A4		BOREHOLE LOG

BOREHOLE NUMBER: **BHURS5**	PAGE **1** OF **2**
DRILLING DATES: 01/06/2001	DRILLING METHOD: Continuous Flight H.S Auger
DRILLER: Tekar	BOREHOLE DIAMETER: 200mm
LOGGED BY: ED	SCREEN TYPE & DIAMETER: 50mm PVC
CHECKED BY:	SCREEN SLOT SIZE: 1mm & Geowrap

BOREHOLE CONSTRUCTION



SAMPLE NUMBER	SAMPLE TYPE	SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	DESCRIPTION	COMMENTS
				0	Dry, loose, light brown fine sandy SILT.	NVO
					Dry, very stiff, light brown, slightly fine sandy, very clayey SILT, occasional fine sand laminations, occasional gypsum in powder form.	NVO
		0 SPT 1 n=24		1.0		
TPH, Metals	⊠	0 SPT 2 n=>50		2.0	Dry, very stiff, light brown-brown, very silty CLAY, occasional gypsum in powder form and crystals.	NVO SPT Weight bouncing.
		0 SPT 3 n=>50		3.0		
		0 SPT 4 n=20		4.0	Dry, very stiff to hard, light brown-brown silty CLAY, occasional crystal - probably gypsum, occasional organic carbon,	NVO
TPH, Metals, BTEX, PAH	⊠	0 SPT 5 n=>50		5.0	colour darkening with depth, occasional shell fragments,	
		0 SPT 6 n=>50		6.0		
		0		7.0	becoming lighter in colour.	
		0		8.0		
		SPT 7 n=>50			Dry, very stiff, brown to dark brown, very silty CLAY (intact), occasional shell fragments, occasional (iron oxide) staining.	NVO
		0		9.0		
		0		10.0		

LOCATION / NOTES:

NVO - No Visual or Olfactory evidence of contamination.

GPS Location - 9371576.6
4453378.3

LEGEND

- ⊠ Disturbed Sample
- ■ Undisturbed Sample
- * Headspace Analysis
- † Down Borehole Analysis
- ▼ Groundwater Table
- ▽ Perched Water Table

BOREHOLE LOG

Job Title: Terrestrial Soil and Groundwater Survey
Location: SANGACHAL, AZERBAIJAN
Client: BP

URS
Dames & Moore
O'Brien Kreitzberg
Thorburn Colquhoun

App'd: ED	Drawn: DH	Date: JUNE 2001
		Ref: ED/DH/LON
Scale: AS SHOWN		Job No: 27527-064-401
Drg. Size: A4		BOREHOLE LOG

BOREHOLE NUMBER: **BHURS5**	PAGE **2** OF **2**
DRILLING DATES: 01/06/2001	DRILLING METHOD: Continuous Flight H.S Auger
DRILLER: Tekar	BOREHOLE DIAMETER: 200mm
LOGGED BY: ED	SCREEN TYPE & DIAMETER: 50mm PVC
CHECKED BY:	SCREEN SLOT SIZE: 1mm & Geowrap

BOREHOLE CONSTRUCTION	SAMPLE NUMBER	SAMPLE TYPE	SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	DESCRIPTION	COMMENTS
					10			
	TPH, Metals	Disturbed	SPT 8 n=>50				Dry, very stiff to hard, grey to dark grey, slightly silty CLAY (intact), some orange (iron oxide) staining, occasional shell fragments.	NVO
				Dry	11.0			
			SPT 9 n=>50					
					12.0		Borehole terminated at 11.8mbgl, well installed at 11.5mbgl..	
					13.0			
					14.0			
					15.0			
					16.0			
					17.0			
					18.0			
					19.0			
					20.0			

LOCATION / NOTES:

NVO - No Visual or Olfactory evidence of contamination.

GPS Location - 9371576.6
4453378.3

LEGEND

- ⊠ Disturbed Sample
- ■ Undisturbed Sample
- * Headspace Analysis
- † Down Borehole Analysis
- ▼ Groundwater Table
- ▽ Perched Water Table

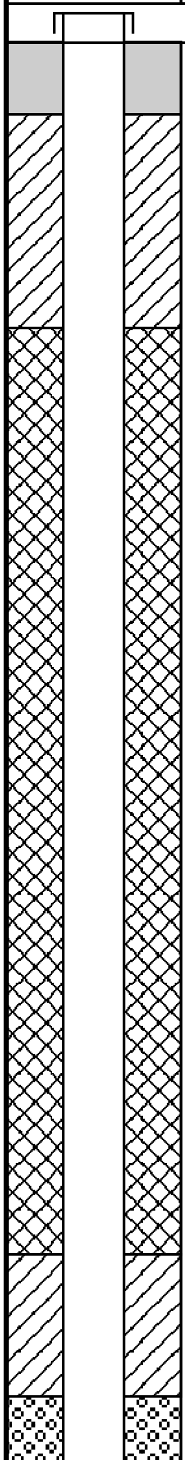
BOREHOLE LOG

Job Title: Terrestrial Soil and Groundwater Survey
Location: SANGACHAL, AZERBAIJAN
Client: BP

URS
Dames & Moore
O'Brien Kreitzberg
Thorburn Colquhoun

App'd:	Drawn:	Date:
ED	DH	JUNE 2001
		Ref: ED/DH/LON
Scale: AS SHOWN		Job No: 27527-064-401
Drg. Size: A4		BOREHOLE LOG

BOREHOLE NUMBER: **BHURS6**	PAGE **1** OF **2**
DRILLING DATES: 31/05/2001	DRILLING METHOD: Continuous Flight H.S Auger
DRILLER: Tekar	BOREHOLE DIAMETER: 200mm
LOGGED BY: ED	SCREEN TYPE & DIAMETER: 50mm PVC
CHECKED BY:	SCREEN SLOT SIZE: 1mm & Geowrap



SAMPLE NUMBER	SAMPLE TYPE	SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	DESCRIPTION	COMMENTS
				0	Dry, loose, light brown sandy SILT.	NVO
					Dry, light brown, slightly clayey, fine sandy SILT. Some gypsum in powder form,	NVO
		0 SPT 1 n=50		1.0		
		0 SPT 2 n=>50		2.0		
					getting darker with depth.	
TPH, Metals, BTEX, PAH	Disturbed	0 SPT 3 n=39		3.0		
		0 SPT 4 n=51		4.0	Dry, very stiff, light brown-brown, slightly fine sandy silty CLAY (intact). Laminated with organic carbon and gypsum in powder form,	NVO
		0 SPT 5 n=34		5.0		
					mottled grey-brown,	
					occasional shell fragments.	
		0		6.0		
		0 SPT 6 n=49		7.0	Dry, very stiff, laminated grey-brown silty CLAY (fissured), much organic carbon laminations,	NVO
					occasional fine sand seam (oxidised),	
		0 SPT 7 n=>50		8.0	occasional shell fragments,	
		0		9.0		
					occasional fine to medium sand seam, much shell fragments.	
TPH	Disturbed	0		10.0		

LOCATION / NOTES:

NVO - No Visual or Olfactory evidence of contamination.

GPS Location - 9370451.5
4450520.5

LEGEND

- Disturbed Sample
- Undisturbed Sample
- * Headspace Analysis
- Down Borehole Analysis
- Groundwater Table
- Perched Water Table

BOREHOLE LOG

Job Title: Terrestrial Soil and Groundwater Survey

Location: SANGACHAL, AZERBAIJAN

Client: BP

URS
Dames & Moore
O'Brien Kreitzberg
Thorburn Colquhoun

App'd:	Drawn:	Date:
ED	DH	JUNE 2001
		Ref: ED/DH/LON
Scale: AS SHOWN		Job No: 27527-064-401
Drg. Size: A4		BOREHOLE LOG

BOREHOLE NUMBER: **BHURS6**	PAGE **2** OF **2**
DRILLING DATES: 31/05/2001	DRILLING METHOD: Continuous Flight H.S Auger
DRILLER: Tekar	BOREHOLE DIAMETER: 200mm
LOGGED BY: ED	SCREEN TYPE & DIAMETER: 50mm PVC
CHECKED BY:	SCREEN SLOT SIZE: 1mm & Geowrap

BOREHOLE CONSTRUCTION	SAMPLE NUMBER	SAMPLE TYPE	SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	DESCRIPTION	COMMENTS
	Metals				10			
					11.0		Dry, very stiff to hard, brown-greyish brown, slightly silty to fine sandy CLAY)intact), occasional crystals - probably gypsum, occasional shell fragments, some orange (Iron oxide) staining, some organic carbon.	NVO
					12.0			
	TPH, Metals			Dry	13.0		Dry, very hard, calcium carbonate EVAPORITE	NVO Dry, groundwater not encountered.
							Borehole terminated at 13.5mbgl.	
					14.0			
					15.0			
					16.0			
					17.0			
					18.0			
					19.0			
					20.0			

LOCATION / NOTES:

NVO - No Visual or Olfactory evidence of contamination.

GPS Location - 9370451.5
4450520.5

LEGEND

- Disturbed Sample
- Undisturbed Sample
- * Headspace Analysis
- Down Borehole Analysis
- Groundwater Table
- Perched Water Table

BOREHOLE LOG

Job Title: Terrestrial Soil and Groundwater Survey
Location: SANGACHAL, AZERBAIJAN
Client: BP

URS
Dames & Moore
O'Brien Kreitzberg
Thorburn Colquhoun

App'd:	Drawn:	Date:
ED	DH	JUNE 2001
		Ref: ED/DH/LON
Scale: AS SHOWN		Job No: 27527-064-401
Drg. Size: A4		BOREHOLE LOG

FINAL REPORT

Shah Deniz Stage 1 Technical
Appendix 11

FAUNA and FLORA

BP EXPLORATION (CASPIAN SEA) LTD
BAKU, AZERBAIJAN

UF

URS Dames & Moore
Nizami 86, Apt. 7
Baku, Azerbaijan
Tel: (99412) 93 4116
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Contents

1 Overview

The Technical Appendix describes the approach used in gathering baseline data, with respect to specific environmental parameters, for the Environmental and Social Impact Assessment (ESIA) of the Shah Deniz Stage 1 Gas Export Project. A review of past assessment documents focussing on the Sangachal area highlighted a lack of site-specific information. The Shah Deniz Stage 1 Gas Export Project ESIA data gathering process was designed to provide sufficient data to properly inform the ESIA process.

The various studies were undertaken by URS however they were conducted in association with, and often carried out by, members of the Azerbaijani scientific community, who were involved in both the design and implementation of study processes. This enabled the existing expert knowledge of the local area and its characteristics to be utilised for the ESIA process.

Methodologies for data collection were implemented in order to:

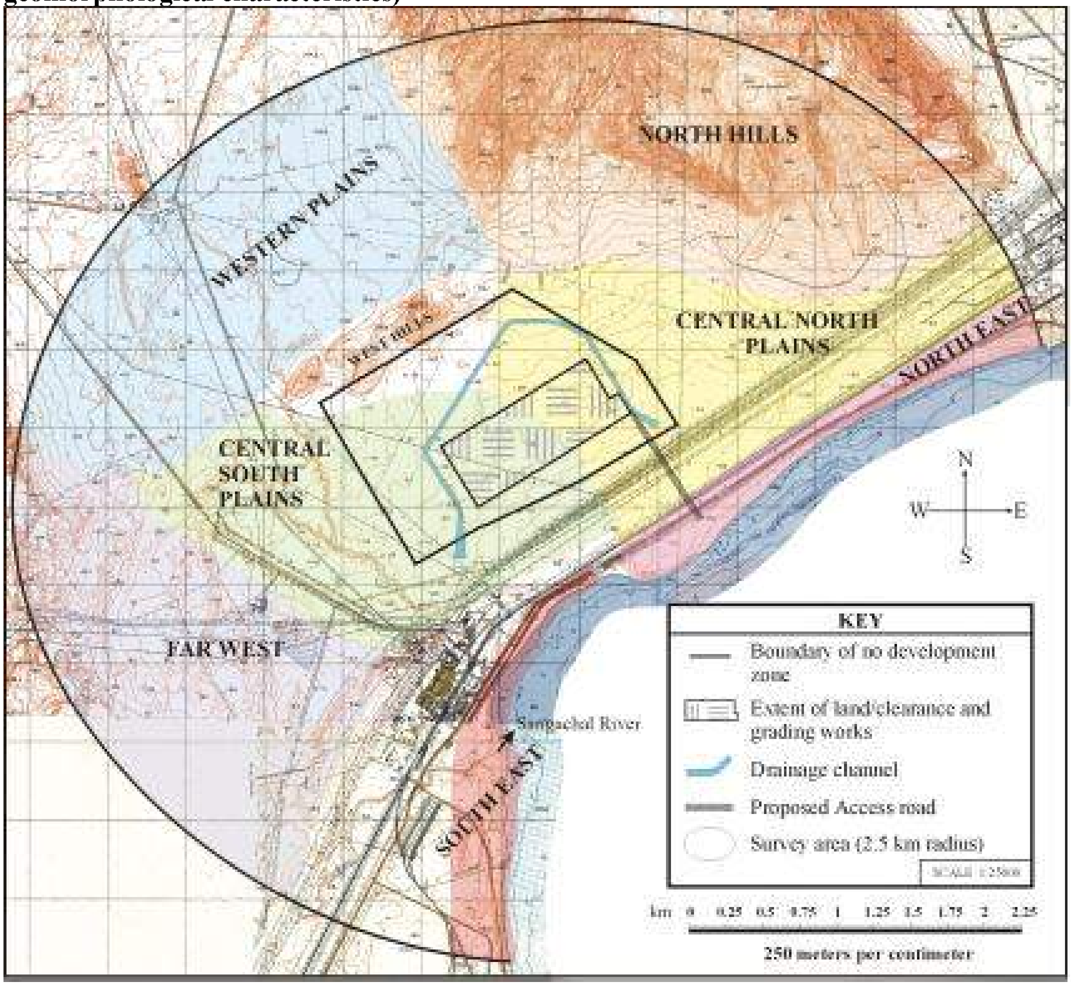
- Increase site specific information regarding a number of environmental parameters
- Account for any activities not planned within the early engineering documents

2 Introduction

To describe the coastal and terrestrial biological resources of the Sangachal area, a thorough review of available secondary data sources was undertaken in order to identify data gaps and the scope out the necessary studies to address these gaps. The following sections contain the proformas used to collect and summarise the baseline information along with the resulting technical reports. The proformas and reports cover surveys conducted in May-June 2001 of the coastal and inland terrestrial environment. The scientific experts involved in the studies in order to ensure the information gathered was applicable to the ESIA process generally provided technical reports as templates for completion.

The study area comprised the coastal and inland terrestrial environment within a five kilometre radius of the existing Early Oil Production (EOP) terminal (Figure 1 overleaf). This area, although considerably larger than BPs anticipated 'ecological footprint' for both construction and operation of the ACG Phase 1 and SD Stage 1 developments, was chosen to account for uncertainties (exact facilities, locations, methods of construction etc.) particularly during the construction phase. In addition, this larger area contributed to a good understanding of current environmental conditions.

Figure 1 Geographic location and extent of survey sectors (defined primarily on geomorphological characteristics)



The environmental parameters investigated are listed below. For each of these, the particular methodologies by which they were investigated are outlined and the results provided. The area chosen was studied on foot; walking at a comfortable pace of 1-2.5 km/hr and using a series of transect lines where appropriate.

1. Botany – habitats and characteristics
2. Mammals (Mammalia)
3. Herpetofauna – Reptiles (Reptilia) and Amphibians (Amphibia)
4. Avifauna – Birds (Aves)

3 Botany

3.1 Introduction

The botanical survey was undertaken over a period of four days (04-6-01 to 07-6-01). The individuals involved and their affiliation are listed below.

Individual	Expertise	Affiliation
Vahid Hajiyev	Higher plants	Azerbaijan Institute of Botany Director
Sevda Alverdiyeva	Lower plants	Azerbaijan Institute of Botany
Vugar Kerimov	Higher plants	ASPI

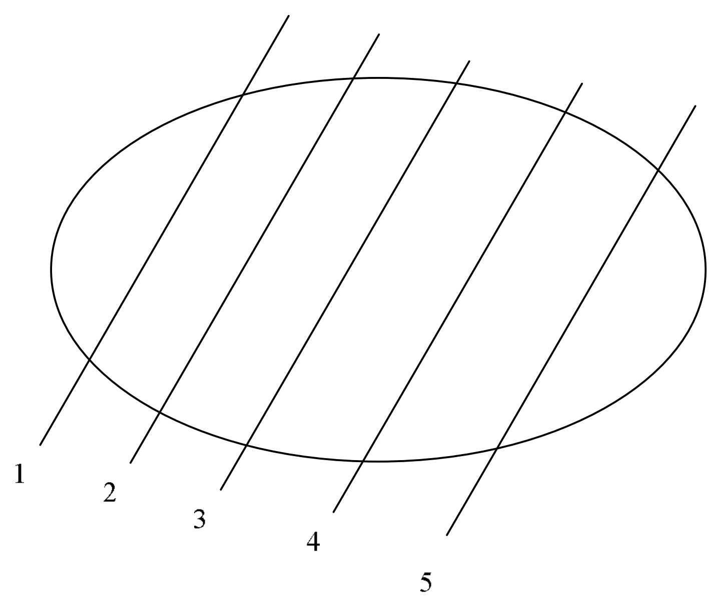
A URS consultant and translator accompanied the specialists listed above.

3.2 Methodology

The following methodology was used for the botanical survey.

3.2.1 Parallel-line search

A parallel-line search is the most appropriate method for assessing the presence of visible species in reasonably small areas. An example of a study area and transects to be walked are shown below.



The botanists involved in the data collection process were provided with maps defining the study area and the transects to be walked. If the participating scientists concluded that further assessment along the same transect would yield little, if any, new information they moved on to a new transect. For each transect walked, information regarding higher or lower plant species was gathered, depending on the specialisation of the scientist involved. The transect proforma used for the flora survey included the following parameters:

- transect #;
- transect portion (GPS coordinates necessary at each significant change in vegetative composition);
- habitat or habitat range (which section of each transect);
- name and floristic description including diagnostic and dominant species
- regional/global extent; and
- physiognomic and floristic classifications: class, subclass, group, subgroup, formation, alliance, and association, as well as families, genera, and species.

An assessment of the difficulties of type recognition, such as gradual transitions to other types, or other difficulties in identification was also made where appropriate.

3.2.2 Sample plots

Each survey day two or more Two m² quadrants were selected within which to record all higher plant species and the numbers of these present. Two m² was chosen as the plot area due to the low herbaceous nature of the vegetation typical of the study area. Stakes were used to mark off each quadrant. Care was taken to choose sample plots representative of the habitat being sampled. The Domin scale of cover-abundance was used, as illustrated in the Table 1, for each higher plant species identified in the sample plot.

Table 1 Domin scale of cover-abundance

+	One individual, reduced vigor
1	Rare
2	Sparse
3	<4%, frequent
4	5-10%
5	11-25%
6	26-33%
7	34-50%
8	51-75%
9	76-90%
10	91-100%

A photo and GPS co-ordinates were taken of each sample plot chosen and the data entered onto a proforma as illustrated in Table 2.

Table 2 Sample Plot Data Proforma

Date	**Transect number**	**Quadrant location (GPS)**	***Photo id#***	**Family**	***Genus species***	**Number of individuals**	**Domin Scale #**

3.2.2.1 Azeri Red Data Book/IUCN Red List Species

Any Azerbaijan Red Data Book or IUCN Red List species identified was recorded accompanied by:

- a photograph;
- GPS co-ordinate; and
- number of individuals identified

3.3 Reporting

Reporting consisted of completed data sheets and the results of any necessary laboratory work. Reports, in Russian and Azeri, were submitted to URS Dames & Moore, both on paper and in electronic form, for review within a specified time period. Any necessary changes identified as a result of the review were incorporated and a final report submitted to URS. Photographs, were appropriate, included the following information:

- Roll and photo number
- Date and time taken
- Species in photo
- GPS co-ordinates where appropriate

The filled-in proformas and recommendations from the scientists involved can be found in Appendix A.

4 Mammals and Herpetofauna

4.1 Introduction

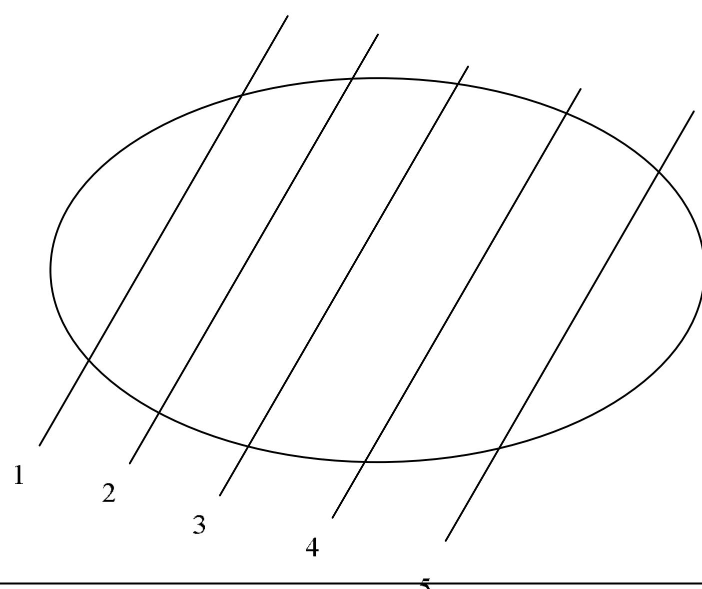
The survey to identify mammals, reptiles, and amphibians was undertaken over a period of three days and one night (11-6-01 to 13-6-01 and 14-6-01, respectively). The individuals involved and their affiliation are listed below.

Individual	Expertise	Affiliation
Irina Rakhmatilina	Mammals	Azerbaijan Institute of Sciences, Department of Zoology
Svetlana Jafarrova	Herpetofauna	Azerbaijan State University
Nijat Hansanov	Zoology	ASPI

Two URS consultants accompanied the specialists listed above.

4.2 Methodology

A parallel-line search is the most appropriate method for assessing the presence of visible species in reasonably small areas. An example of a study area and transects to be walked are shown below.



Field teams were instructed to begin at transect #1 and walk to the end of the final transect as determined by GPS coordinates. The walking pace adopted was comfortable and consistent. For each transect walked the following information was logged on a field data sheet as illustrated in Table 3.

- Date/time for each transect start
- Fauna species recorded as seen, along with the time at which seen
- If another individual of an already documented species was seen, another time mark was logged on the appropriate transect data sheet.
- Time for each transect end point

Table 3: Field Data Sheet

Date				
Individual				
Transect # X				
Start time				
End time				
Genus species	**Time seen**	**Time seen**	**Time seen**	**Time seen**

For final data consolidation, the following format was used:

Table 4: Data consolidation

Species	Associated habitat (GPS range)	Number seen				Total
		Transect 1	Transect 2	Transect 3	Transect X	

4.2.1 Azeri Red Book/IUCN Red List Species

For any rare or threatened species documented, the following format was used.

Table 5: Rare species encountered

Threatened species present	Azeri Red Book Inclusion?	IUCN inclusion?	IUCN threat category if relevant.	Area most common in
Genus species				

4.2.2 Night-time survey

A nighttime survey was undertaken in order to ensure that all species of mammals and herpetofauna, nocturnal as well as diurnal, were recorded. Due to time constraints placed on the nighttime survey, a smaller area than that used for the daytime survey was chosen. The area chosen was also specifically chosen as an area where bat activity could be expected to occur for at least some of the bat species in the area. Mist nets were used for the capture and subsequent identification of hard to see small mammals. Any trapped mammals were handled safely and released following identification.

The following format was used to log data for the live traps.

Table 6: Live trap data

Participant						
Starting Time						
Completion Time						
	Live Trap Size		**GPS Coordinates**	**entrapped group**	**biotope**	**sex**

The following data was logged data for bats caught in the mist nets.

- Catch time
- Net number
- Species
- Sex
- Weight
- Age
- Antibrachium (forearm) length
- Ring number

4.3 Reporting

Reporting consisted of completing data sheets. Reports, in Russian and Azeri, were submitted to URS Dames & Moore, both on paper and in electronic form, for review within a specified time period. Any necessary changes identified as a result of the review were incorporated and a final report submitted to URS. Photographs, where appropriate, included the following information:

- Roll and photo number
- Date and time taken
- Species in photo
- GPS co-ordinates where appropriate

In addition reports contained a brief outline long-term monitoring plan within the context of the area surveyed.

The completed proformas and reports generated by the scientists involved can be found in Appendix B.

5 Avifauna

5.1 Introduction

The primary goal in this baseline study was to identify important breeding and visiting bird species and to map the areas they preferentially occupy.

The ornithological survey was undertaken over a period of four days (28-5-01 to 31-5-01). The individuals involved and their affiliation are listed below.

Individual	Expertise	Affiliation
Ilyas Babayev	Ornithologist	Azerbaijan Academy of sciences, Zoology department
Elchin Sultanov	Ornithologist	Azerbaijan Academy of sciences, Ornithology department
Simon Aspinall	Ornithologist	Independent consultant

Two URS consultants accompanied the specialists listed above.

5.2 Methodology

5.2.1 Breeding bird census

The field team walked line transects recording all species within a fixed distance. For convenience, this area was subdivided, mainly on geomorphological grounds, into seven smaller areas (Figure 1). Single morning or afternoon visits were made to pre-chosen areas during 28-31/5/01 inclusive. Morning surveys commenced between 0800 and 0830 and concluded around midday. Afternoon surveys were conducted between c1400 and 1730.

Ideally, two visits were made to each pre-chosen site, starting at dawn and continuing for three-four hours each day, and when possible, or preferable, censused the entire site once, rather than to make a second visit to each site. This depended on numbers of birds found, ease of access and the weather, amongst other variables.

The team counted and mapped where appropriate the distribution of breeding species in the study area. In addition, the survey team recorded pairs, territorial (i.e. singing) males and any evidence indicative of breeding nearby e.g. collecting nesting material, food carrying, alarming, distraction display etc. A GPS was used to record the transects walked and elsewhere where appropriate.

5.2.2 Migrant species

All migrant species and their population sizes were recorded. These were recorded at the same time as the breeding survey as well as at other times. Survey work during the middle of the day concentrated on waterfowl.

The ornithologists filled in the following proforma.

Table 6: Species encountered

SITE NAME: Start coordinates:
End coordinates:

DATE: TIME - Start: OBSERVER:
End:

Species	No.	Sex	Activity	GPS coord.	Notes
Latin name		Male, female, unknown	Song, food-carrying display, distraction	N E	e.g. flew west calling

5.3 Reporting

Reporting consisted of filling in the proforma provided above. This proforma was completed by the team and consolidated into the format as provided in Table 7.

Table 7: Bird Species Encountered*
(All figures refer to minimum number of pairs or occupied territories).

Species	SE Coast	NE Coast	North Hill	Central Plain south	Central Plain north	West Hills	Western Plains
Date (a.m./p.m.)							

*areas e.g. SE coast refer to those depicted in Figure 1

A final report incorporating all the data collected by the three ornithologists can be found in Appendix C.

6 Appendix A Botany Proformas

Disclaimer

These reports have been prepared at the request of URS, by local and international experts for the sole use of BP. As such, the report represents the investigations, findings and conclusions of these individuals. Where reports were issued in a language other than English, translations were verbatim.

These reports in no way represent the views, assumptions or opinions of URS. No other warranty, expressed or implied, is made as to the professional advice included in, or contents of, these report. URS is not responsible for any liability arising out of, or in connection with, any reliance on or use of the advice or information provided.

6.1 Completed Transect Proformas

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
1	N4014600 E04947245	Wet coastal sand	Formation №1 Argusietum sibirca pp 50-60% sometimes 20-30% Dominants.		
			1.A.sibirica (L.)Dandy Low, brushy-fluffy plant with branchy rhizom, 5-30 cm high, perennial, white flowers on top of the tendril. Corona tubular conical Blossom:-V Fruit.:-VI	Azerbaijan: Samur-Devechi lowland, Caspian coast, Apsheron, Lencoran. World: Balkans, Near East, Iran Mongolia, Japan.	Fam.: Boraginaceae Juss Genus: Argusia Boehm. Species: A.sibirica ies (L.)Dandy
1	N4014996 E04947183	Salt argillaceous soil (semidesrt)	Formation №2 Artemisietum tschernieviana pp. 75-80% Dominants		
			1. A.tschernieviana Bess. Subshrub, height 50-75 cm Stem and leaves fluffy. Branches faceted, striated. Lives linear, pointed. Baskets egg-like. Inflorenscence paniculate. Blossom: -IX Fr.: -X-XI	Azerbaijan: Samur-Devechi lowland, Caspian coast, Apsheron, Kura-Araz lowland, Lencoran. World: Balkans, Near East.	Fam.: Asteraceae Dumort. Gen: Artemisia L. .Species: A.tschernieviana Bess.

[1] GPS coordinates necessary at each significant change in vegetative composition
[2] including diagnostic and dominant species
[3] class, subclass, group, subgroup, formation, alliance, and association, as well as families, genera, and species

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
			2. A.pseudalhagi (Bieb.) Fish. et Mey. Perennial, 60 cm high. Deep rooted. Light green naked plant. Straight stem, oblong obtuse leaves, flowers on leave fistula. Bell. Corona pink-reddish Blossom: -VI Fr.: -VIII-IX	Azerbaijan: Major Caucasus (Guba zone), Samur-Devechi lowland, Caspian coast, Apsheron, Kura zone. World: Near East.	Fam.- Fabaceae Lindl. Gen- Alhagi Gagneb. Spec.- A.pseudalhagi (Bieb.) Fish. et Mey.
1	N4015014 E04947178	Argillaceous sand	Formation №3 Alhagetum pseudalhagi, pp 60-70% Dominants		
			1. A.pseudalhagi (Bieb.) Fish. et Mey. Perennial, reaches 60 cm. Deep rooted. Light green naked plant. Straight stem, oblong obtuse leaves, flowers on leave fistula. Bell. Corona pink-reddish Blossom: -VI Fr.: -VIII-IX	Azerbaijan: Major Caucasus (Guba zone), Samur-Devechi lowland, Caspian coast, Apsheron, Kura zone. World: Near East.	Fam.- Fabaceae Lindl. Gen- Alhagi Gagneb. Sp.- A.pseudalhagi (Bieb.) Fish. et Mey.
			2. S. dendroides (Fish. et Mey).Moq. Low, 50 cm, subshrub with branches protruding from base. Periodical leaves, semicylinder flowers by 2-6 or more in balls in leave fistula. Black oval glittering semen Blossom.- V Fr.- VI	Azerbaijan: Absheron, Gobustan, Caspian coast, Kura-Araz lowl., Kura zone, Nakhichevan valley World: Caucasus, European part FSU	Fam.-Chenopodiaceae Vent. Gen.- Suaeda Forssk. Spec.- S. dendroides (Fish. et Mey).Moq.
1	N4015026 E04947179	Wet coastal sand	Formation №4 Juncusetum acutus pp– 70-80% Dominant		

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
			1. J. acutus L. Dark green perennial, branches from base, 1 m high. Bushy smooth stems, pricky top. Cylindre leaves with pricky tops. Flowers gather in short compact oval paniculate inflorenscence Blossom.- V Fr.-VII-VIII	Azerbaijan: Samur-Devechi lowland, Apsheron, Kura-Araz lowland, Lenkoran lowl., World: Atlantic Europe, Mediterranean, N.Iran	Fam.- Juncaceae Juss. Gen- Juncus L. Sp.- J. acutus L.
			2. Ph. australis (Cav.)Trin. 2 m high perenial. Rhizome of long underground shoots. Wide up to 2 cm bluish rigid leaves. Panicle 6-20 cm high, pyramidal . Anther violet, pinnate, reddish Blossom.- VII Fr..- IX	Azerbaijan: Almost anywhere but for high mountain.zones. World: Warm and moderate belts but for Arctic.	Fam:- Poaceae Barnhard. Gen: - Phragmitec Adams. Spec.:- Ph. australis (Cav.)Trin.
	N4015048 E04947181	Wetland. Coastal sand	Formation №5 Phragmitesum australis pp 80-90% Dominant		
			1. Ph. australis (Cav.)Trin. 2 m high perenial. Rhizome of long underground shoots. Wide (up to 2 cm) bluish rigid leaves. Panicle 6-20 cm high, pyramidal . Anther violet, pinnate, reddish Blossom.- VII Fr..- IX	Azerbaijan: Almost anywhere but for high mountain.zones. World: Warm and moderate belts but for Arctic.	Fam:- Poaceae Barnhard. Gen.: - Phragmitec Adams. spec.:- Ph. Australis (Cav.)Trin.
1	N4015264 E04947056	Argillaceous sand, alluvial soils	Formation №6 Tamarixetum meyeri pp 50-60% Dominant		
			1. T. meyeri Boiss. Naked, bluish grey shrub of brown greyish bark. Spear-shaped coming down leaves. Clusters lateral cylindrical, 3-9mm wide. Bracts blunt, 1-2mm long. Corona bell-like. Petals pink, egg-like, straight. Boll 3-5 cm long Fr.- V. Blossom.- IV	Azerbaijan: Major Caucasus (Guba zone), Steppe plato, Kura-Araz lowl., Nakhichevan valley, alluvial soils World: Eastern Mediterranean, Balkans, Near East, Iran	Fam:- Tamaricaceae Link. Gen:- Tamarix L. Sp.:- T. meyeri Boiss.

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
			2. C. bakuense Litv. 1.5c m high shrub with protruding branches. Small filiform leaves 2-4 mm long early falling down. Flowers come in bunches by 2-5. Fruit oval. Blossom.- V Fr.- VI	Azerbaijan: Apsheron, Kura-Araz lowl., (Sangachal) World: Eastern Caucasus. Azerbaijan endemic	Fam:- Polyganaceae Juss. Gen:- Callugonum L. Spec.:- C. bakuense Litv.
		Bark of Calligonum bakiense Nitr.	Xanthoria parietina (L.) Th. Fr. Thallus laciniated, orange-yellow. Apothecia superficial, almost adjoining or with short petioles, of yellow-orange-reddish flat disc. Polymorphic. Widely spread in Azerbaijan in parks, gardens, forests, roofs and so forth. Settles on bark, rocks, moss.	In Azerbaijan 110 habitats Europe, Asia, N.America, Tasmania, Antarctics	Class: Ackolichenes Teloschistaceae Xanthoria (L.)Beltr. X. parietina (L.) Th. Fr.
		Bark of Calligonum bakiense Nitr.	Physcia adscendens (Fr.) Oliv. Whitish-greyish thallus, laciniates adjoin substatum weakly, more dispersed, cilia on edge. On samples taken apothecia abscent. Settles on bark, moss rocks. Widely spread	In Azerbaijan 38 habitats Europe (Switzland, Norway, Finland, Dane) Asia,.Americas	Physciaceae Physcia (Ach.)Wain. P. adscendens (Fr.) Oliv
		Bark of Lucium uuthenicum Murr.	Caloplaca holocarpa (Hoffm.) Wade Thallus of whitish or ashy thin crust, sometimes barely visible. Apothecia numerous, independent or twisted. Slightly concaved or flat disc, yellow or orange yellow. Settles on bark or rocks. Widely spread.	In Azerbaijan 54 habitats Europe, N&C America, New Zealand	Teloschistaceae Caloplaca Th. Fr. C. holocarpa (Hoffm.) Wade
1	N4017832 E04947715	Wet coastal sand	Formation №7 Argusietum sibirica Pp 50-60% Dominants		
			1.A.sibirica (L.)Dandy Low, brushy-fluffy plant with branchy rhizom, 5-30 cm high, perennial, white flowers on top of the tendril. Corona tubular conical Blossom:-V Fruit.:-VI	Azerbaijan: Samur-Devechi lowland, Caspian coast, Apsheron, Lencoran. World: Balkans, Near East, Iran Mongolia, Japan.	Fam.: Boraginaceae Juss Gen: Argusia Boehm. Spec.: A.sibirica (L.)Dandy
			2. L. ruthenicum Murr. Shrub of protruding branches which are whitish and prickly. Leaves linear-bladed, naked, narrow at base. Flowers come in bunches on peduncles. Corona violet with egg-like blades. Bacca black. Blossom.- V Fr.- VII 2	Azerbaijan: Caspian coast, Apsheron, Kura-Araz lowland, Kura valley, Nakhichevan Valley. World: Minor Caucasus, Iran, Dj-Kashk., Mongolia, Tibet	Fam:- Solanaceae Juss. Gen:- Lycium L. Spec.:- L. ruthenicum Murr.

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
	N4017832 E04947715	Wet coastal sand	Formation №8 Argusietum sibirica Pp 70-80% Dominants		
			1.A.sibirica (L.)Dandy Low, brushy-fluffy plant with branchy rhizom, 5-30 cm high, perennial, white flowers on top of the tendril. Corona tubular conical Blossom:-V Fruit.:-VI	Azerbaijan: Samur-Devechi lowland, Caspian coast, Apsheron, Lencoran. World: Balkans, Near East, Iran Mongolia, Japan.	Fam.: Boraginaceae Juss Gen: Argusia Boehm. Spec.: A.sibirica (L.)Dandy
			2. J. acutus L. Dark green perennial, branches from base, 1 m high. Bushy smooth stems, pricky top. Cylindre leaves with pricky tops. Flowers gather in short compact oval paniculate inflorenscence Blossom.- V Fr.-VII-VIII	Azerbaijan: Samur-Devechi lowland, Apsheron, Lencoran lowl., Kura-Araz lowl. World: Atlantic Europe, Mediterranean, N.Iran	Fam.- Juncaceae Juss. Gen- Juncus L. Spec.- J. acutus L.
			3. T. meyeri Boiss. Naked, bluish grey shrub of brown greyish bark. Spear-shaped coming down leaves. Clusters lateral cylindrical, 3-9mm wide. Bracts blunt, 1-2mm long. Corona bell-like. Petals pink, egg-like, straight. Boll 3-5 cm long Fr.- V. Blossom.- IV	Azerbaijan: Major Caucasus (Guba zone), Steppe plato, Kura-Araz lowl., Nakhichevan valley, alluvial soils World: Eastern Mediterranean, Balkans, Near East, Iran	Fam.:- Tamaricaceae Link. Gen:- Tamarix L. Spec.:- T. meyeri Boiss.
1	N4017913 E04947825	Wet coastal sand	Formation №9 Argusietum sibirika + Canvolvus persica L. Pp 60-70% Dominants		
			A.sibirika (L.)Dandy Low, brushy-fluffy plant with branchy rhizom, 5-30 cm high, perennial, white flowers on top of the tendril. Corona tubular conical Blossom:-V Fruit.:-VI	Azerbaijan: Samur-Devechi lowland, Caspian coast, Apsheron, Lencoran. World: Balkans, Near East, Iran Mongolia, Japan.	Fam..: Boraginaceae Juss Gen.: Argusia Boehm. Spec.: A.sibirica (L.)Dandy.

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications [3]
			2. C. persicus L. Perennial whitish brushy plant. Rhizome branchy, stems abundant in leaves, straight, erect or creeping. Short base, thick, ellipsoid leaves. Flowers in leave fistula in uniflorous polyumbels. Corona white funnel-shaped with 5 wooly strips. Blossom - V Fr- VI-VII	Azerbaijan: Samur-Devechi lowland, Caspian lowl., Apsheron, Lencoran lowl., Kura-Araz lowl., World: Caspian coast, Balkans, Near East, Iran	Fam:- Convolvuleceae Juss. Gen:- Canvolvus L. Sp.:- C.persicus L.
1	N4018307 E04948451	Argillaceo us sand	Formation № 10 Lucium ruthenicum Pp 30-35% Dominant		
			1. L. ruthenicum Murr. Shrub of protruding branches which are whitish and prickly. Leaves linear-bladed, naked, narrow at base. Flowers come in bunches on peduncles. Corona violet with egg-like blades. Bacca black. Blossom.- V Fr.- VII 2	Azerbaijan: Caspian coast, Apsheron, Kura-Araz lowland, Kura valley, Nakhichevan Valley. World: Minor Caucasus, Iran, Dj-Kashk., Mongolia, Tibet	Fam:- Solanaceae Juss. Gen:- Lycium L. Sp.:- L. ruthenicum Murr.
			2. A.pseudalhagi (Bieb.) Fish. et Mey. Perennial, reaches 60 cm high. Deep rooted. Light green naked plant. Straight stem, oblong obtuse leaves, are flowers on leave fistula. Bell. Corona pink-reddish Blossom: -VI Fr.: -VIII-IX	Azerbaijan: Major Caucasus (Guba zone), Gobustan, Samur-Devechi lowland, Caspian coast, Apsheron, Kura zone. World: Near East. .	Fam.- Fabaceae Lindl. Gen- Alhagi Gagneb. Sp.- A.pseudalhadi. (Bieb.) Fish. et Mey
2	N4020528 E04948973	Argillaceo us solonchak.	Formation №11 Salsoletum nadulosa + Suaeda dendroides Pp 50-60% Dominants.		

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
			1. S. nadulosa (Moq.)Iljin. Low, 10-30cm, shrub of heavily protruding branches of greyish scales. Buds almost globular, greyish. Leaves periodical, short, triangular-lanceolate, gibbous at the bottom. Flowers singular, in bushy spiciform inflorescence. Fruits with bud-shaped red or orange wings. Blossom.-VII Fr.-VIII	Azerbaijan: Casp.lowland., Apsheron, Gobustan, Steppe plato, Kura-Araz lowl., Nakhichevan valley World: Caucasus, European FSU	Fam.- Chenopodiaceae Vent Gen-. Salsola L. Sp.- S. nadulosa (Moq.)Iljin.
			2. S. dendroides (Fish. et Mey).Moq. Low subshrub with branches protruding from base, 50 cm. Periodical leaves, semicylindric flowers by 2-6 or more in balls in leave fistula. Black oval glittering semen Blossom.- V Fr.- VI	Azerbaijan: Casp.lowland., Apsheron, Gobustan, Steppe plato, Kura-Araz lowl., Kura lowl., Nakhichevan valley World: Caucasus, European part FSU	Fam.-Chenopodiaceae Vent. Gen- Suaeda Forssk. Sp- S. dendroides (Fish. et Mey).Moq.
			3.S. ericoides Bieb. Low, heavily branched shrub 30-60 cm high of bushy branches. Leaves periodical, succulent, semicylindrical, widely rounded, bended. Fruits with wide or not so wide wings. Blossom:- VI Fr.:- VII	Azerbaijan: Casp.lowland., Apsheron, Gobustan, Steppe plato, Kura-Araz lowl., Nakhichevan valley World: Minor Caucasus	Fam.-Chenopodiaceae Vent. Gen- Salsola L. Sp.: S. ericoides Bieb.
			3. H. strobilaceum (Pall) Bieb. Small heavily branched subshrub with erecting branches. Branches bluish, naked, with semiglobular buds. Leaves accumbent, underdeveloped, of two blades. Flowers come by 3 in fistulas of succulent fore- florets Blossom. -VIII Fr.- X	Azerbaijan: Shirvan, Mugan, Salyan steppe Minor Caucasus	Fam.-Chenopodiaceae Vent. Gen- Holosnemum Bieb. Sp.: H. strobilaceum (Pall)Bieb.

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
2	N4020939 E04948523	Argillaceo us solonchak and semidesert	Formation №12 Artemisetum fragrans Pp 40-50% Dominants.		
			1. .S. nadulosa (Moq.)Iljin. Low, 10-30cm, shrub of heavily protruding branches of greyish scales. Buds almost globular, greyish. Leaves periodical, short, triangular-lanceolate, gibbous at the bottom. Flowers singular, in bushy spiciform inflorescence. Fruits with bud-shaped red or orange wings. Blossom.-VII Fr.-VIII	Azerbaijan: Casp.lowland., Apsheron, Gobustan, Steppe plato, Kura-Araz lowl., Nakhichevan valley World: Caucasus, European FSU	Fam.- Chenopodiaceae Vent Gen-. Salsola L. Sp.- S. nadulosa (Moq.)Iljin.
			2. S. dendroides (Fish. et Mey).Moq. Low subshrub with branches protruding from base, 50 cm. Periodical leaves, semicylindric flowers by 2-6 or more in balls in leave fistula. Black oval glittering semen Blossom.- V Fr.- VI	Azerbaijan: Absheron, Gobustan, Caspian coast, Kura-Araz lowl., Kura zone, Nakhichevan valley World: Caucasus, European part FSU	Fam.-Chenopodiaceae Vent. Gen- Suaeda Forssk. Sp.- S. dendroides (Fish. et Mey).Moq.
2	N4021505 E04947950	Argillaceo us solonchak and semidesert	Formation №13 nadulosa Pp 40-50% Dominant		
			1.S. nadulosa (Moq.)Iljin. Low, 10-30cm, shrub of heavily protruding branches of greyish scales. Buds almost globular, greyish. Leaves periodical, short, triangular-lanceolate, gibbous at the bottom. Flowers singular, in bushy spiciform inflorescence. Fruits with bud-shaped red or orange wings. Blossom.-VII Fr.-VIII	Azerbaijan: Casp.lowland., Apsheron, Gobustan, Steppe plato, Kura-Araz lowl., Nakhichevan valley World: Caucasus, European FSU	Fam.- Chenopodiaceae Vent Gen-. Salsola L. Sp.- S. nadulosa (Moq.)Iljin.
2	N4021545 E04947950	Argillaceo us solonchak	Formation №14 Salsoletum dendroides Pp 60-65% Dominant		

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
			1.S. dendroides Pall. Subshrub, 40-70 cm high, with dense lowered stems of branches in the upper part. Light green plant. Leaves periodical, fleshy, short, adjoining stem, bluntish. Flowers on spiciform branches in wide paniculate pyramidal inflorescence. Fruit of yellowish or pink wings. Blossom. –VII Fr. –IX	Azerbaiajn: All mountains and lowlands World: Minor Caucasus, Iran	Fam:- Chenopodiaceae Vent Gen:- Salsola L. Sp.:- S. dendroides Pall.
2	N4022701 E04945331	Salt argillaceou s sand	Formation №15 Salsoletum dendroides + Tamarix meyeri Pp 45-50% Dominants		
			1.S. dendroides Pall. Subshrub, 40-70 cm high, with dense lowered stems of branches in the upper part. Light green plant. Leaves periodical, fleshy, short, adjoining stem, bluntish. Flowers on spiciform branches in wide paniculate pyramidal inflorescence. Fruit of yellowish or pink wings. Blossom. –VII Fr. –IX	Azerbaiajn: All mountains and lowlands World: Minor Caucasus, Iran	Fam:- Chenopodiaceae Vent Gen:- Salsola L. Sp.:- S. dendroides Pall.
			2. T. meyeri Boiss. Naked, bluish grey shrub of brown greyish bark. Spear-shaped coming down leaves. Clusters lateral cylindrical, 3-9mm wide. Bracts blunt, 1-2mm long. Corona bell-like. Petals pink, egg-like, straight. Boll 3-5 cm long Fr.- V. Blossom.- IV	Azerbaijan: Major Caucasus (Guba zone), Steppe plato, Kura-Araz lowl., Nakhichevan valley, alluvial soils World: Eastern Mediterranean, Balkans, Near East, Iran	Fam:- Tamaricaceae Link. Gen:- Tamarix Sp.:- T. meyeri Boiss.
			3.C. dactylon (L.)Pers. Perrenial. Rhizom long, creeping and branchy. Stem comes out of base and branchy and naked, 50cm and over. Leaves linear-spear-shaped, rigid, naked or hirsute, grey-bluish. Inflorescence of 3-8 spiciform branches palmatipartited on top of stem. Blossom -VII Fr – IX	Anywhere in Azrbaijan World: C. Europe, Balkans, Near East, Minor Caucasus, Iran, Hindo-Himalai, Djung-Kashk., Mongolia	Fam: Poaceae Barnhart. Gen: Cynodon Rich. Sp.: C. dactylon (L.)Pers.

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
		Soil	Diploschistes gupsaceus Auct. Thallus ash-white or almost white very thick crust of warty dull surface. Apothecia submerged in thallus. Disc black, often with whitish bloom, initially pointed then expanded. Thallus verge very thick, often turning over disc. Encountered on lime substratum and soil, usually in open areas. Pp 15-20%	In Azerbaijan 7 haitats Europe, Asia	Thelotremataceae Diploschistes Norm. D. gupsaceus Auct.
		Soil	Squanaria lentigera (Web.) Poelt Thallus stamineous- or olive- green with very thick whitish bloom in shape of roundish relatively poorly secured on soil rosettes. Thallus rosettes smallscaled in center, laterally of leaf-like blades. Blades wide, daedalous, with verges up. Apothecia roundish or irregularly angular, in central part of thallus. Disc yellow- or dark- brown of concave or flat, sometimes convex surface. Encountered on lime containing soils in steppe.	In Azerbaijan 26 habitats Europe, Asia, N.Africa (Algiers) , N.America	Lecanoraceae Squamarina Poelt S. lentigera (Web.) Poelt
3	N4022697 E04942385	Salt argillaceou s sand	Formation №16 Salsoletum nadulosa + Suaeda dendroides Pp 60-65% Dominants		
			1.S. nadulosa (Moq.)Iljin. Low, 10-30cm, shrub of heavily protruding branches of greyish scales. Buds almost globular, greyish. Leaves periodical, short, triangular-lanceolate, gibbous at the bottom. Flowers singular, in bushy spiciform inflorescence. Fruits with bud-shaped red or orange wings. Blossom.- VII Fr.-VIII	Azerbaijan: Casp.lowland., Apsheron, Gobustan, Steppe plato, Kura-Araz lowl., Nakhichevan valley World: Caucasus, European FSU	Fam.- Chenopodiaceae Vent Gen-. Salsola L. Sp.- S. nadulosa (Moq.)Iljin.
			2. S. dendroides (Fish. et Mey).Moq. Low, 50 cm, subshrub with branches protruding from base. Periodical leaves, semicylindric flowers by 2-6 or more in balls in leave fistula. Black oval glittering semen Blossom.- V Fr.- VI	Azerbaijan: Absheron, Gobustan, Caspian coast, Kura-Araz lowl., Kura zone, Nakhichevan valley World: Caucasus, European part FSU	Fam.-Chenopodiaceae Vent. Gen- Suaeda Forssk. Sp.- S. dendroides (Fish. et Mey).Moq.
		Soil	Squamaria lentigera (Web.) Poelt Pp 15%		
		Soil	Collema crispum (Huds.) Web. Thallus of small leaves, almost scaly, thin. Thallus blades on verges denticulated, turned up, on top greenish black or dark olive. Apothecia densely crowded on surface, of dark brown disc. Encountered on limestone rock and argillaceous soil. Pp 5%	In Azerbaijan 6 habitats Europe, Asia, Americas, N.Africa	Collemataceae (Collema)Weber C. crispum (Huds.) Web.

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
		Soil	Diploschistes gupsaceus Auct. Pp 15%		
		Soil	Fulgensia fulgens (Sw.) Elenk. Thallus in the form of light or grayish- orange, sometimes lemon yellow leaf-like rosettes. Rosettes poorly folded or flat in the center, barbed blades well developed laterally. Apotecia bright orange-yellow or brownish orange, situated only in the center of thallus. Encountered in most dry habitat on limestone, potassium or gypsum soil and moss. Scattered.	In Azerbaijan 21 habitats Europe (Mediterranea, Germany, Poland, Chek, Hungary), N.Africa, Asia, Australia, Grenland, Tasmania	Teloschistaceae Fulgensia Mass. F. fulgens (Sw.) Elenk.
3	N4020476 E04944485	Desert. Salt argillaceou s sand	Formation №17 Artemisetum frograns + Salsola dendroides Pp 60-70% Dominants		
			1.T. polium L. Grey or white felty perennial very branchy subshrub. Leaves seated, oblong or linear, small heads of paniculate or shield shaped inflorescence. Corona small, white, seeds grey and wrinkled. blossom - VII Fr- IX	Anywhere in Azerabaijan World: Mediterranean, Iran, Asia Minor, Balkans	Fam:- Lamineceae Lindl. Gen:- Teucriun L. Sp.:- T. polium L.
		Rocks	Aspicilia contorta (Hoffm.) Kremplh. Thallus whitish- or greenish grey rarely ochre tint in the form of separate or rarely close scales. Apothecia roundish or angular, come by 1 or rarely by 2-3, submerged in the scale center. Disc concave or flat, usually with whitish bloom. Predominantly encountered on limestone of low and high mountainous zones. Scattered.	In Azerbaijan 10 habitats Europe, Asia (moderate zones), Africa, N.America	Aspiciliaceae Aspicilia Mass. A. contorta (Hoffm.) Kremplh.
		Rock	Caloplaca ferruginea (Huds.) Th. Fr. Thallus ash- or dark grey crust, warty and often cracked in center, sometimes poorly developed. Apothecia numerous separate or crowded. Disc flat or slightly convex, orange or brownish red. Encountered on rock. Pp 5%.	In Azerbaijan 28 habitats Europe, Asia, N.America	Teloschistaceae Caloplaca (Huds.) Th. Fr. C. ferruginea
		Rock	Caloplaca saxicola (Hoffm.) Nord. Thallus leave-shaped yellowish- or reddish-orange rosettes. Rosettes warty or cellular in center, laterally with clear-cut leave-shaped radial blades. Thallus blades narrow, closely adnated to substratum. Apothecia numerous. Dics and thallus almos same color. Encountered on rock. Scattered	In Azerbaijan 31 habitats Europe, Asia, Africa, N&S Americas, N.Zealand	Teloschistaceae Caloplaca Th.Fr. C. saxicola (Hoffm.) Nord.

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
		Rock	Lecanora atra (Huds.) Ach. Thallus whitish or ash-grey thick warty crust with lateral black narrow strip. Apotecia roundish or irregular. Disc black, naked, with smooth or denticulated edge. Encountered on silicate and lime containing rock, rare on bark. Scattered	In Azerbaijan (?) habitats Europe, Asia, N&S Americas , Greenland, N.Zealand .	Lecanoraceae Ach. Lecanora L. atra (Huds.)
		Soil	Toninia coeruleonigricans (Leight.) Th. Fr. Thallus dark olive or grey with naked or almost completely covered with thick white bloom scales, often congested in pads. Disc black, naked or with whitish bloom. Encountered on ground and moss. Scattered	In Azerbaijan (?) habitats Europe, Asia, NAmerica (USA, Canada), C.America (Mex) Greenland, N.Zealand, N.Africa	Lecideaceae Mass. Toninia coeruleonigricans (Leight.) Th. Fr.
		Soil	Collema crispum (Huds.) Web.		
		Soil	Psora lurida (With.) DC. Thallus is formed of leaf-like overlapping scales, light or dark brown on top, lighter below. Apotecia disc reddish-brown or almost black, naked, flat or convex. Encountered on limestone soil and moss. Rare individuals	In Azerbaijan (?) habitats Europe, Asia, NAmerica (Canada), S.Africa	Lecideaceae Psora P. lurida (With.) DC.
		Soil	Diploschistes gupsaceus Auct. Покрытие 15-20%		
4	N4020837 E04945155	Rocky slopes	Formation №18 Salsoletum nadulosa + Noaea mueronata Pp 40-50% Dominants		
			1.S. nadulosa (Moq.)Iljin. Low, 10-30cm, shrub of heavily protruding branches of greyish scales. Buds almost globular, greyish. Leaves periodical, short, triangular-lanceolate, gibbous at the bottom. Flowers singular, in bushy spiciform inflorescence. Fruits with bud-shaped red or orange wings. Blossom.-VII Fr.-VIII	Azerbaijan: Casp.lowland., Apsheron, Gobustan, Steppe plato, Kura-Araz lowl., Nakhichevan valley World: Caucasus, European FSU	Fam.- Chenopodiaceae Vent Gen-. Salsola L. Sp.- S. nadulosa (Moq.)Iljin.
			2.N.mucronata (Forssk.)Aschers. Grey-bluish subshrub 20-60 cm high of short rigid branches curled on end. Leaves periodical, rigid, shield-shaped, naked or rough. Flowers single, 5 stamen, ovary with 2 stigmae. Blossom – VII Fr. – X	Azerbaijan: Major Caucasus (Guba zone), Gobustan, Samur-Devechi lowland, Caspian lowl., Apsheron, Kura valley, Steppe plato. World: Mediterranean Asia Minor, Balkans, Caucasus Minor, Iran	Fam: Chenopodiaceae Vent. Gen: Noala Moq. Sp.: N.mucronata (Forssk.) Aschers

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
		Soil	Fulgensia fulgens (Sw.) Elenk.		
		Moss	Cladonia foliaceae (Huds.) Wield. Scale of primary thallus fairly large, narrow or wide, irregularly divided, mainly flat, reyish-greenish-yellowish or grayish-greenish on top, grayish-yellowish or whitish below. No podetia. Encountered on limestone or sand soil, on moss. Single individual.	In Azerbaijan habitats Europe (Germany, Poland, Chek, Hungary), N.Africa, Asia, Australia, Grenland, Tasmania	Cladoniaceae Cladonia Wigg. C. foliaceae (Huds.) Wield.
		Soil	Diploschistes gupsaceus Auct. Pp 5%		
			Toninia coeruleonigricans (Leight.) Th. Fr. Scattered		
		Soil	Fulgensia fulgens (Sw.) Elenk. Single individual.		
		Soil	Collema crispum (Huds.) Web. . Scattered		
		Soil	Squamaria lentigera (Web.) Poelt Pp 10%		
		Soil	Diploschistes gupsaceus Auct. Pp 10%		
		Rocks	Candelariella aurella (Hoffm.) Zahlbr. Candelariella aurella (Hoffm.) Zahlbr. Thallus green or egg-yellow in the form of small grained crust. Apotecia similar color, numerous, crowded or separated. Apotecia disc slightly convex of well visible thick or thin verge. Scattered.	In Azerbaijan 34 habitats Europe, Asia, N&C Americas , Greenland, N.Zealand	Candelariaceae Candelariella Mass. C. aurella (Hoffm.) Zahlbr.
		Rocks	Caloplaca saxicola (Hoffm.) Nord Рассеяно		
		Rocks	Caloplaca citrina (Hoffm.) Th. Fr. Thalus in the form of yellow or greenish-yellow small grained or soredium crust often formed of separate cells divided by cracks. Apotecia disc orange or reddish-yellow. Encountered on rocks, sometimes on bark.	In Azerbaijan 21 habitats Europe, Asia, N&C Americas	

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
5	N4020432 E04945232	Argillaceo us sand	Formation №19 Tamsrixetum meyeri Pp 75% Dominants		
			1. T. meyeri Boiss. Naked, bluish grey shrub of brown greyish bark. Spear-shaped coming down leaves. Clusters lateral cylindrical, 3-9mm wide. Bracts blunt, 1-2mm long. Corona bell-like. Petals pink, egg-like, straight. Boll 3-5 cm long Fr.- V. Blossom.- IV	Azerbaijan: Major Caucasus (Guba zone), Steppe plato, Kura-Araz lowl., Nakhichevan valley, alluvial soils World: Eastern Mediterranean, Balkans, Near East, Iran.	Fam:- Tamaricaceae Link. Gen:- Tamarix L. S.:- T. meyeri Boiss.

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
			2.S. dendroides Pall. Subshrub, 40-70 cm high, with dense lowered stems of branches in the upper part. Light green plant. Leaves periodical, fleshy, short, adjoining stem, bluntish. Flowers on spiciform branches in wide paniculate pyramidal inflorescence. Fruit of yellowish or pink wings. Blossom. –VII Fr. –IX	Azerbaiajn: All mountains and lowlands World: Minor Caucasus, Iran	Fam:- Chenopodiaceae Vent. Gen:- Salsola L. Sp.:- S. dendroides Pall.
			3. S. dendroides (Fish. et Mey).Moq. Low, 50 cm, subshrub with branches protruding from base. Periodical leaves, semicylindric flowers by 2-6 or more in balls in leave fistula. Black oval glittering semen Blossom.- V Fr.- VI	Azerbaijan: Absheron, Gobustan, Caspian coast, Kura-Araz lowl., Kura zone, Nakhichevan valley World: Caucasus, European part FSU	Fam.-Chenopodiaceae Vent. Gen- Suaeda Forssk. Sp.- S. dendroides (Fish. et Mey).Moq.
			4. A.pseudalhagi (Bieb.) Fish. et Mey. Perennial, reaches 60 cm. Deep rooted. Light green naked plant. Straight stem, oblong obtuse leaves, flowers on leave fistula. Bell. Corona pink-reddish Blossom: -VI Fr.: -VIII-IX	Azerbaijan: Major Caucasus (Guba zone), Gobustan, Samur-Devechi lowland, Caspian coast, Apsheron, Kura zone. World: Near East.	Fam.- Fabaceae Lindl. Gen- Alhagi Gagneb. Sp.- A.pseudalhagi (Bieb.) Fish. et Mey.
5	N4020184 E04945028	Rocky mountains piedmont	Formation № 20 Alhagetum pseudalhagi + Salsola nadulosa Pp 80-85% Dominants		
			1. A.pseudalhagi (Bieb.) Fish. et Mey. Perennial, reaches 60 cm. Deep rooted. Light green naked plant. Straight stem, oblong obtuse leaves, flowers on leave fistula. Bell. Corona pink-reddish Blossom: -VI Fr.: -VIII-IX	Azerbaijan: Major Caucasus (Guba zone), Gobustan, Samur-Devechi lowland, Caspian coast, Apsheron, Kura zone. World: Near East.	Fam.- Fabaceae Lindl. Gen- Alhagi Gagneb. Sp.- A.pseudalhagi (Bieb.) Fish. et Mey.

Transect #	Transect portion [1]	Environment/ habitat	Name and floristic description [2]	Regional/global extent	Physiognomic and floristic classifications[3]
			2.S. nadulosa (Moq.)Iljin. Low, 10-30cm, shrub of heavily protruding branches of greyish scales. Buds almost globular, greyish. Leaves periodical, short, triangular-lanceolate, gibbous at the bottom. Flowers singular, in bushy spiciform inflorescence. Fruits with bud-shaped red or orange wings. Blossom.-VII Fr.-VIII	Azerbaijan: Casp.lowland., Apsheron, Gobustan, Steppe plato, Kura-Araz lowl., Nakhichevan valley World: Caucasus, European FSU	Fam.- Chenopodiaceae Vent Gen-. Salsola L. Sp.- S. nadulosa (Moq.)Iljin.
			3.A.fragrans Willd. 30-40 cm high perennial. Vertical root, lower leaves have stalk, oblong, seated, globular. Inflorescence narrow, pyramidal paniculate. Flowers yellow. Blossom:- IX-X Fr.- X-XI	Azerbaijan: Gobustan, Samur-Devechi lowland, Caspian lowl., Apsheron, Kura valley, Lencoran, Mugan, Diab. World: Caucasus Minor, Iran	Fam:- Asteraceae Dumort Gen:- Artemisia L. Sp.:- A.fragrans Willd.

6.2 Sample Plot Proformas

Date	Transect #	Sample plot GPS coordinates	Family	Genus	Species	Domin Scale mark
4.06.01	1	N4014663 E0494723 2	Boraginacea Juss.	Argusia Boehm.	*A.sibirika* (L.)Dandy.	8
			Poaceae Barnhart.	Phragmites Adams	*Ph. australis*(Cav.)Trin.	4
4.06.01	1	N4015014 E04947178	Fabaceae Lindl.	Alhagi Gagneb.	*A. pseudalhagi* (Bieb.)Fisch.	7
			Boraginacea Juss.	Argusia Boehm.	*A.sibirika* (L.)Dandy.	5
			Cheno-podiaceae Vent.	Suaeda Forssc.	S. *dendroides* (Fish.et Mey.)Moq.	4
			Cheno-podiaceae Vent.	Salsola L.	*S.denproides* Pall.	4
			Poaceae Barnhart.	Bromus L.	*B. japonicus* Thunb.	4
			Fabaceae Lindl.	Medicago L.	*M.minima* (L.) *Bartalini*	3
			Poaceae Barnhart	Adonis L.	*A. australis* L.	2
			Poaceae Barnhart.	Poa L.	*P.bulbosa* L.	2
4.06.01	1	N4015026 E04947179	Juncaseae Juss.	Juncus L.	*J. acutus* L.	8
			Tamaricaceae Link.	Tamarix L.	*T.meyeri* Boiss.	4
			Poaceae Barnhart	Phragmites Adams.	*Ph.australis*(Cav.)Trin.	4
			Boraginacea Juss.	Argusia Boehm.	*A.sibirika* (L.)Dandy.	4
			Fabaceae Lindl.	Alhagi Gagneb.	*pseudalhagi* (Bieb.)Fisch.	4
			Poaceae Barnhart.	Poa L.	*P.bulbosa* L.	3
			Fabaceae Lindl.	Medicago L.	*M. minima* (L.) Bartalini	3
			Poaceae Barnhart.	Cynodon Rich.	*C.dactylon* (L.)Pers.	3
			Fabaceae Lindl.	Astragalus sp.	*A. sp*.	1
			Alliaceae J.Agardh.	Allium L.	*A.rubellum* Bieb.	1
4.06.01	1	N4015048 E04947181	Poaceae Barnhart.	Phragmites Adams.	*Ph.australis*(Cav.)Trin.	10
			Juncaseae Juss.	Juncus L.	*J.acutus* L.	2
4.06.01	1	N4015312 E04947092	Polyganaceae Juss.	Calligonum L.	*C.bakuense* Litv.	6
			Tamaricaceae Link.	Tamarix L.	*T. meyeri* Boiss.	4
			Fabaceae Lindl.	Alhagi Gagneb.	*A. pseudalhagi* (Bieb.)Fisch.	5
			Cheno-podiaceae Vent.	Climacoptera Botsch.	*C. crassa* (Bieb) Botsch.	4
			Cheno-podiaceae Vent.	Petrosimonia Bunge.	*P. bpacheata* (Pall.)Bunge	2

Date	Transect #	Sample plot GPS coordinates	Family	Genus	Species	Domin Scale mark
			Poaceae Barnhart.	Eremopyrum (Ledeb.)Jaub et Spach	*E. orientale* (L.) Jaub et Spach	1
			Scrophulariaceae Juss.	Veronika L	*V. amoena* Bieb.	2
			Poaceae Barnhart.	Cynodon Rich.	*C. dactylon* (L.)Pers.	2
			Solanaceae Juss.	Lycium L.	*L.ruthenicum* Murr.	2
			Poaceae Barnhart	Catabrosella (Tzvel.)Tzvel.	*C.humilis* (Bieb.)Tzvel.	2
			Fabaceae Lindl.	Astragalus L.	*A. sp*.	2
			Cheno-podiaceae Vent.	Suaeda Forssk.ex Scop.	*S.dendroides* Pall.	2
			Poaceae Barnhart	Hordeum L.	*H. leporinum* Link.	1
			Cheno-podiaceae Vent.	Anabasis L.	*A.salsa* L.	1
			Cheno-podiaceae Vent.	Spinosia L.	*S. tetrandra* Stov.	1
4.06.01	1	N4017743 E049947630	Boraginaceae Juss	Argusia Boehm.	*A.sibirika* (L.)Dandy	8
			Cheno-podiaceae Vent.	Kalidium Moq .	*K.caspicum* (L.)Ung.-Sternb.	4
			Cheno-podiaceae Vent.	Suaeda Forssk.ex Scop.	*S.dendroides* Pall.	2
			Solonaceae Juss.	Lycium L.	*L.ruthenicum* Murr.	2
			Alliaceae J.Agardh.	Allium L.	*A.rubellum* Bieb.	1
			Poaceae Barnhart	Hordeum L.	*H. leporinum* Link.	1
			Fabaceae Lindl.	Trigonella L.	*T. monspeliaca* L.	1
4.06.01	1	N4017913 E4947825	Boraginaceae Juss.	Argusia Boehm.	*A.sibirica* (L.)Dandy.	4
			Canvolvulaceae Juss.	Canvolvulus L.	*C.persicus* L.	7
5.06.01	2	N4020614 E049489927	Chenopodiaceae Vent.	Salsola L.	*S.nodulosa* (Moq.)Iljin.	6
			Chenopodiaceae Vent.	Salsola L.	*S.ericoides* Bieb.	4
			Chenopodiaceae Vent.	Holosnemum Bieb.	*H.strobilaceum* (Pall.)Bieb.	4
			Poaceae Barnhart.	Bromus L.	*B.japonicus* Thunb.	3
			Poaceae Barnhart	Catabrosella (Tzvel.)Tzvel.	*C.humilis* (Bieb.)Tzvel.	2
			Alliaceae J.Agardh.	Allium L.	*A.rubellum* Bieb.	1
			Lamiaceae Lindl.	Sideritis L.	*S.montana* L.	1
			Brassicaceae Barnett.	Torularia (Coss.)O.E. Schulz.	*T. contortu pliceta* (Steph.) O.E. Schulz.	1
			Cheno-podiaceae Vent.	Anabasis L.	*A.salsa* L.	1
			Lameaceae Lindl	Nepeta L.	*N. sp*.	+

Date	Transect #	Sample plot GPS coordinates	Family	Genus	Species	Domin Scale mark
			Poaceae Barnhart.	Puccinellia Part.	*P.bulbosa* (Grossh.)Grossh.	+
			Asteraceae Dumort.	Jurinea Cass.	*J. elegans* (Stev.)	+
5.06.01	2	N4020939 E049485523	Asteraceae Dumort.	Artemisia L.	*A.fragrans* Willd.	8
			Chenopodiaceae Vent.	Salsola L.	*S.nodulosa* (Moq.)Iljin.	7
			Chenopodiaceae Vent.	Salsola L.	*S.ericoides* Bieb.	5
			Poaceae Barnhart.	Catabrosella (Tzvel.)Tzvel.	*C.humile* (M.B.)Criseb.	2
			Asteraceae Dumort.	Filago L.	*F.arvense* L.	2
			Fabaceae Lindl.	Medicaco L.	*M.minima* (L.)Bartalini	2
			Fabaceae Lindl.	Medicogo L.	*M. orbicelaris* (L.)Bartalini	1
			Plantagineceae Juss.	Plantago L.	*P.minuta* Pall.	1
			Poaceae Barnhart.	Agropyrum L.	*A.orientale* L.	?
			Scrophulariaceae Juss.	Veronika L	*V.amoena* Bieb.	+
			Fabaceae Lindl.	Trigonella L.	*T. manspeliaca* L.	+
			Alliaceae J.Agardh.	Allium L.	*A.rubellum* Bieb.	1
			Poaceae Barnhart.	Poa L.	*P.bulbosa* L.	1
			Geraniaceae Juss.	Erodium L Her.	*T. sp.*	1
			Poaceae Barnhart.	Brachypodium Beauv.	*B.sp.*	1
5.06.01	2	N4021505 E04947990	Chenopodiaceae Vent.	Salsola L.	*S.nodulosa* (Moq.)Iljin.	6
			Efemer			5
6.06.01	3	N4021859 E04947367	Chenopodiaceae Vent	Salsola L.	*S.dendroides* Pall.	6
			Poaceae Barnhart.	Cynodon Rich.	*C.dactylon* (L.)Pers.	5
			Tamariceae Link.	Tamarix L.	*T.meyeri* Boiss.	4
			Fabaceae Lindl.	Alhagi Gagneb.	*A.pseudalhagi* (Bieb.)Fisch.	4
			Alliaceae J.Agardh.	Allium L	*A.rubellum* Bieb.	2
			Iridaceae Juss.	Iris L.	*I.acutiloba* G.A.Mey.	+
6.06.01	3	N4022488 E04942634	Asteraceae Dumort.	Arfemisia L.	*A.fragrans* Willd.	5
			Chenopodiaceae Vent.	Salsola L.	*S.nodulosa* (Moq.)Iljin.	4
			Poaceae Barnhart.	Poa L.	*P.bulbosa* L.	4
			Poaceae Barnhart.	Catabrosella (Tzvel.)Tzvel.	*C.humilis* (M.B.)Criseb.	4
			Cheno-podiaceae Vent.	Climacoptera Botsch.	*C.crassa* (Bieb.) Botsch.	2

Date	Transect #	Sample plot GPS coordinates	Family	Genus	Species	Domin Scale mark
			Cheno-podiaceae Vent.	Anabasis L.	*A.salsa* L.	2
7.06.01	5	N4020348 E04945259	Chenopodiaceae Vent.	Salsola L.	*S.dendroides* Pall.	6
			Fabaceae	Alhagi Gagneb.	*A.pseudalhagi* (Bieb.)Fisch.	4
			Tamariceae Link.	Tamarix L.	*T.meyeri* Boiss.	4
			Plantaginaceae Juss.	Plantago L.	*P.minuta* Pall.	2
			Cheno-podiaceae Vent.	Anabasis L.	*A.salsa* L.	1
			Cheno-podiaceae Vent.	Climacoptera Botsch.	*C.crassa* (Bieb.) Botsch.	4
			Chenopodiaceae Vent.	Petrosimonia Bunge.	*P.brachiata* (Pall.)Bunge	2
			Poaceae Barnhart	Hordeum L.	*H.leporinum* Link.	
			Poaceae Barnhart	Cynodon Rich.	*C.dactylon* (L.)Pers.	2
			Caryophyllacea Juss.	Holosteum L.	*H.umbellatum* L.	1
			Brassicaceae Burnett	Meniokus Desv.	*M.linifolius* Steph.	1
			Poaceae Barnhart	Aeluropus Trin.	*A. littoralis* (Gouan.)Parl.	1
			Iridaceae Juss.	JunoTratt.	*J.aucasica* (Hoffm.)Klatt	1
7.06.01	5	N4020434 E04945232	Tamariceae Link.	Tamarix L.	*T.meyeri* Boiss.	.8
			Fabaceae Lindl.	Alhagi Gagneb.	*A.pseudalhagi* (Bieb.)Fisch.	5
			Alliaceae J.Agardh.	Allium L	*A.rubellum* Bieb.	2
			Asteraceae Dumort.	Cardus L.	*C. albidus* Bieb.	2
			Asteraceae Dumort.	Arfemisia L.	*A.canasica*	2
			Rhamnaceae Juss.	Rhamnus L.	*R. pallasii* Fish.	2
			Bbrassicaceae Burnett	Lepidium L.	*L. resicarium* l.	1
7.06.01	5	N4020184 E04945028	Chenopodiaceae Vent.	Salsola L.	*S. nodulosa* (Moq.)Iljin.	8
			Asteraceae Dumort.	Artemisia L.	*A.phragrans* Willd.	6
			Poaceae Barnhart.	Catabrosella (Tzvel.)Tzvel.	*C.humilis* (M.B.)Criseb.	4
			Chenopodiaceae Vent.	Salsola L.	*S. ericoides* Bieb.	3
			Poaceae Barnhart	Alhagi Gagneb.	*A. pseudalhagi* (Bieb.)Fisch.	2
			Asteraceae Dumort.	Filago L.	*F.arvenisis* L.	2
			Asteraceae Dumort.	Trogopason L.	*T. sp.*	2
			Scrophulariaseae Juss.	Veronika L.	*V. amoena* Bieb.	2
			Chenopodiaceae Vent.	Comphorosma L.	*C. lessingii* Litv.	1

6.3 Endemics & Species Listed in Azerbaijan and 1997 IUCN Red List of Threatened Plants[4]

SR #	Genus	Species	Endemic (Y/N)	Azerbaijan Red Book (Y/N)	1997 IUCN Red List of Threatened Plants (Y/N)	IUCN World Designation
1*.	Anabasis L.	*A. salsa* (G.A. Mey.) Benth	Azerbaijan	Y	N	
2*.	Juno Tratt.	*J. caucasica* (Hoffm.)Klatt	Caucasus	Y	N	
3*.	Medicogo L.	*M. caucasica* Vess.	Caucasus	Y	N	
4.	Astragalus L.	*A. bacuensis* Bunge	Azerbaijan	Y	Y	Indeterminate[5]
5.	Calligonum L.	*C. bacuensis* Litv.	Azerbaijan	Y	Y	Indeterminate[2]
6.	Iris L.	*I. acutiloba* G.A. Mey.	Azerbaijan	Y	Y	Endangered[6]

*Proposed species to be included in next official Azerbaijan Red List

[4] Walter, K.S. and Gillett, H.J. [eds] (1998). *1997 IUCN Red List of Threatened Plants*. Compiled by the World Conservation Monitoring Centre. IUCN - The World Conservation Union, Gland, Switzerland and Cambridge, UK. lxiv + 862pp.

[5] Taxa known to be Extinct, Endangered, Vulnerable, or Rare but where there is not enough information to say which of the four categories is appropriate.

[6] Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating. Included are taxa whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction.

6.4 Written Report and Recommendartions

By prof. V.Hadjiyev

Sangachal Terminal Survey

The survey encompassed an area 5 km long from the Caspian coastline to the south of the Sangachal Terminal (the lowland of town Narimanneft through to the Terminal.

Formation — Argusiactum sibirica
Adventic weed in psomophyte-literal environment L.Dandy is the pioneer to settle.

Description № 1.
Transsect 1 — Wet shell sand
№ 4014600
E 04947245

Here, Argusia (L.) sibirica thickets encountered. Coverage 50-60%, sometimes 20-40 %, scattered, Argusia sibirica pp. 50-60 %, Phragmates australis (Cav.) Trin. pp 5-10 %, sometimes rare individuals.

Sample plot 1

Argusia sibirica L.Dandy

№ 4014663 — Phragmites australis (Caq.)Trin.
E 04947237

Description № 2
№ 401996 — Formation Artemisietum tschernieviana Bess. Pp. 75-80 %
E 04947183 — Wormwood-efemeral desert. Shale soil .

Artemisietum tschernieviana Bess. :	Pp. 40-45 %	Agrostis tenuis Sibth. :	Pp. 10-15 %
Catabrosela humilis (Bieb.)Tzevel. :	Pp. 15-20 %	Medicago minima (L.)Bartalini :	pp.15-20 %
Iris sp. :	individuals	Salsola ericoides Bieb :	Pp. 10-15 %
Allium moschatum :	pp 10-15 %	Tamarix meyeri Bieb :	individuals
Allium sibiricum L. :	individuals	Colligonum bakuense Litv :	individuals
Plantago salsa Pall. :	Pp. 10-15 %	Chenopodium album L :	individuals
Pleconax subconica (Friv.)Sankova :	-	Brassica campestris L :	individuals
Poa bulbosa	15-20 %	Carduus albidus Bieb.	Pp. 10-15 %

: :

Sample plot 2

One endemic species, *Colligonum bakuense* Litv. encountered in the coenosis on sand hills, rarely on argillaceous ground.

Description № 3
№ 4015014 formation Alhagietum psedalhagi
E 04947178 encompasses a small massif, pp 60-70 %

In the formation Alhagi pseudoalhagi (Bieb.)Fish. pp 30-40 % encountered.
Argusia sibirica L. Dandy. pp 15-20%
Suaeda dendroides (Fish. et Mey.)Moq. pp 15-20 %

Judging by seeds and stems of dried ephemeral (in this formation 10 ephemerals are supposed to be encountered) 4 species were defined: Poa bulbosa L., Medicago minima (L.)Bartalini, Bromus japonicus Thunb., Adonis aestivalis L. No lichens encountered

Sample plot 3

Description 4
№ 4015026 Wet sand coastal line
E 04947179 Juncusetumacutus scrubs. Psamophyte and literal environment

The following species encountered in the formation: Iuncus acutus L. pp 40-50 %, Tamarix meyeri L. pp 15-20 %, Phragmites australis (Cav.)Trin. pp 15-20 %, Astragalus sp. individuals, Alhagi pseudoalhagi (Bieb.)Fish. individuals, Argusia sibirica L. Dandy. ppп 10-15%, Allium rubellium Bieb. individuals

Sample plot 4

Description 5.
№ 4015048 Reed thickets – Phragmitesum australis on dry argillaceous,
often turf soils
E 04947181 pp 85-90 %

Encountered are Phragmites australis (Cav.)Trin pp 80-85, 1.5 - 2 м. high, roots – 3 м long.; Juncus acutus L. pp 15-20 % is encountered mainly in wet coastal sand, sometimes in water.

Description 6.
№ 4015264 Argillaceous sand soil.
E 04947056 Formation Tamarixetum meyeri pp 50-60 % on dry
Sierozem soil

In this formation Tamarix meyeri Boiss accounts for pp 20-30 %, Salsola dendroides Pall. pp 20-25 %, Suaeda dendroides Pall. rare individuals, Salsola crassa Botsch rare individuals, Anabasis salsa L. individuals. One endemic species Colligonum bakuense Litv. encountered within the formation: an ancient decorative species, pp 20-25 %,

This formation neighbours Phragmites australis (Cav.)Trin , a 2.5 км long northward strip.

In this formation only Colligonum bakuense Litv. was found to provide ground for 2 different species of lichen individuals: Xanthoria parietina (L.) Th. Fr. and Physcia adscendens (Fr.) Oliv., however, widely distributed in the area. Only one species Caloplaca holocarpa (Hoffm.) Wade (also widely spread) was encountered on Lycium L. shrubs. In Azerbaijan there are 54 habitats thereof.

Sample plot 5

Formation — Argusiaetum+Lyciumetum sibirica
№ 4015312 — Crubs Colligonum bakuense Litv. pp 60-65 %
E 0494092 — on knobby and argillaceous soils

Colligonum bakuense Litv., pp 40-45 %, Tamarix meyeri Boiss. pp 10-15 %, Astragalus bacuensis pp10-15 %, Climacoptera crassa (Bieb.) Botsch.pp10-15 %, Petrosimonia brachiata (Pall.)Bunge.pp10-15 % , Hordeum lepornum Link. Stev. pp10-15 %, Suaeda dendroides Pall. rare., Eremopirum orientale (L.)Jamb. rare., Veronica amoena Bieb. rare., Spinacia tetrandra rare., Anabasis salsa rare.. The coenosis composition clearly testifies to salty soil.

Description 7.
№ 4017419 — Coastline , wet coastal sands
E 04947373
Argusia sibirica pp10-15 %, Lycium ruthenucum Murr. pp10-15 %, about 10 species of dried ephemerals. Formation is on desert habitat.

Sample plot 6.
№ 4017743 — Formation Argusietum sibirica pp 60-80 %.
E 04947630

On sands are Argusia sibirica (L.)Dandy. pp60 %, Kalidium caspicum (L.)Ung.-Sternb. pp10-15%. Lycium ruthenucum Murr. Suaeda dendroides Pall . Allium rubellium Bieb. Trigonella monspeliaca L., rare. Hordeum leporinum Link, a weed, is rare in the coenosis.

Description 8.
№ 4017832 — Wet coastal sand. Psamophyte-literal coast. Edificator, weed and
E 04947715 — pp70-80 % — adventives account for pp 70-80%

Argusia sibirica (L.)Dandy pp60-65 %, Tamarix meyeri Boiss.pp10-15 %, Alhagi pseudalhagi (Bieb.)Fisch.pp10-15 %, Juncus acutus L.pp20-25 %, Phragmites australis (Cav.)Trin.pp10-15 %, Cynodon dactylon (L.)Pers.pp10-15 %, Salsola nodulosa (Moq.)Iljin.pp10-15 %, Anabasis salsa L.rare., Trigonella monspeliaca L. rare., Petrosimonia brachiata (Pall.) Bunge. rare., Filago arvensis L. rare individuals.
Most ephemerals completed their development. In this coenosis adventive Lepidium vesicorium L. encountered.

Sample plot 7

Description 9.
№ 4017913 — Wet coastal sand. Psamophyte-literal coast. Edificator, weed and
E 04947825 — adventives account for pp 70-80%

A small coenosis with dominant Canvolvulus persicus L. The species pioneers coastal sands. Encountered in spots, pp30-40 %. Ephemerals not encountered (dried up).

Description 10.
Formation — Luciumetum on dry hills, sometimes with "camel" thorn

№ 4018307 Scrubs Lycium ruthenicum Murr.pp30-35 %
E 04948451
Lycium rutenicumpp20-25 %, Alhagi pseudalhagi (Bieb.)Fish.pp10-15.

.

Description 11
№ 4020529 Formation Salsoletum nodulosae + Suaeda dendroidespp80-85 %
E 04948973 Desert of salt sand

Salsola nodulosa (Moq.) pp10-15 %, S. ericoides Bieb.pp10-15 %, Suaeda dendroides Pall.pp10-15 %, Halocnemum strobilaceum (Pall.) Bieb.pp10-15 %, Bromus japonicus Thunb. Catabrosella humilis (Bieb.)Tzvel.pp10-15 %,pp15-20 %, Jurinea elegans (Stev.)Dc. Rare, only on rocks.

Sample plot 8

Transsect 2.
№ 4020614 Ditto, pp 75-80 % Salt soil desert of Sierozem
E 04948927

Salsola nodulosa (Moq.)Ilyin. pp40-60 %, S. ericoides Bieb.pp10-15 %, Halocnemum strobilaceum (Pall.) Bieb.pp10-15 %, Catobrosella Humilis (Bieb.)Tzvel. pp20-25 %, Poa bulbosa L. pp10-15 %., Anabasis salsa L. rare., Nepeta L. sp. rare., Puccinellia bulbosa (Grossh.)Grossh. rare., Sideritis мontana L. rare., Torularia contortuplicata (Steph.)O.E. Schulz. rare., in spring the ephemeral species mount to 15-17.

Sample plot 9

Transsect. 2
Description 12
№ 4020939 Formation Artemisietum fragrans + Salsoletum nodulosae pp 80-85 %
E 04948523 Desert of Sierozem

Artemisia fragrans Willd.pp50-55 %, Salsola nodulosa (Moq.) Ilyin. pp30-35 %, Suaeda dendroides Pall.pp-15-20 %. Ephemerals and ephemeroids pp40-60 %. These are Bromus japonicus, Catabrosella humilis (Bieb.)Tzvel, Filago arvense L., Medicago minima (L.)Bartalini, M. orbicularis(L.)Bartalini, Plantago minuta Pall. Also species of genera Allium L., Trigonella L., Agropyron Gaertn., Brachypodium Beang., Erodium L Her., the sporostrotes are represented by seaweed Nostoc commune, rare., moss also rare.

This grouping is most typical of flat environment where it is encountered in small areas of few m^2 and normally alternates with homogeneous Salsoletum nodulosae and Artemisietum fragrans groupings, therefore, in this environment the community is complex and compound. It is also encountered on mild and steep slopes. Visually the soil coverage ranges 40 to 90 %.

Sample plot 10

Description 13
№ 4021505 Formation Salsoletum nodulosae pp 40-60 %
E 04947990 Mountainous saltwort in desert of sierozem soil

Salsola nodulosa (Moq.)Ilyin. pp30-40 %, ephemerals 30-40 %. Of 15 ephemeral species, contributing to coenosis, majority dried up.

Description 14.
№ 4021545 Formation Salsoletum dendroides Pall.pp60-65 %

E 04947990 Dendritic saltwort on meadowlike soils.
Salsola dendroides Pall. pp 20-30 %, ephemerals pp30-35 %.

Peashrub grouping plays a very insignificant role in the vegetation landscape of the Terminal area. In fact, this coenosis is belongs to river zoning or meadowlike grouping. In other zones beyond river side the peashrub grouping was encountered together with halophyte weed (Atriplex tatarica L., Suaeda dendroides Pall., Salsola ericoides Bieb. and so forth.). All the above mentioned ephemerals and ephemeroids are encountered in the coenosis.

Sample plot 11

№ 4021851859 Formation Salsoletum dendroides + Tamarix meyeri pp. 60 %.
E 04947367 Dendritic saltwort+tamariks, meadowlike soils
Salsola dendroides . (Moq.)Pall.pp60 %, Tamarix meyeri Boiss.pp20-30 %, Cynodon dactylon (L.)Pers. 20-25 %, Alhagi pseudalhagi G.A.Mey.pp10-15 %, Iris acutiloba, rare. Ephemerals dried up, 10-12 species.

Description 15
Formation Tamarixetum on meadowlike sands
№ 4022701 pp45-50 %.
E 04945331

Tamarix meyeripp60 %, Salsola dendroidespp40 %, Allium rubellum, Suaeda dendroides, and also species of genera Veronica L., Cynodon Rich., AlyssiumL., Ranunculus L., Alhagi Gadneb, Atriplex L., Lepidium L., Bromus L. and others. This type of coenosis is widely spread in the Terminal central area. Phyto-sociological analysis of the record made testifies to transitional coenosis. Conditioned by Poa bulbosa turf process, which is generally typical of Salsoletum dendroides Pall. is changed with the turf process typical of meadowlike coenoses conditioned by Cynodon dactylon (L.)Pers.

Two lichen species were encountered in the formation on the ground: Diploschistes gupsaceus Auct. coverage pp 25-30% and Squamaria lentigera (Web.) Poelt coverage pp 15% , sometimes scattered. No other species encountered.

Transsect 3
Description 16
№ 4022697 Formation Salsoletum nodulosae + Suaeda dendroides pp 60-65 %
E 04942385 Mountainous saltwort with dendritic sea blite on sierozem desert

Salsola nodulosa (Moq.)Ilyin. pp60 %, Suaeda dendroides Pall.pp 40 % .
On the ground and argillaceous slopes Salsola nodulosa (Moq.) Ilyin. is accompanied by saltwort Suaeda dendroides Pall., however, in this environment its combination with Salsola ericoides was rarely observed. However, this composition of coenosis is common for the Terminal environment, where it is observed in fragments. In this environment the coenosis composition differs by existing turfing processes normally specific to flat environment and not observed on steep argillaceous slopes.
According to the record, apart from the dominants the absolute constants are therophyte Catabrosella humilis (M.B. Criseb.) and geophyte Allium rubellum Bieb., However, Catabrosella humilis (M.B. Criseb.) does not condition turfing process because it is rare here, as identified in the Scale. Apart from the above said species individuals of Kallidium caspicum (L.)Ung.-Stornb. also contribute to coenosis, visually accounting for 60-65 %, sometimes 30 %.

Sample plot 12

№ 4022488 Ditto
E 04942634

This combination is frequent and occurs in small spots on flat ground. The turfing degree in the coenosis is rather high and is accounted for by Poa bulbosa and Catabrosella humilis (M.B.)Criseb. Scale point 3-2-3. 2 edificators (Artemisia fragrans Willd., Salsolanodulosa (Moq.)Ilyin.) and 2 turfing conditioners Poa bulbosa L. and Catabrosella Humilis (M.B.) Criseb., 17-19 ephemeral species, rare Climacoafera.crassa (Bieb.)Botsch, Anabasis salsa L. all these contribute to formation composition.

Lichens are also encountered in this formation. Initially only rare individuals of Squamaria lentigera (Web.) Poelt are encountered, later on a small area of Diploschistes gupsaceus Auct. Coverage 50 %. Squamaria lentigera (Web.) Poelt is also encountered, coverage 15 %, Collema crispum (Huds.) Web. pp 5% and Fulgensia fulgens (Sw.) Elenk. Coverage pp1%. Single individual of moss.

Transsect. 4.
Description
№ 4020476 Formation Artemisietum fragransae + Teocrium polium pp80-85 %.
E 04944485 Wormwood desert of sierozem

Artemisia fragrans Willd. pp60-70 %, Teucrium polium L.pp10-15 %, Ranunculus oxyspermuspp10-15 %, Medicago rigidula (L.)All. Rare individuals of M. minima (L.)Bartalini, individuals. Individuals of Salsola nodulosa (Moq.)Ilyin., also, 15 ephemeral species.

This kind of coenosis in the Terminal area is normally observed on dry slopes and other more or less rocky locations. Density of Teucrium polium L. in this coenosis does not go beyond 4 of the Domin Scale, whereas wormwood Artemisia fragrans reaches 5-6.

Lichens were encountered in this formation only on rocks and soil cover around rocks. Aspicilia contorta (Hoffm.) Kremplh., Caloplaca ferruginea (Huds.) Th. Fr., Caloplaca saxicola (Hoffm.) Nord., Caloplaca citrina (Hoffm.) Th. Fr., Lecanora atra (Huds.) Ach. were observed on rocks. Collema crispum (Huds.) Web., Psora lurida (With.) DC., Toninia coeruleonigricans (Leight.) Th. Fr., Diploschistes gupsaceus Auct. around rocks.

Description 18.
№4020837 Rocky slope
E04945155 Formation Salsoletum nodulosae+Noaea mucronata
Mountainous salty desert with Noaea on sierozem

Salsola nodulosa(Moq.)Ilyin, Noaea mucronata (Forssk.)Aschers.

This formation of Salsoletum is common for piedmont of the Terminal area where it occupies vast areas терминала, занимая большие площади. Presence of turf generator Poa bulbosa, ranking high in the Domin Scale. The coenosis comprises 15-17 species.

Also in this formation, lichens were observed on the rocks and soil cover around rocks with composition similar to the above-mentioned formation. This apparently can be explained by their structural similarity. Also encountered were Caloplaca citrina (Hoffm.) Th. Fr. Lecanora atra (Huds.) Ach., Aspicilia contorta (Hoffm.) Kremplh., Candelariella aurella (Hoffm.) Zahlbr, Caloplaca saxicola (Hoffm.) Nord. Here, on rocks moss cover occurs on which Cladonia foliaceae (Huds.) was encountered. Ground lichens are represented by genera

Toninia coeruleonigricans (Leight.) Th. Fr., Fulgensia fulgens (Sw.) Elenk., Collema crispum (Huds.) Web., Squamaria lentigera (Web.) Poelt Diploschistes gupsaceus Auct.

Lichens play a definite role in the composition of complex steppe phytocoenoses. Their occurrence and species change with regard to relief, elevation, grass composition and the degree of colonisation of soil generating rocks. Collema crispum (Huds.). is typical for salt steppe soils. As solonetzcity of soil grows Collema is joined by Diploschistes gupsaceus Auct., Toninia coeruleonigricans (Leight.). Fine-turf and sheep's fescue and mixed fodder plants of steppe communities provide ground for Fulgensia fulgens (Sw.), Squamaria lentigera (Web.) and others. Coenotype role of lichens in steppe depends on the degree of their domination. On rarer grass soil, elevated or sufficiently warmed areas coenotype role of lichens grows, whereas in heavily turfed steppe communities they practically do not exist.

Sample plot 13

№ 4020348 Salsoletum dendroidespp60-65%
E 04945254

Salsola dendroides Pall., Alhagi pseudalhagi (Bieb.)Fish, Aelurupus littoralis (Goncen.)Pare., Plantago minuta Pall., Tamarix meyeri Boiss., Hordeum leporinum Link., Meniokus linifolius Steph., Juno caucasica (Hoffm.)Klatt , Holosteum umbellatum L., Petrosimonia brachiata (Pall.)Bunge, Anabasis salsa L., Climacoptera crassa (Bieb.0Botsch.and other ephemerals dried up.

Transsect 5
Description 19
№ 4020434 Formation Thickets of Tamarixetum meyeri pp75%

E 04945232

Tamarix meyeri Boiss.п/п 60%, Salsola dendroides Pall.pp10-15%, Suaeda dendroides (Fish. et Mey.)Moq.pp10-15%, Alhagi pseudalhagi (Bieb.)Fish. pp10-15 %. Ephemerals about 10 species. Single individual of seaweed Nostoc commune encountered.

Sample plot 14

№ 4020434 Ditto
E 04945232

Tamarix meyeri Boiss. высота 2,5 м,pp40-60%, Alhagi pseudalhagi (Bieb.)Fishpp20-25%, Carduus albidus Bieb.,ppArtemisia alpina Pall.pp10-15%, Allium rubellum(Bieb.)pp5-10%, Tulipa sp. Representatives of genera Camphorosma L., Rhamnus L., Lepidium, Artemisa and other species are represented by single individuals.

Description 20
№ 4020184 Formation Salsoletum nodulosa
E 04945028 Rocky slopes pp 50-60%

Sample plot 15

Salsola nodulosapp60%, Artemisia fragrans Willd.pp40%, S. ericoides pp10-15%, rarely observed shrubs of Rhamnus pallasii Fisch.

The core of biological spectrum as generally observed in the communities of rock deserts: terophytes prevail in spring, geophytes emerge later on. Outumn physionomy of community after first outumn rainfalls is charachterized by herbs. Poa bulbosa L. и Catabrosella Humilis (M.B.)Criseb. First tier: Salsola nodulosa (Moq.)Ilyin., sometimes Artemisia fragrans. Other representatives of the community form second and third tiers. Generally, tiers are feebly marked in desert environment, although sometimes they are more or less obvious.

The root system of majority of subshrub halophytes is well deveoped. Thus, Salsola nodulosa (Moq.)Ilyin has roots reaching 2-3 m. It is capable of growing without soil and atmospheric humidity. For normal development it has sufficient storage of water. In the Gobustan there are around 600-700 species of phanerogamy of which number some 200-250 were encountered around the Terminal. Of these only few play a leading role in vegetation groupings. Only few species of the surveyed territory have the potential to become capable edificators of such groupings, set phytosocial organisation. Predominantly, these are shrubs, subshrubs, annuals and perennials. Often, spring annuals become edificators. The latter later on bring about phytocoenosis, therefore, geobotanical surveys should also be made in autumn.

Historically, deserts of the Gobustan area have been shaped by aboriginal species of this area, called endemics. Endemic species in the Gobustan mount to 50-60. Among these there are both Azerbaijan and Caucasus endemics. During this visit to the area some 10-15% thereof were not observed, therefore, in order to make a complete list of endemics survey should also be made in springtime, when they grow and blossom.

In this country there are numerous valuable, both economically and academically, species, also in the Gobustan and the Sangachal area. Because of anthropogenic impact they are becoming rare and eventually dissapear from coenosis.

With regard to the above stated report it should be recommended:

1. Increase flora and fauna protection in the area.
2. Set educational and awareness programs
3. Make a large scale map of flora and vegetation of the Sangachal Terminal area.
4. Pinpoint on the map endemic, rare and endangered species locations
5. Mark vegetation types
6. Set up oases, water reservoirs and lawns
7. Mark potential recreation spots and so forth.

Appendix B Mammals and Herpatofauna proformas

Disclaimer

These reports have been prepared at the request of URS, by local and international experts for the sole use of BP. As such, the report represents the investigations, findings and conclusions of these individuals. Where reports were issued in a language other than English, translations were verbatim.

These reports in no way represent the views, assumptions or opinions of URS. No other warranty, expressed or implied, is made as to the professional advice included in, or contents of, these report. URS is not responsible for any liability arising out of, or in connection with, any reliance on or use of the advice or information provided.

6.5 Mammals & Herpetofauna Species Encountered

English name	*Genus species*	Study area sub-section encountered in?*								Biotope	Evidence of encounter?*	Time (D/N)
Herpetofauna		**SC**	**NC**	**CS**	**CN**	**WP**	**FW**	**WH**	**NH**			
Marsh frog	*Rana ridibunda*	X	X	X			X			wetlands	sighting	D
Spur-thighed tortoise	*Testudo graeca*	X	X	X						semi desert & beach side		
Caspian turtle	*Mauremys caspica*			X						wetlands	carapice & sighting	D
Caspian gecko	*Cyrtopodion caspius*	X	X							semi desert & beach side	Sighting & captured	D & N
Caucasian agama	*Stellio caucasius*		X							rocky places	sighting	
Racerunner	*Eremias velox*	X	X	X	X	X	X	X		Semi desert & beach side	Sighting & captured	D
Eremias species	*Eremias arguta*	X		X	X						Sighting & captured	D
Snake-eyed lizard	*Ophisops elegans*	X	X				X		X	foothills	sighting	D
Grass snake species	*Natrix tesellata*	X	X							wetlands	sighting	D
Dahl's whip snake	*Coluber najadum*								X	foothills	sighting	D
Whip snake species	*Coluber schmidti*	X								beach side	sighting	D
Mammals												

English name	*Genus species*	Study area sub-section encountered in?*								Biotope	Evidence of encounter?*	Time (D/N)
Ear shrew	*Hemiechinus auritus*								X	open semidesert	resident information	N
Horseshoe bat species	*Rhinilophus genus*								X	cave	sighting	D
Asian barbastelle bat	*Barbastella leucomelas*								X	cave	captured	D
Kuhl's pipistrelle	*Pipistrellus kuhlii*	X	X	X	X	X	X	X	X	numerous	captured, audible, sighting	N
Brown hare	*Lepus europaeus*	X	X	X	X	X	X	X	X	semi desert, beach side	sighting, nests	D & N
Small jerboa	*Allactaga elater*	X	X	X	X	X	X	X	X	semi desert & beach side	sighting & burrows	D & N
House mouse	*Mus musculus*	X								riverside	captured	N
Grey hamster	*Cricetulus migratorius*									semi desert	sighting	N
Red tailed sanderling	*Meriones lybicus*	X	X	X	X	X	X	X	X	semi desert & beach side	burrows	D & N
Wolf	*Canis lupus*			X		X			X	semi desert & foothills	resident information	D
Golden jackal	*Canis aureus*	X	X				X			wetlands	excrement & resident information	D

English name	*Genus species*	Study area sub-section encountered in?*								Biotope	Evidence of encounter?*	Time (D/N)
Ordinary fox	*Vulpes vulpes*	X	X	X	X	X	X	X	X	semi desert, beach side & foothills	excrements, sighting, footprints, burows & resident information	D & N
Caspian seal	*Phoca caspica*	X	X							beach side	dead bodies	d

*Area abbreviations
Southeast coast (SC)
Northeast coast (NC)
Central north plains (CN)
Central south plains (CS)
Western plains (WP)
Far west (FW)
West hills (WH)
North hills (NH)

6.6 Mammal Life Cycles

Common English name	*Genus species*	Event	Month											
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Ear shrew	*Hemiechinus autitus*	Breeding												
		Pregnancy												
		Hibernation												
Horseshoe bat	*Rhinolophus agenus*	Breeding												
		Pregnancy												
		Hibernation*												
Asian barbastelle bat	*Barbastella leucomelas*	Breeding												
		Pregnancy												
		Hibernation*												
Kuhl's bat	*Pipistrellus kuhlii*	Breeding												
		Pregnancy												
		Hibernation*												
Brown hare	*Lepus europaeus*	Breeding												
		Pregnancy												
		Hibernation												
Lesser jerboa	*Allactaga elater*	Breeding												
		Pregnancy												
		Hibernation	**N/A**											
House mouse	*Mus musculus*	Breeding												
		Pregnancy												
		Hibernation	**N/A**											
Grey hampster	*Cricetulus migratorius*	Breeding												
		Pregnancy												
		Hibernation	**N/A**											
Sanderling	*Meriones lybicus*	Breeding												
		Pregnancy												
		Hibernation	**N/A**											
Wolf	*Canis lupus*	Breeding												
		Pregnancy												
		Hibernation	**N/A**											
Golden jackal	*Canis aureus*	Breeding												
		Pregnancy												
		Hibernation	**N/A**											
Common fox	*Vulpes vulpes*	Breeding												
		Pregnancy												
		Hibernation	**N/A**											
Caspian seal	*Phoca caspica*	Breeding												
		Pregnancy												
		Pregnancy latency**												

6.7 Herp Life Cycles

Common English name	*Genus species*	Event	Month											
			1	2	3	4	5	6	7	8	9	10	11	12
Marsh frog	*Rana ridibunda*	Spawning				■	■							
		Incubation/Metamorphosis						■	■	■				
		Hibernation	■	■	■								■	■
Spur-thighed tortoise*,**	*Testudo graeca*	Breeding				■	■	■						
		Incubation						■	■	■				
		Hibernation	■	■	■								■	■
Caspian turtle	*Mayremis caspica*	Breeding				■	■	■						
		Incubation							■	■				
		Hibernation	■	■	■							■	■	■
Caspian gecko	*Cyrtopodion caspius*	Breeding					■	■						
		Incubation							■	■				
		Hibernation	■	■	■								■	■
Caspian agama	*Stellio caucasius*	Breeding					■	■	■					
		Incubation							■	■				
		Hibernation	■	■								■	■	■
Eremias species	*Eremias velox*	Breeding				■	■							
		Incubation					■	■	■					
		Hibernation	■	■								■	■	■
Eremias species	*Eremias arguta*	Breeding				■	■							
		Incubation					■	■	■					
		Hibernation	■	■								■	■	■
Snake-eyed lizard	*Ophisops elegans*	Breeding				■	■							
		Incubation					■	■	■					
		Hibernation	■	■									■	■
Grass snake species	*Natrix tesellata*	Breeding				■								
		Incubation						■	■	■				
		Hibernation	■	■									■	■
Dahl"s whip snake	*Coluber najadum*	Breeding					■	■						
		Incubation								■	■			
		Hibernation	■	■	■							■	■	■
Whip snake	*Coluber schmidti*	Breeding					■	■						
		Incubation							■	■				
		Hibernation	■	■	■								■	■

* Included in Azerbaijan 1989 Red List
** Included in IUCN 1997 L=Redlist of Threatened Species

6.8 Night work

Live Trap Results

	Surname and Name (participant)	**Irina Rahmatulina**	**Hassanov Nijat**
	Starting Time	***05 22***	
	Completion Time	***07 30***	

Trap No.	Live Trap Size (photos shown below)		Way Point	GPS Coordinates	entrapped group	biotope	sex
1.	**m**	36	**N**	***40.16112***	empty	seaside semi-desert	
			E	***049.46978***			
2.	**m**	37	**N**	***40.16111***	empty	seaside semi-desert	
			E	***049.46983***			
3.	**m**	38	**N**	***40.16112***	empty	seaside semi-desert	
			E	***049.46986***			
4.	**l**	39	**N**	***40.16094***	empty	seaside semi-desert	
			E	***049.46990***			
5.	**l**	40	**N**	***40.16089***	empty	seaside semi-desert	
			E	***049.46994***			
6.	**m**	41	**N**	***40.16088***	empty	seaside semi-desert	
			E	***049.46983***			
7.	**m**	42	**N**	***40.16090***	empty	seaside semi-desert	
			E	***049.46983***			
8.	**m**	43	**N**	***40.16099***	empty	seaside semi-desert	
			E	***049.46984***			
9.	**m**	44	**N**	***40.16084***	***Mus musculus***	riverside (tamarsk+salty plant)	**female (pregnant)**
			E	***049.46807***			
10.	**l**	45	**N**	***40.16082***	empty	riverside (tamarsk+salty plant)	
			E	***049.46803***			
11.	**l**	46	**N**	***40.16079***	empty	riverside (tamarsk+saltwort)	
			E	***049.46798***			
12.	**l**	47	**N**	***40.16082***	empty	riverside (tamarsk+saltwort)	
			E	***049.46798***			
13.	**s**	48	**N**	***40.16084***	empty	riverside (tamarsk+saltwort)	
			E	***049.46799***			
14.	**m**	49	**N**	***40.16082***	empty	riverside (tamarsk+saltwort)	
			E	***049.46789***			
15.	**s**	50	**N**	***40.16079***	empty	riverside (tamarsk+saltwort)	
			E	***049.46770***			
16.	**m**	51	**N**	***40.16080***	empty	riverside (tamarsk+salty plant)	
			E	***049.46757***			
17.	**l**	52	**N**	***40.16079***	empty	riverside (tamarsk+salty plant)	
			E	***049.46756***			
18.	**l**	53	**N**	***40.16077***	empty	riverside (tamarsk+saltwort)	
			E	***049.46756***			
19.	**s**	54	**N**	***40.16077***	empty	riverside	

Trap No.	Live Trap Size (photos shown below)		Way Point	GPS Coordinates	entrapped group	biotope	sex
						(tamarsk+saltwort)	
			E	***049.46753***			
20.	**l**	55	**N**	***40.16078***	empty	riverside (tamarsk+saltwort)	
			E	***049.46739***			
21.	**l**	56	**N**	***40.16071***	empty	riverside (tamarsk+saltwort)	
			E	***049.46703***			
22.	**s**	57	**N**	***40.16070***	empty	riverside (tamarsk+saltwort)	
			E	***049.46704***			
23.	**m**	58	**N**	***40.16074***	empty	riverside (tamarsk+saltwort)	
			E	***049.46695***			
24.	**s**	59	**N**	***40.16069***	***Mus musculus***	riverside (tamarsk+saltwort)	**female**
			E	***049.46694***			
25.	**l**	60	**N**	***40.16077***	empty	riverside (tamarsk+saltwort)	
			E	***049.46608***			

(S)mall trap =13 x 7 см	**(M)edium = 23 x 8,5 см**	**(L)arge tra = 20 x 10 см**
		

Mist Nets Results

Bats caught around the Sangachal terminal during 11 - 14 . 06. 2001								
	Catch time	**Net №**	**Species**	**Sex**	**Weight**	**Age**	**Antibrachium length**	**Ring №**
1	11 30	from	Barbastella					
		cave	leucomelas	male	9, 7 g	2 years	42, 0mm	XD99699
2	21. 45 - 22. 15	1	P. kuhlii	male	7, 5 g	2 years	35, 5mm	XDO099601
3	21. 45 - 22. 15	1	P. kuhlii	male	7, 5 g	2 years	34, 0mm	XDO099602
4	21. 45 - 22. 15	1	P. kuhlii	male	7, 9 g	2 years	35, 0mm	XDO099603
5	05. 22 - 06. 00	1	P. kuhlii	female	7, 0 g	2 years	35, 0mm	XDO099604
6	05. 22 - 06. 00	1	P. kuhlii	male	5, 7 g	1 years	34, 3mm	XDO099605
7	05. 22 - 06. 00	1	P. kuhlii	male	6, 6 g	2 years	35, 0mm	XDO099606
8	05. 22 - 06. 00	2	P. kuhlii	female	8, 5 g	2 years	33, 5mm	XDO099607
9	05. 22 - 06. 00	2	P. kuhlii	female	7, 5 g	1 years	36, 5mm	XDO099608
#	05. 22 - 06. 00	2	P. kuhlii	female	7, 7 g	2 years	34, 0mm	XDO099609

Sangachal River and Mist Net Type used to trap bats

Tagging and Subsequent Carture of Bats

6.9 MAMMALS FAUNA SURVEY AROUND THE SANGACHAL TERMINAL (IN A RADIUS OF 5 KM)

Materials and Methods

The survey of mammal populations was conducted on separate sections around Sangachal Terminal during 4 days (including one night) in accordance with the submitted map.

The main methods: visual (including by means of binoculars), itinerary pedestrian along the routes (average length of last ones are 2 km), selective (various biotopes). Met animals (their dead bodies and skeletons), burrows, dens, asylums, diverse signs of vital functions (food remains, tracks, excrements) and typical habitats were registered.

Live traps of three types (sizes – 20 x 10 sm, 23 x 8,5 sm, 13 x 7 sm) were placed for the night time observation near the newly digged burrows of rodents (tamarisk and alhagi bushes) at the littoral area (Route No. 3). Two Japanese nets (the length of each one – approximately 20 m, height – 5 m) were placed at the distance of 300 m one from another on the same route at the right bank of the river-canal Jeirankechmez. The registration of the species and quantitative composition of bats around the Sangachal Terminal was conducted by means of detectors "Peterson D 200". In addition the registration of diverse small animals (bats, rodents, predators) was conducted within 5 km routes passing through a saline land plain west and northwest of the Sangachal Terminal (altogether 3 routes) as well.

Local natives and the Sangachal Terminal's employees were questrioned as well.

Survey Results

The routes covered following typical biotopes around the Sangachal Terminal:

Flat clay saline land

This territory is a poorest in terms of fauna covering more than a half of all the area. The dense clay soil and minimum herbage are the main reasons for a scarce animal world. There were rarely fixed single burrows of jerboa, one brown hare bedstone, and during night time were also fixed on the 10 km route: 6 *Lepus europaeus*, 9 *Allactaga elater*, 1 *Cricetulus migratorius*, 2 *Vulpes vulpes*. *Pipistrellus kuhlii* fed everywhere. We could register in all 5 species on a saline land (Routes No 9, 10). We learnt also from the Terminal employees and herders that jackals and wolves inhabited there. 7 species altogether.

Foothills and bozdags (northeastern side)

It was found excrements of fox and hare, which were also observed on within day and night time in the stony foothills located northeast of the Terminal. In the bozdags caves that are represented as chocking semi heaped up tunnels descending from top of the surface were available scattered excrements of bats. In one of the surveyed caves was found a male of *Barbastella leucomelas* (ХД 99699, length of forearm was 42 mm, weight – 9,7 g, released the same evening, 11 June from Baku). In another section of cave hung *Rhinolophus. Pipistellus kuhlii* inhabit usually in the edifices of wintering places.

We heard from herders about the wolves inhabit in bozdags as well. As a result, 6 species were revealed in that biotope.

Littoral area

Section 1: southeastern side of the coast (Route No 4) is a littered saline land with slender tamarisk bush, arborescent saltwort and alhagi through average hilly clayey line (between the highway and the sea), converting to a sandy coquina overgrown by (*Argusietum sibirica*) towards the east. Limestone bare rocks tower directly near the sea. To the west at the road mound the soil is friable, grown by motley grass. Just on that roadside section are extended the colony *Meriones lybicus* and have been found excrements of *Vulpes vulpes.* Under bushes of the average line were found burrows of *Allactaga elater* and approximately 5 burrows of sanderlings. Alongside the seashore within 2,5 km were found on a some distance from one another 2 skeletons and 3 black oiled dead bodies of *Phoca caspica.*
As a result, it was revealed 4 species on the section of the seashore.

Section 2: (southwestern side of the Terminal territory) – the most saturated biotope. Includes such habitats as: 1. coquina, overgrown by (*Argusietum sibirica*) (side with a beach); 2. sandy coquina with saltwort, alhagi and tamarisk bushes (average part of the territory); 3. reeds on the dense clayey soil with numerous cow traces; 4. sandy hillocks with slender saltworts; 5. narrow bank of a river (canal) predominantly with the saltwort and tamarisk bushes on a clay-sandy soil.

Excrements of *Vulpes vulpes* were fixed through all over the second section, but their dens and themselves were met in the second habitat where a lot of *Meriones lybicus* was available. Rodents burrows were also available in the fifth habitat (canal's bank). No signs of mammals' life were found in reeds (although it is a typical ecotope of jackals) in the habitat 1. Dead bodies and skeletons of seals were scattered about the seashore.

The nighttime snaring of rodents by means of 25 life traps of different sizes has shown 8% of a hit (2 *Mus musculus* on the bank of a canal).

During evening flight just 5 *Pipistrellus kuhlii* were fallen into a net (2 of them disentangled themselves and flied away), before dawn – 11 (4 flied away). 9 small animals in all were ringed (5 males and 4 females). Flights of those bats and their ultrasounds were surveyed all over the territory around the Terminal.

Conclusion

Short-term observations on the territory around the Sangachal Terminal including coverage of main typical biotopes and polls have shown the presence of 13 mammals species pertaining to 6 classes (Table 2).

From those animals *Pipistrellus kuhlii* (settle in humans' dwellings and feed all over the territory), *Lepus europaeus, Allactaga elater, Vulpes vulpes* were actually occurring everywhere. *Rhinolophus ferrumequinum* and *Barbastella leucomelas* live in caves. *Canis lupus* lives in foothills and mountains. *Canis aureus* tries to keep itself near the reeds and tamarisk bushes. *Meriones lybicus'* colonies were located in a friable soil under roots of different bushes and in a motley grass (including legumes and ephemeras).

All the noted bats relate to the protected species according to the Bern Convention and the "EUROBATS" Agreement.

It is necessary to note that the saline land semi-desert where the Terminal is located is the kind of territory populated by mammals in an extremely poor extent and does not represent any danger to them. The only exceptions are the bats registered throughout the surveyed territory. Taking into consideration gas kicks, possible breakdowns and oil spills that inevitably would make a negative impact upon insects that constitute an essential part of the food for the bats it's required to take all necessary precautions. In order to concretize possible consequences of the influence of terminals and pipelines on the mammals it's necessary to undertake additional, thorough survey of the territory in terms of season aspect. It's especially required to accentuate the necessity of night works – a time of the mammal main activity.

I. K. Rakhmatulina
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Herpatofauna Survey Report

The routes passed through wormwood and saline land deserts, rocks, scattered stones and along the sea coastline. The registration of species and the count of quantity were made lengthways the lines of different extensions and width of 3 m. Belonging of species was determined on the basis of "Qualifier of amphibious and reptiles of the USSR's fauna" (Bannikov, Darevsky, 1977).

Such species as *Eremias arguta, Eremias velox, Stellio caucasica, Ophisops elegans* are common for the researched territory: within 1 km of the route were fixed 6 *Eremias velox,* 5 *Eremias argut,* 12 *Stellio caucasica,* 11 *Ophisops elegans.*

4 individuals of *Cyrtopodion caspica,* 1 individual of *Coluber najadum,* 1 slough of *Coluber schmidti,* 2 shells of 1 live *Testudo graeca,* 2 individuals of *Natrix tesellata,* 1 *Maryemus caspica* were met during three days of survey. Females of the most of species were revealed in more rare manner than males owing to the concluding stage of reproductive cycle.

It is necessary to notice that a summer period observation is not quite an "unbiased time" for the reptiles survey owing to a change of the activity cycle from daytime to nighttime by the most of species. For a study of the dynamics of number and density of the noted species populations the summer period observations are to be supplemented by a spring and an autumn observations.

7 Appendix C Ornithology Report

Disclaimer

These reports have been prepared at the request of URS, by local and international experts for the sole use of BP. As such, the report represents the investigations, findings and conclusions of these individuals. Where reports were issued in a language other than English, translations were verbatim.

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Report to Dames & Moore
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Azerbaijan

ENVIRONMENTAL BASELINE STUDY

OF THE BP

SANGACHAL TERMINAL AREA

-

ORNITHOLOGY

-

Results of a
Breeding Bird Survey
conducted during May 2001.

Simon Aspinall, Elchin Sultanov
& Ilias Babayev

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7.1 EXECUTIVE SUMMARY

- A breeding bird survey was completed of the area within five kilometres radius of the BP Sangachal terminal site during May 2001.

- The footprint of the expanded terminal site itself will not adversely impact the breeding population of any species of bird. Away from the confines of this area, however, there are rare, threatened and sensitive species that require consideration.

- Two national 'Red Data' species, namely black-bellied sandgrouse and long-legged buzzard, were found to be present within the study area. Both occurred in areas well away from the terminal site and are thus unlikely to be affected by construction or operation of the terminal. The Western Route export pipeline already crosses their favoured area, apparently without adverse effect. Outside the breeding season these species may occupy other areas within the study area, but, once again, are still unlikely to be 'inconvenienced'.

- The purple gallinule, a Red Data species known to have bred previously in the area, was not found during the present study, although may still be present. Little bustard is yet another Red Data species that may visit the area in winter, most probably to the area of steppe west of the terminal.

- one significant survey finding was the discovery of a new breeding species for azerbaijan, syke's (booted) warbler. upward of 14 territories were located in wet tamarisk south of the access road to the terminal. even though not considered rare or threatened internationally, there is good reason to safeguard this population. discussion with bp hse personnel suggests that additional suitable habitat can actually be created to help the population expand.

- Although too late in the spring to be surveyed during the current study, many migrant species, including some Red Data and/or globally threatened species, are known to pass through the area. Most simply overfly without stopping, e.g. honey buzzard and lesser kestrel, following the coastal lowlands northwards to their breeding grounds. None of these species is likely to be disrupted by construction or operation of the terminal.

- Sangachal Bay supports important numbers of waterfowl during migration periods and, particularly, in winter. These have been the subject of previous studies on behalf of AIOC. Neither migrant, nor wintering birds are discussed at length further in the following report, although they are included in long-term monitoring proposals.

- A number of proposals for environmental enhancement are given in the appendices, these relating in particular to breeding birds and to environmental education opportunities.

- A summary of year-round ornithological monitoring and research requirements is also given in the appendices. A fuller outline is to be prepared separately in consultation with BP HSE in Baku.

7.2 Introduction

A considerable amount of ornithological data has been collected previously from coastal waters and islands (and platforms) from north of Apsheron south to Kyzyl Agach. The international importance of much of the area for waterfowl has, as a result, been firmly established. Involved in particular are island seabird breeding colonies in summer and ducks, coots, grebes and other wetland species visiting or wintering in the area. There is, however, sparse quantitative data on breeding bird populations along the coastal fringe and immediate hinterland. A survey was thus commissioned by BP to look at the area of the pipeline landfall and reception terminal at Sangachal during the breeding season. The following report presents the results of that survey. Part of the work involved collaboration with Azeri ornithologists and training in western methodologies for bird survey and census techniques.

The survey was completed over 28-31/5/01 inclusive.

7.3 Methods

The study area was arbitrarily set as all land within five kilometres radius of the expanded terminal site. For convenience, this area was subdivided, mainly on geomorphological grounds, into seven smaller areas (Figure 1). A brief description of each is given below.

Single morning or afternoon visits were made to each of these areas during 28-31/5/01 inclusive. Morning surveys commenced between 0800 and 0830 and concluded around midday. Afternoon surveys were conducted between c1400 and 1730.

Within each area, a pre-planned transect route was walked at an average speed of 1-2km/hr. Transects varied in length from c3-8 kilometres. A hand-held Garmin GPS was used to record and map the route followed (Figure 1), thereby permitting repeat surveys to be completed in later years. The single survey team consisted of three observers and an interpreter, who remained together at all times. All birds heard or seen were recorded and any evidence of breeding activity was documented. No maximum distance limit from the transect to record a bird was set, the only proviso being that the bird/s should be within that survey area. All birds, whether seen or only heard, were recorded. Variation in detectability of different species is discussed later.

Incidental bird sightings made, and other reports received, were also taken into consideration in the compilation of this report.

SE and NE Coast

The narrow coastal strip seaward of the main road was divided into two, NE and SE, respectively north and south of the landfall jetty. These areas differed substantially in terms of their ecology and the division is thus justified. The southern area, SE, supported shallow lagoons and wet (marshy) slacks with riparian vegetation, particularly *Phragmites australis* (reed) and *Typha sp.* (reedmace). Intermittent streams reached the shore in both areas (SE & NE), these supporting variable amounts of reed growth and/or tamarisk scrub. The northern area, NE, was largely rocky down to the shore, with the exception of a brackish lagoon near its southern limit. Tamarisk *Tamarix sp.* was locally abundant in both areas.

The coastal waters of Sangachal Bay were surveyed from shore. The bay is known to be important for waterfowl during migration periods and in winter, but not in summer when only feeding terns *Sterna sp.* would be expected.

Safety restrictions meant that the reedbeds that have developed between the north and south bound carriageways of the main road to and from Baku were not surveyed.

Central Plain

The central plain was arbitrarily divided into two, respectively north and south of the access road to the Sangachal terminal. The northern area, in particular, has been badly impacted by mudflows, especially to the west, and perhaps also by heavy grazing pressure. In the southern sector are low mud cliffs suitable for burrow-nesting birds.

Ornithologically the greatest interest lies in the low-lying wet grazing marsh (with reeds, reedmace and rushes *Juncus sp.*) and in the tamarisk scrubland. This is of greater extent in the southern area, where reedbed growth is also far more extensive. Innumerable pipelines cross both areas north to south.

North Hill

Due to a shortage of time, the North Hill was not surveyed other than along its southern foot. Bird populations in this area are in any case deemed unlikely to be impacted either by construction activity or operation of the expanded terminal. The rocky slopes run up to sheer faces in places, these being suitable for nesting by a number of bird of prey and corvids (choughs, ravens etc) amongst other species. The entire area is apparently treeless. Mud volcanoes are present near the summit, these being the source for mud-flows traversing the plains at Sangachal.

West Hills

The isolated trio of hills lying immediately to the west of the terminal is lower than the North Hill, but possesses a similar rocky topography. Only low cliff faces are present, these being largely inadequate for nesting by birds of prey, excepting perhaps kestrel (and little owls). Relict Juniper *Juniperus sp.* is found on the summit of the northernmost hill. An extensive archaeological site was discovered on the northern-most hill, with several widely spaced smaller sites also being located. These were notified to the archaeological survey team.

Western Plains

The Western Plains lie to the west of the West Hills and are crossed by the western route pipeline. As with the central plain, mud-flows have affected part of this area, although not so greatly as in the latter's case (or at least not impacting the area so markedly). The area is crossed by at least one stream with low mud cliffs, the narrow channel itself sustaining tamarisk stands. The area is otherwise semi-arid steppic range-land. Grazing is reportedly a major landuse in winter.

Table 1. Breeding bird populations[1] in the Sangachal study area, May 2001.

(All figures refer to minimum number of pairs or occupied territories).

Species	SE Coast	NE Coast	North Hill	Central Plain south	Central Plain north	West Hills	Western Plains
Date (a.m./p.m.)	28/5 a.m.	29/5 a.m.	28/5 p.m.	30/5 a.m.	30/5 p.m.	31/5 p.m.	31/5 a.m.
Little Bittern	1	-	-	-	-	-	-
Purple Heron	1	-	-	1 (1/6)	-	-	-
Ruddy Shelduck	-	-	-	-	-	-	1
Long-legged Buzzard*	-	-	?	-	-	-	1+
Kestrel	1	-	1	1+	1	-	1
Chukar	-	-	2	-	-	1	-
Stone Curlew	-	-	-	-	1	-	-
Black-winged Stilt	2	3	-	1?	2	-	-
Collared Pratincole	5	-	-	-	-	-	-
Little Ringed Plover	-	-	-	-	1	-	-
Kentish Plover	8	6	-	-	2	-	-
Common Tern	-	6-8	-	-	-	-	-
Little Tern	-	7	-	-	-	-	-
Black-bellied Sandgrouse*	-	-	-	-	-	-	2
Rock Dove	1	3	+	-	-	-	-
Cuckoo	-	-	-	1+	-	-	-
Little Owl	-	-	1	-	-	?	-
European Bee-eater	-	-	-	6	-	-	1+
Hoopoe	1	2	-	3	-	-	-
Short-toed Lark	-	-	-	1	1	-	2
Crested Lark	3	7	-	7	2	2	5
Black-headed Wagtail	2	-	-	2	2	-	-
White Wagtail	-	-	-	5	2	-	-
Rufous Bush Robin	-	-	-	9	-	-	-
Isabelline Wheatear	1	1	-	3	-	-	7
Finsch's Wheatear	1	-	5	-	-	6	1
Moustached Warbler	-	-	-	1	-	-	-
Reed Warbler	9	3	-	7	-	-	-

Table 1 (cont.)	SE Coast	NE Coast	North Hill	Central Plain south	Central Plain north	West Hills	Western Plains
	28/5 a.m.	29/5 a.m.	28/5 p.m.	30/5 a.m.	30/5 p.m.	31/5 p.m.	31/5 a.m.
Great Reed Warbler	1	-	-	2	-	-	-
Syke's (Booted) Warbler	-	-	-	14	-	-	-
Menetries' Warbler	-	-	-	11	-	-	-
Rock Nuthatch	-	-	4	-	-	5	-
Red-backed Shrike	-	1	-	1	-	-	-
Chough	-	-	1	-	-	-	-
Magpie	-	-	-	1	-	-	-
Hooded Crow	-	-	-	2	-	-	1
Raven	-	-	-	-	-	-	1
Starling	1+	3	-	Many	-	-	Many
House Sparrow	1+	-	-	Many	1+	-	-

[1] Possible, probable and confirmed breeding records are all included; * signifies national Red Data species

Swifts (Apus apus), swallows (Hirundo rustica), house martins (Delichon urbica) and sand martins (Riparia riparia) feed in large numbers over the area and are probably also breeding within the study area.

Table 2. Other species of bird recorded in the Sangachal study area, May 2001.

(All counts are of individuals).

Species	SE Coast	NE Coast	Central Plain south	Central Plain north	West Hills	Western Plains
Great Crested Grebe	-	4	-	-	-	-
Great Cormorant	1	2	-	-	-	-
Glossy Ibis	-	-	1	-	-	-
Honey Buzzard*	-	-	15	-	-	2
Egyptian Vulture	-	-	-	-	1	-
Steppe Buzzard	-	-	2	-	-	-
Buteo sp.	-	-	-	1	-	-
Lesser Kestrel**	-	-	2	-	-	-
Shelduck	-	3	-	-	-	-
Wigeon	-	1	-	-	-	-
Mallard	-	3	-	-	-	-
Greater Sand Plover	2	18	-	-	-	-
Wood Sandpiper	1	-	-	-	-	-
Black-headed Gull	-	1	-	-	-	-
Slender-billed Gull	-	2	-	-	-	-
Herring Gull	8	6	-	-	-	-
Gull-billed Tern	-	1	-	-	-	-
Sandwich Tern	-	15	-	-	-	-
Whiskered Tern	4	-	-	-	-	-
Red-throated Pipit	-	-	1-2	-	-	-
Grey-headed Wagtail	-	-	-	-	-	-
Sedge Warbler	-	-	1	-	-	-
Rosy Starling	-	-	1	-	-	-
Goldfinch	-	-	2	-	-	-

* - Red Data species; ** - globally threatened (note that lesser kestrel is not actually a Red Data species in Azerbaijan , yet it is considered globally threatened).

7.4 RESULTS

Survey results are given in Tables 1 and 2. Table 1 provides minimum population estimates, as number of pairs, for all possible, probable and confirmed nesting species, along transect corridors in each of the seven survey plots (Figure 1). Table 2 provides details of visiting migrant species recorded in the same survey areas, some of these being late departing winter visitors or non-breeding, immature birds.

The position of nesting colonies was recorded precisely using the GPS (Table 3). This concerned only four species, namely collared pratincole, common tern, little tern and bee-eater, most other species were recorded nesting either singly or in adjacent territories within a specific habitat, for example reed warblers in a reedbed. No bird of prey nests were located, although certain species may be nesting within the study area, long-legged buzzard and kestrel in particular. Many species of birds of prey use traditional eyries annually, which is, of course, relevant to their successful conservation.

Table 3. Location of important bird colonies in the Sangachal terminal study area.

Species	Area name	Northing	Easting	Estimated no. pairs
Collared Pratincole	SE coast	40.16742	49.47095	5
Common Tern	NE coast	40.18939	49.50476	6-8
Little Tern	NE coast	40.18939	49.50476	7
European Bee-eater	Central plain (south)	40.18633	49.46848	6

One notable observation concerned a migrant species, Syke’s booted warbler (hereafter Syke’s warbler), found breeding in wet tamarisk scrub to the south of the access road to the existing terminal. This is noteworthy as it constitutes the first confirmed breeding season presence of the species in Azerbaijan and it is undoubtedly nesting here (see also Appendix 2). Nesting habitat typical for this species is present widely over the central southern survey area. The area occupied by this species lies east and west of a line joining 40.19236N 49.48428E and 40.18326N 49.47402E (see transect route as mapped on Figure 1).

Two national Red Data species were recorded. One of these, black-bellied sandgrouse, was recorded only on the Western Plains (single flying bird landed at c40.21425N 49.45283E and a pair flushed at 40.22109N 49.43737E). The species seems likely to be nesting and feeding in this area alone, although birds may visit other areas outside of the breeding season. During hot weather sandgrouse need to make daily visits to freshwater to drink. Where these birds visited to do so was not discovered.

The second such species, long-legged buzzard, was seen hunting widely over the Western Plains (centred around 40.21452N 49.43727E) and is likely to be nesting either in tamarisk bushes there or on a cliff north or west of the plains. A bird was also seen hunting over the central plains to the north of the terminal.

The home range of birds of prey is likely to be many tens of square kilometres i.e. almost throughout the entire study area, although the feeding territory of no single species, or individual pair of any species, was actually mapped during this study (see later discussions).

7.5 DISCUSSION

Amongst species of breeding bird present in the Sangachal study area, only two are listed as national Red Data species, namely black-bellied sandgrouse and long-legged buzzard. The former probably nests on the Western Plains (see Table 1), also wintering in the area. Long-legged buzzard hunts over the plains throughout the area, including around the immediate area of the terminal, and probably nests either in tamarisk found in the gullies crossing the Western Plain or on a cliff or crag on the North Hills or further to the west. No globally threatened species were recorded, although one such species, namely little bustard, may occur either on passage or in winter in the study area.

One further Red Data species, purple gallinule, has bred previously in the area (Sultanov pers. obs.) and may still do so, although it was not detected during the present study. Night-time surveys (listening for this species) may find it still present in the area.

Of particularly significant interest was the discovery of Syke's warblers breeding in the damp scrubland to the south of the terminal's current access road. This species had not previously been recorded as breeding anywhere in Azerbaijan, although was known as a scarce passage migrant through the Caspian lowlands. The habitat where the species is present is typical of that species elsewhere in its range and it seems probable that Syke's warbler was simply overlooked prior to this survey. It is plausible, furthermore, that it is in fact present in most similar damp scrubby habitats along the Caspian coast.

It is also likely that with further surveys additional species may be recorded breeding within the study area. Bearded tit, penduline tit, reed bunting and crakes are all likely to be present in reedbed habitats. No night-time surveys were completed and other than providing population estimates for little owls, these may provide firm evidence of certain species breeding on the site (e.g. purple gallinule, crakes and stone curlew). Other species not recorded during the current or previous studies, nightjar and Savi's warbler (both of which sing at night), for example, may also be found.

It should be noted that although nesting localities were identified for each species in each of the seven survey areas within the study area, the feeding areas of individual species were not determined absolutely. For most passerines e.g. warblers, wheatears and wagtails, the area over which feeding can be expected to have taken place would be relatively small and confined to the area in which they were recorded as nesting. For some other species, corvids (magpies, ravens, crows and choughs), terns and birds of prey (raptor), for example, foraging may take place a considerable distance from the actual nest site, over areas away from the nesting locality. The adult Egyptian vulture observed over the West Hills, and long-legged buzzard foraging over the Central Plains, are specific examples. Both may nest on North Hill, or in the latter's case, the Western Plains. Seabirds too may also make long-distance foraging trips away from their nest-sites. Both common terns and little terns were observed foraging close inshore along the entire length of coast (and beyond) in the study area.

Time constraints did not permit second visits to any site, or to the completion of a full census throughout the entire study area. Strong winds, particularly during afternoon surveys, will have affected bird activity and made them less conspicuous. Surveys would ordinarily be suspended when winds exceed Force 3, but time did not permit on this occasion. Nonetheless, there is no reason to assume that all members of the avian community have not been recorded, even if their true population sizes remain obscure. Estimates given can be taken as representing absolute minima in almost all instances.

Partly due to the training programme, the team remained together at all times. Ideally, in open terrain, teams of a maximum of two persons would survey along transects. A single trained observer, familiar with the area and species likely to be encountered, would also prove to be adequate. A second observer could then walk a parallel transect 200m or further away from the first observer, thereby covering a greater survey area and producing improved population estimates and/or density estimates.

Also, due to time constraints, surveys could not be completed in all areas during the period of greatest bird activity. In future, similar surveys should completed between c0600 and 1000 and between c1600 and 2000 depending on the habitat concerned. Transects across open terrain may be permissible during other times, when cloud cover is high for example, but it should be born in mind that bird activity is greatest early and late in the day. Census or survey work in scrub and reedbeds should certainly only take place early in the day, and would be reliant on identification of birds from their calls or songs.

Only when these conditions have been adhered to can comparisons strictly be made, either between different sites or between years at a single site. Although certain species are more readily detected than others, this will not actually have affected the net result of the survey. Difference in observer ability is an important consideration, however, particularly where the quality of a survey is reliant on identification of bird songs or calls. (Outside of the breeding season this is of lower importance). The quality of optical equipment (telescopes and binoculars) is also very important.

Those surveys completed in May 2001 can be replicated by following the same transect routes in future years, thereby permitting direct comparison. In the Sangachal area, however, it should be realised that the wet scrubland in particular is successional, thus this habitat can be expected to change through time, with concomitant changes in the numbers of pairs of different species of bird, as well as in the bird community itself. The same can probably be said of much of the plains, which have been badly impacted by mudflows, with the vegetation still to recover or redevelop. Recovery to its former state may in fact not be possible. Instead, a different floral community may well develop (see botanical survey report).

Since comparison of the results of future monitoring with this ornithological baseline of breeding birds is likely to be confused by natural habitat change through time, it is recommended that management activities deemed likely to enhance wetlands, both along the coast and east of the terminal, be undertaken. Protection of existing bird colonies found in the study area (see Table 3) should also be a priority.

Appendix 1 discusses the possibility of environmental enhancement in the area of the Sangachal terminal, in line with other of BP's current programme of environmental initiatives in Azerbaijan. The opportunity to create a wetland reserve, for educational and awareness purposes, forms part of the proposal presented.

Impact of terminal expansion – construction and operational phases

Individual species or groups of species at risk in the Sangachal study area are summarised in Table 4.

Terminal area

The footprint of the expanded terminal area will not adversely impact the breeding population of any species of bird, even if a small number of individuals of a number of species will necessarily be displaced. None of these species is otherwise considered threatened or rare and thus no mitigating or remedial measures are required.

It is also improbable that either construction or operation of the terminal will affect bird populations in the immediately surrounding area (i.e. within 1km radius), especially as much of the area has been ecologically disrupted by mudflows. No especially sensitive or threatened species of breeding bird occurs in areas where building work is scheduled.

West Hills and North Hill

The rocky hills west and north of the expanded terminal are unlikely to be impacted by construction activity or by subsequent operation. It was noticed that quarrying (by an unknown party) had partly damaged the archaeological site on the eastern side of the northernmost of the West Hills, and an alternative source of stone or other materials should certainly be sought by whoever is responsible.

The North Hill lies outside the area likely to be influenced by the day to day activities of the terminal.

Central Plain

Much of the northern and western half of area has been affected in the past by natural mudflows. This, together with heavy grazing pressure, has probably reduced the quality of the habitats present in the area.

The ephemeral wetlands lying north and south of the current access road to the terminal, which mostly dry out in summer, are of interest and support a typical lowland wetland bird community (Table 1), although of neither exceptional quality nor great areal extent. Even so, these areas should, and need not be adversely affected by expansion of the terminal. In supporting the, to date, only proven breeding Syke's warblers in Azerbaijan, the tamarisk scrub south of the access road clearly has some significance. This area is outside the immediate development zone itself, but within the boundaries of the area eventually likely to fall under BP's control. There will thus be an obligation to maintain sufficient habitat to sustain this isolated population (something which BP might care to showcase).

A proposal to manage wetland areas on the central plain and along the Caspian coast is expanded on later (see Appendix 1).

Western Plains

The Western Plains hold one or more pairs of the only two Red Data species considered to be breeding in the study area. It is important that these plains are not overly disturbed by oil-related activities, other than being subject to patrol and access along the pipeline corridor. Only existing tracks and other rights of way should be used, and off-road driving should not be permitted. This should become company policy in all steppic habitats, which are known to be particularly vulnerable to damage by vehicular traffic, at any time of year.

Table 4. Key species of bird and habitats at risk in the Sangachal study area

Area	Habitat	Species or habitat at risk
Terminal area	Mud plain	NONE
Central Plain	Semi-arid plain, grazing marsh & tamarisk scrub	Breeding Syke's warbler Wetland, including reedbed, & breeding bird community
West Hills	Rocky hills	NONE
North Hill	Rocky hill & mud volcanoes	NONE
SE & NE coast	Shingle beach, wetlands, Inshore waters & benthic habitats	Nesting common tern, little tern, collared pratincole & ? purple gallinule. Coastal wetland, including reedbed, & breeding bird community. Waterfowl on migration and in winter
Western Plains	Rolling semi-arid steppe	Breeding black-bellied sandgrouse & long-legged buzzard. ? Little bustard in winter

NE & SE Coast
One of the most vulnerable habitats for breeding birds in the area is the coastal wetlands. Even though no Red Data species actually occur, care should be taken to ensure that these wetland areas are not physically damaged and that their hydrological regime is not disrupted. Beach-nesting tern colonies may need to be cordoned off in the breeding season to ensure breeding success. Disturbance, including that from people simply visiting on foot, will need to be minimised or prevented locally during the summer (May-July).

The Caspian coast, inshore waters and benthic habitats are particularly sensitive environmentally. Pollution and physical damage to littoral and subtidal (benthic) habitats are the main threats. Although the current study concerned itself primarily with breeding birds, it is during migration periods and in winter, more-so during the latter period, when the coastal waters of Sangachal (and indeed the entire Caspian Sea) assume their greatest importance for birds. Survey reports of waterfowl numbers present in Sangachal Bay are held by AIOC/BP in Baku.

The landfall area is one area where disruption to the current habitats is likely to be unavoidably greatest. Other than possible translocation of reptiles, there is probably little to be gained from mitigation during the construction phase and it is probably best simply to restore the habitat after work has been completed. The landfall area is just south of an elevated headland, where a visitor centre might be located (see Appendix 1).

The proposal, or possibility of BP actually managing part of the study area as a *de facto* 'local nature reserve' will vastly outweigh the very minor effects brought about by developments. Enhancement of the environment can be very simply achieved in the Sangachal area. However, all taxa, not just birds, should be taken into consideration in the design and execution of this proposal.

Appendix 1. Recommended research, survey, monitoring and related activities

An abridged version of a full proposal and discussion document delivered directly to BP is provided here.

1. Breeding bird surveys – Sangachal study area only

Since the area is possibly to be managed as a local nature reserve, monitoring of changes in bird populations from those of the baseline year would not relate to any impact due to the terminal expansion. Rather, they would relate to the effectiveness of management activities actually designed to improve the attractiveness of the area to wildlife (and to birds in particular). It is suggested therefore that special efforts be made to conserve those colonies located, manage those wetlands present on the plains and along the littoral back-beach and to minimise motorised or other disturbance away from the terminal itself.

This stated, annual breeding bird surveys would need to be completed to measure the success and/or suitability of management carried out. 'Common Bird Census' methods should be employed.

2. Numbers and seasonal distribution, feeding ecology & local movements of migrant and wintering waterfowl – Sangachal Bay & offshore areas

There is no question that Sangachal Bay is at its most important during migration periods and through the winter months. Waterfowl numbers are high from at least October until March (Sultanov and Babayev pers. obs.). Most waterfowl may be visible from shore in calm weather and monthly land-based counts should prove adequate for monitoring purposes. Observations should, however, also commence on feeding and roosting behaviour of both visiting and breeding species of waterfowl.

Offshore, aerial surveys should be employed. This would give rapid survey returns, providing a 'snapshot' picture of the gross distribution and numbers of waterfowl. Boat-based transects may not be practical, or any cheaper in the long run. It is suggested that helicopter flights be conducted monthly from September to March (inclusive) during Year One and from November to March in subsequent years. A standardised, repeat survey grid and methodology should be drawn up.

Repeat annual surveys would form part of an ongoing monitoring programme.

3. Monitoring seabird colonies – offshore islands and platforms

This would focus on annual monitoring of breeding colonies and measuring productivity (reproductive success) and follow well-established methods. This is the sort of work to use a PhD student for - i.e. by funding a doctoral thesis for one or more Azeri biologists.

4. Beached Bird Survey – selected beaches Apsheron to Kyzyl Agach

It is by conducting "Beached Bird Surveys" that 'normal' mortality levels and seasonal patterns of the same can be established. This exercise has biological value, but is also useful in education and PR. Schoolchildren might be involved in such a hands-on activity.

5. Ongoing training and collaboration

Western scientists continuing to work with Azeri scientists would form an important component of the proposed work. Training in recording methods, analysis and data and report presentation is essential if ongoing work is to meet the needs and expectations of BP.

6. Education and environmental awareness programme

Creation of a reserve area

This is somewhere where the habitat would be managed for wildlife, with guided trails, interpretive boards and other facilities. The idea would be to have an “outdoor classroom” for schoolchildren. A series of projects might be devised - tortoise or terrapin survey and study, life history of dragonflies, frogs etc., bird identification and survey and botanical studies. The simplest solution would be to create a wetland using treated wastewater. These would be of value to many species groups and also a perfect way to green up and beautify the area.

Secondary treatment of wastewater using reedbed technology is an ideal way to demonstrate an environmentally friendliness at the same time as creating an area of value to wildlife. A reedbed would be used by migrant and wintering birds as well as by certain breeding species. Habitat restoration may also be considered (see below).

Expansion of the tamarisk scrub wetland, which is used for nesting by Syke’s warblers, could be achieved with ease and might be considered worthwhile. Restoration and management of habitat, particularly along the littoral zone, should also be considered. For example, a track has been built in one area cutting off the water supply to a reedy lagoon, the reeds subsequently dying. This area could easily be (and should be) restored, as should be the landfall area post- forthcoming operations. The eventual possibility of managing the hydrology of these areas to keep them wet all year should be assessed, as their value for wildlife would then be increased.

Visitor centre

The idea of siting a interpretive centre come wildlife watch point near the Sangachal terminal is an attractive one. A possible suitable site has already been identified on an elevated headland (40.18407N 049.49380E) immediately north of the landfall jetty. The idea would be to have an educational display and materials in a place where wildlife, particularly waterfowl, can be readily observed. Large numbers of waterfowl occur in Sangachal Bay during migration periods and in winter. An annotated checklist of the flora and fauna of the Sangachal area might be compiled for publication and distribution.

Sponsorship

A number of sponsorship options offering a tangible product should be considered. One immediate possibility would be support for the publication of an updated ‘Red Data’ book for Azerbaijan (all flora and fauna). Even though the conservation status of many species is not well known, production of Red Data listing is a vital starting point. A second possibility, of value to ongoing studies, would be translation of relevant scientific papers from Azeri or Russian into English. Even just titles and abstracts of the wealth of existing literature being translated may prove invaluable.

Sponsorship of PhD theses in applied scientific or other studies (see e.g. No. 3 above) would also be of value.

Appendix 2. Article on the discovery of nesting Syke's warblers for BP magazine

BP recently commissioned studies of the flora, fauna and heritage of the area surrounding its Sangachal operations in Azerbaijan, these necessarily being prior to the proposed expansion of the terminal. These essential studies will form an important environmental baseline against which to measure HSE performance. A survey of breeding birds on the site found the unexpected, a new breeding species for Azerbaijan.

The survey team of Elchin Sultanov, Ilias Babayev and Simon Aspinall describes its own discovery and the future prospects for the diminutive Syke's warbler.

Some 360 species of bird have been recorded in Azerbaijan, and yet despite a wealth of studies, there is much still to be learnt about this ornithologically-rich country. An exciting discovery made during a survey at the Sangachal terminal this year underlines this point.

In late May, a three-man ornithological team found several pairs of Syke's warbler (Hippolais rama) nesting in moist tamarisk scrub immediately to the south-east of the terminal. This constituted a new breeding species for the country, where hitherto it was known merely as a scarce migrant visitor along the Caspian coastlands.

The species was found to be widespread in suitable habitat in the area, with upward of fourteen territories actually being mapped. Although it seems most likely that the species was previously overlooked, its presence at Sangachal is possibly the result of a recent range expansion. Whatever the true situation, the habitat is typical of the species elsewhere in its range. Moreover, since this habitat is relatively widespread along the southern and western Caspian coastlands, it suggests that once surveys investigate new areas further pairs may well be located.

Although outside the 'footprint' of the expanded terminal site, the area lies close to the access road and will ultimately fall well within the area coming under BP's jurisdiction once the terminal is fully up-and-running. HSE personnel based in Baku visited the area to investigate ways of ensuring the area is safeguarded, but instead came up with a simple way to actually increase the amount of available suitable habitat preferred by the warblers! Sympathetic management will involve planting up with riparian plants, such as reeds and bullrushes, and the all important tamarisk in which the birds build their nests. Managing water supplies to the area would, it seems, be relatively straightforward and to the net benefit of several different faunal groups.

Sangachal will thus not only be a major industrial terminal, but also something of a local nature reserve. A number of interesting reptiles and mammals also occur, spur-thighed tortoises, Caspian terrapins and jirds among them, with dragonflies and marsh frogs abundant in the many wetlands. There is also a newly-found 11th Century archaeological site being investigated on the hills next to the terminal, this again having only come to light during the recent fieldwork.

[Editors note: Although not that dramatic or glamorous to look at, Syke's warblers have an interesting migration, spending the winter in the Indian subcontinent and returning north to their breeding grounds in late April each year. The breeding range extends from the Caspian across western and central Asia to Sinkiang].

NOT FOR CITING

Appendix 3. Unofficial Red Data list for birds in Azerbaijan (provided by Dr. Babayev).

The, as yet, still unofficial Red Data list for birds, including both visiting and breeding species now contains 53 species, up from 37 species on the existing official version of the list.

English Common Names	Latin names (Genus species)
White Pelican	*Pelecanus onocrotalus*
**Dalmatian Pelican	*P. crispus*
Spoonbill	*Platalea leucorodia*
Black Stork	*Ciconia nigra*
Greater Flamingo	*Phoenicopterus ruber*
Bewick's Swan	*Cygnus columbianus bewicki*
Mute Swan	*C. olor*
**Red-breasted Goose	*Branta ruficollis*
**Marbled Teal	*Marmaronetta angustirostris*
**White-headed Duck	*Oxyura leucocephala*
Osprey	*Pandion haliaetus*
Honey Buzzard	*Pernis apivorus*
**Pallas' Sea Eagle	*Haliaeetus leucoryphus*
**White-tailed Eagle	*H. albicilla*
Short-toed Eagle	*Circaetus gallicus*
Goshawk	*Accipiter gentilis*
Levant Sparrowhawk	*A. brevipes severtsov*
Shikra	*A. badius*
Long-legged Buzzard	*Buteo rufinus*
Steppe Eagle	*Aquila rapax*
**Imperial Eagle	*A. heliaca*
Golden Eagle	*A. chrysaetos*
Lammergeier	*Gypaetus barbatus*
**Black Vulture	*Aegypius monachus*
Griffon Vulture	*Gyps fulvus*
Saker	*Falco cherrug*
Lanner	*F. biarmicus*
Peregrine	*F. peregrinus*
Hobby	*F. subbuteo*
Caspian Snowcock	*Tetraogallus caspicus*
Caucasian Snowcock	*T. caucasicus*
Black Francolin	*Francolinus francolinus*
Grey Partridge	*Perdix perdix*
Pheasant	*Phasianus colchicus talischensis*
**Caucasian Black Grouse	*Lyrurus mlokosiewieczi*
Purple Gallinule	*Porphyrio porphyrio*
Common Crane	*Grus grus*
Demoiselle Crane	*Anthropoides virgo*
**Great Bustard	*Otis tarda*
**Little Bustard	*Otis tetrax*
**Sociable Plover	*Chettusia gregaria*
White-tailed Plover	*Chettusia leucura*
**Black-winged Pratincole	*Glareola nordmanni*
Mediterranean Gull	*Larus melanocephalus*
Black-bellied Sandgrouse	*Pterocles orientalis*

English Common Names	*Latin names (Genus species)*
Eagle Owl	*Bubo bubo*
White-throated Robin	*Irania gutturalis*
Marsh Tit	*Parus lugubris*
Trumpeter Finch	*Bucanetes githagineus*
Great Rock Nuthatch	*Sitta tephronota*
Great Rosefinch	*Carpodacus rubicilla*
Short-toed Treecreeper	*Certhia brachydactyla*

Note that on account of their continued abundance in the country, certain species considered globally threatened by IUCN are not even listed as national Red Data species in Azerbaijan. Conversely, many of those species actually listed as Red Data species are not regarded as globally threatened. The latter, which are of greater international priority, are indicated here with a double asterisk (**).

Appendix 4. Scientific names of species mentioned in the text

Common English Name	Latin name (Genus species)	Common English Name	Latin name (Genus species)
Great Crested Grebe	*Podiceps cristatus*	Cuckoo	*Cuculus canorus*
Great Cormorant	*Phalacrocorax carbo*	Little Owl	*Athene noctua*
Little Bittern	*Ixobrychus minutus*	Nightjar	*Caprimulgus europeus*
Purple Heron	*Ardea purpurea*	European Bee-eater	*Merops apiaster*
Glossy Ibis	*Plegadis falcinellus*	Hoopoe	*Upupa epops*
Ruddy Shelduck	*Tadorna ferruginea*	Short-toed Lark	*Calandrella c. cinerea*
Shelduck	*Tadorna tadorna*	Crested Lark	*Galerida cristata*
Wigeon	*Anas penelope*	Red-throated Pipit	*Anthus cervinus*
Mallard	*Anas platyrhynchos*	Black-hdd. Wagtail	*Motacilla (f.) feldegg*
Honey Buzzard	*Pernis apivorus*	Grey-hdd. Wagtail	*Motacilla f. thunbergi*
Egyptian Vulture	*Neophron percnopterus*	White Wagtail	*Motacilla alba*
Steppe Buzzard	*Buteo (b.) vulpinus*	Rufous Bush Robin	*Cercotrichas galactotes*
Long-legged Buzzard	*Buteo rufinus*	Isabelline Wheatear	*Oenanthe isabellina*
Lesser Kestrel	*Falco naumanni*	Finsch's Wheatear	*Oenanthe finschii*
Kestrel	*Falco tinnunculus*	Savi's Warbler	*Locustella luscinioides*
Chukar	*Alectoris chukar*	Reed Warbler	*Acrocephalus scirpaceus*
Purple Gallinule	*Porphyrio porphyrio*	Sedge Warbler	*Acrocephalus schoenobaenus*
Stone Curlew		Moustached Warbler	*Acrocephalus melanopogon*
Black-winged Stilt	*Himantopus himantopus*	Great Reed Warbler	*Acrocephalus arundinaceus*
Collared Pratincole	*Glareola pratincola*	Syke's Warbler	*Hippolais rama*
Little Ringed Plover	*Charadrius dubius*	Menetries' Warbler	*Sylvia mystacea*
Greater Sand Plover	*Charadrius leschenaultii*	Bearded Tit	*Panurus biarmicus*
Kentish Plover	*Charadrius alexandrinus*	Rock Nuthatch	*Sitta neumayer*
Wood Sandpiper	*Tringa glareola*	Penduline Tit	*Remiz pendulinus*
Black-headed Gull	*Larus ridibundus*	Red-backed Shrike	*Lanius collurio*
Slender-billed Gull	*Larus genei*	Chough	*Pyrrhocorax pyrrhocorax*
Herring Gull	*Larus cachinnans*	Magpie	*Pica pica*
Gull-billed Tern	*Gelochelidon nilotica*	Hooded Crow	*Corvus c. cornix*
Sandwich Tern	*Sterna sandvicensis*	Raven	*Corvus corax*
Whiskered Tern	*Chlidonias hybrida*	Starling	*Sturnus vulgaris*
Common Tern	*Sterna hirundo*	Rosy Starling	*Sturnus roseus*
Little Tern	*Sterna altifrons*	House Sparrow	*Passer domesticus*
Black-bellied Sandgrouse	*Pterocles orientalis*	Goldfinch	*Carduelis carduelis*
Rock Dove	*Columba livia*	Reed Bunting	*Emberiza schoeniclus*

FINAL REPORT

Shah Deniz Stage 1 Gas Export Project - Technical Appendix 13

Cultural Heritage

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CONTENTS

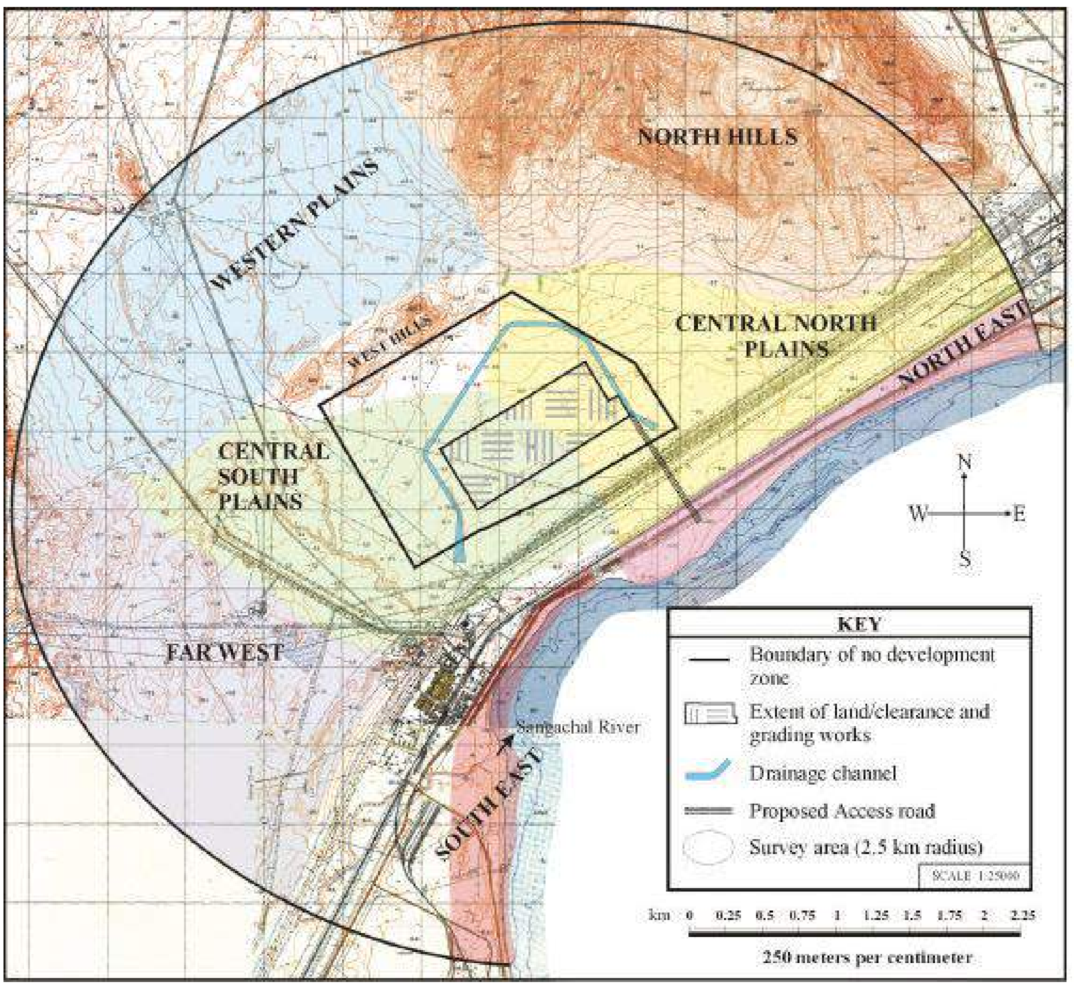
1 Introduction

A non-intrusive field survey was undertaken over a period of four days (04-6-01 to 07-6-01) over an area of approximately 5 km radius around the proposed terminal expansion site (Figure 1). The purpose of the survey was to document features of archaeological significance in the Sangachal area. Personnel from the Institute of Archaeology and Ethnography, Azerbaijan Academy of Sciences participated in the survey and are listed below.

Individual	Expertise	Affiliation
Nadir Khasanov	Archeology	Azerbaijan Institute of Archaeology
Elmira Abbasova	Archeology	Azerbaijan Institute of Archeology

A URS consultant accompanied the scientists in the field

Figure 1 Geographic location and extent of survey sectors



1.1 Methodology

This study was designed to characterize the project area in terms of its significance to cultural heritage (archaeological, historical, religious, and unique natural sites).

This involved review of existing reports, maps and aerial photography if available. While identifying sites of local and regional significance around the proposed development locations, particular emphasis was given to sites of national importance or sensitivity.

During the field survey, archaeologists located and assessed whether or not there were any known sites of archaeological interest in the region. The study targeted areas identified in the desk-based study as having archaeological potential. Additionally, further features of archaeological interest were identified as well as locations that have potential for archaeological remains.

This included the initial assessment of significance based on:

- The rarity of a site/find/feature within the region or local landscape;
- The nature and complexity of the site/find/feature;
- The presence of associated sites/finds/features; and
- The integrity and survival of the site/find/feature.

All sites identified in the field were recorded using GPS and accompanying photography, with data summarized on a Pro Forma, developed for this study. The Proforma recorded the following:

- GPS Reference
- Photographic Reference
- Site (restricted, spread etc)
- Artifacts (isolated, many, grouped etc)
- Nature (structural, cemetery, carvings, implements, pottery etc.)
- Cultural identity (Palaeolithic, Mesolithic, Neolithic, etc.)

The integrity of each of the sites identified was also determined and any negative influences of the proposed development identified.

1.2 Reporting

Reporting, in Russian or Azerbaijani, consisted of filling in the Proformas described above for each feature of potential archaeological significance identified during the survey. In addition, a written report regarding archeologically interesting features was authored by the survey scientists.

These were handed into URS Dames & Moore for review. All questions on the Pro Forma were answered after review. Based on URS feedback, necessary clarifications/changes were made and a final report submitted to URS.

The report generated by the scientists involved with the survey work and completed proformas can be found in Appendix A.

Appendix A Archeological Report and Proformas

Disclaimer

These reports have been prepared at the request of URS, by local and international experts for the sole use of BP. As such, the report represents the investigations, findings and conclusions of these individuals. Where reports were issued in a language other than English, translations were verbatim.

These reports in no way represent the views, assumptions or opinions of URS. No other warranty, expressed or implied, is made as to the professional advice included in, or contents of, these report. URS is not responsible for any liability arising out of, or in connection with, any reliance on or use of the advice or information provided.

1.3 Report on Archeological Monuments around Sangachal Terminal

We (N.Hassanov, E.Abbasov) conducted an overground archaeological research from 4th to 7th of June 2001. There were 10 archaeological monuments found as a result of the overground archaeological research. The monuments are the following:

1st Sangachal habitation place (Coordinates 94 N40.21194 ?49.46144) is formed by high mountains. Some artificial grooves were found on the surface of flat mountains. By the way, at I. Jafarzadeh's opinion this type of grooves is typical for Gobustan. Remains of some construction built from big stones were found at the bottom of the mountains. The grooves as well as the remains of fireplace on the mountains belong to the mentioned habitation place. They belong to ancient period and Middle Ages. The habitation place covers a big territory. Very valuable monument, well preserved. It is recommended to keep the terminal away from this territory.

Two archaeological monuments were defined at 2nd Sangachal habitation place (Coord.-95 N40.21194? 49.46144). One of them relatively belonged to ancient period and resembled a cove. The bottom of standing head to head rocks forms triangle emptiness. The highest place inside the cove is 3 meters. 6 meters in width and 8 meters lengthwise. Till now more than 20 coves of this type were registered in Gobustan. Both sides of the emptiness were covered by stone wall. Certain rock drawings were found inside of one of the stones.

One of the drawings is an image of goat with profile directed to the left. The body, legs and horns of the goat were drawn by straight parallel lines. Comparatively well preserved. Other drawing was also an image of goat drawn at the same direction slightly to the right. Slightly bigger size of the goat drawing and worse level of preservation distinguished the first drawing. Tailpiece of the goat image was slightly disintegrated. In general, the surface of the rock where these images were found was very rough being affected by strong erosion. Both of the goat images formed a complete composition. From the level of planning and existence of other archaeological parallels these images can be attributed to the II millennium BC Thus, the same type of goat images were found in Gobustan Rock Drawings complex located nearby to the place of finding. Research workers attributed most of these images to the mid of Bronze Age, i.e. II millennium BC. Besides, such images of goat were drawn in the same style on the Azeri earthenware of that age.

There was an image of sign slightly lower from the mentioned images of goats on the same mountain. The structure of the sign formed by a circle, a straight line drawn downwards from the circle and arched line directed downwards crossing the straight one was look like a schematic image of human. Such signs were discovered only onto one of the rocks of "Yazili Tepe" (Drawing Hill) in Gobustan. The same signs were discovered on the rocks attributed to the Bronze Age during the exploration of Dubandi monument in Apsheron. This sign also formed a new composition with the goat images mentioned above and was attributed to the same period.

The habitation place was used during the next ages. Discovered overground archaeological materials confirmed our conception. The overground archaeological materials consist of different fragments of earthenware potteries. The fragments of earthenware potteries have a shape of a saucepan and a jar type pots. These archaeological materials are typical for the Middle Ages. An initial examination of the territory confirms that the habitation place covered quite a wide area during the middle ages. The remains of constructions were scattered all over the habitation place. Unglazed fragments of earthenware potteries are frequent among the archaeological materials. Unglazed earthenware potteries are mainly bodies and arms of water pots – jars. Unglazed potteries were covered with reddish, greyish and blackish engobe layer. The potteries were made on potter's wheel with graceful mastery and smooth thin walls. Very valuable monument. Archaeological exploration must be conducted prior to the work in this area.

3rd Sangachal habitation place (Coord.-101 N40.21159 ? 49.46043) located near to the 2nd one. At our opinion this habitation place is the continuation of the 2nd one. The remains of constructions were scattered all over the habitation place.

House foundations located 5-10 meters away from each other can be clearly identified in the habitation place. Based on an overgound inspection it was defined that 8 house foundations can be well observed.

Houses in the habitation place were built by stone and partially by burnt bricks. A special soil was used as a mortar. It is possible to see the shapes of some houses. There are some houses with length more than 20 meters. The houses were built with big stones. Based on certain marks of foundations we can assume that the construction was a part of castle.

Fragments of earthenware potteries were spread all over the ground surface. There were more unglazed fragments among earthenware potteries. Unglazed potteries were mainly necks, arms and handles of pots with shapes like jug and jar. Unglazed oil lamp draws a special attention. A thick soot layer is formed on some parts of the oil lamp. Unglazed hookah head was performed very skilfully.

The bottom of the hookah's part for tobacco stuffing is decorated with many-petaled flower image. The image was punched onto the surface. Be the way, the hookah heads were usually casted. Mouthpiece made from a reed was put on hookah head.

Unglazed potteries discovered in other areas of the 4th Sangachal habitation place (Coord. 102 N4021063 ? 49.46021) consisted of bottoms and handles of jugs and jars. Jar handles were made in a tape shape. Sometimes you can meet big jug handles. Green glaze was used for glazing of the potteries.

Most of the unglazed potteries were covered by engobe layer from both inside and outside. Glazed earthenware potteries belong to neck and arm parts of jars and cans.

5th Sangachal (t) habitation place (Coord. 120 N40.21659 ? 49.47658). One part of the habitation place is located on a landscape, another one is on the hill. One of the earthenware potteries had a geometrical lines and spots on its neck drawn by engobe. The pot was covered by transparent glaze. The spots clarifies that the handles of the pot connects the neck to the arm. The outside wall of the second pot was covered by white engobe.

Based on discovered overground archaeological materials we attribute the habitation place to the middle ages. The habitation place is a very valuable, well-preserved monument. No construction activities can be conducted in this area.

6th Sangachal habitation place (t) (Coord. 116 N40.21300 ? 49.44386). The habitation place covers an area of 7-10 hectares. Being surrounded by hills the habitation place is located on a landscape. The remains of walls in the habitation place are well observed. Houses were built close to each other. There are stains of burning on the remains of the construction.

Dwelling houses were mainly built up with stones. Some houses were identified to be 5x7 meters in size. The houses were mainly planned as right-angled. Houses with circular plans can also arrest an attention.

Fragments of earthenware potteries were spread all over the habitation place. The earthenware potteries belong to bodies, arms, necks and handles of unglazed jar and jug shaped pots. The earthenware potteries were covered by greyish, reddish engobe layer. It is a valuable monuments. It was well maintained and preserved . The area can be used for other purposes after an appropriate archaeological dig performed around the monument.

8th Sangachal habitation place (Coord.120, N40.21659 ? 49.47658). The main area of the habitation place is located on a landscape. Other parts are on the mountains. Remains of construction materials were spread all over the habitation place. These construction materials consisted of stones. There is a groove pattern on one of slab stones. We have no doubt that this finding was a part of an architectural monument. Different fragments of earthenware potteries were scattered all over the ground. The fragments of earthenware potteries belong to bodies and handles of jar type pots made on potter's wheel. The habitation place is attributed to the Middle Ages. It is a valuable monument. We can discuss the possibility to use this area after an appropriate archaeological dig performed in the habitation place.

Gochdash (ram-shaped) monument of Sangachal (?) (Coord. 151. N40.19644 ? 4949693) is located close to a railroad. It is on a landscape. It is hard to observe the remains of overground constructions. However there are many fragments of earthenware potteries scattered all over the area.

Even though some portions of big ram-shaped stone are broken still it is well preserved. The fragments of earthenware potteries discovered in the area are attributed to the early Middle Ages, and the ram-shaped stone to XV-XVI centuries.

It is a valuable monument. After being investigated the valuable monuments as well as ram-shaped stone must be removed from this area.

9th Sangachal habitation places (?) (Coord. 164 N40.19350 ? 49.45478) is located on a landscape. There are no remains of construction observed on the surface of the ground. We guess the small ground hills are the construction remains. Earthenware potteries were spread all over the habitation place. Different types of earthenware potteries are typical for early middle ages. We attribute the habitation place to the same period. It is a valuable monument. The area can be used for other purposes after performing an appropriate archaeological dig.

1st Sangachal cemetery (Coord. 178/179/180)

N	4021973	?	49.42137
	4022396		49.42143
	4022348		49.42093)

Total area of the cemetery is more than 20 hectares. This ancient and middle age cemetery is still utilized. Overground signs of the middle age cemetery were well preserved. These signs consist of gravestones, sepulchres and tombstones. On some graves ram-shaped stones were used instead of tombstones. An images of camelcade can be found on some tombstones. The tombstones are 126cm lengthwise with gravestones 2 meter in height. It is very valuable monument. This area cannot be used for any other purposes.

Safi Hamid sanctuary. As per the information given by Haji Elmira (? ??? ?????????) Aga Safi Hamid from Imam Musseyi Kazim's family was buried there. This sanctuary is still used. It is a valuable monument. No construction or excavation works are allowed in this area.

We would like to thank Doctor of Historical Science A.I.Novruzlu and candidate of historical science N.Musseyibov for their scientific advice and participation in preparation of this report.

E. Abbassov
N. Hassanov

1.4 Completed Proformas

Shah Deniz Stage 1 Gas Export Project ESIA
Pro Forma for Archaeology

Waypoint 94	**Date** *04.06.2001*	**Constraint Level:**
Easting From: *4946144* To:	Northing From: *4021194* To:	Location Name: *1st Sangachal settlement*
Photographic Reference		
Roll Number: *1*. Frame Number: *01. 02*. Summary Description of Object Photographed: *hilly area changing to plain area*		
Description of Feature/Artefacts *stone cave*		

Site: Restricted/small ☐ Spread/vast ☐
Surface (radius) ☐ Linear length, m *covers the area of approximately one or more hectares* ☐

Artefacts: Isolated/single ☐ Grouped/dense ☐
Many/scattered ☐ *Ware debris and debris of other objects were found here*

Nature:
- Structural/settlement/building remains (enter brief description) ☐
  Construction remains are easily observed. Rocks. Burned bricks pieces were found.
- Cemetery/graves (enter brief description) ☐
- Stone carvings (enter brief description)
  Walls of stone cave were decorated with stone carvings
- Stone implements (enter brief description) ☐
  Rocks with carved grooves and oven remains belong to the settlement described.
- Metal implements (enter brief description) ☐
  Metal pieces almost completely corroded.
- Pottery (enter brief description) ☐
- Organic (enter brief description) ☐
- Other (specify) ☐

Cultural Identity: Please note here method used for determination, including any lab analysis reports (*Visual) search and comparative analysis methods were used*

Palaeolithic	☐
Mesolithic	☐
Neolithic	☐
Bronze Age	☐
Iron Age	☐
Antique	X
Medieval	X

- Significance of findings: note the initial assessment of significance based on: *This is a very important site. Pipeline Route should be moved away from this site.*
- the rarity of a site/find/feature within the region or local landscape; *Site is of universal importance. The unique monument.*
- the nature and complexity of the site/find/feature; *A very complicated area for research.*
- the presence of associated sites/finds/features; *Associated areas exist in Nakhchivan and Middle Asia.*
- the integrity and survival of the site/find/feature. *Stone carvings retained very well*

Waypoint 95	**Date** 04.06.2001	**Constraint Level:**
Easting From: *49.46144* To:	Northing From: *40.21194* To:	Location Name: *2nd Sangachal settlement*

Photographic Reference

Roll Number: 1. 2.

Frame Number: 03. 01.

Summary Description of Object Photographed: *Rocky area. Rocks are all around the site*

Description of Feature/Artefacts

Site: Restricted/small ☐ Spread/vast ☐

Surface (radius) ☐ Linear length, m *This is a big site. The area of the site is approximately few hectares.* ☐

Artefacts: Isolated/single ☐ Grouped/dense ☐

Many/scattered ☐ *Archaeological findings were found here (Ware debris etc)*

Nature: Structural/settlement/building remains *Construction remains can be observed.*
(enter brief description) *2 archaeological monuments were found here. Stone cave's (Nadir calls them Rocky dwellings) internal height is 3m, width is 6 m, length 8m and it has a triangle form. There are more than 20 similar monuments.* ☐

Cemetery/graves
(enter brief description) ☐

Stone carvings
(enter brief description) ☐

Many r*ocky dwellings* were found. *There are more than 20 of this kind of dwellings. On the wall of dwelling there was a picture of a goat with legs and horns drawn as parallel lines. A tile part of the goat's body was destroyed by errosion. G*enerally speaking the whole area is hardly eroded.

Stone implements
(enter brief description) ☐

Two Rocks leant on each other and standing above ground were found

Metal implements
(enter brief description)

Pottery
(enter brief description) ☐

Pottery ware and other debris in form of pitcher and pot were found. Reddish, greyish, blackish unglazed ware debris was covered with engobe layer. Wares were made with use of potter's wheel.

Organic
(enter brief description) ☐

Other (specify) ☐

Cultural Identity: Please note here method used for determination, including any lab analysis reports Chemical analysis, (v*isual) search and comparative analysis methods were used*

Palaeolithic	☐
Mesolithic	☐
Neolithic	☐
Bronze Age	☐
Iron Age	☐
Antique	X
Medieval	X

- Significance of findings: note the initial assessment of significance based on: *This is a very important site. Detailed arkhaeological survey must be conducted prior to construction activities. .*
- the rarity of a site/find/feature within the region or local landscape; This *Site is of universal and republic importance. The unique monument.*
- the nature and complexity of the site/find/feature; *A very complicated area for research.*
- the presence of associated sites/finds/features; *Associated areas exist in Nakhchivan, Gobustan and Middle Asia.*

the integrity and survival of the site/find/feature. *The monuments retained well but some parts were exposed to erosion*

Waypoint **101**	**Date** 04.06.2001	**Constraint Level:**
Easting From: 49.46043 To:	Northing From: 4021159 To:	Location Name: *3rd Sangachal settlement*

Photographic Reference

Roll Number: 1. 2.

Frame Number: 04. 05, 06. 02., 03

Summary Description of Object Photographed: The area is located at the bottom of the mountain at not very high hillocks.

Description of Feature/Artefacts

Site: Restricted/small ☐ Spread/vast ☐

Surface (radius) ☐ Linear length, m *The area of* ☐ *e is approximately few hectares.*

Artefacts: Isolated/single ☐ Grouped/dense *There are a lots of archaeological findings (Nadir says that "they are in majority")* ☐

Many/scattered ☐ *Archaeological materials are spread all over the site (Ware debris, different parts of jug and pitcher debris etc)*

Nature: Structural/settlement/building remains ☐

(enter brief description) *Construction remains: Rocks. Burned bricks pieces, collapsed building remains*

Cemetery/graves ☐

(enter brief description)

Stone carvings

(enter brief description)

Stone implements ☐

(enter brief description)

Artificial fire grooves (place where people kept a fire) were found on the surface if big rocks

Metal implements

(enter brief description)

Pottery ☐

(enter brief description)

Pottery ware debris were spread all around the site. Neck and handle parts of unglazed ware debris were found.

Organic ☐

(enter brief description)

Other (specify) ☐

Cultural Identity: Please note here method used for determination, including any lab analysis reports Chemical analysis and *comparative analysis methods were used*

Palaeolithic ☐

Mesolithic ☐

Neolithic ☐

Bronze Age ☐

Iron Age ☐

Antique ☐

Medieval X

- Significance of findings: note the initial assessment of significance based on: *This is a very valuable site. This site referred to medieval period.*
- the rarity of a site/find/feature within the region or local landscape; *The unique monument. The Site is of universal and republic importance.*
- the nature and complexity of the site/find/feature; *A very complicated area for research due to hard erosion of area .*
- the presence of associated sites/finds/features; *Associated areas exist in Gobustan, Nakhchivan and Middle Asia.*

the integrity and survival of the site/find/feature. Due to *heavy erosion of the area archaeological findings retained poorly*.

Waypoint **102**	**Date** 04.06.2001	**Constraint Level:**
Easting From: 4946021 To:	Northing From: 4021063 To:	Location Name: *4th Sangachal settlement*

Photographic Reference

Roll Number 1.
Frame Number: 07, 08.
Summary Description of Object Photographed: Plain area covered with rocks.

Description of Feature/Artefacts

Site:	Restricted/small	☐	Spread/vast Site covers not a big area of 2-3 hectares.	☐
	Surface (radius)	☐	Linear length, m 2-3 hectares.	☐
Artefacts:	Isolated/single	☐	Grouped/dense	☐
	Many/scattered	☐	*A lots of glazed and unglazed ware debris and ware parts were found.*	

Nature:
- Structural/settlement/building remains (enter brief description) *Some construction remains were found* ☐
- Cemetery/graves (enter brief description) ☐
- Stone carvings (enter brief description)
- Stone implements (enter brief description) ☐
- Metal implements (enter brief description)
- Pottery (enter brief description) ☐ *At the area of the settlement unglazed ware debris consist of jug and pitcher parts and their handles. Engobe layer from the inside covered a majority of unglazed wares.*
- Organic (enter brief description) ☐
- Other (specify) ☐

Cultural Identity:
Please note here method used for determination, including any lab analysis reports *Chemical analysis, scientific research and comparative analysis methods were used*
- Palaeolithic ☐
- Mesolithic ☐
- Neolithic ☐
- Bronze Age ☐
- Iron Age ☐
- Antique ☐
- Medieval X

- Significance of findings: note the initial assessment of significance based on: *This is a very important site. This site referred to medieval period.*
- the rarity of a site/find/feature within the region or local landscape; *The unique monument. This Site is of universal and republic importance.*
- the nature and complexity of the site/find/feature; *A very complicated area for study*
- the presence of associated sites/finds/features; *Associated areas exist in Apsheron, Shamakha and in Nakhchivan..*

the integrity and survival of the site/find/feature. All archaeological materials found are in a very good condition.(ware debris etc)

Waypoint **120---103**	**Date** 05.06.2001	**Constraint Level:**
Easting From: 49.47658 To:	Northing From: 40.21659 To:	Location Name: *5th Sangachal settlement*

Photographic Reference

Roll Number 1, 2.

Frame Number: 09., 10. 04.

Summary Description of Object Photographed: The plain area with hillocks; small rock pieces (pebbles) are covering the area.

Description of Feature/Artefacts

Site: Restricted/small ☐ Spread/vast Site ☐ covers the area of a several hectares.

Surface (radius) ☐ Linear length, m ☐

Artefacts: Isolated/single ☐ Grouped/dense ☐

Many/scattered ☐ *Ware debris was scattered all over the area.*

Nature: Structural/settlement/building remains ☐
(enter brief description)) *Construction remains were not found*

Cemetery/graves ☐
(enter brief description)

Stone carvings
(enter brief description)

Stone implements ☐
(enter brief description)

Metal implements
(enter brief description)

Pottery ☐
(enter brief description)
Ware debris was scattered all over the area. Ware debris presented with shoulder (?!), neck and handle parts of pitcher and jar formed wares. One of those fragments was decorated with engobed geometrical figures and spots.

Organic ☐
(enter brief description)

Other (specify) ☐

Cultural Identity: Please note here method used for determination, including any lab analysis reports *Chemical analysis and comparative analysis methods were used*

- Palaeolithic ☐
- Mesolithic ☐
- Neolithic ☐
- Bronze Age ☐
- Iron Age ☐
- Antique ☐
- Medieval X

- Significance of findings: note the initial assessment of significance based on: *This is a very important settlement. All types of construction activities must be prohibited in this area.*
- the rarity of a site/find/feature within the region or local landscape; *This Site is of republic importance.*
- the nature and complexity of the site/find/feature; *A very complicated area for study*
- the presence of associated sites/finds/features; *Associated areas exist in Apsheron, Nakhchivan and Shirvan*

the integrity and survival of the site/find/feature. All debris found are in a good condition.

Waypoint 151	**Date** 05.06.2001	**Constraint Level:**
Easting From: 49.49693. To:	Northing From: 40.19644 To:	Location Name: *Sangachal Gochdash Memorial*

Photographic Reference

Roll Number 1. 2

Frame Number: 12 07.

Summary Description of Object Photographed: The plain area located nearby the railway.

Description of Feature/Artefacts

Site: Restricted/small ☐ Spread/vast *Site covers the area of a several hectares.* ☐

Surface (radius) ☐ Linear length, m ☐

Artefacts: Isolated/single ☐ Grouped/dense ☐

Many/scattered ☐ *Not much ware debris was scattered at the area*

Nature: Structural/settlement/building remains
(enter brief description)) The plain area. *Construction remains was not found.* ☐

Cemetery/graves
(enter brief description) ☐

Stone carvings
(enter brief description)

Stone implements
(enter brief description) ☐

Metal implements
(enter brief description)

Pottery
(enter brief description) ☐
Pottery ware debris was scattered all over the area.

Organic
(enter brief description) ☐

Other (specify) ☐

Cultural Identity: Please note here method used for determination, including any lab analysis reports *Comparative analysis and route survey methods were used*

Palaeolithic ☐
Mesolithic ☐
Neolithic ☐
Bronze Age ☐
Iron Age ☐
Antique ☐
Medieval X

- Significance of findings: note the initial assessment of significance based on: *This is a very valuable site. A detailed survey must be conducted at this area. Only after that (and obligatory movement of Goch Dash) necessary construction activities can be conducted.*
- the rarity of a site/find/feature within the region or local landscape; *The unique site. This Site is of universal and republic importance.*
- the nature and complexity of the site/find/feature; *A very complicated area for study*
- the presence of associated sites/finds/features; *Associated areas exist in many regions of Azerbaijan*

the integrity and survival of the site/find/feature. Goch Dash and other findings are in a good condition in spite of some erosion

Waypoint 164	**Date** 05.06.2001	**Constraint Level:**
Easting From: 49.45478. To:	Northing From: 40.19350 To:	Location Name: *9th Sangachal*

Photographic Reference

Roll Number 1. 2
Frame Number: 13 08.
Summary Description of Object Photographed: The plain area located nearby the railway.

Description of Feature/Artefacts

Site: Restricted/small ☐ Spread/vast *Site covers the small area of a few hectares.(1-2 hectares)* ☐
Surface (radius) ☐ Linear length, m ☐

Artefacts: Isolated/single ☐ Grouped/dense ☐
Many/scattered ☐ *Not much ware debris was scattered at the area*

Nature: Structural/settlement/building remains ☐
(enter brief description)*No above ground construction remains was found. We assume that small hills could be a covered by soil remains of buildings.*
Cemetery/graves ☐
(enter brief description)
Stone carvings
(enter brief description)
Stone implements ☐
(enter brief description)
Metal implements
(enter brief description)
Pottery ☐
(enter brief description)
Pottery ware debris of medieval period are scattered at the area.
Organic ☐
(enter brief description)
Other (specify) ☐

Cultural Identity: Please note here method used for determination, including any lab analysis reports
Route survey method was used
Palaeolithic ☐
Mesolithic ☐
Neolithic ☐
Bronze Age ☐
Iron Age ☐
Antique ☐
Medieval X

- Significance of findings: note the initial assessment of significance based on: *This is a very valuable site. Construction activities can be conducted at this area only after detailed survey.*
- the rarity of a site/find/feature within the region or local landscape; *This Site is of republic importance.*
- the nature and complexity of the site/find/feature; *A very complicated area for study*
- the presence of associated sites/finds/features; *Associated areas exist in dry regions of Azerbaijan*

the integrity and survival of the site/find/feature *Ware debris of small size but are in a good condition*

Waypoint 178/ 179 / 180	**Date** 07.06.2001	**Constraint Level:**
Easting From: 49.42137 4942143 4942093 To:	Northing From: 4021973 4022396 4022348 To:	Location Name: *Sangachal Cemetery and Sophi-Hamid Worship*

Photographic Reference

Roll Number 1. 2

Frame Number: 14,15. 09, 10, 11.

Summary Description of Object Photographed The cemetery is located in plain area.

Description of Feature/Artefacts

Site: Restricted/small ☐ Spread/vast *The area of the site is 20 hectares. Tombstones are of two types – horizontal and vertical. Horizontal ones are of 126cm in a length. Vertical tombstones are of 2m in height.* ☐

Surface (radius) ☐ Linear length, m ☐

Artefacts: Isolated/single ☐ Grouped/dense ☐

Many/scattered ☐

Nature: Structural/settlement/building remains ☐

(enter brief description)*The area of the cemetery exceeds 20 hectares. The medieval elements remained in a good condition on tombstones. These elements consist of features on tombstones*

Cemetery/graves ☐

(enter brief description)

a lots of old graves. They are mostly destroyed, broken and spread all over the area in the form of small pebbles.

Stone carvings

(enter brief description)

There are a lots of carvings on tomb stones (Arabic characters, features of different type)

Stone implements ☐

(enter brief description)

Metal implements

(enter brief description)

Pottery ☐

(enter brief description)

Organic ☐

(enter brief description)

Other (specify) ☐

Cultural Identity: Please note here method used for determination, including any lab analysis reports

Palaeolithic	
Mesolithic	
Neolithic	
Bronze Age	
Iron Age	
Antique	
Medieval	X

- Significance of findings: note the initial assessment of significance based on: *This is a very valuable site. All kind of activities must be prohibited at this area.*
- the rarity of a site/find/feature within the region or local landscape; *This is a unique site. This Site is of republic importance.*
- the nature and complexity of the site/find/feature; *A very complicated area for study*
- the presence of associated sites/finds/features; *Associated areas exist in many regions of Azerbaijan(Nakhchivan, Gazakh, Shamakhi etc)*

the integrity and survival of the site/find/feature *Tombstones are comparatively in a good condition*