1 Introduction

This Environmental Statement (ES) has been prepared following a detailed Environmental and Socio-economic Impact Assessment (ESIA) of the proposed Phase 1 development of the Azeri, Chirag and Deep Water Gunashli (ACG) oil fields 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 (IFIs), described in greater detail in Section 2. 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 studies have been carried out by AIOC in the region since 1994 as outlined below. The ACG FFD Phase 1 ESIA programme of work has built on these earlier studies where appropriate and has conducted additional studies to augment the existing 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.

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 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 20^{th} 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.

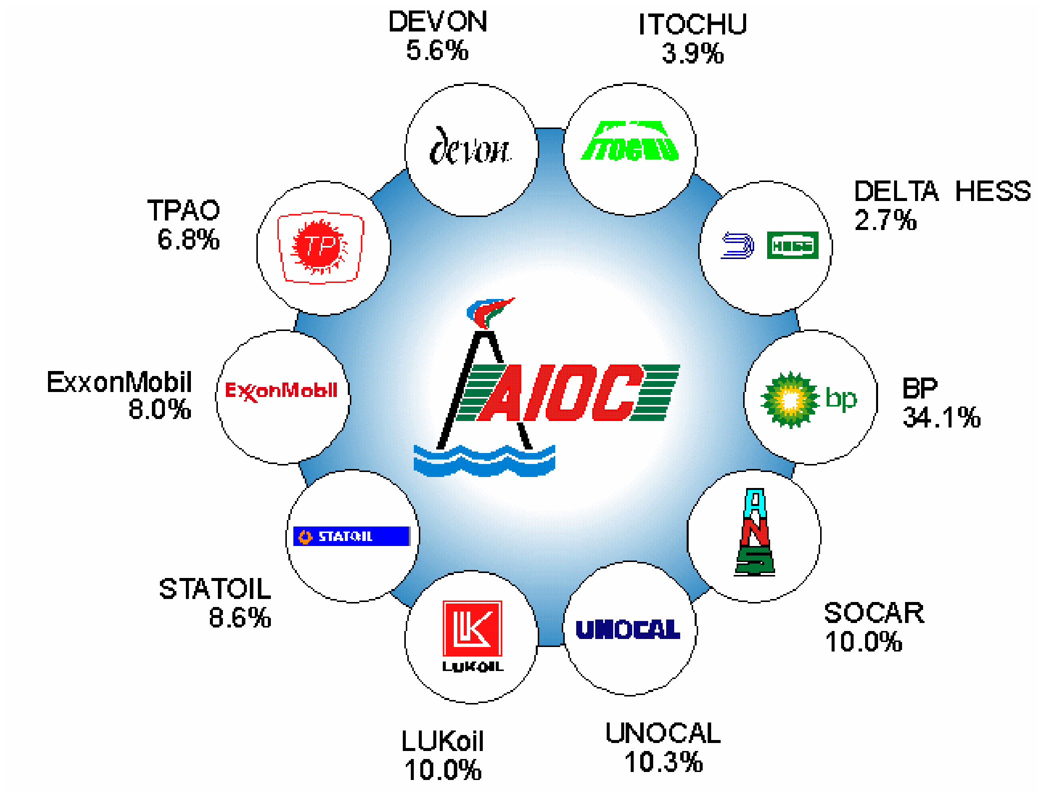
In seeking to stimulate the development of these significant reserves, Azerbaijan has invited Foreign Oil Companies (FOCs) to invest in the development of its hydrocarbon wealth. By inviting FOCs to jointly develop existing and potential reserves it is intended that sufficient investment, including international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

Figure 1.1 Location of Azerbaijan

1.3 ACG Production Sharing Agreement and Full Field Development

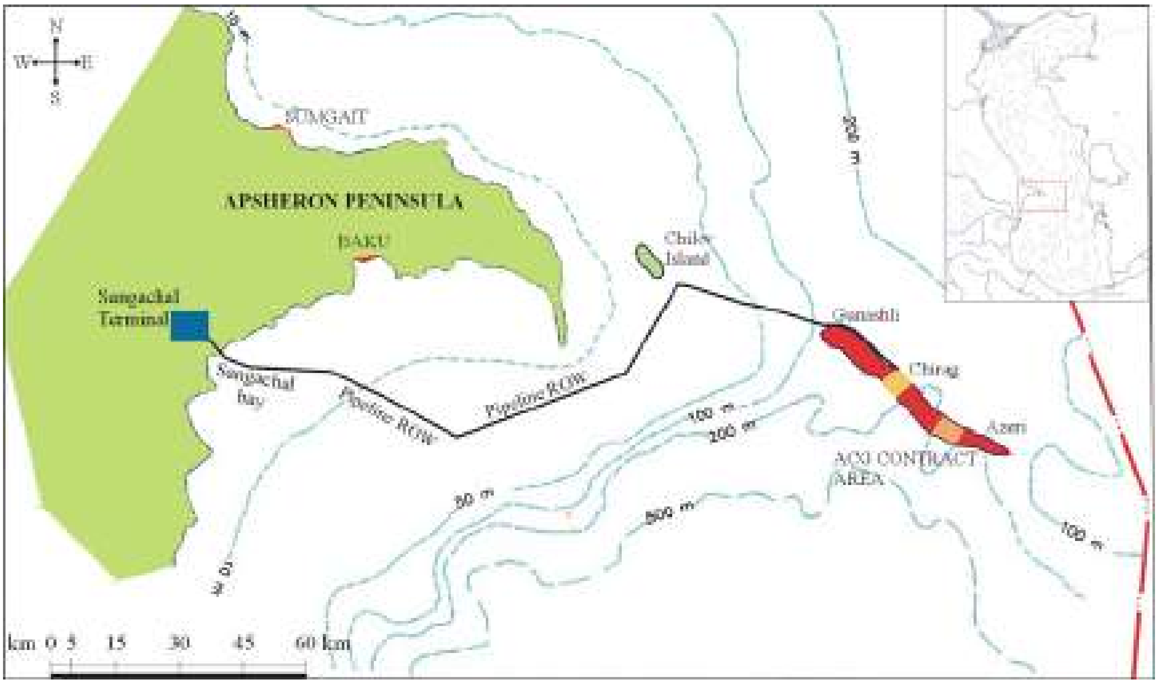
The first PSA in Azerbaijan was signed in September 1994 between the State Oil Company of the Azerbaijan Republic (SOCAR) and the Azerbaijan International Operating Company (AIOC), a consortium of FOCs. The PSA lasting for 30 years, passed into Azerbaijan law in December 1994, and grants the consortium rights to develop and manage the hydrocarbon reserves found in the ACG field termed the "Contract Area". In July 1999, BP was appointed operator for the PSA on behalf of AIOC member companies. The member companies of AIOC are shown in Figure 1.2.

Figure 1.2 Members of AIOC



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, representing roughly half of the proven oil reserves in Azerbaijan's offshore fields. It lies in the Azerbaijan sector of the Caspian Sea, approximately 120 km south east of Baku and covers an area of 432 square kilometres in water depths ranging from 100 m to 400 m (Figure 1.3). Primary oil bearing zones occur at depths of between 2,500 m and 3,000 m below the seabed.

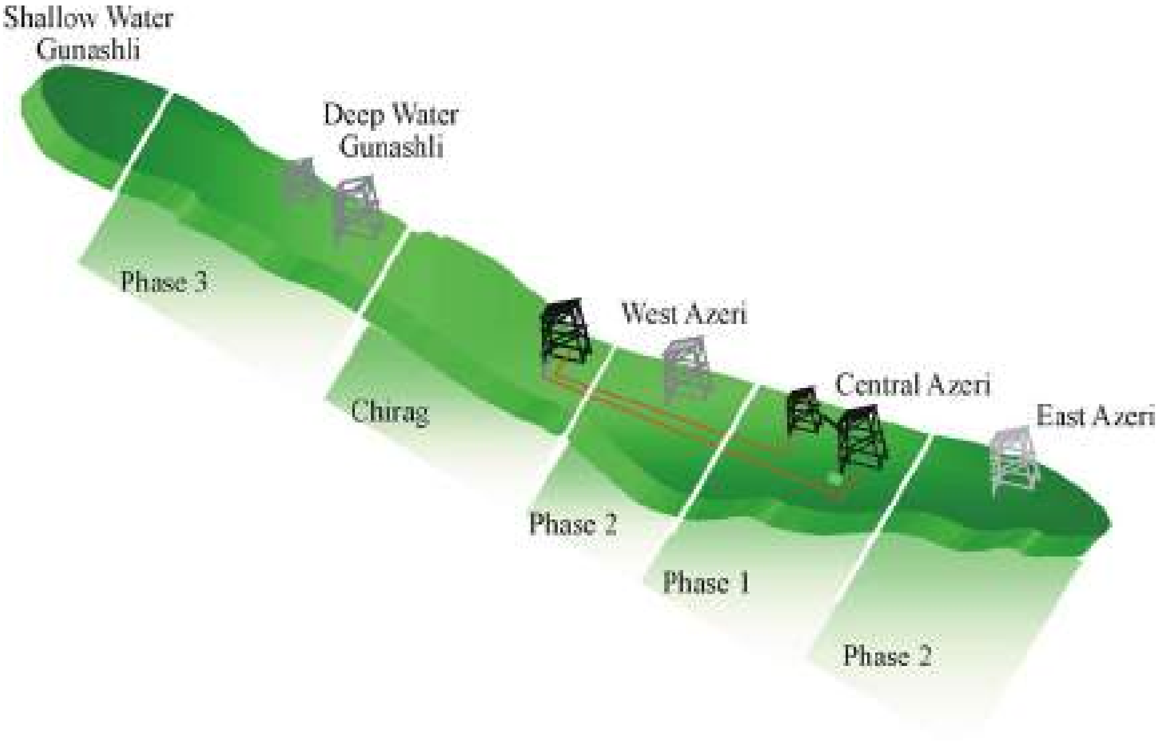
Figure 1.3 ACG Contract Area Development Location



AIOC's operation in Azerbaijan started with the Minimum Obligatory Work Programme (MOWP) set out in the PSA, which contained an objective to commence the production of oil as rapidly as possible. In this setting, the Early Oil Project (EOP) was developed as the first production activity in the Contract Area and has been producing oil and associated gas since 1998. The EOP is further described below.

Beyond the initial production of early oil, the development of the ACG Contract Area is known as Full Field Development (FFD). It is currently conceived that FFD will be achieved through the implementation of three further phases of development (Figure 1.4) resulting in potential oil production rates in excess of one million barrels per day (bpd). Overall, FFD represents a large capital investment in the Caspian Sea region. It is expected to cost approximately $US10 billion, over the phased life of the project, representing about 10% of the investment required to extract the region's anticipated reserves.

Figure 1.4 ACG Full Field Development (FFD)



The ACG Phase 1 development represents the first stage of the ACG FFD. In commencing Phase 1, AIOC is continuing its long-term commitment to Azerbaijan and also to those countries through which the export pipeline(s) will pass.

The environmental and socio-economic programmes of work carried out by AIOC, 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 AIOC in identifying and understanding the potential effects that their proposed activities may have on these environments and enabling the proposed programmes to be designed and planned in a manner that would minimise any adverse effects.

Table 1.1 AIOC ACG FFD environmental and social programmes undertaken to date

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
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

An Environmental and Socio-Economic Overview of the ACG FFD concept was completed in July 2000 and presented to the Azerbaijan regulators and other interested parties. The document was made available to the public, including NGOs, national scientific communities and the IFIs. The document sets forth the environmental and socio-economic programme and schedule to which AIOC will comply in undertaking FFD. It was approved by MENR in June 2001.

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 (designed and operated by ERT Ltd) which 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 by AIOC. To meet this need, ERT 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.

The laboratory employs nine Azerbaijani scientists and five support staff and operates its technical services in accordance with the Organisation Economic Cooperation and Development (OECD) principles of Good Laboratory Practice (GLP) and an audited Health and Safety system.

1.3.1 Early Oil Project

The EOP comprises the Chirag-1 platform and transfer of oil through a 24” sub-sea oil pipeline from Chirag-1 to an onshore oil reception terminal situated 38 km south of Baku at Sangachal. Gas export from Chirag-1 is through a 16” sub-sea gas pipeline to SOCAR’s Oil Rocks facility to the north west of the Contract Area. Oil is exported to market from Sangachal by one of two pipeline routes to Black Sea ports; the Northern Export Route (NER) across Russia to Novorossiysk, and the Western Export Route (WER) to Supsa, Georgia. First oil from EOP was exported from Sangachal terminal in the fourth quarter of 1997. Current oil production rates from the EOP are some 125,000 bpd with gas export to the local market of around 100 million standard cubic feet per day (MMscfd).

1.3.2 Phase 1 Development

The Phase 1 project, the focus of this ES, will develop the central part of the Azeri reservoir, to the south east of Chirag-1, and 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. The Phase 1 development is fully described in Chapter 5, Project Description.

1.3.3 Phase 2 and 3 Developments

The Phase 2 development will start detailed engineering in 4Q 2001. The 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. It is anticipated that the 24" EOP pipeline will be reconverted from gas service 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 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 Azeri sector of the Caspian Sea for many years. In addition, other FOCs 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 ACG area include:

- Oil Rocks to the north west, which comprises a number of fields and produces approximately 15,770 bpd;

- shallow-water Gunashli, adjacent to BP's Deep-Water Gunashli tract and one of Azerbaijan's largest oil producing fields, and
- the Bahar field, the northern portion of which has been operational since the 1970s, providing gas to Azerbaijan.

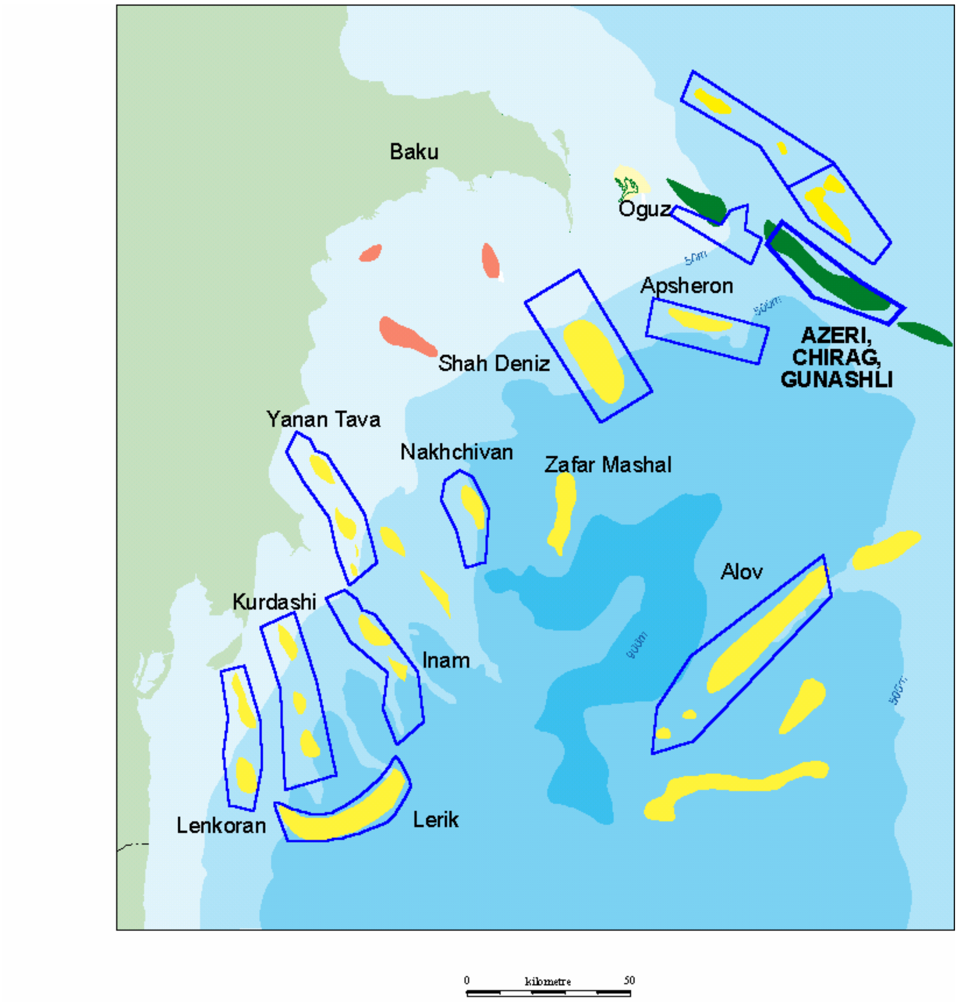
To date, offshore exploration and development PSAs have been signed as follows:

- 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 however, drilling has been delayed, due (reportedly) 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 km^2 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; Shah Deniz, 1996, Inam, 1998 and Alov, 1998.

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 ACG FFD project, BP is undertaking a number of other projects in the Caspian Region. These projects are briefly outlined below.

1.4.2.1 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 and 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 2005.

1.4.2.2 Shah Deniz Gas Export Project

The Shah Deniz gas/condensate field lies approximately 100 km to the southwest of Baku in water depths ranging from 50 m to 500 m (Figure 1.5). Early appraisal well drilling indicated that Shah Deniz is a world-class gas condensate field, the full potential of which requires further appraisal.

Full Field Development (FFD) of the Shah Deniz field will also be undertaken in a series of stages. At present it is envisaged that FFD will comprise two stages. Stage 1 development is more advanced in its definition and will be located on the Eastern Flank of the field in approximately 100 m of water. Initial Stage 1 development will comprise a fixed production and drilling platform and two sub-sea pipelines to deliver gas and condensate separately to a new reception and gas-processing terminal to be constructed adjacent to the existing ACG oil-receiving terminal at Sangachal. First gas delivery from the Shah Deniz field is anticipated in 2005. To maintain gas production rates, the installation of a six well sub-sea development is proposed three to four years after first delivery of gas. The sub-sea development, also on the Eastern Flank, will be installed in 350 m of water and produced fluids will be tied back to the Stage 1 platform via a pipeline for onward transport to the onshore terminal.

1.4.2.3 Shah Deniz Gas Pipeline Project (SDGP)

Shah Deniz gas, conditioned for transportation and sales, will be transferred from the terminal to an export pipeline system, ultimately delivering the gas to the Turkish market. The proposed pipeline route would run from the Sangachal Terminal, through Azerbaijan and Georgia and into Turkey. Markets in Turkey will be supplied from the town of Erzurum. Plans to run SDGP in parallel with the proposed BTC oil pipeline for most of the route, are being considered.

1.4.2.4 Inam and Alov Projects

Inam is located in the South Caspian basin in shallow water depths only 40 km offshore (Figure 1.5). To date one exploration well has been drilled in the field.

The Alov field, further offshore to the southwest of Baku, is located in water depths of between 450 and 1,000 m and is still in the exploration phase.

1.5 BP HSE Policy

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 companies involved in 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 Phase 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 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. Personnel 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.

The environmental standards laid down in the ACG PSA will be applied to ACG Phase 1. In addition, international, industry and BP environmental standards will also be applied where appropriate and in agreement with the AIOC Partners. BP environmental policy and the PSAs require that environmental and social impact assessments be completed for the developments.

The findings of the environmental and socio-economic assessment process are presented in this ES. Details of the environmental and social mitigation and management measures that will be instigated for Phase 1 (to ensure that the goals, objectives and standards of the ACG PSA are met) are included in this ES (Chapters 14 and 15). In addition, a set of HSE Standards for the ACG Phase 1 project has been developed and approved by the AIOC partners. These define the minimum design requirements in the key areas of potential environmental impact (and are included as Appendix 3).

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 ACG Phase 1 development is to ensure that any adverse environmental or socio-economic impacts arising from Phase 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 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 Phase 1 development planning is currently underway. This allows for the ESIA team to provide feedback (to the design engineers) of any environmental and socio-economic issues identified during the ESIA 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.
Glossary	A glossary of terms and acronyms.
Introduction	A general introduction to the Phase 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 national and international environmental standards and guidelines, BP project environmental standards and expectations and the HSE standards set out in the ACG PSA.
ESIA Methodology	A description of the methods used to conduct the ESIA.
Options Assessed	A description of the alternative options assessed for the Phase 1 Project.
Project Description	A detailed description of the Phase 1 Project.
Environmental Baseline	A description of the environmental baseline conditions in the vicinity of the Phase 1 Project activities.

Socio-Economic Baseline	A description of the socio-economic baseline conditions in the vicinity of the Phase 1 Project activities.
Consultation	An overview of the consultation undertaken during the ESIA programme along with the issues and concerns raised.
Environmental and Socio-Economic Aspects	Determination of all environmental and socio-economic aspects associated with the Phase 1 Project.
Potential Environmental Impacts	An assessment of the potential environmental impacts associated with the Phase 1 development.
Potential Socio-Economic Impacts	An assessment of the potential socio-economic impacts associated with the Phase 1 development.
Cumulative Impacts	An assessment of the potential cumulative impacts arising from the interaction between the ACG Phase 1 Project and other projects.
Transboundary Impacts	An assessment of the potential transboundary impacts arising from the ACG Phase 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.

1.6.3 Additional Studies

In addition to the main ESIA programme of work, a number of studies have been conducted to provide further data, which is required to augment the existing knowledge base so that an informed impact assessment study can 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:

Air Dispersion Modelling Study	Air dispersion modelling of estimated air emissions from the terminal and offshore facilities.
Marine Dispersion Modelling	Modelling of cooling water discharges offshore including temperature plume and the fate of antifoulant chemicals.
	Modelling of drilled cuttings discharge dispersion

characteristics.

These models were run in July 2001.

Oil Spill Risk Assessment	Identification of potential spill scenarios from offshore facilities and sub-sea pipelines. This risk assessment was conducted in June/July 2001.
Crude Oil Weathering Study	A study was undertaken in June/July 2001 for the determination of crude oil weathering characteristics and OSIS constants for the oil spill dispersion models. Determination of effectiveness of dispersants.
Oil Spill Dispersion Modelling	The spill trajectory and fate of crude oil 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 oil 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 the nearshore sediment dynamics, 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 the socio-economic environment at the local and regional level within areas of the proposed Phase 1 development was undertaken from April – August 2001.

Technical reports have been prepared for each specific study and these are included in a separate Technical Appendix to this ES.

2 Policy, Regulatory and Administrative Framework

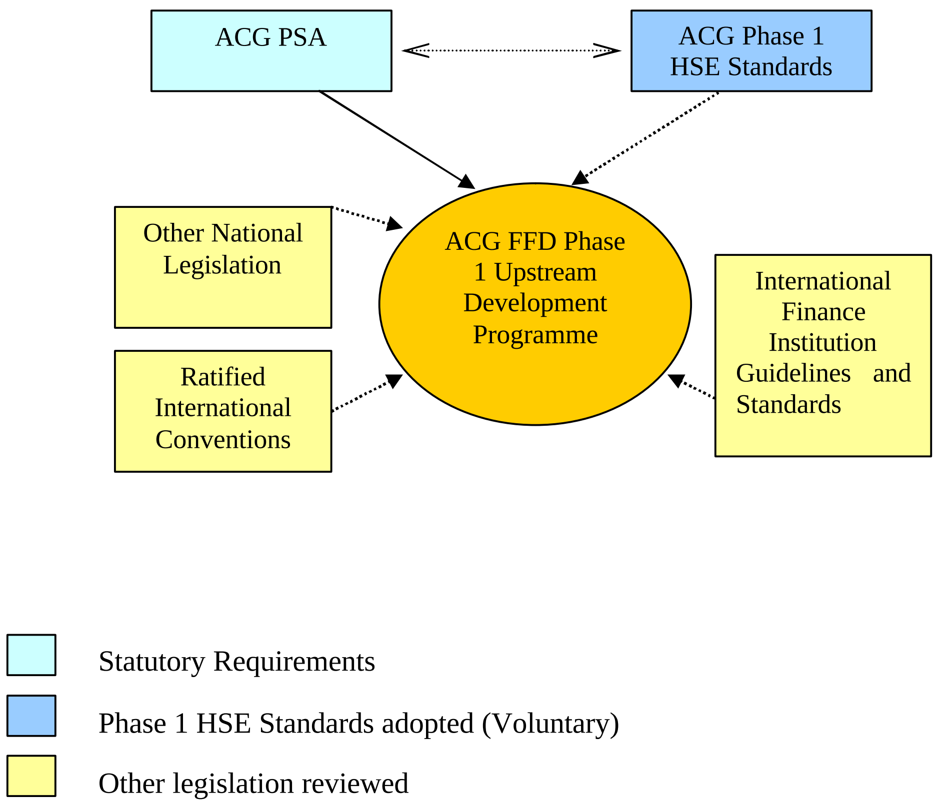
2.1 Introduction

The ACG Full Field Development (FFD) Phase 1 Programme is subject to the terms and conditions of the ACG Production Sharing Agreement (PSA). Using the PSA Appendix IX Environmental Standards as a basis, the AIOC partners developed and approved the Phase 1 Health, Safety & Environment (HSE) Design Standards in 1999. These Standards were based on, and incorporated elements of, international standards.

Beyond the framework of the PSAs and Phase 1 HSE standards, 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 AIOC may seek funding from International Finance Institutions (IFIs), AIOC 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 sustainable manner.

Figure 2.1 provides a visual summary of legislative framework relevant to the ACG Phase 1 project.

Figure 2.1 – Legislative Framework of ACG Phase 1 Project



The following sections present an overview of each of these key elements of the legal and policy framework for the ACG FFD Phase 1 project.

2.2 The ACG Production Sharing Agreement

The ACG PSA is the legally binding agreement for the joint development and production sharing for the Azeri and Chirag Fields and the Deep Water Portion of the Gunashli Field in the Azerbaijan sector of the Caspian Sea. This contract, between the State Oil Company of Azerbaijan Republic (SOCAR) and AIOC was made and entered into in Baku on the 20th September 1994; it was enacted into Azerbaijan law in December 1994. Under the terms of the PSA, AIOC has the right, until 2024, to develop and produce hydrocarbons from the ACG offshore fields. 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.

According to Article 26.3 of the PSA, AIOC 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 current international petroleum standards and practices'* at the execution date of the PSA.

In addition, the environmental standards that must be met throughout the life of the contract are stipulated in Appendix IX of the PSA.

The requirement to prepare environmental documentation, including an Environmental Impact Assessment of any new facilities and gain approval from the Azerbaijan Ministry for Ecology and Natural Resources (MENR) is also a condition of Appendix IX Section II B of the PSA.

The environmental standards and practices set out in the ACG PSA are provided in the Technical Appendix (Appendix 1).

2.3 ACG Phase 1 Health, Safety & Environment (HSE) Design Standards

In 1999, AIOC partners' Contracts Management Committee (CMC) approved a set of HSE standards for the design of Phase 1. These standards built upon the standards set out in the PSA, taking into consideration international standards and local environmental conditions. The Phase 1 HSE Design Standards serve as the standards that AIOC has self-imposed for Phase 1 engineering design. Therefore, while the PSA is the legal basis for conducting operations, these standards seek to supplement, enhance and further define those standards set forth in the PSA.

The Phase 1 HSE Design Standards have been presented to the MENR as part of the Full Field Development Environmental and Socio-Economic Overview Document, which was approved by the MENR in June 2001. These standards are provided in the Technical Appendix (Appendix 2).

2.4 International Conventions

The Azerbaijan Republic has entered into and ratified a number of international conventions, many within the last year. Although not required by the PSA, AIOC will endeavour to assist the government in meeting their obligations with respect to these conventions. The conventions relevant to the ACG FFD Phase 1 development 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 Phase 1 development:

2.4.1 1998 Convention on Access to Information to Public Participation in Decision Making Process and the Administration of Justice concerning Environmental Matters (Aarhus Convention)

The objective of the Convention is to guarantee the rights 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.

2.4.2 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. Therefore under the terms of this Convention, 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.

However, in the strictest sense, 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 Azerbaijani 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.

2.4.3 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. Azerbaijani authorities should provide the information to littoral Parties to the Convention, which include the Russian Federation and Kazakstan, upon reasonable payment.

2.4.4 1973 Convention on the Prevention of Pollution from Ships and Protocol 1978 (MARPOL 73/78 Annexes I - IV)

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 Azerbaijani government may view the ACG FFD Phase 1 development in this category. At the outset however, it is important to point out, in the international arena, the application of MARPOL 73/78 to platforms is not settled and has not been interpreted uniformly by all states.

The requirements of this convention are set out below.

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. However, all ships, including platforms, are 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 considered a ‘special area’ under this convention);
- the oil content is < 15 parts per million (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 FFD Phase 1 (e.g. diesel for refueling), the Azerbaijani 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 AIOC, environmental and social standards, practices and guidelines set forth by International Finance Institutions (IFIs) have been reviewed in the preparation of this ESIA. Potential IFIs 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)
- Other Export Credit Agencies (ECAs)

2.5.1 World Bank Group

The World Bank Group (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. Therefore 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 FFD Phase 1:

- IFC Environmental, Health and Safety Guidelines, Oil & Gas Development (Offshore), 2000
- World Bank Standards, Oil & Gas Development (Onshore), 1998
- World Bank Operational Policy 4.01, Environmental Assessment

In addition, a number of EBRD policies and guidelines were also reviewed as part of FFD Phase 1 as follows:

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

2.6 National legislation

As indicated in Section 2.1, the ACG PSA sets out the national environmental legislation specific to the exploration and development of the contract areas. As part of the ESIA process, other national environmental legislation was also reviewed for the Phase 1 projects. Particular regard was given to the Environmental Impact Assessment process.

2.6.1 Environmental impact assessment

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 Ministry of Ecology and Natural Resources using the Law of the Azerbaijan Republic on Environmental Protection, August 1999 and the Handbook for the Environmental Impact Assessment Process published in 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.

AIOC/BP has incorporated the elements of this handbook in the Phase 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 comprising 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 and Socio-economic Impact Assessment

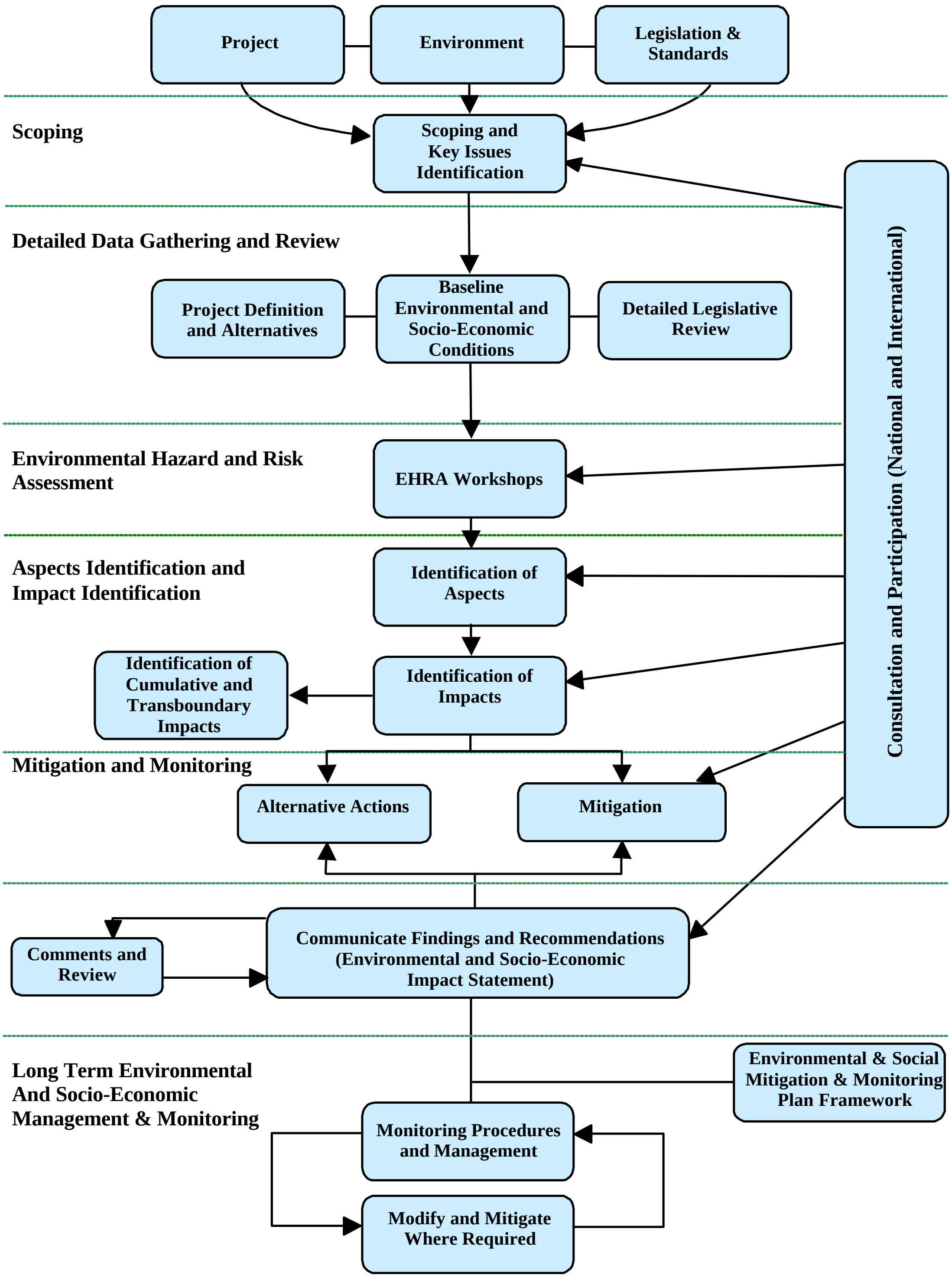
In addition, the responsibility for implementation of the requirements set out in international environmental conventions ratified by the Azerbaijan Republic lies with the Ministry. Further definition of the roles and responsibilities of this new organisation are anticipated within the next few months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

3.1.1.1 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 AIOC partner policy and standards.
- 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 this project's Scoping exercise were presented in a Scoping Report that was submitted to International Funding Institutions (IFIs) and the Azerbaijan Ministry of Ecology and Natural Resources, Baku, Azerbaijan.

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 ACG PSA Contract Area offshore. Such studies include the AIOC Early Oil Project (EOP) EIA and the ongoing monitoring of EOP operations. 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 tasks of the ESIA process to supplement the existing information base especially where existing data was found 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.

Both 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 the Environmental Description (Chapter 6) and Socio-economic Baseline (Chapter 7). Technical reports detailing the results of the primary studies are presented in the Technical Appendices.

3.3.2 Project alternatives and definition

3.3.2.1 Alternatives

The initial step in defining a project is to identify, at a conceptual level, viable alternatives to the project so that a viable base-case design may be realised. Consideration of project alternatives occurs at two levels as follows:

- to the development as a whole including the “no development” option, and
- engineering alternatives within the selected project’s design definition.

Once project alternatives are defined in the Project Concept stages, they are assessed and compared on financial, logistical, technical design, safety and environmental/socio-economic criteria. The project alternative that is determined to be likely to result in the best balance in regards these criteria is typically, the one that moves forward into the detailed design phase.

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 in the base case design still exist, the opportunity to provide feedback on environmental and socio-economic factors was exploited as discussed below.

3.3.2.2 Definition

ESIA environmental engineers have worked alongside design engineers to gather and interpret relevant engineering design information. Information gathered for the proposed ACG phase 1 project was reviewed, assessed and passed on to the assessment team.

The continuous interaction between the various project team components allowed the impact assessment team to identify and feedback to the design engineers in areas where there was a requirement for greater definition on the programme and the mitigation measures that are proposed as 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 ACG Phase 1 project is described in Chapter 2. The definition of relevant national and international standards and requirements has ensured that the project development has been assessed against all relevant existing environmental regulations and guidelines as well as AIOC partners' environmental and other policies and 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 was 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. Further, each was 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 relevant 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 ACG Phase 1 began during the Scoping phase and continues throughout the entire ESIA process and will continue into the construction and operational phases of the developments. 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. The ESIA Public Consultation and Disclosure Plan (PCDP) as presented at Technical Appendices 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:

"*An 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 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 operator and partner standards and operator/partner 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 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 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 environmental and socio-economic 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	+

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					
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
	1	2	3	4	5

CONSEQUENCE

Based on its consequence-likelihood score, each environmental aspect was again ranked into five categories or orders of significance as illustrated in Table 3.3.

Table 3.3 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 (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 the 'significance' 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 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 ACG Phase 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 ACG Phase 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
- oil 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

Many 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. 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 Framework will be developed for the ACG Phase 1 project, and will be further developed as the project progresses. It will describe the various environmental management strategies and generic procedures for their implementation. Further, it will identify 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 ACG Phase 1 contractor(s) to consider the provisions and requirements of the Plan when developing their own environmental management arrangements for the works programme. 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 Phase 1 of the ACG Full Field Development (FFD) project is to produce and deliver to the market the recoverable reserves in the central part of the Azeri Field. Oil and gas produced at the existing Chirag-1 platform will be transported to the Phase1 facilities by means of interfield pipelines to be installed and will be co-mingled with production at the central Azeri field. Production is anticipated to be over 400,000 barrels of oil per day and the lifetime of operation, 25 years. It is proposed that associated gas produced from the Phase 1 project will be used as a fuel supply for the new facilities and for re-injection for reservoir pressure maintenance. Surplus gas will be delivered to the State Oil Company of Azerbaijan Republic (SOCAR) for delivery to the local Azerbaijani market.

The project will require offshore drilling and production facilities, a means of transferring the produced hydrocarbons to shore and a hydrocarbon reception and processing facility onshore to provide storage and onward delivery facilities for the export product.

To achieve the primary project objective, a number of decisions have to be made as to which of the 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, which importantly, is synergistic with the standard engineering design phases. Stages of the CVP are as follows:

Appraise → **Select** → **Define** → **Execute** → **Operate**

At the time of writing this Environmental Statement, the Phase 1 project was in the initial stages of the Execute stage in the above process. As part of the Select stage, a number of alternative engineering design options were considered starting at a conceptual level including the "no development option" and subsequently adding detail for each conceptual option through the design and planning process. For the major components of the development the project design 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. The screening criteria used for the major components during the option evaluation process to Select included:

- safety;
- technical feasibility;
- environmental implications;
- capital expenditure (CAPEX);
- schedule and ability to execute the project;
- operating expenditure (OPEX);
- availability;
- operability;
- reputation; and
- partner and government agreement.

It should be noted that AIOC also considers Best Available Control Technology (BACT) in its selection process and as a mechanism for minimising releases to the environment in a cost effective and legislatively compliant manner. BACT uses 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 through to the least appropriate for the requirement. Each technology is considered on a cost benefit basis, taking into account technical and operational limitations. In the assessment of the options available for the project components and utilities required for the offshore and onshore facilities selected, BACT was determined in many cases by using Best Practicable Environmental Option (BPEO) and environmental cost benefit analysis studies.

This Chapter reviews the main decisions regarding the engineering and design options that were made for the ACG Phase 1 project components in order to arrive at the project's Base Case Design as described in Chapter 5. It should be noted that in addition to the core criteria listed above, key drivers in the decision-making process included the availability of infrastructure and resources in Azerbaijan as well as the wider Caspian region. Further, as part of the consideration of environmental implications, environmental protection measures were included as the selected options became more defined.

4.2 No development option

Were the Phase 1 Project not to go ahead, this would result in a number of potentially negative effects on the Caspian region. In particular, Azerbaijan would not benefit from the revenue generated from the export of oil from the ACG field, which is estimated to be significant, particularly for the period between 2007 and 2017. As most of the national share of this revenue (estimated to exceed all other sources of public 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 ACG export earnings which could (with prudent management) end Government budget deficits and lead to positive social and environmental change.

There are a number of additional benefits to good governance, which would not be realised in the event of a 'no development option'. Government would remain dependant on import duties thereby denying opportunities for a more liberal trade environment. Similarly, Government expenditure on public reform and administration programs and infrastructure modernisation and development would not be possible in the absence of significant revenues.
More specifically, the development of the ACG field will provide a range of employment and training opportunities for Azerbaijani citizens arising from the development through construction to operation. A 'no development option' would deny technology transfer opportunities to Azerbaijan and capacity building for the Caspian region. In addition, these developments 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.

There are a number of infrastructure upgrades necessary to achieve the project objective within the schedule, as there will be a requirement to assemble many of the facilities in Azerbaijan. The construction phase of the project will create many opportunities for employment of Azerbaijani citizens and at the same time will raise the capabilities of the workforce to international standards in construction and operation of oil and gas projects. Without Phase 1 of the ACG FFD these upgrades would be less likely to take place resulting in the loss of opportunity to increase the competitiveness of the Azerbaijan construction and oil and gas sector, including the development of a skilled workforce. 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.

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. 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.

The no development option would also mean that specific environmental benefits accruing from the project such as the opportunity to provide 'cleaner' fuels to the market (replacing 'dirtier' fuels, eg, wood); additionality, through social investment programmes; biodiversity investment; and significantly, oil revenues; would not be forthcoming.

4.3 The Project

It was decided at an early stage in the project design stage to integrate the ACG Phase 1 production into the existing ACG Early Oil Project (EOP) as opposed to developing a standalone ACG Phase 1 option. As such, the development will expand upon existing facilities as far as possible.

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 FFD.

The existing EOP terminal at present receives oil from the Chirag-1 platform. Once the ACG Phase 1 development becomes operational, oil (and associated gas) from Chirag-1 will be co-mingled with Phase 1 hydrocarbons for onward transfer to the 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. Environmental benefits would also be realised through expansion of the existing facility as this eliminates the requirement for additional land-take at a separate and new location. This is also true for the offshore subsea pipeline in that the offshore pipeline corridor, nearshore landfall approach will be similar to that for the existing EOP pipeline, thereby avoiding impacting the seabed and coastline at another location. This means that the existing environmental footprint remains relatively constant, thereby minimising the potential for new and duplicate environmental impacts at numerous geographic locations.

4.3.1 Offshore facilities

A number of offshore drilling and production concepts were considered for ACG Phase 1. Early concepts included the installation of a number of drilling and production centres however, due to the availability of technology and in particular directional drilling capabilities to allow extended reach into the oil reservoirs, the project design team was able to design the facilities that resulted in a reduced number of drilling and production centres. This reduction in drilling and production centres means that project construction, installation and operational activities would be confined to a smaller area which in turn, minimises potential impacts on the environment. The requirement for directional drilling to enable extended reach to the reservoir targets and a need for primary separation of the produced fluids meant that a surface structure was required as opposed to a subsea system.

The options considered for the offshore facilities included the development of production, drilling and living quarters platform. A number of drilling well slot platform sizes were evaluated including 12, 24, 36, 48 and 52 slot platforms. Based upon production requirements an optimum total of 48 wells would be required for Phase 1 and the use of side track/recompletion technology meant that the project could achieve more than 100 reservoir penetrations. It was thus decided to develop a 48 well slot facility along with the production and accommodation facilities to minimise the number of platforms necessary for the development.

As regards product processing, consideration was given to full and partial processing of produced fluids offshore and to transporting wet fluids to shore for processing prior to export. Processing offshore also allows the integration of existing production fluids from the EOP development with Phase 1 production, one of the objectives of the Project.

Full offshore processing would require considerable infrastructure and facilities. The availability of an existing terminal site and infrastructure onshore near Sangachal (i.e. the EOP terminal) that could be expanded to meet the additional hydrocarbon production from Phase 1 meant that full offshore processing was not considered a viable operational or environmental option.

In comparison to full offshore processing, partial offshore processing has reduced space and weight requirements on the platform and as such was selected for the development. Again, this reduced space and weight requirement for the platform has flow-on benefits for the environment by reducing the area of intervention and hence reducing potential impacts. It does require however, that further processing be conducted onshore to produce stabilised products for export.

Partial processing offshore will include separation of associated gas from the produced fluids which would then used as fuel gas in gas turbines for power generation on the offshore facilities, gas lift requirements and gas injection requirements for reservior pressure maintenance. The separation and use of gas provides both environmental benefits (as opposed to alternative energy sources) and energy efficiencies benefits.

An early design option for the offshore processing of product was to have a single stage separator operating at approximately 35 bar. As a consequence, there would have been a requirement for compression to bring all the gas up to 60 bar pressure. An alternative option was selected therefore, whereby a two-stage separation process was designed with the first stage separator operating at 60 bar. Most gas will be separated in the first stage separator with the remaining gas separated out at a second stage separator operating at 25 bar. This smaller volume and lower pressure gas would then be compressed back to 60 bar and added to the gas export. The result of this option selection is that the overall compression requirements are greatly reduced on the platform in favour of a second stage separation. This results in important offshore energy efficiencies with inherent environmental benefits due to the significantly lower emissions (from reduced compression capacity).

Alternatively, no offshore separation of gas from the product stream would require multiple multi-phase pipelines to shore, additional processing facilities onshore and would not provide gas for power generation offshore or gas lift. This option was therefore, not considered as a suitable one for the development.

A secondary consideration for two stage production separation selection is the ability to separate the majority of the produced water offshore and to use the recovered produced water as a source for re-injection water. Thus, the first stage separators primary function is for gas/liquid separation and the second stage separator's primary function is for oil and water separation.

The reservoir will also require pressure maintenance to assist the flow of hydrocarbons to the production platform and the design of the programme requires that the facility is made to use both gas and water injection for this purpose. Compression facilities for reservoir pressure maintenance on the platform were thus evaluated. Integration of these facilities on the drilling and production platform was however, found to require excessive space and had substantial weight support requirements. In addition, the provision of these facilities would also have delayed the construction and start of operations of the drilling and production platform.

The requirement for pressure maintenance for the Azeri field portion of the FFD and the technical problems associated with a single installation led to the decision to construct and install a dedicated platform in the field that has the capacity to host all of the gas injection compression and water injection equipment to enhance the Azeri field production rates. Gas and water injection will be necessary for the successive Phases of Azeri field FFD and space and weight considerations have been catered for within the design of the compression and water injection platform. Whilst consideration was given to dual platforms (with gas injection on one platform and water injection on the other), the construction and installation of a single pressure support platform was selected to service the needs of the three separate production centres planned for the Azeri field (FFD Phases 1 and 2). This up-front investment in facility design to accommodate future production requirements means that one facility, rather than numerous facilities would be developed, thus confining potential impacts on the environment to a smaller area.

In summary, the final decision was to construct and install a single production, drilling and quarters (PDQ) platform. This was inclusive of a primary two-stage separation facility to separate gas, oil and produced water before oil and gas export to the onshore terminal at Sangachal for final processing. Facilities will be added to the topsides to receive oil from the EOP Chirag-1 platform. The PDQ will be bridge linked to a single compression and water injection (C&WP) platform with compression and injection facilities for gas and water for Phase 1 along with a standalone compressor for received Chirag-1 gas (eliminating the need for flaring of associated gas on Chirag-1) as well as space requirements for later Azeri field FFD compression and injection facilities.

Reservoir pressure maintenance will not be a requirement in the early stages of Phase 1 development and as such, it is proposed that the C&WP be installed approximately one year after the installation of the PDQ. The dehydration facilities for Phase 1 will be installed with the C&WP and the consequence of this is that chemical hydration inhibition/corrosion inhibition of the export gas will be necessary during the early production phase.

Design of the layout of the platform topsides facilities included consideration of feasible installation methods offshore. As heavy lift vessels are not available in the Caspian Sea, the preferred layout will be such that a topside floatover method of installation from an available transportation barge can be used. This has meant that the drilling facilities on the PDQ will be centrally located. Floatover installation means that the topside modules may be installed and mechanically completed onshore prior to offshore installation, keeping offshore commissioning activities to a minimum.

The offshore processing, compression and injection facilities could be supported by either jackets or barges. Due to the requirement for transportation of materials into the Caspian, the jacket option proved the more attractive option as components for the jacket can be more easily transported into Azerbaijan for assembly than could barge components.

The sub-structure options available included concrete or steel jackets. Construction of concrete jacket structures use more raw materials than do steel jackets and infrastructure availability within Azerbaijan would not easily allow for construction of a concrete monolith type sub-structure. In addition, the decommissioning of a concrete sub-structure may not be feasible, whereas technology exists for the removal of a steel jacket.

Once the decision was made to use a steel jacket sub-structure there was an option to either build new jackets or refurbish existing jackets designed and constructed in recent years by SOCAR. AIOC conducted a number of integrity studies on the existing jackets and came to the conclusion that the jackets were not suitable to support the topsides that have been designed for the ACG Phase 1 project. A decision was made therefore, to fabricate new steel jackets for Phase 1. The C&WP jacket and topsides support structure will be constructed in a similar manner. Construction experience and lessons learned during the building of the PDQ will be passed on to the C&WP construction team with the objective of optimising further costs, safety and project schedule.

The option to pre-drill a number of wells prior to installation of the PDQ as opposed to waiting for the PDQ to be installed prior to commencing drilling was considered. Pre-drilling will enable hydrocarbons to be brought onstream more rapidly following installation of the PDQ and as first oil is scheduled for early 2005, it was decided that pre-drilling would be necessary to achieve the project schedule.

4.3.2 Transfer of hydrocarbons to shore

4.3.2.1 Options

The alternative options available for the transfer of the produced hydrocarbons to shore included shuttle tanker or subsea pipeline. It is considered that a pipeline presents a much lower oil spill risk than offshore loading and shuttle tanker transportation as tanker transportation would imply increased vessel movements between the offshore facility and the terminal and a consequent increased collision risk. Offshore storage of oil, tanker loading and off-loading operations would also result in increased VOC emissions to the atmosphere. In addition, the Caspian Sea is an enclosed water body with insufficient tanker capacity currently available to provide transportation of the oil production rates arising from the development. Furthermore, the use of shuttle tankers for oil transport is not feasible without full oil processing offshore to a stabilised condition. The shuttle tanker option was therefore discounted early in the processing evaluations considered and the sub-sea pipeline transfer option adopted as the base case for the development.

4.3.2.2 Subsea pipeline configuration options

Initially, a total of 38 sub-sea pipeline options were evaluated for ACG FFD. These options were reduced to sixteen based on technical considerations and from these, four main options were selected for more detailed evaluation once all of the technical and commercial aspects were considered. The four options remaining included:

1. conversion of the existing EOP 24” oil pipeline to gas service and tie in of a Phase 1 gas line into the existing subsea wye; installation of a new 30” oil line to Sangachal; installation of two new interfield lines from Chirag-1 to the Phase 1 facilities for oil and gas transfer.
2. retention of the existing EOP 24” oil pipeline in oil service and installation of a new 32” oil line as well as a new 24” gas line; no interfield lines are required with this option as the existing oil line remains dedicated to Chirag-1.
3. retention of the existing EOP 24” oil line in oil service and tie in Phase 1 oil into the existing subsea wye; installation of a new 24” oil line and 24” gas line to Sangachal as well as two new interfield oil lines from Chirag-1 to Phase 1 and from Phase 1 to the existing subsea wye.
4. conversion of the existing EOP 24” oil pipeline to gas service and tie in a Phase 1 gas line into the existing subsea wye; installation a new 32” oil line to Sangachal.

Each option was compared and ranked based on a number of criteria including:

- compatability with ACG FFD objectives;
- technical merit;
- constructability;
- impacts on the environment;
- cost and commercial attractiveness; and
- schedule.

At the time of writing, option 1 was chosen as the preferred option as it satisfied the technical requirements of both Phase 1 and FFD and at the same time maximised shareholder value. Only one new export pipeline would need to be installed and it defers the requirement for a second pipeline to be installed for FFD. Installation of the second line at a later date allows for more knowledge of the reservoir and properties of the crude to be established, allowing the size requirement for the second oil line required for FFD to be adjusted according to requirements prior to installation. It should be noted that the laybarge available for pipeline installation would require upgrading to enable installation of a line of 30” diameter. This option also contains provision for Chirag-1 oil production to be co-mingled with Phase 1 oil on board the Phase 1 facilities for combined oil export to the onshore terminal through a single pipeline.

Option 2 would require all FFD lines to be installed during Phase 1 removing the flexibility for changing the size of any of the lines at a later date. This option would also require an offshore booster station. In addition, and ass with Option 1, the laybarge would need to be upgraded to enable the installation of the 32” pipeline. Laybarge upgrade also applies to Option 4. In addition, Option 4 does not contain any plan for a second line for FFD and hence the option provides limited flexibility for future requirements. Maximum oil subsea transport is also limited to 833,000 bpd which is short of the 1,000,000 bpd peak rate planned for FFD. Options 2 and 4 do not allow provision for Chirag-1 production to be commingled with Phase 1 hydrocarbons.

Option 3 consists of two oil pipelines for Phase 1 and hence provides more operational flexibility and less strategic risk. As with Option 1 it also requires a second pipeline to be installed for FFD providing flexibility in the design of this line as more information on the oil from the field becomes established. This option provided a solution to many of the technical requirements for Phase 1 and FFD oil and gas export to shore however the high costs associated with this option were limiting.

An additional option is under consideration for Phase 1 that includes retention of the existing EOP 24” pipeline in oil service and installation of a new 30” oil pipeline to shore. The new interfield lines between Chirag-1 and Phase 1 facilities for oil and gas transfer would also be installed for this option, as in option 1 and option 3, but an additional new gas line from Phase 1 to shore would also be installed. The installation of this dedicated gas line is being considered in order to provide additional oil and gas export capacity. This represents an acceleration of the installation of the gas line originally planned for the ACG Phase 3 development, however this option remains under review and a final decision is not expected until a later date.

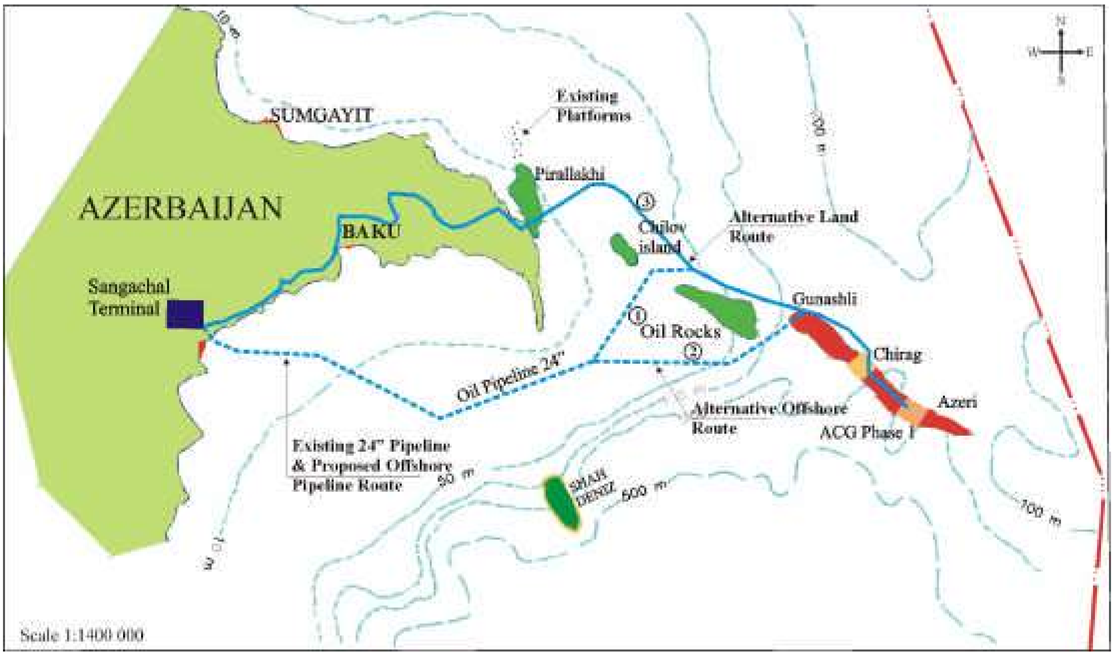
4.3.2.3 Pipeline routes

During the new pipeline route selection process, three alternative pipeline corridor routes were considered (Figure 4.1):

1. A route that follows the existing EOP 24" oil pipeline corridor with landfall alongside the EOP landfall site at Sangachal Bay; the total length of this pipeline route would be 190 km.
2. A route that initially follows the existing EOP 24" oil pipeline corridor but at the western edge of the Contract Area follows a more direct westerly route that is south of Oil Rocks to join the existing EOP pipeline route at a distance of approximately 120 km from the landfall; landfall would be alongside the EOP landfall site at Sangachal Bay and the total length of this pipeline route would be 190 km.
3. A route that initially follows the existing EOP 24" oil pipeline corridor, but at the western edge of Oil Rocks continues to the northwest making a landfall on the Apsheron Peninsula north of Dubandi then continuing north of Baku and then parallel along the coast to Sangachal; the offshore length of this route would be 113 km and the onshore length would be 120 km.

Option 1 was considered to be the preferred route for the new 30" oil pipeline as this follows the existing proven route. This has 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. A geotechnical investigation of Option 2 was carried out and the results indicated that areas of the seabed where the pipeline does not follow the existing route consisted of unsuitably unstable material. An additional constraint is the potential to impact on areas of the seabed, which have not previously been subject to environmental impacts from pipeline construction, installation and operational activities. Option 3 was also discounted principally due to the additional length of this route, the difficulty of pipeline installation in the Apsheron Peninsula, environmental considerations (as for Option 2), as well as the increased safety risks associated with the onshore route.

Figure 4.1 Alternative Pipeline Routes



4.3.3 Terminal

As stated above an early decision to develop the Phase 1 terminal as an extension of the existing EOP terminal was made. Following the discovery of gas and condensate in the Shah Deniz contract area by BP, Shah Deniz field development design includes the requirement for a gas/condensate processing terminal to be sited onshore. As ACG terminal facilities are planned at the Sangachal site, this location has also been considered to be the preferred site for the Shah Deniz terminal as opposed to developing a new site at a different location.

Benefits of using the same location include the use of existing access and infrastructure, shared new terminal facilities, potential for integrated operational control as well as combined maintenance and support services. In addition, potential cost savings would be possible from combined engineering construction works at one location, as well as the advantage of developing a skilled workforce at one location.

Due to the potential for the construction of the Shah Deniz terminal at the same location, planning for the terminal expansion for Phase 1 has included terminal layout options with a view to realising the potential synergies between the AIOC FFD and the Shah Deniz FFD project.

Two options have been considered during the terminal facility design:

- independent (stand alone) terminal facilities for Phase 1 and Shah Deniz; 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 50-100 m to the west. It was considered however, that the standalone option would not capture any 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 ACG and SD flares 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 would be the approach 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.

4.3.3.1 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 Garadagh Cement Plant.
- A 2.5 km road running from the south east of the terminal and connecting to the main Baku to Astara highway.
- 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 at the same time is located in a position where the predominant prevailing wind direction is away from the Umid 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 Environmental evaluation of the selected option

A BPEO study was carried out in 1999 that highlighted the key areas of potentially high environmental impact and provided recommendations as to the approach to impact reduction. Four key areas that would potentially result in unacceptable impact were identified as follows:

- continuous low-level operational flaring;
- disposal of produced water onshore;
- fugitive emissions from storage tanks; and
- energy efficiency.

The results of this study were endorsed by all AIOC partners and ultimately led to the development of the Phase 1 environmental basis of design and Phase 1 environmental design standards.

Each of these issues was also considered further through a robust assessment of the options proposed on technical feasibility, safety and on a financial/environmental cost benefit basis. The cost to the project was calculated by using the capital cost to reduce the emission of one tonne of CO_2 per year. This cost benefit analysis also considered power generation and drill cuttings discharges.

4.4.1 Flaring

The studies assessed a number of technologies available for the reduction of volumes of gas flared during offshore and onshore operations. Routine flaring operations were considered such as continuously lit pilots and make-up gas supply required under low flow conditions to prevent air ingress at the flare tip. The base case design is for no routine flaring of associated gas however the flare will also be used in the event of an emergency blow-down of the facilities to prevent loss of life or loss of the facilities. Non-routine flaring of gas will also be required at times of process upsets including periods of facility shutdown, start-up and during commissioning of the facilities.

Options assessed for the reduction of emissions from flaring included:

- flare gas metering which allows the rate of purge gas flow to be optimised (and leakage from valves to be identified) to prevent the unnecessary burning of excessive gas;
- source reduction techniques involving the selection of high integrity valves so gas is less likely to pass through seats and seals;
- flare gas recovery which allows for recovery of low volume gas leakage from the process valves into a flare collection system and is compressed and returned to the process;
- inert gas purge, so eliminating the need for hydrocarbon purging; and
- auto ignition systems which reduces the amount of pilot gas necessary as the flare would be auto-ignited when required. Auto-ignition systems can be either electronic or using a UMOE ® (patented compressed nitrogen driven projectile launcher) ignition system.

The options incorporated or rejected for the onshore and offshore facility flares are shown in Table 4.1 and 4.2 respectively.

Table 4.1 Flare emission reduction options onshore

Options incorporated	Options rejected
Source reduction techniques (high integrity valves and low loss fittings)	Non-continuous pilot-electronic ignition
Flare gas recovery	UMOE projectile ignition system
Nitrogen purge	-

The analysis concluded that the addition of auto ignition resulted in marginal benefit for the extra cost involved and the risk of venting gas if the auto ignition system fails during an emergency blow-down event would result in the venting of gas directly to the local atmosphere.

Table 4.2 Flare emission reduction options offshore

Options incorporated	Options rejected
Source reduction techniques (high integrity valves and low loss fittings)	Flare gas recovery
	Nitrogen purge
	Non-continuous pilot-electronic ignition
	UMOE projectile ignition system

Flare gas recovery was rejected for the offshore facilities due to the requirement to deliver gas from the recovery system to the offshore process at a minimum of 25 bar. This would mean that an additional compressor would be required to compress flare gas for this purpose. In addition, an increased risk to personnel was identified due to the extra equipment required and the maintenance necessary would result in additional time for personnel to work in a hazardous area.

As there is no flare gas recovery offshore nitrogen purge was unnecessary as purge gas would be made up from the gas flows to the flare from internal valve leakage.

The auto ignition systems were rejected for the same reasons given above for the onshore flare system.

4.4.2 Produced water disposal onshore

Prior to the installation of the compression and water injection platform (C&WP)Produced water will be sent with the oil from offshore for separation at the terminal in the first year of production. Once the C&WP is operational, the water will be separated and treated for re-injection offshore as part of the reservoir pressure maintenance regime. Water remaining after the offshore separation process will be sent to the terminal for separation and disposal. It should be noted that were there to be a loss of the offshore water injection facilities, treated produced water will be discharged to the sea offshore.

Three options were considered for the disposal of produced water separated onshore as part of the onshore terminal oil dehydration process.

- treatment followed by discharge via the outfall to Sangachal Bay;
- deep well injection at a suitable onshore location; and
- evaporation ponds.

Assessment of the sensitivities of the receiving environment in Sangachal Bay (Chapter 6) determined that the area is a known fish breeding, spawning and nursery ground and concerns with respect to potential discharges to this environment by Azerbaijani regulators, fishermen, NGOs and local residents indicates that this option is not acceptable. There are a number of additional risks associated with this option including ensuring the selection of the most appropriate outfall location, the lack of agreed discharge standards and the available water treatment technologies.

The use of evaporation ponds was rejected on the basis of the total area of land required was prohibitive as were the geology and climatic conditions of the region.

Injection of the produced water into a suitable dedicated onshore disposal well is the preferable option. Further evaluation of the injected produced water migration routes and attendant risks, including to potential potable aquifers and outcropping is ongoing.

4.4.3 Fugitive emissions from oil storage tanks

The technologies assessed for the reduction of fugitive emissions from oil storage tanks at the terminal included:

- external floating roof tank with primary and secondary seals and low loss fittings allowing emptying and filling without creating an internal vapour space;
- vented internal floating roof tank, based on the same principal as the external floating roof tank except that they have a fixed external roof above the floating roof which provides external protection from the elements; and

- closed internal floating roof tank with vapour recovery system, based on the internal floating roof tank except that the internal vapour space is not open to atmosphere and fugitive emissions are recovered and returned to the process stream.

The preferred option, after consideration of the criteria above, was an external floating roof tank with primary and secondary seals with low loss fittings. The evaluation was driven by a balance between the environmental benefit in terms of emissions reduction, operability and cost. This approach, including the use of low loss fittings, will result in reduced estimated emissions compared to the internal floating roof tank with primary seals. An additional vapour recovery system was also assessed but the benefit was marginal for the extra cost involved.

4.4.4 Energy efficiency and waste heat recovery

Energy efficiency through waste heat recovery from power generation turbine exhausts was considered for the onshore terminal. The process was considered to be unsuitable for the Phase 1 offshore facilities due to the weight and complexity of equipment that would need to be installed offshore. Further there is very limited use of recovered heat on offshore installations other than the glycol regeneration package on the C&WP. It is more cost effective to power this unit from the electric supply generated offshore.

For the onshore process recovered heat could 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. Two options were considered for the onshore terminal:

- waste heat recovery unit; and
- waste heat recovery with back end exchange.

Use of either of these options would result in a reduction in size of the oil heaters. The technology results in a higher reduction of emissions but the higher cost as well as the expected additional maintenance requirements of the plant for this option led to the rejection of this technology. Back end exchange units are also problematic with oils of high wax content, such as the crude from the Azeri field, leading to more downtime and maintenance requirements. There is however to be an allowance for future waste heat recovery to be incorporated on the terminal, but a waste heat boiler will not be installed until the heat can be used for Shah Deniz and ACG Phase 2. As such the project has decided to incorporate the ability to retrofit in the future, a waste heat recovery unit without back end exchange into the terminal design.

4.4.5 Power generation

Power generation is required offshore for essential platform utilities and all drilling system and topside processing requirements. The option of having power generation offshore and onshore as opposed to a single source onshore was assessed. Platform power import from onshore eliminates the need for offshore power generation facilities. The assessment found that there was a resulting small reduction in total offshore and onshore CO_2 emissions from this option, however all of the emissions were concentrated on one point resulting in higher NO_x levels onshore with an associated potential local air quality issue. In addition, the technology available is not at present field proven (for instance, efficiency losses are anticipated with the transmission technology available) and not cost effective, hence this option was rejected.

The platform design option chosen was based in part on the decision to use centralised gas turbine generators due to their simple and robust design and their dual fuel capability (fuel gas and diesel). This technology has a proven track record in reliability in offshore facilities. Dual fuel gas turbines were also selected for the onshore terminal.

Combustion emissions from the turbines and the options to be able to reduce emissions were considered for the selection of the gas turbine generators. The options considered included:

- standard industrial type gas turbines;
- aero-derivative turbines; and
- Dry Low Emission (DLE) burner technology.

The aero-derivative turbines were selected for both the offshore and onshore facilities as opposed to industrial turbines as they provide higher efficiency and hence a reduction in CO_2 emissions. Low NO_x DLE turbines are known to reduce NO_x emissions to the atmosphere. The technology of single fuel gas turbines for DLE is available and reliable. However, the dual fuel DLE turbines using diesel for start up and gas when available has not been proven in the field as reliable and achievable of the low NO_x emissions specifications of these units. For this reason it has been decided to install dual fuel conventional turbines at both onshore and offshore locations for the start up of the project. Onshore it is predicted that there is insufficient gas available for start up, hence conventional dual fuel turbines will be installed initially that will be DLE ready, and the DLE single fuel gas engines will be installed at the first engine change out at the terminal.

DLE fired oil heaters have been incorporated into the Phase 1 onshore facilities.

Optional exhaust control technologies available to reduce combustion emissions from the turbines were also considered and were rejected as follows:

- CO_2 extraction membranes which can extract up to 85% of CO_2 from turbine exhausts; the technology however is in the early stages of development and if fitted is likely to reduce turbine efficiency; and
- Selective Catalytic Reduction (SCR) provides NO_x reduction via back end scrubbing; this option however presents an increased safety risk in that ammonia would be emitted from the process and there are risks associated with handling and disposal of the catalyst. In addition, this technology would not be economical for small-scale offshore plant facilities.

4.4.6 Drilled cuttings

Drilled cuttings generated during drilling operations carried out with Non Water Based Mud (NWBM) 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.

A number of processing and remediation trials for the cuttings have been implemented and trials are ongoing.

Ship-to-shore involves transferring the bulk cuttings contained on the drilling rig (or PDQ) to a vessel for onward transfer to shore. Shipping of cuttings to shore and onshore processing requires more energy and generates greater amounts of atmospheric emissions in comparison with offshore re-injection. Ship to shore also requires greater handling of the cuttings both offshore and onshore with presenting increasing health and safety risks. Furthermore, in periods of bad weather the transferring of bulk cuttings to a vessel presents greater risk of spillage or even may result in weather downtime for the drilling operation.

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 the disposal formation. A suitable formation has been identified offshore for disposal (Subanchi) and the decision was made to construct dedicated cuttings re-injection wells offshore for disposal of cuttings from NWBM based drilling. Shipment of cuttings to shore will also be used as a contingency disposal route if the cuttings re-injection equipment or disposal well is unavailable. NWBM cuttings generated prior to the commissioning of a cuttings re-injection well will also be shipped to shore for storage and treatment.

A BPEO study was carried out to assess the disposal of drilled cuttings generated from the 26” top-hole section drilled using seawater and/or Water Based Mud systems (WBM) as a drilling fluid (URS, 2001). 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 very localised in the vicinity of the discharge point. The rate of cuttings generation during drilling of the 26” hole section 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) for the 26” section may potentially increase safety risks. Evaluation of the re-injection of these drilled cuttings determined that at the planned ROP, the high rate of cuttings generation would result in unacceptable risks to the re-injection well facilities. In addition, the high volumes of cuttings generated from the multiple wells required from Phase 1 would require the drilling of additional re-injection wells.

The base case design for the Phase 1 project is described in detail in the Chapter 5. Additional detailed discussion of the impacts arising from the Base Case is included in Chapters 9 to 13.

5 Project Description

5.1 Introduction

This Project Description describes the base case project design for the Azeri, Chirag and deep water Gunashli (ACG) Full Field Development (FFD) Phase 1 Project. The project is designed to produce oil and gas from the reserves in the central Azeri field and will consist of a number of components including:

- fixed platform installations offshore for drilling and production operations;
- subsea pipelines for the transportation of oil and gas, and
- an onshore terminal for the reception and processing of oil and gas.

Drilling and production operations offshore will be carried out from a new drilling, production and quarters (PDQ) platform to be constructed and installed in mid to late 2004 over a pre-installed drilling template. A number of wells will be drilled in the field from a semi-submersible drilling rig, prior to installation of the PDQ, to enable early production following installation. For the base case drilling design, it is anticipated that this will involve the drilling of between eight to ten pre-platform (template) wells in total. As the project design changes however, there is the possibility that the actual number of wells could be limited to nine and this is used throughout this Chapter for the basis of quantification and qualification.

Drilling of the first well is under evaluation, although it may be necessary to drill an early well prior to the installation of a subsea template for drilling of the remaining eight wells. In this event, an Environmental Impact Assessment (EIA) prepared for the first well drilling programme will be submitted to the Azerbaijan Ministry of Ecology and Natural Resources (MENR) for approval (AIOC, 2001a).

To enable production from the reservoir, it will be necessary to maintain pressure within it and this will be achieved by re-injecting associated gas liberated from the production process in addition to water injection. A gas compression and water injection platform (C&WP) platform will be constructed and installed alongside the PDQ for this purpose, approximately one year after the installation of the PDQ. The C&WP will be bridge-linked to the PDQ and will consist of gas compression, treatment and injection facilities as well as seawater treatment and water injection pumping facilities. It should be noted that the C&WP will also provide compression and injection facilities for all Azeri field development. As such, space and weight considerations will be included in the platform design for the facilities and equipment necessary for the ACG FFD Phase 2 development. In addition, the Phase 1 development will also be designed to receive oil and gas produced from the existing Early Oil Project (EOP) centred around the Chirag-1 platform to the north of the Azeri field. Chirag-1 oil will be commingled with Phase 1 oil on board the PDQ for export to shore, whilst gas will be received at the C&WP for compression and re-injection.

A new 30" sub-sea pipeline will be installed as part of Phase 1 for the transportation of Phase 1 (and Chirag) oil to shore for further processing and stabilisation at the terminal. Current project planning is to transport any excess gas to shore through the existing EOP 24" oil pipeline from Chirag-1, which will be converted from oil to gas service. As discussed in Chapter 4 (Options Assessed), at the time of writing the document, an additional subsea gas export pipeline option is under consideration for Phase 1. This would include the retention of the existing 24" pipeline in oil service and the installation of a new dedicated gas line. The new gas line would represent an acceleration of the installation of the 30" gas line originally planned for the ACG FFD Phase 3 development. The base case design for Phase 1 however, is for conversion of the existing 24” from oil to gas service and this impact assessment has been conducted on that basis.

In addition to the export pipelines, interfield lines between the Phase 1 facilities and Chirag-1 will be installed for oil and gas transfer between the platforms. A subsea line for transfer of gas from the PDQ to an existing subsea wye on the 24” pipeline to shore will also be installed for gas export.

The existing EOP terminal at Sangachal will be expanded for Phase 1 oil and gas reception and processing. The expansion will include; a new oil and gas inlet, two new oil process trains, gas compression and dewpoint control packages as well as two additional oil storage tanks and a tank storage facility for produced water.

The key milestone schedule for the main stages of the Phase 1 development are shown in Figure 5.1. The dates provided are estimated based on the planned schedule at the time of writing this document and are potentially subject to change.

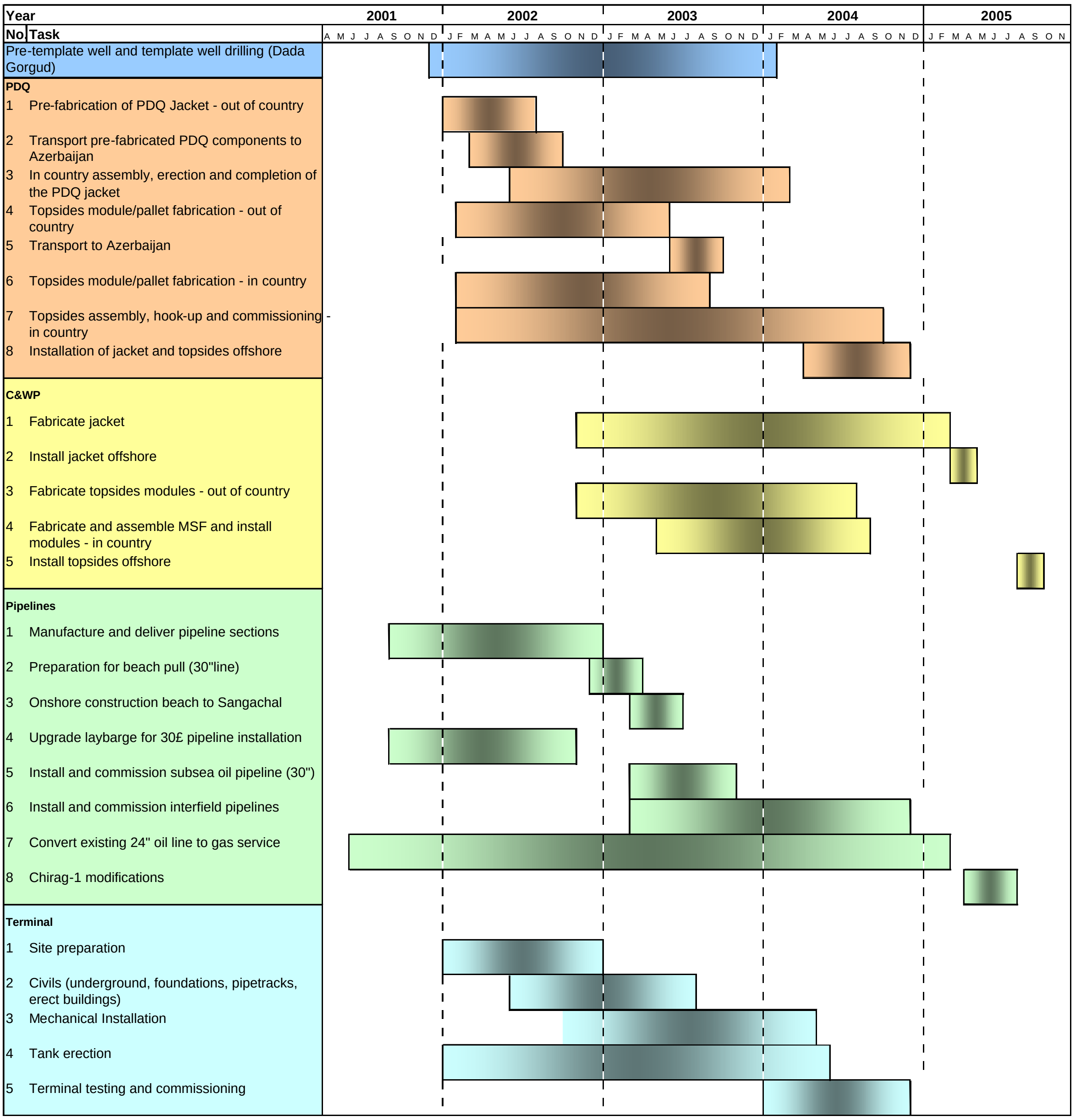
This Chapter describes all of the activities associated with the Phase 1 project including:

- 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:

- template drilling (early drilling from the semi-submersible drilling rig prior to installation of the PDQ);
- platform drilling (drilling from the PDQ);
- offshore platform construction and installation;
- offshore production;
- pipelines (installation and operation);
- terminal construction;
- terminal operations;
- transportation of components to Azerbaijan;
- decommissioning; and
- waste management.

Figure 5.1 Estimates schedule for Phase 1 development activities



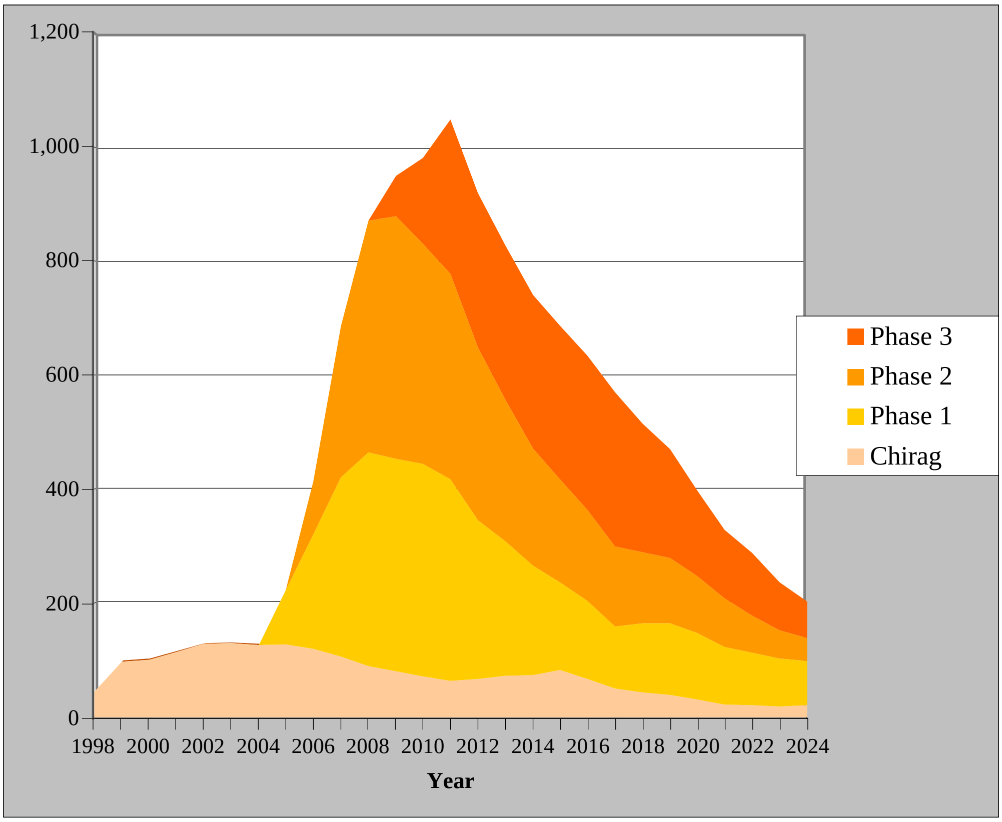
The emissions and discharges associated with each stage of the development have been estimated as far as possible using standard techniques and included within each section. A summary of emissions and discharges from the Phase 1 development is included in Section 5.11.

5.1.1 Estimated production rates

As discussed in Chapter 1 (Introduction), Phase 1 is the first phase of ACG FFD following EOP and two further phases for FFD are planned. Phase 2 will develop the remaining part of the Azeri field and Phase 3 the deep water Gunashli field. Estimated production profiles for each Phase of the ACG development are shown in Figure 5.2.

The entire ACG field may contain in excess of 13 billion barrels of oil in high quality fluvial/lacustrine reservoirs of Pliocene age. Oil bearing strata can be divided into two major compartments, the Pereriv sandstone and Balakhany sandstone structures with at least seven, stacked, oil bearing formations in the field. Approximately 56% of the oil is in the Pereriv formation and the remaining oil in the shallower Balakhany formation. The limited fluid samples in the field suggest significant spatial variation of oil within the reservoir, API values vary from 31 to 40 degrees from northwest to southeast. Similarly, wax content varies from 4-16% across the structure as well as vertically.

Figure 5.2 Estimated production profiles from ACG FFD (1,000 bbls)



Recoverable reserves at the end of the PSA (2024) are estimated to be 4,645 million barrels of oil, or 34.9% of the total original oil in place in the Pereriv, Balakhany 7, 8, 9 and 10 horizons. The recovery factor from productive Pereriv formation is 45.9% and from the poorer quality Balakahany reservoirs, 20.8%. Continued production beyond the PSA would increase recovery factors further.

It is estimated that Phase 1 could recover 1,425 million barrels of oil, that is 30.7% of the total field reserves. It is anticipated that a total of 1,174 million barrels will be taken from the Pereriv and 251 million barrels from the Balakhany 8 and 10 horizons.

5.2 Template drilling

This initial stage of the development will include the drilling of nine wells from a semi-submersible drilling rig prior to installation of the PDQ to enable rapid production from Phase 1 soon after installation of the fixed production facilities. A total of 48 wells are planned for Phase 1, the remaining 39 wells will be drilled from the PDQ (platform drilling) and this is described in Section 5.3.

As mentioned an EIA has been conducted for drilling operations at the first Phase 1 well and this document will be submitted to the MENR should an early well be required (AIOC, 2001a). As the drilling programme and operations are similar for all nine wells planned as part of the base case, this section describes the activities and estimates the emissions for the full early drilling phase. This stage of the development has been termed "template drilling" in order to distinguish it from the later "platform drilling".

5.2.1 Template well programme

The base case design for the template wells is for three well types as follows:

- four type 1 wells with the 9 $^{5}/_{8}$" casing run and cemented just above the top Pereriv, with the 8 ½" section still to be drilled;
- four type 2 wells with a 9 $^{5}/_{8}$" casing set across the Pereriv; and
- one cuttings re-injection well (CRI).

An intensive data acquisition programme is planned for the template wells. The data acquisition programme will include well logging, pressure measurement, and core sampling. In addition, a total of three Drill Stem Tests (DST) on different wells are planned for the template wells. The results from these tests will reduce existing uncertainties on the reservoir conditions and will assist well placement during the continuing Phase 1 drilling programme.

5.2.2 Drilling rig

The semi-submersible drilling rig, the Dada Gorgud (Figure 5.3), has been selected for the template well drilling programme.

Figure 5.3 The Dada Gorgud

The Dada Gorgud will undergo the following minor modifications to meet the requirements of programme:

- addition of a third mud pump;
- an increase to the accommodation capacity from 100 to 120 beds and improving the current facilities, and
- improvement to the cuttings handling system, this will involve a revision of the complete solids control system from the flow line, through the shale shakers and including transfer of cuttings generated through drilling with non-water based mud (NWBM) systems from the shale shakers into cuttings boxes for shipment to shore.

5.2.3 Drilling rig installation

The Dada Gorgud will be towed to the drilling location by two anchor handling tugs. A third vessel will accompany the tow and assist in positioning the rig and its anchors.

On arrival at the drilling location, the rig will be positioned using its anchor system. The first anchor will be dropped short of the planned well location and chain or cable payed out to allow the rig to move to the desired position. The remaining anchors will then be deployed to secure the rig in position. Should the rig require further anchoring, extra piggy-back anchors will be deployed, as appropriate. The laying of anchors and rig positioning will take approximately four days.

A total of eight, 10 tonne anchors will be used by the rig, in addition a proportion (up to 300 m) of each anchor chain will lie on the seabed, resulting in a potential area of seabed disturbance from anchor setting and anchor chains[1] amounting to 12,400 m^2.

5.2.4 Template well drilling operations

The generic well plan for the template well drilling programme, including the proposed drilling mud systems to be used is shown in Table 5.1. The casing program is shown in Figure 5.4

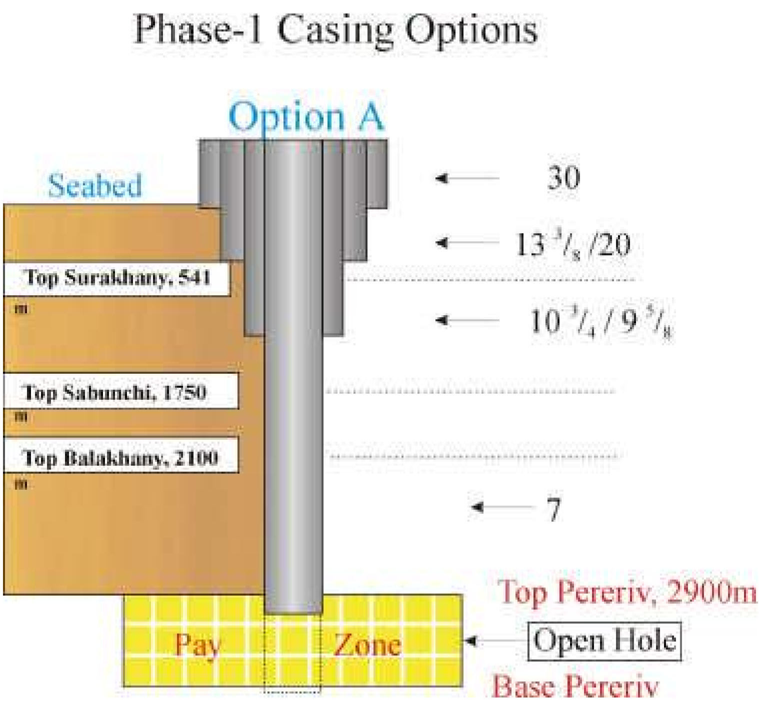
Table 5.1 Template well generic well plan

Hole Size (drill bit size diameter in inches)	Casing size (inches)	Depth[1] (m)	Proposed drilling mud system
36	30 conductor	300-350	Sea water with viscous sweeps
26	20	550	Water Based Mud (WBM)
16	13 ?	1,250-1,500	Non Water Based Mud (NWBM)
12 ¼	10 ¾ x 9 ?	3,050 (total vertical depth) top of the Pereriv formation	NWBM
8 ½	7	+/-5m below Pereriv	Acid soluble carbonate mud or viscosified brine based mud.

[1] depths taken from the drill rig floor (200 m above the seabed) to the total depth of the well section.

1 Assuming a 5m wide by 200 m wide disturbance from each anchor and a 2 m wide disturbance from each anchor chain.

Figure 5.4 Casing diagram



The primary function of the drilling mud system is the removal of cuttings from the well and the control of formation pressures. The mud systems also have a number of other important functions including:

- sealing permeable formations;
- maintaining wellbore stability;
- cooling, lubricating and supporting the bit and drilling assembly; and
- transmitting hydraulic energy to tools and bit.

Before drilling the first well a 12 ¼” pilot hole will be drilled to a depth of 650 m, within 50m of the wellhead to establish any hazards associated with shallow gas and allow a mitigation programme to be developed if necessary. Once the pilot hole has been drilled it will be plugged with cement and abandoned.

The 36” surface hole will be drilled using seawater and viscous sweeps. Drilling fluid, in this case sea water, pumped down the drill string, forces drilled cuttings to return up the annulus and then out onto the seabed. Viscous slugs of bentonite or guar gum (spud mud) will be used to sweep the hole of drilled cuttings as required. The frequency of these sweeps will depend upon the hole conditions. Once drilled, a 30” conductor will be run and cemented into place. A pin connector will be run to enable a marine riser to be installed which will connect the well to the rig and allow subsequent well sections to be drilled with a circulating drilling mud and drilled cuttings to be returned to the rig.

The 26” hole sections will be drilled using a WBM system. Once the section is drilled, 20” casing will be run and cemented into place. Drilled cuttings will be returned to the rig with the circulating mud and passed through the solids control package for separation of the mud from the cuttings. The solids control system will consist of a series of shale shakers, a vacuum degasser and dual centrifuge for the recovery of fine particles. The returned fluids containing the entrained cuttings will enter the vibrating screens of the shale shakers, which retain the larger cuttings particles and allow the drilling fluid to pass through the screens into the mud pit. The underflow comprising of smaller sand particles and silts will be recovered underneath the shale shakers. The muds may then go through the centrifuge for removal of the smallest solid particles. The separated muds will then be re-circulated downhole and the drilled cuttings discharged to the sea via the cuttings caisson at a depth of 11 m below the surface.

The density of the drilling mud system will be monitored and adjusted to the down hole conditions. 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. In addition, the large volume of drilled cuttings generated whilst drilling the top hole sections can reduce the efficiency of the solids control equipment. It is therefore sometimes necessary to dilute the drilling muds with water or replace the mud system. Excess WBMs will be discharged to sea.

The ingredients of the proposed WBM system and the estimated chemical usage for each 26” hole section is shown in Table 5.2.

Table 5.2 WBM and estimated chemical usage from each 26” top-hole section

Chemical	Composition	Function	Estimated use 26” (tonnes)	OCNS category[1]
Barite	Barium sulphate ore	Weighting agent	350	E
Bentonite	Clay ore	Viscosifier and removal of cuttings	50	E
KCL	Potassium chloride	Borehole stabiliser	3	E
Glydrill	Alkyl glycol	Stabiliser to plug micro-fractures	33.5	E
Guar Gum	Non-ionic polymer	Viscosifier and removal of cuttings	0.18	E
KOH	Potassium hydroxide	Acidity control	0.15	D
Polyplus/ Polysal	Cellulose polymer/ Modified starch	Fluid loss control and reduces the risk of drill string sticking	3.3	D
Soda ash	-	Chemical balance	0.08	E
XCD/Drispac	Bio-polymer	Viscosifier and weighting agent – suspension & removal of cuttings.	1.25	E

[1] Offshore Chemical Notification Scheme (see Chapter 10, Section 10.3.3). OCNS category E is the lowest category. Category E chemicals are of low aquatic toxicity, readily biodegradable and non-bioaccumulative.

It should be noted that WBMs to be used for all Phase 1 wells will meet the USEPA (United States Environmental Protection Agency) 96 hour LC_{50} tests or Caspian Sea specific ecotoxicity tests as stipulated in the ACG Contract Area PSA. In addition, no WBMs or cuttings generated from hole sections drilled with WBMs will be discharged unless the chloride concentration is less than four times the ambient chloride concentration of the receiving water. To achieve this, it is proposed that fluids containing KCl will be diluted by approximately 10 times their volume prior to discharge.

The estimated volume of cuttings to be released to the sea from the 36” surface hole and 26” hole section of each template well are shown in Table 5.3.

Table 5.3 Estimated cuttings and mud discharge volumes, template well drilling

Hole Section (inches)	Section Length (m)[1]	Drilling Fluids	Cuttings Generation		Mud Generation		Total Volume/ Section (m^3)
			Cutting Volume (m^3/hr)	Cuttings Volume (m^3)	Mud Volume (m^3/hr)	Mud Volume (m^3)	
36	150	Seawater	35.90	180	71.81	359	539
26	350	WBM	9.86	173	5.92	104	276
Total Discharge per well				353		463	**815**
Total Discharge (9 wells)				3,177		4,176	**7,335**

1 depths taken from the seabed (200m below the rig floor)

A NWBM system will be used for the 16" and 12 $^1/_4$" well sections in order to improve the well bore stability. It is likely that synthetic based mud (SBM) system containing a linear alpha olefin (LAO) base fluid will be used. Once each section is drilled casing will be run and cemented into place.

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. No cuttings generated from these sections will be discharged to the sea. The second well to be drilled will be a CRI well and work is ongoing to define if CRI is a possible option for the template wells. Until the cuttings re-injection facilities are operational and before the CRI well is drilled, NWBM cuttings will be contained and transported to shore for further treatment and disposal. Shipment of cuttings to shore for treatment and disposal will also be used in the event that CRI is not available. CRI is further discussed in the Platform Well section (Section 5.3). Excess and used NWBM will be contained and sent to shore for treatment, for re-use or for disposal. Alternatively excess and used muds can be disposed of using the CRI system.

Estimated quantities of drilled cuttings and mud systems generated from the 16" and 12 $^1/_4$" well sections are provided in Table 5.4.

Table 5.4 Estimated cuttings and mud generation volumes from the 16" and 12 ¼" template well sections

Hole Section (inches)	Section Length (m)	Drilling Fluids	Cuttings Generation		Mud Generation		Total Volume/ Section (m^3)
			Cutting Volume (m^3/hr)	Cuttings Volume (m^3)	Mud Volume (m^3/hr)	Mud Volume (m^3)	
16	750	NWBM	2.35	118	1.41	71	188
12 ¼	1440	NWBM	2.10	121	1.05	60	181
Total				239		131	**369**
Total (9 wells)				2,151		1,179	**3,321**

5.2.5 Cementing

The cement used to anchor the casing within the hole is pumped down the casing or conductor and up the annulus formed between the casing and the well bore. The casing for each hole section consists of steel tubing that lines the hole. It is used to seal off the weak shallow formations and to prevent the hole from collapse. Some excess cement may also be displaced into the water column and onto the seabed next to the well. A remotely operated vehicle (ROV) carrying a camera will be used to monitor returns to the seafloor and therefore limit cement losses at the seabed. However, the cement programme has been designed so that the top of cement need only come to inside the preceding casing and therefore resulting releases from the cement programme are unlikely except for the surface hole casing. The chemical constituents in the cement such as setting retarders and accelerators, surfactants, stabilisers and defoamers to be used in the template well cement programme are provided in Table 5.5.

Table 5.5 Template well cement chemicals

Additive	Estimated Total Use Per Well (bulk cement in tonnes)	OCNS category
LiteFIL™ Accelerator	113 total combined	E
Extender		E
LiteFIL™ Cemcrete		E
Accelerator		E
Accelerator	70 total combined	E
Extender		E
Retarder		E
Extender	53 total combined	E
Retarder		E
GasBLOK™		B

5.2.6 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 sensors located within specially adapted drill-collars.

5.2.7 Drill stem testing

A total of three Drill Stem Tests (DST) are planned during the template well programme. During these tests, formation fluids will be flowed to surface and pressure, temperature and flow rate measurements will be made to evaluate well performance characteristics. Samples of the formation fluid will also be collected for analysis.

Following testing, hydrocarbons will be sent to the burner boom for disposal by flaring as this is the only practical handling option for these hydrocarbons. Flaring may be initiated using diesel to ignite the hydrocarbon mixture. A high efficiency burner, (a 'four-headed Green Dragon') will be used to flare the oil during well testing and reduce the release of unburnt hydrocarbons. During flaring, specialist operators will monitor the mixture of hydrocarbons and air, to ensure high burning efficiencies of greater than 99% and minimise any oil 'drop-out' to the sea surface. In total it is anticipated that each of the three well tests will be tested for a total period of 88 hours. Flaring activities at each well will last for a maximum of 32 hours. The maximum flow rate of hydrocarbons to be flared is expected to be less than 10,000 bbl per well.

5.2.8 Drilling hazards

There are a number of potential drilling hazards that may be encountered during drilling operations, including stuck pipe, loss of circulation and well kick. Previous problems encountered down hole during past drilling operations in the ACG field 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.

5.2.8.1 Stuck pipe

The clays present in the shallow formations in the field are very soft, amorphous, sticky and display a high concentration of illite/smectite, which combines to provide a clay which swells when exposed to low salinity water. A number of evaporite (a mineral formed as a direct cause of evaporation) stringers have also been encountered in the ACG field, resulting in a reduction in the drilling fluids pH with an associated increase in calcium contamination caused by reaction with the anhydrite. This has led to mud circulation problems and stuck pipe during previous drilling. The use of NWBM 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.

5.2.8.2 Loss of circulation

During loss of circulation, mud passes into the formation and more mud is required to maintain the hydrostatic head by introducing more mud into the hole. Borehole ballooning was observed on previous wells at ACG where fluid losses were observed while drilling, with losses returning from the supercharged formation when the pumps were stopped. In the event of loss of circulation, materials such as mica or walnut shells are added into the mud to help seal the formation.

5.2.8.3 Well control

The reservoirs in the field are pressured formations and the wells are all designed so that the wells are monitored and controlled against unplanned influx. There is a risk of high salinity saltwater kicks and in extreme cases high salinity brine may flow between casings or breach the lower casing strings and reach the seabed.

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 of the 26” hole section with a rig mounted diverter. Deeper well sections will be drilled with 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 can close the annulus between the drillpipe 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 oil to be contained for disposal.

5.2.8.4 Hydrogen sulphide H_2S (sour gas)

H_2S has been detected in the appraisal wells (GCA-2 and GCA-6) previously drilled in the ACG Contract Area. As the potential distribution of H_2S is uncertain, H_2S safety plans will be in effect for all well operations.

Reservoir modelling has attempted to narrow down the potential range of H_2S concentrations that may be expected in the Phase 1 development area and at the time of writing the design has been developed to allow for H_2S gas concentrations as follows:

- single well design H_2S concentration (gas phase): 1,200 parts per million by volume (ppmv); and
- blended design H_2S concentration (gas phase): 500 ppmv.

Further definition of H_2S levels will be obtained during the well testing programme for the template wells.

5.2.9 Contingency chemicals

A number of chemicals will be stored on the drilling rig for use as contingency during the drilling programme. The proposed inventory and estimated usage for all contingency chemicals for use in the template well programme and their estimated usage are detailed in Table 5.6.

Table 5.6 Proposed contingency chemical inventory and estimated usage for each template well

Chemical	Function	Estimated Use (Tonnes)	OCNS Category
Drilling Detergent	Detergent- dispersant	0.2	E
Glutaraldehyde	Biocide-Prevent Bacteria Growth	0.3	C
Sodium Bicarbonate	Calcium/pH control	1.2	E
Citric Acid	PH Control	1.5	E
M-I Seal, F, M, C	Fibre – LCM	3.6	E
Nut Plug, F, M, C	Ground Nutshells – LCM	5.0	E
Mica F, M,C	Flake Mica – LCM	5.0	E
Pipelax W	Stuck Pipe agent	1.8	D
Defoamer A	Alcohol Defoamer	0.4	D
Spersene CF	Chrome Free Lignosulfonate – Thinner	2.0	E
Tannathin	Chrome Free Lignite - Thinner	0.9	E
Tackle	Polymer thinner	0.5	E
Novawet[1]	Wetting Agent for SBM	1.8	E
Novathin[1]	Thinner for SBM	1.8	E
Ecotrol	HTHP Fluid Loss Control	5.0	E
Kla-Cure	Clay Inhibition	11.0	E
Drill XT	Bit Balling Control	8.8	D
SafeSolv	Well Cleanup Solvent	2.6	C
SafeSurf	Well Cleanup Surfactant	2.6	B
Safevis HDE	Liquid HEC polymer for viscosity in Completion	2.6	D
Safecor HT	Corrosion Inhibitor	1.8	D
Kleenup	Detergent for cleaning	1.8	E

Chemical	Function	Estimated Use (Tonnes)	OCNS Category
Lubriglide Beads	Polymer beads – Torque Reduction	4.5	E

[1]also classified as part of the SBM system

5.2.10 Drilling template installation

A 12 slot drilling template will be installed on the seabed at the drilling location. The drilling template will be assembled in Azerbaijan and sea-fastened to a transportation barge (TM12) at the quayside in the SPS yard and will be taken to the drill site location. The crane barge *Derrick Barge Azerbaijan* (DBA) will be used to lift the template from the transportation barge and position it on the seafloor at the project development location. The template will be piled into position by the DBA.

5.2.11 Drilling rig utilities

Normal operations at the semi-submersible drilling rig (the Dada Gorgud) in addition to drilling, completion and testing will include loading and offloading of cargo vessels and mud and chemical transfers. The majority of equipment, stores and chemicals will arrive by supply vessel and will be transferred from vessel to rig either by 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 to the rig 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.

5.2.11.1 Power generation

All rig power requirements will be supplied on-board by means of diesel generators. The Dada Gorgud is equipped with three main levels of power generation. The main power is provided by 4 diesel generators rated at 1628 kW with a small twin diesel cement unit rated at 2 x 224 kW which is only used intermittently (2-5% of the operating time) for cementing casing. Finally there is an emergency diesel generator to provide essential services, which is rated at 235 kW. Diesel consumption is estimated to be nine tonnes per day.

5.2.11.2 Cooling water

The drilling process on board the Dada Gorgud will require cooling for normal operation. Seawater will be drawn by pumps at a rate of 600 m^3/hr for this purpose and once passed over the drilling equipment to be cooled, the heated seawater will be discharged back into the sea via a subsurface caisson. No antifoulant chemicals will be added to the seawater.

5.2.11.3 Sewage treatment

The sanitary wastes generated on the Dada Gorgud will be treated to United States Coastguard Standards, using Type II IMO (International Maritime Organisation) certified equipment.

Sanitary wastes include all black (sewage) and grey water (water from shower and washing facilities). These will be combined and processed in a treatment system. Treatment onboard the Dada Gorgud utilises an extended aeration process to produce a final effluent treated to a BOD (Biological Oxygen Demand) of 40 mg/l, suspended solids 40 mg/l and Coliform 200 Most Probable Number (MPN) 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.

Degraded material is displaced by incoming sewage and passing 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. Total residual chlorine of the effluent will be less than 2.0 mg/l, with levels monitored to ensure performance. Sewage sludge will be transported onshore where it will be treated prior to disposal.

5.2.11.4 Drainage

Drainage water on the rig 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.

All drainage water has the potential to contain some amounts of oily waste. There are three dedicated routes for drainage on board the Dada Gorgud:

- discharge to sea;
- hazardous area drainage tank for transport to shore; and
- bilge water tank for transportation to shore.

Drainage routes onboard the Dada Gorgud are illustrated in Figure 5.5.

Clean water drainage will be discharged to sea. The volume of water discharged from the drainage systems will be dependent on the level of rainfall during the drilling programme and the area of rain capture by the Dada Gorgud.

When drilling with WBM, drain waters may be directed to the cuttings chute for discharge if they are uncontaminated, and in addition, this effluent may contain surplus rig wash detergent, which is an OCNS category E chemical. Based on an average estimated usage a rate for rig wash detergent concentrate of 250 gallons per year, and a maximum likely period for discharge of rig wash waters of 576 days it is estimated that the maximum amount of rig wash detergent concentrate that would be discharged is approximately $1.1m^3$/year.

The Hazardous Area Drainage Tank (HADT) receives drainage 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 material in the HADT will be transported to shore for disposal.

The waste oily water tank receives drainage from the pontoons, the compressor room, the hydraulic power room and the generator room. Oily water in this tank will be either treated to remove the oil and discharged to sea or the entire contents will be transported to shore for disposal. All tank sludges will be transported to shore for disposal.

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. Oily water collected is treated by passing through a three-filter system and the treated effluent discharged 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 is transported onshore for disposal.

Figure 5.5 Drainage on board Dada Gorgud

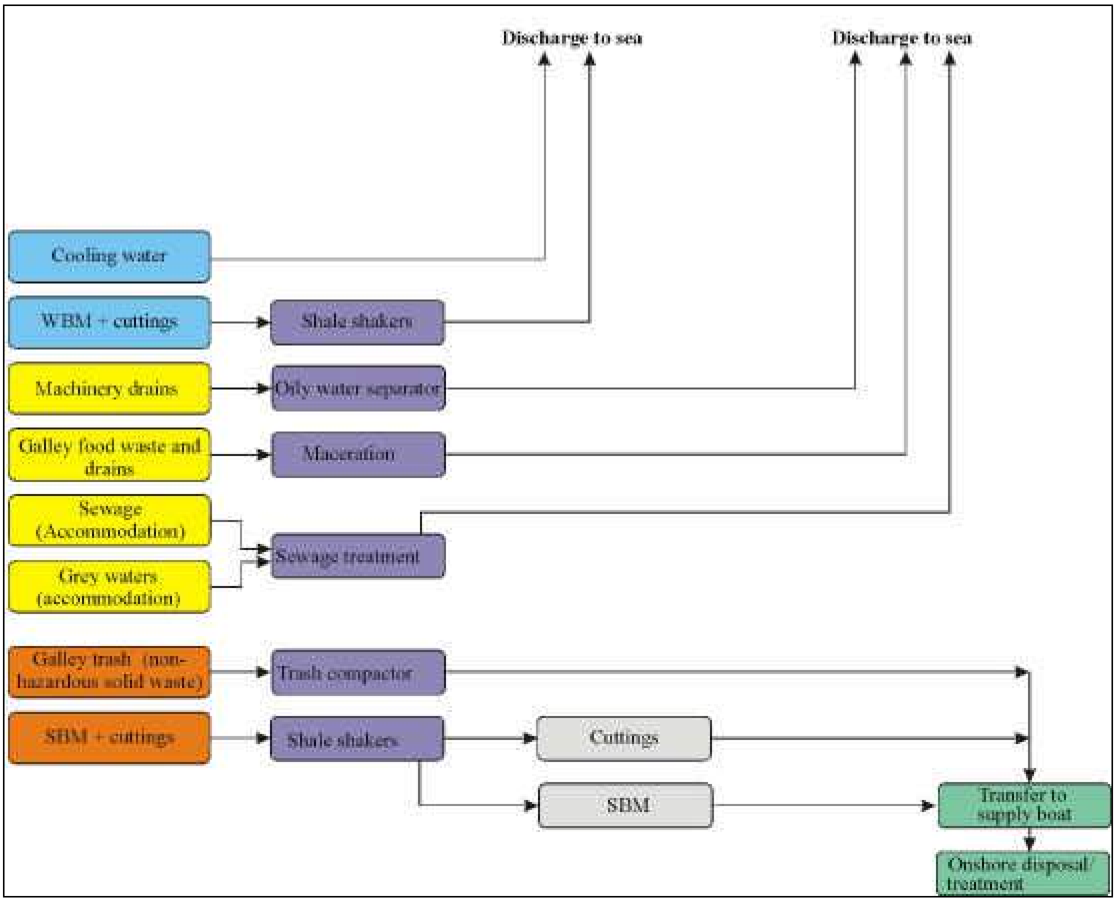


Table 5.7 lists the different rig areas outlining their potential hazards and the disposal treatment/ routes.

Table 5.7 Drainage area classification

Rig area	Category	Hazard	Disposal route
Pipe rack	Normally dirty area	Diesel is used to wash pipe and joint lubricants are applied. Also possibility for some mud release if pipe is removed from well. The pipe rack ends will be bunded for containment.	HADT when pipe is on deck.
Pipe deck	Normally clean area	The pipe ends are serviced by drains to the HADT due to conditions outlined above but the rest of the pipe areas are serviced by overboard drains which have the potential for plugging if there is a spill.	To sea or HADT in the event of a spill.

Rig area	Category	Hazard	Disposal route
Well test	Possibly dirty area	This area will be utilised for cuttings disposal, skip storage and handling. It will be bunded and served by the hazardous drains system, with the capacity to dump discharge to the sea when not drilling with WBM. Well testing operations would also require use of the hazardous drains system.	HADT when well testing or handling NWBM cuttings skips. To sea at other times.
Shale shaker house	Normally dirty area	Drilling mud spills.	To sea (WBM). HADT (NWBM).
Mud pump room	Normally dirty area	Drilling mud spills.	To sea (WBM). HADT (NWBM).
Compressor room	Normally dirty area	Diesel leaks possible.	Oily bilge water tank.
Hydraulic power room	Normally dirty area	Diesel/hydraulic oil leaks possible.	Oily bilge water tank.
Generator room	Normally dirty area	Diesel leaks possible.	Oily bilge water tank.
Helideck	Normally clean area	Refuelling system has been removed therefore helideck drainage mainly has to cope with rain water.	To sea.
Drill centre and rotary table	Normally dirty area	Drilling mud.	Sea (WBM) or recycled into mud system. HADT (NWBM) or recycled into mud system.
Cuttings storage area	Only required for NWBM	Lose of containment and spill of cuttings and mud. Area bunded and served by hazardous drains.	NWBM and cuttings onshore disposal. Liquid spillage to HADT.
Crane area	Possibly dirty area	N/A	Manual clean-up if spill.
Walkways	Clean area	N/A	To sea.

5.2.12 Accommodation

The drilling rig will have air conditioned quarters on board for up to 120 people. The accommodation includes galley, mess and recreation room. Potable water is produced by the desalination unit.

5.2.13 Other wastes

Solid and liquid waste generated on board the Dada Gorgud will be classified as one of the following categories, segregated and stored in appropriate skips or containers before being transferred to a ship for transport to shore for disposal:

- 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 and residual oil from the test separator will be transported to shore for disposal. Other liquid waste such as detergents used for cleaning purposed will also be temporarily stored prior to shipping back to shore.

Food waste will be passed through a macerator and discharged to the sea.

The estimated quantities of waste that will be generated onboard the Dada Gorgud during the template well programme are provided in Table 5.8. These have been calculated using operational data gained during the Chirag drilling programme.

Table 5.8 Estimated waste generation from the Dada Gorgud during the template well programme (576 days)

Waste	Classification	Quantity
General waste	Non-hazardous combustible solid waste	126 tonnes
Waste oil	Hazardous liquid wastes	31 tonnes
Chemical sacks	Hazardous solid waste	57 tonnes
Empty drums (55 gal)	Hazardous solid waste	122
Empty drums (25 litre)	Hazardous solid waste	297
Scrap metal	Non-hazardous non combustible solid waste	35 tonnes
Fluorescent tubes	Hazardous solid waste	0.32 tonnes
Clinical waste	Hazardous solid waste	114 kg
Oily/paint solids	Hazardous liquid wastes	20 tonnes
Paint thinner	Hazardous liquid wastes	1.6 tonne

5.2.14 Well suspension and rig removal

Each well will be temporarily suspended using cement and mechanical plugs to isolate any hydrocarbons and overpressured formations. A corrosion cap will be installed on the sub-sea wellhead following retrieval of the BOP and riser system. The well suspension programme will be designed to allow future well re-entry following installation of the platform.

5.2.15 Emissions and discharges during the template well programme

5.2.15.1 Atmospheric emissions

There are a number of activities during the template well drilling programme that will result in emissions to the atmosphere:

- exhaust emissions from helicopters and support vessel activities;
- power generation emissions from the Dada Gorgud;
- emissions from gas venting of storage vessels, bulk material 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); and
- flaring of hydrocarbons flow for the drill stem tests.

Estimated releases for the duration of the template well programme are provided in Table 5.9 and Figures 5.6 and 5.7, based on the following assumptions:

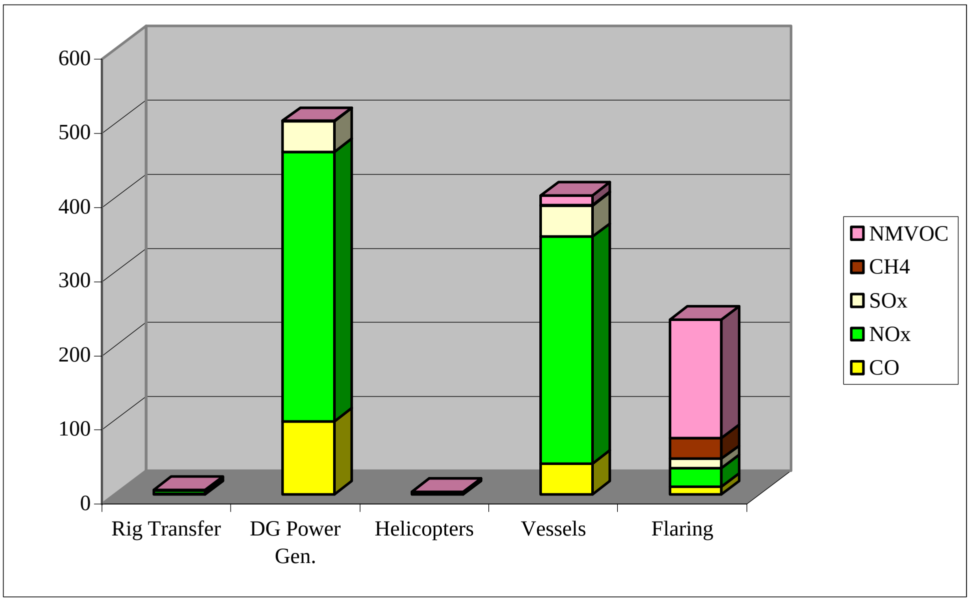
- transfer and installation of the Dada Gorgud will take 4 days to be positioned at the first well drilling site and would require three tugs;
- template well drilling programme duration: 576 days(64 days per well);
- Dada Gorgud daily average diesel fuel consumption of 9 tonnes;

- standby vessel daily fuel consumption of 3 tonnes;
- typical supply vessel daily fuel consumption of 6 tonnes;
- supply vessel trips - 7 return trips per week, return trip duration of approximately 10 hours;
- helicopter fuel consumption of 0.24 tonnes/hour;
- helicopter trips - 4 return trips per week, return trip duration of approximately 1.5 hours; and
- 3 well tests in total for a period of 88 hours, resulting in 32 hours of flaring with a maximum flow rate of less than 10,000 bbl per well;
- Gas to Oil Ratio GOR is 1,100 scf/bbl.

Table 5.9 Estimated emissions to the atmosphere during the template well drilling programme (tonnes)

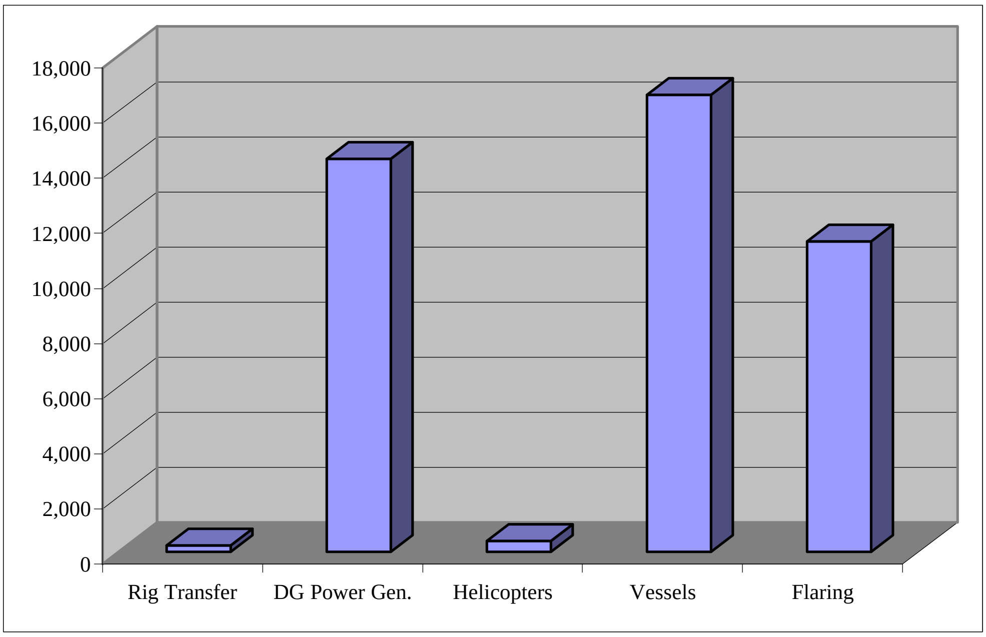
Emissions	Rig Transfer	Power Generation on the Dada Gorgud	Flaring of Hydrocarbons Following Well Testing (3 well tests)	Vessels	Helicopters	Total
CO	1	98	10	41	1	151
CO_2	230	14,256	11,253	16,589	379	42,707
NO_x	4	363	25	306	1	700
SO_x	1	41	12	41	1	97
CH_4	0	1	28	1	0	30
NMVOC	0	0	159	12	0	172

Figure 5.6 Estimated emissions to the atmosphere during the template well drilling programme (tonnes)



Note: gaseous species are combined for presentational purposes only.

Figure 5.7 Estimated CO_2 emissions during the template well drilling programme (tonnes)



5.2.15.2 Discharges to the sea

The estimated discharges to the sea during the template well drilling programme include:

- a total of approximately 7,335m^3 cuttings and WBM from the surface hole 36" hole section and 26" hole section for 9 wells;
- a total of approximately 65 m^3 of drill cuttings from the pilot hole drilling;
- cooling water at 600 m^3/hr;
- sewage waters;
- drainage water; and
- food waste.

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 of black water and 0.22 m^3 per day of grey water. The estimated volumes of sanitary waste discharged to the sea during the template well programme is given in Table 5.10. These figures are based on a total template well drilling period of 576 days with 120 personnel on board the rig and 15 on board the supply vessel

Table 5.10 Estimated amounts of sanitary waste discharged to sea during the template well drilling programme

Parameters		Dada Gorgud	Support Vessels
Grey water (m^3)	Per day	26	3.3
	Total	14,976	1,900
Black Water (m^3)	Per day	12	1.5
	Total	6,912	864

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5.3 Platform drilling

Once the Production Drilling and Quarters (PDQ) platform is installed over the template, drilling will continue from the platform. The combined facilities onboard the PDQ are described in detail in Section 5.4. The drilling facilities and platform drilling programme are described here.

The drilling facilities will be housed on the upper deck area of the platform topside and will comprise of the derrick equipment set, complete with substructure, incorporating the BOPs. The whole derrick equipment set will be mounted on a skidding arrangement to permit access to any of the 48 well slots. The derrick will be centre-mounted and sized to accommodate the topdrive and the full drill string required for drilling operations as well as all the mechanised tubular handling equipment. The drilling service module will comprise a pipe rack with a racking arrangement to accommodate drillpipe from 3 ½" to 6 $^5/_8$" outside diameter, and conductor casing up to 30" in diameter. The drilling service module will accommodate mud storage, pumps, cementing, dry bulk storage and main switch room. The physical interface between the PDQ topside and the drilling modules will be a flat, open deck. Overboard lines, caissons, stairway access/escape routes to and from the rig will be included as part of the derrick equipment set and drilling support module. . Drilling bulk fluid storage will be on the lower deck level.

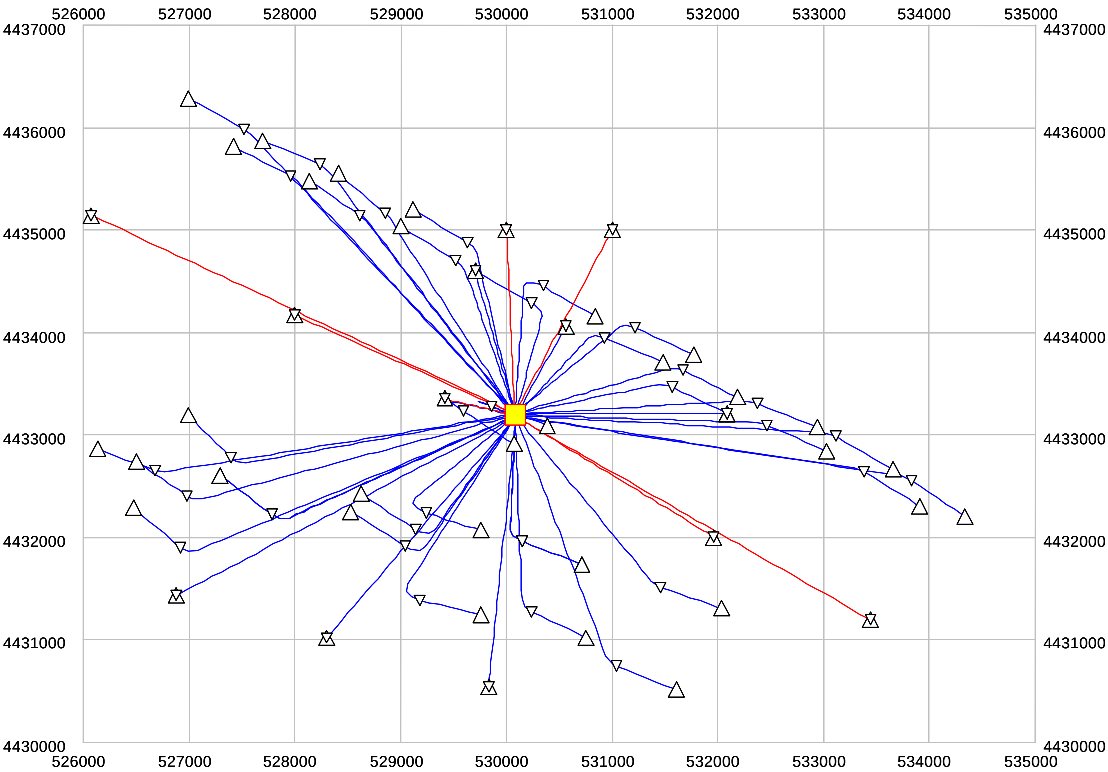
Once the platform is installed and commissioned, the cuttings re-injection well (CRI), drilled during the template well drilling programme, will be tied back to the platform, followed by four of the template wells (Section 5.2.1) which will then be completed. The 8$^1/_2$" hole section will then be drilled on the four remaining template wells and completed, assuming they have not been drilled through the reservoir before platform installation. Drilling will then begin on the remaining platform wells. Up to 48 wells may be drilled for Phase 1 (including the nine template wells); these wells will consist of oil producers, gas injectors, water injectors and CRI wells. The maximum number of each type of well for Phase 1 is shown in Table 5.11. It should be noted that this is the base case design and may be subject to change. In addition, it should be noted that the number of wells shown in Table 5.11 does not total 48. As the reservoir is developed the service of each well will be assessed and optimised to give best value. For instance, some gas injection wells may first be producing wells for a period of time before they are converted to gas injection service. The drilling schedule for the platform wells is currently under evaluation and will be finalised following the results of the template well programme.

Table 5.11 Phase 1 wells

Total number of well slots:	**48**
Total number of producing wells:	43 max
No. of gas injection wells:	10 max
No. of water injection wells:	12 max
No. of CRI wells:	2 max

The potential bottom hole location and reach of the wells from the central PDQ position is shown in Figure 5.8.

Figure 5.8 Bottom hole location and reach of Phase 1 wells



5.3.1 Platform drilling operations

The planned platform well drilling design will be similar to the template well programme however there are some differences already incorporated into the well design including:

- driving or hammering the 30" conductor for the surface hole section and drilling out; and
- drilling the 26" hole section using seawater as a drilling fluid with viscous sweeps using bentonite clays to remove cuttings instead of a WBM system.

For the top hole sections batch setting of the conductor and batch drilling is under consideration. Batch drilling involves driving/hammering the 30" conductor for each well consecutively, and then drilling 26" holes consecutively, instead of constructing the top hole sections for each well sequentially.

Drilled cuttings from the 26" hole section will again be returned to the surface and discharged to the sea following separation from the drilling fluid. Discharge from the platform will be at a depth of 97 m below the sea surface. At the time of writing, the mud programme for the platform wells is the same as that presented for template well drilling, although this may be subject to change after receipt of operational data from the template drilling programme.

The estimated cuttings and mud discharge volumes are shown in Table 5.12.

Table 5.12 Estimated cuttings discharge, platform well drilling

Hole Section (in)	Section Length (m)	Drilling Fluids	Cuttings Generation		Mud Generation		Total Volume/ Section (m3)
			Cutting Volume (m^3/hr)	Cuttings Volume (m^3)	Mud Volume (m^3/hr)	Mud Volume (m^3)	
36/30	150	Seawater	35.90	180	71.81	359	539
26	350	Seawater	9.86	173	5.92	104	276
Total Discharge per well				353		463	**815**
Total Discharge (39 wells)				13,767		18,057	**31,785**

The 16" and 12 ¼"hole sections will be drilled with a NWBM system similar to that used for the template wells.

As with the template well programme, the 8 ½" section will be drilled with careful selection of a drilling mud to minimise swelling of the sensitive shale sediments and this mud is likely to be a barite weighted viscosified brine based mud.

All cuttings will be separated from the muds and sent to the cuttings re-injection system for disposal. The amount of cuttings generated from these hole sections is shown in Table 5.13.

Table 5.13 Estimated cuttings and mud generation volumes from the 16", 12 ¼" and 8 ½" platform well sections

Hole Section (in)	Section Length (m)	Drilling Fluids	Cuttings Generation		Mud Generation		Total Volume/ Section (m^3)
			Cutting Volume (m^3/hr)	Cuttings Volume (m^3)	Mud Volume (m^3/hr)	Mud Volume (m^3)	
16	750	NWBM	2.35	118	1.41	71	189
12 ¼	1440	NWBM	2.10	121	1.05	60	181
8 ½	600	Acid soluble carbonate or viscosified brine	1.01	24	0.40	10	34
Total per well				263		141	**404**
Total (39 wells)				10,257		5,499	**15,756**

5.3.1.1 Cuttings re-injection

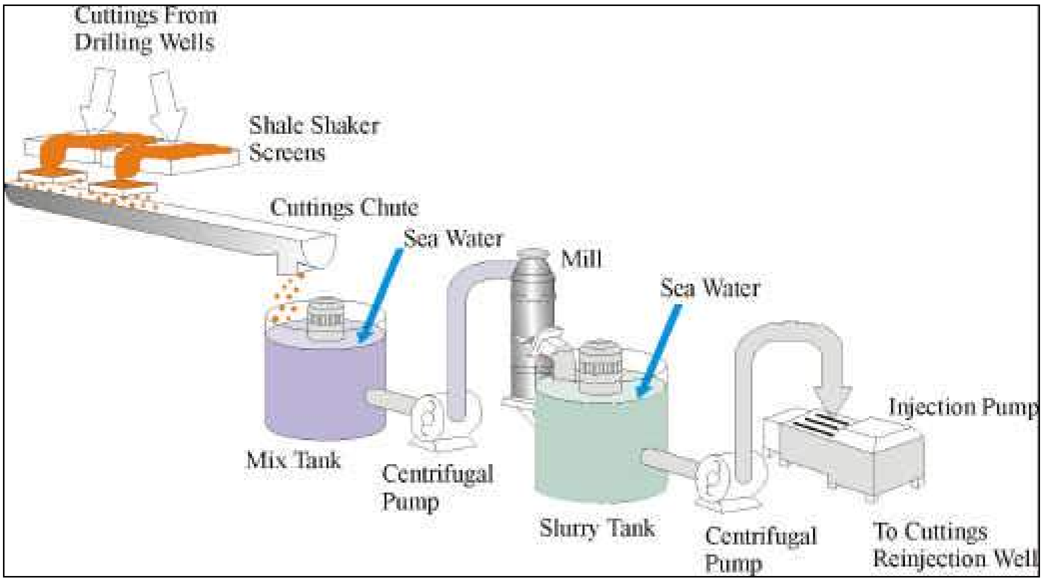
There will be no discharge to sea of cuttings generated from drilling operations with NWBM below the 26" hole sections. The design base case for the disposal of these drilled cuttings is re-injection into a dedicated disposal well by the use of a cuttings re-injection (CRI) facility. There is provision for two platform slots for dedicated CRI wells. Facilities will be provided on board the PDQ to collect, treat, store and inject NWBM cuttings from the 16", $12^1/_4$" and 8 ½" hole sections as well as used drilling muds, produced sand and other wastes, as agreed. Considerable work has been undertaken on this method of cuttings disposal, with the emphasis on ensuring that there are no losses or complications to operations, once the cuttings have been injected into the subsurface geology. CRI is an industry standard approach to cuttings disposal and BP have successfully undertaken up to 40 deep CRI applications world-wide. CRI is generally undertaken in mudstone or shale rich formations. The planned target for the injection of the drill cuttings in the Azeri field is the Sabunchi shale formation, which is present between depths of 2,001 – 2,350 m below rotary table.

Prior to re-injection, the cuttings will be transferred from the shale shakers to a slurrification unit on the rig for processing prior to injection. The slurrification process involves milling the cuttings to a mean particle size of about 300 microns (0.3 mm), or less, in the presence of water, usually seawater. Small particle sizes are necessary to prevent blocking of either the re-injection annulus or disposal fracture in the near-well region. It is anticipated that a viscosifier, oxygen scavenger and/or biocide will be added to the slurry to improve its handling characteristics and to minimise corrosion.

On completion of the slurry conditioning process, the resulting waste slurry is pumped into sub-surface fractures created by injecting the slurry under high pressure into the disposal formation. The sub-surface fractures are initially created by injecting a slug or a pad of water. Once the fracture has been created, its size and geometry will be controlled by the down hole flow rate, injection pressure and the properties of the injected slurry. Waste slurry can be injected either continuously or intermittently in batches.

If practical, cuttings will be injected in batches which promotes the development of a more compact domain of smaller multiple fractures close to the wellbore. The batch process consists of intermittent injection of roughly the same volumes of slurry and shutting-in the well after each injection. This allows the disposal fracture to close onto the waste and to dissipate any build-up of pressure in the disposal formation. The presence of the cuttings within the fracture will increase the pressure at which the fracture will theoretically close. As a consequence of this higher fracture closure pressure and dependant on the tensile strength of the rock, a further re-injection will create a new fracture at a slightly different direction. This process can continue to create a network of induced fractures radiating out from the wellbore. Batch sizes may range from 75 to 4,000 barrels and are dictated primarily by the volume of the slurry holding tank and the cuttings generation and slurry injection rates. Each batch injection may last from a few hours to several days, depending upon the batch volume and the injection rate. Injection rates are usually 2 to 10 barrels per minute.

Figure 5.9 CRI process



If at any time the CRI unit is unavailable during drilling of the hole sections below the 26” section the cuttings will be contained and transported to shore for treatment and disposal. Excess NWBM drilling muds will also be transported to shore for treatment and re-use or disposal.

5.3.1.2 Cementing

As with the template wells casing will be run following the drilling of each hole section down to the $8^1/_2$" hole section and secured into place by cementing. The 30" conductor is driven and will not need to be cemented into place. The cementing programme for the platform wells will be finalised following the results of the template well drilling programme.

5.3.1.3 Well Logging

Wells will be logged as required during the platform drilling programme using the methods as described in the template well drilling programme (Section 5.2.6).

5.3.2 Drilling hazards

Drilling hazards and mitigation measures adopted to counter these hazards were discussed in the template well drilling section (Section 5.2.8). Similar mitigation measures to counter drilling hazards during platform drilling will be adopted, however these may be modified following the results of the template well programme and through improvements in technology. Likewise, contingency chemicals used for the drilling programme will also be selected following the results of the template well programme.

5.3.3 Well completion

After each well is drilled to a total depth it will be completed and hydrocarbon flow stimulated. Completion operations begin with circulating a clean completion fluid that will displace the mud remaining in the hole. The wells will be completed 'open hole', that is, no casing will be run for the $8^1/_2$" hole section. A gravel pack liner will be installed, then gravel will be circulated around the liner for sand filtration purposes. Completion tubing for flow of oil from the reservoir to surface will then be installed.

The cleaning or pre-flush fluids 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. Based on the defined average well it is estimated that there will be 1,000 bbls of completion fluids used in each of the development wells. All completion fluids will be contained at surface and backloaded to shore for re-cycling excepting 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.

Based on sand production experience at Chirag-1 wells, down hole sand control is required for all wells, with open-hole gravel packs (OHGP) as the base-case choice of sandface completion for all well types. The gravel pack installation may be sequenced as follows:

- run a cleanup assembly, displace casing to filtered brine;
- run screens into the open hole and circulate mud in open hole to a level above the screens;
- activate the crossover type tool, circulate above the screens; and
- perform gravel pack and isolate the formation.

The drilling fluid used for the $8^1/_2$" hole section will also coat the well bore, the gravel pack will contain an enzyme system that destroys this coating, allowing oil from the reservoir to flow up the completion tubing and onto the platform.

5.3.4 Emissions and discharges during the platform drilling programme

The PDQ utililities including all support vessels, helicopters, power generation, cooling water, sewage treatment and drainage utilised during the platform drilling programme are common to both the drilling and production operations.

Emissions and discharges that are unique to the drilling programme include atmospheric emissions from the CRI pump and the discharge of drilled cuttings from the 30" surface hole and 26" hole section. These are summarised below.

The CRI pumps are electrically driven, hence the atmospheric emissions generated from the operation of the CRI pumps from their power requirements would amount to approximately 144 tonnes of CO_2 for 39 wells, all other gas species emissions would amount to less than 1 tonne for the entire platform well programme.

The cuttings and seawater based muds that will be discharged from the 30" surface and 26" top-hole sections during the platform drilling programme will amount to 31,785m^3 for 39 wells.

5.4 Offshore platforms

5.4.1 Overview of the Production, Drilling and Quarters Platform (PDQ)

The PDQ jacket and topsides will be assembled onshore (Section 5.5) before transportation to the offshore location for installation. The topsides will have a centre-bay design, which will enable installation onto the fixed steel eight-leg jacket using a float-over method.

The platform will contain 48 well slots, the topsides will consist of an extended wellbay plus two end-modules, with two main deck levels comprising facilities for drilling, production, accommodation and all platform utilities. It will also provide pumping facilities for all Chirag-1 oil production.

Drilling facilities will be mainly housed on the upper deck level and have been described in Section 5.3. The completed wells will be tied back to the wellbay, which houses the Wellheads and Xmas trees on the lower deck.

The production separator module will be housed on the upper deck level and will contain two HP separators, two LP separators and one test separator. The two 50% separation trains will be designed for a maximum 200,000 bpd liquid each, 400,000 bpd total. Within this module there will also be space and weight considerations for a second (future) test separator, identical in size and duty as the first test separator. Chemical tote tanks will be stored on top of this module. Oil transfer to the subsea pipelines will be via three electrically driven oil booster pumps and three electric driven Main Oil Line (MOL) pumps housed in the lower deck.

A flash gas compressor cantilever deck, containing a single flash gas compressor, suction drum and discharge cooler will be housed on the upper deck. This cantilever will also house the main oil and gas pipeline export pig launchers along with the fuel gas treatment package and the sand separation package. Additional space and weight allowances will be available on this deck for a second compression package to be installed in the future; as well as space and weight considerations for the future 100,000 bwpd produced water treatment package. This will consist of two 50,000 bwpd trains and the proposed installation date for water compression is scheduled for 2008. Further gas compression installation is anticipated around 2010.

Living quarters with accommodation for 200 personnel on a permanent basis, will include the platform control room and the helideck sized large enough to land the Sikorski-76, Sikorski-61 and Mil8 MTV helicopters. The living quarters will have the ability to accommodate an additional 100 personnel on a temporary basis to support offshore hook-up and commissioning activities.

Two cranes will be housed on the topsides one to the north and the other to the south, the platform flare boom will be 90 m high and inclined to extend from the north of the platform.

The utilities module will be housed on the lower deck and will contain two fire pumps, two seawater lift pumps, seawater treatment package, two potable water makers, single potable water storage tank, instrument air receiver, emergency power generation package, workshop and sewage treatment package. Four lifeboats will also be housed on the utilities module.

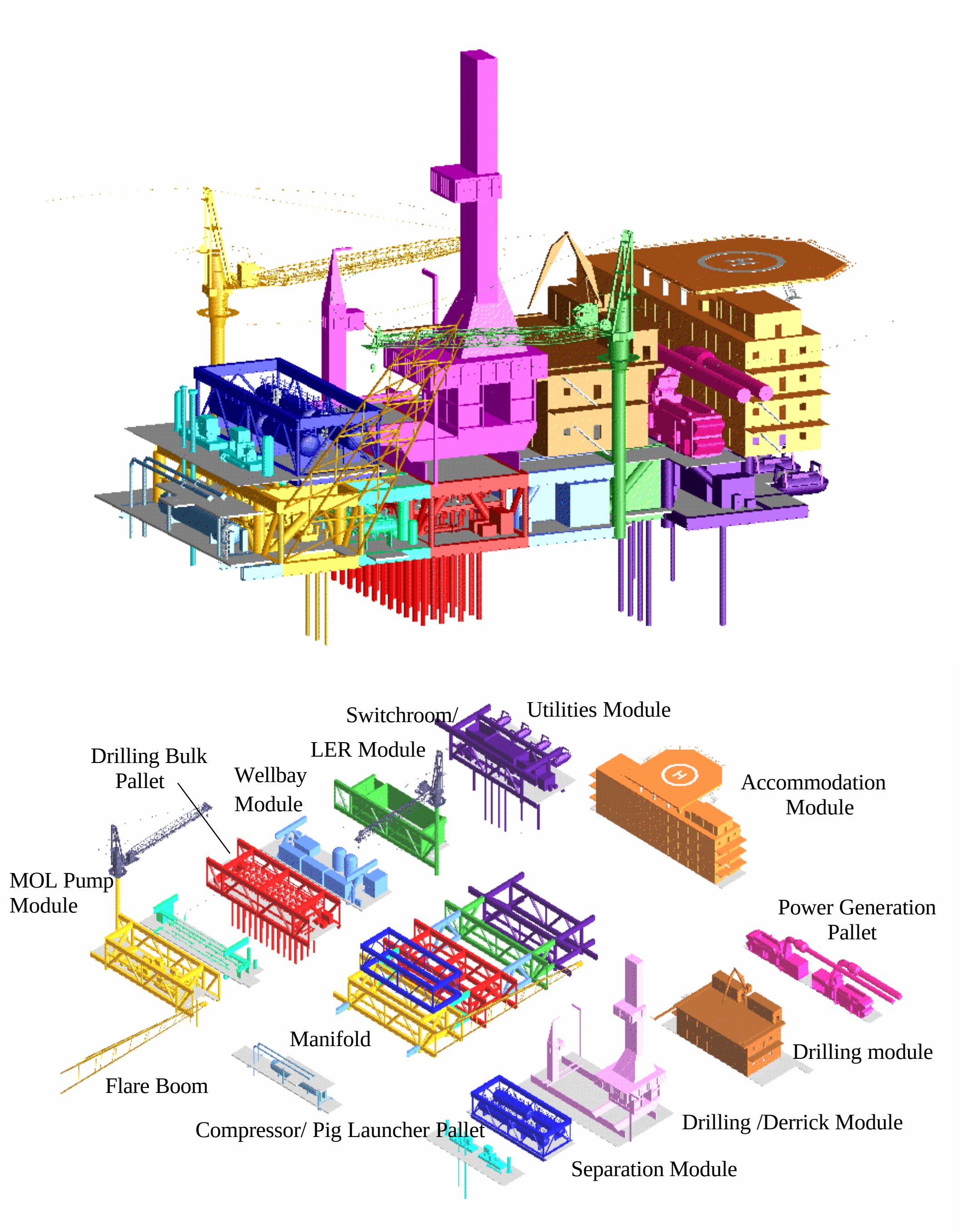
The main power generation package will be situated between the accommodation and the drilling support module and will consist of two turbine driven power generation packages, including all inlet and exhaust ducting.

The topsides will also contain a mezzanine deck housing a laboratory and heating, ventilation and air conditioning plant.

A single boat landing will be installed on the southeast top of jacket area. Ladder access to the sea will be provided on the jacket legs opposite of the boat landing. In order to protect the platform well conductors from vessel impact, protection will be installed onto the jacket north and south faces after topside installation to prevent vessel collision with the well conductors. These protection devices will fill the gap left in the jacket as a result of the float over installation barge clearance requirements

A blow up diagram showing the PDQ topsides facilities and modules is shown in Figure 5.10.

Figure 5.10 PDQ facilities



5.4.2 Overview of the Compression and Water Injection Platform (C&WP)

The C&WP will provide the facilities to compress the gas produced from both the PDQ and Chirag-1 platforms for re-injection into the reservoir for pressure maintenance purposes. The C&WP will also provide the seawater treatment and water injection pumping equipment required to support the Phase 1 production expectations.

In addition to supporting the Phase 1 facilities, the C&WP topsides will be sized to support all future facilities to supply gas injection and water injection requirements for full Azeri field development (ACG Phase 1 and Phase 2) as well as an export gas compression package sized for 250 MMscfd, a second power generation package and a second platform crane. Ultimately, the platform will be capable of supporting gas injection compression machinery for 920 MMscfd and water injection machinery for 900,000 bwpd. The C&WP will also serve as the water supply platform for all water injection needs for the full Azeri field. The supplied water will be in the form of a mixture of seawater and produced water.

As with the PDQ, the C&WP jacket and topsides will be assembled onshore (Section 5.5). All equipment will be installed on the topsides in such a manner as to allow for the float over installation onto a fixed steel eight-leg jacket.

At the time of writing the final design of the C&WP was under review. The following presents a summary of the components at present.

The lower deck level will house the Phase 1 pig receivers and an associated gas process pallet consisting of the Chirag-1 gas pipeline slug catcher, gas dehydration package and cooling medium pumps and coolers. The C&WP flare and platform crane will be structurally attached at this location. The utilities pallet containing the main power generation package, the emergency generation package, the air compressor package, the inert gas generation package, the LP flare drum and the HP flare drum will also be installed on the lower deck. Adjacent to the utilities pallet will be the switchgear pallet and the seawater pallet containing the seawater treatment equipment, chemical injection package and the seawater lift pumps.

The primary and secondary compression modules will be housed on the upper deck level. The primary compression module will contain two turbine driven gas injection compressors. The secondary compression module will contain the dedicated Chirag-1 gas compressor, the high pressure gas coolers and the fuel gas package. A water injection module containing one turbine driven water injection pump package will also be housed on the upper deck.

Future equipment for full Azeri field development will be located to both the east and west of the Phase 1 equipment, and provisions will be included into the design to allow the future installation of this equipment either as part of the float over or as future lifts.

The current Phase 1 Project requirements on the C&WP are based on the following:

- 24" Gas riser (from Chirag-1);
- 24" Gas riser (to main gas export pipeline pre-installed wye);
- gas compression for the Chirag-1 gas for a total of 125 MMscfd;
- gas injection compression facilities for a total of 350 MMscfd;
- gas dehydration facilities for 475 MMscfd;
- two 12" J-tubes (one for a fibre optic cable and one for future use); and
- seawater treatment and water injection pumping facilities for 225,000 bwpd.

Phase 2 requirements will include:

- a second gas injection compression package sized for 350 MMscfd;
- a seawater treatment and water injection package sized for 775,000 bwpd;
- 20" Gas riser (from West Azeri);
- 20" Gas Riser (from East Azeri);
- 8" Produced water riser (from West Azeri);
- 8" Produced water riser (from East Azeri);
- 18" Water injection riser (to West Azeri); and
- 24" Water injection riser (to East Azeri).

Currently envisaged Phase 3 requirements include:

- 30" Gas riser (to new 30" gas export pipeline);
- gas export compression package for 250 MMscfd; and

All risers (for Phase 1 and future phases of development) will be installed on the C&WP jacket in the fabrication yard prior to jacket installation.

5.4.3 Offshore platform construction and installation

5.4.3.1 Introduction

This section describes the construction, assembly, commissioning and installation of the Phase 1 offshore facilities. At the time of writing this document, the contractors for the construction of the PDQ and C&WP jackets and piles, the subsea template and the PDQ topsides had just been selected and it has been estimated that approximately 4,000 people will be employed for the offshore elements of Phase 1. Employment will gradually build up from January 2002 to September 2002, when it will continue at peak levels until February/March 2004. The entire 4,000 strong workforce will not be on site at any one time with the exact number of workers on site varying over the construction period. It is known that the contractors for the offshore construction propose to source between 70 and 80% of the required personnel within Azerbaijan. It is also understood that the offshore construction contractor will only source labour from the international market where the national labour force cannot supply the skills required for the programme.

Many of the components for construction of these facilities will be pre-fabricated overseas and transported to Azerbaijan for assembly. The site selected for assembly of both jackets, the piles, the subsea template and the PDQ topsides was the Shelfprojectstroi (SPS) yard some 20 km south of Baku and 7 km and 15 km north of Primorsk and Sangachal village respectively (Figure 5.11). At present it is unknown where the C&WP topsides will be assembled.

5.4.3.2 The Shelfprjectstroi (SPS) yard

The SPS yard was opened in 1981 and was fully operational for 6-7 years. The site is owned and operated by SOCAR and has only been used at a very low capacity over the last 10 years, during full operations it has been reported that up to 15,000 people worked at the yard.

The site covers an area of around 150 ha and is bounded to the west by the main Baku to Astara highway and to the east by the Caspian Sea.

The yard has four skidways and piers, fabrication workshops, warehousing and storage areas. The SPS yard was chosen for the in-country offshore facility construction activities because it has a past record and experience of building jackets and the yard has considerable facilities for these activities. The advantages of the SPS yard is that it is located alongside open water with water depths of 11 m allowing access for sea-going vessels. A protected quayside to the south has a five berth allocation and excellent load-out facilities. Rail tracks for material transfer are also available at the site. In addition, the yard has previous experience of jacket fabrication and a skidway system suitable for moving heavy loads. There is also good craneage at the site. To the south of the site and in close proximity to the quayside is the current BP operations supply base.

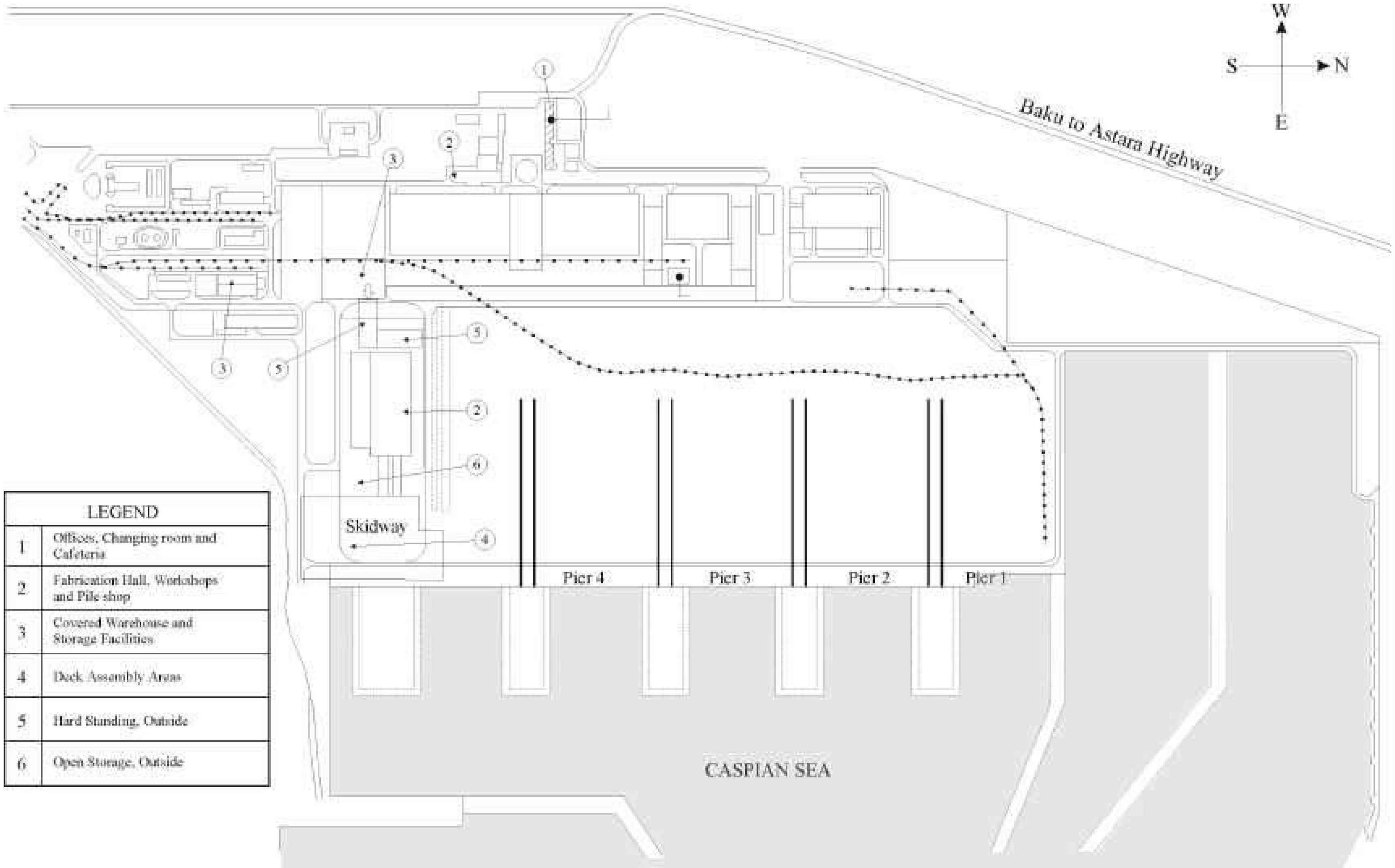
One alternative that was considered is the Zykh yard. However, the Zykh yard is considerably smaller than the SPS yard and has fewer facilities. The facilities available also meant that the load-out method would have led to a different specification for jacket design and this would have had cost implications. The yard would also have required more upgrade than is required at the SPS yard.

Prior to any construction activities the SPS yard will require the following upgrade work:

- access road upgrade;
- security fencing and gates;
- preparation of skidway, quay and laydown area;
- quayside bollards and wall;
- cast skidway blocks;
- new offices;
- toilet units and refurbishment;
- refurbish warehouse;
- refurbish office block;
- external utilities (sewage system, water supply, gas system);
- substation at erection area;
- canteen facilities;
- accommodation camp;
- perimeter light bases;
- hardstandings for clinic, workshop, maintenance shop, training centre and rigging store;
- levelling and grading of the area selected for the PDQ topsides assembly.

It should be noted that yard upgrade activities are not within the scope of this ESIA.

Figure 5.11 Schematic of the SPS yard



5.4.3.3 Drilling template

The 12-slot drilling template will be fabricated, assembled, painted, tested and commissioned between late 2001 and mid 2002. Assembly, painting, testing and commissioning will take place at the SPS yard.

5.4.3.4 PDQ and C&WP jackets assembly

The PDQ jacket will be constructed before the C&WP. As the jackets are essentially the same the C&WP jacket will be constructed in a similar manner. Experience and lessons learned during the PDQ jacket construction will be used for the C&WP construction programme. Construction work on the PDQ jacket is planned to start in early 2002 and will continue through to load out and sea/fastening in March/April 2004. The C&WP platform should be completed approximately one year after this.

To construct the jackets, pre-fabricated plate and rolled tubulars of various lengths will be supplied from Europe (Germany or Italy) and Japan. These components will be fitted together at the SPS yard and the legs welded out, risers and caissons fitted, then the jackets will be painted, tested and commissioned before transfer to the transportation barge.

Twelve jacket piles are required for each jacket. Each pile will be supplied in sections and assembled and painted at SPS before jacket tow-out.

There is currently a jacket standing on the skidway required by the contractor for jacket construction and this existing jacket will be removed by cutting it into smaller sized components. There will be little waste generated during this activity since the materials of the structure will be given back to their owner, SOCAR, and stockpiled at the SPS yard. The methodology for performing this work is the same as that described in the decommissioning section (Section 5.9) and the methods and practices that are to be used will follow tried and tested methods used on construction sites internationally. The issues regarding safety associated with the deconstruction of a large steel structure will be of paramount importance. Accepted work practices for such work will be followed.

5.4.3.5 Topsides construction

The PDQ topsides will comprise a number of modules and components assembled to form the integrated deck. Many of the topsides modules and components will be transported to Azerbaijan from overseas to be loaded onto the deck.

Construction of the topsides will begin by assembling the main structural frame from box-plate girders and tubular supports. The frame will then be lifted onto the load out trusses on skids and rails. Piping and equipment will then be added to the frame and the topsides modules will then be installed by lifting onto the frame to form an integrated deck.
The modules include the following:

- separator module;
- living quarters module;
- control module;
- drilling module;
- flare boom;
- two power generation packages; and
- loadout and transportation frame (not part of the permanent installation).

The majority of the modules and equipment will have been tested prior to arrival, but will be tested and commissioned following hook-up to the deck.

Prior to loadout the deck will be jacked up and the loadout support frame will be skidded into position, once in position the deck will be lowered onto the loadout support frame.

5.4.3.6 Commissioning

As the platform topsides are constructed the utility and process equipment will be installed and secured in place with power and piping following until mechanical completion is achieved. On completion of installation, the equipment will be dynamically tested as part of a systematic sequence. It is anticipated that more than 95% of the process and utilities on each platform will be commissioned onshore before the facilities are loaded-out for offshore installation.

Maximising onshore commissioning has the advantage that commissioning wastes such as hydrotest and flushing fluids, lubrication fluids and diesel for power generation can be more safely handled, contained and disposed of as required. Furthermore it means that any replacement parts or alterations required as a result of defects identified during commissioning can more easily be rectified.

The jacket assemblies for the above platforms will be constructed and then subjected to non-destructive testing (NDT) and certified prior to being placed on a barge for installation offshore.

5.4.3.7 Power supply

The jackets construction contractor intends to make minimal use of the existing power supply on site due to the poor condition of the transmission equipment. This contractor will supply all power required for the jackets fabrication with generating equipment that is approved to international standard. It is expected that approximately 1.75 MW of diesel generation will be required for the jackets fabrication.

The topsides fabricator intends to upgrade the power supply currently on site and will not, therefore, require additional generators other than for back-up/emergency use. The topsides contractor will require to draw approximately 0.75 MW from the National Grid.

5.4.3.8 Sewage

It is recognised that the existing sewage facilities at the SPS yard are inadequate. Both the jackets and topsides fabricators propose to install sewage treatment facilities. These are most likely to produce an effluent that can be subsequently added to the municipal sewage handling system. The existing sewage water pump station at the yard will be upgraded to enable sewage water transfer by pipeline.

5.4.3.9 Workforce

A preliminary estimate is that the workforce will comprise the following proportions:

- 85% Azerbaijani Nationals;
- 10% Third Country Nationals (TCN); and
- 5% Expatriates.

It is anticipated that most, if not all, Azerbaijani nationals will live in their own homes while working at SPS. The TCN's and some expatriates will be accommodated in a camp on, or near, the SPS yard. The camp accommodation may either be new facilities or the existing SPS camp, which will need to be upgraded. It is anticipated that the total workforce involved with the construction activities at the SPS yard will reach a peak during 2003.

5.4.3.10 Traffic

There will be a significant increase in traffic volume, including cars, associated with the transportation of this workforce. It has been proposed that mini-buses and coaches be used to help to reduce the total number of vehicles. The issues relating to transportation of personnel as well as transportation of materials are currently under further consideration in a bid to minimise total traffic volumes and this will be an on-going goal for the project team through-out the onshore phase of this project. The estimated number of buses required to transport personnel into the site is likely to be approximately 20 per day.

5.4.3.11 Wastes generated

Wastes generated from the offshore facilities construction will be classified as one of the following categories, segregated and stored in appropriate skips or containers before being sent for disposal:

- non-hazardous combustible solid waste ;
- non-hazardous, non-combustible waste ;
- hazardous solid waste; and
- hazardous liquid wastes.

The types of wastes anticipated during the construction include; empty paint tins, solvent tins, oily rags, grit from sandblasting, cardboard, wood and packaging materials. Table 5.14 sets out the anticipated waste types and volumes.

Table 5.14 Estimated wastes during offshore platform construction and installation

Category/Waste type	Annual Waste Generated			
	<1 Tonne	<10 Tonne	<100 Tonne	>100 Tonne
Non-Hazardous Combustible Solid Waste				
Paper and cardboard			¨	
Wood, packing crates			¨	
Non-Hazardous Non Combustible Solid Waste				
Cable/electrical wire		¨		
Scrap metals				¨
Surplus construction material (concrete, aggregate)				¨
Insulation				¨
Plastic wrapping			¨	
Polystyrene chips				¨
Other metals (nails, solder)			¨	
Hazardous solid waste				
Empty drums				¨
Sand/shotblast materials				¨
Absorbents (spill clean-up)			¨	
Welding flux			¨	
Dessicants			¨	

Category/Waste type	Annual Waste Generated			
	<1 Tonne	<10 Tonne	<100 Tonne	>100 Tonne
Hazardous liquid waste				
Lubricating Oil			¨	
Oil	¨			
Paints	-	-	-	-
Solvents	-	-	-	-
Primers	-	-	-	-

Key: - not estimable

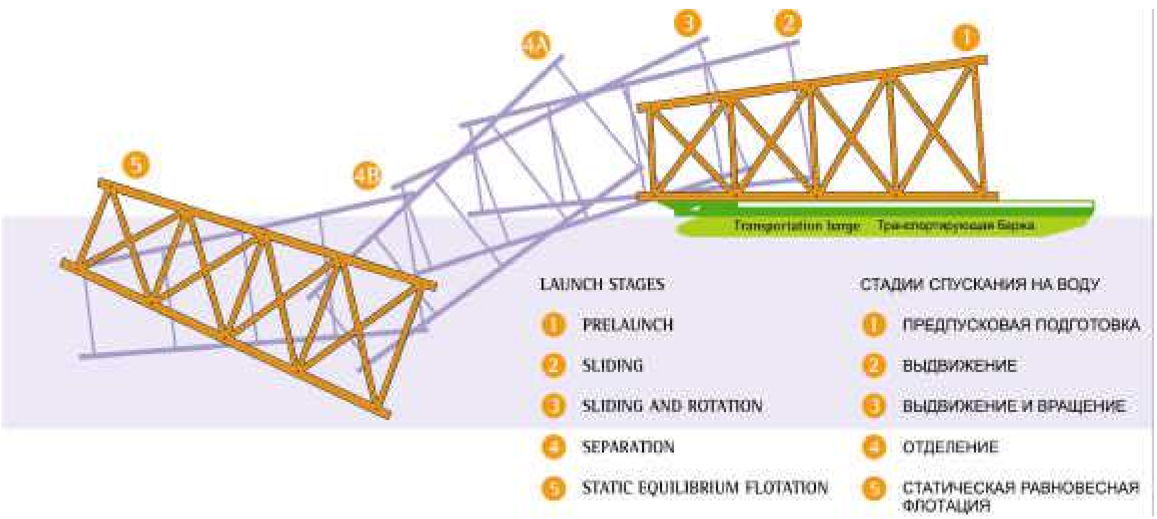
Hydrotest waters used for testing and commissioning of the facilities that contain any additives will be contained. Potential waste disposal routes for these hydrotest waters are under consideration.

5.4.3.12 Installation

Jacket installation

Once fabrication of the jacket is complete it will be skidded onto the transportation barge, STB1. While still on location at the SPS yard, the jacket will be secured to the transportation barge with sea-fastenings. The barge will then be towed to the project development location using three 80 tonne tugs. At a location close to the template location, the barge will be anchored and the sea-fastenings removed. The barge will then be ballasted such that one end of the barge becomes submerged and the platform can be slid off the barge and into the water. The jacket will be fitted with flotation chambers in order to allow it to float above the sea-floor. In this way, the jacket can be manoeuvred into position over the template. With the jacket located in the correct position over the template, the buoyancy provided by floatation chambers will be reduced by release of air and the jacket will be slowly lowered onto the seabed (Figure 5.12). Following positioning of the jacket on the seabed it will be piled into place with twelve piles. The piles will be installed, or driven, by the DBA. The subsea tie-ins between the jackets and the pipelines will be performed from the laybarge, the "Israfil Guseinov". It is anticipated that this vessel will act in the capacity of Dive Support Vessel.

Figure 5.12 Installation of the jacket



5.4.3.13 Topsides installation

The topsides will be towed onboard the STB1 to the development location by three 80 tonne tugs. It is anticipated that two tugs will operate with one remaining on standby. The jacket and topsides have been designed to allow the topsides to be mated with the jacket by means of a float-over operation. This means that the topsides are placed on a transportation barge (STB1) and taken to the jacket as installed. The barge is floated within the structure of the jacket such that the topsides are positioned above their intended installation position on the jacket. The transportation barge is then ballasted down until the topsides reaches and mates with the jacket structure. The topsides structure is then secured to the jacket and the barge is floated from beneath the topsides structure. The barge can then be de-ballasted and removed from the location. Transportation, positioning and installation will take place over a period of 50 days.

Once the topsides are floated out and installed onto the jacket the offshore pipelines will be tied-in to the pre-installed risers on the jacket structure and the jacket riser to the topsides riser/well heads.

5.4.4 Emissions and discharges

5.4.4.1 Construction and assembly activities

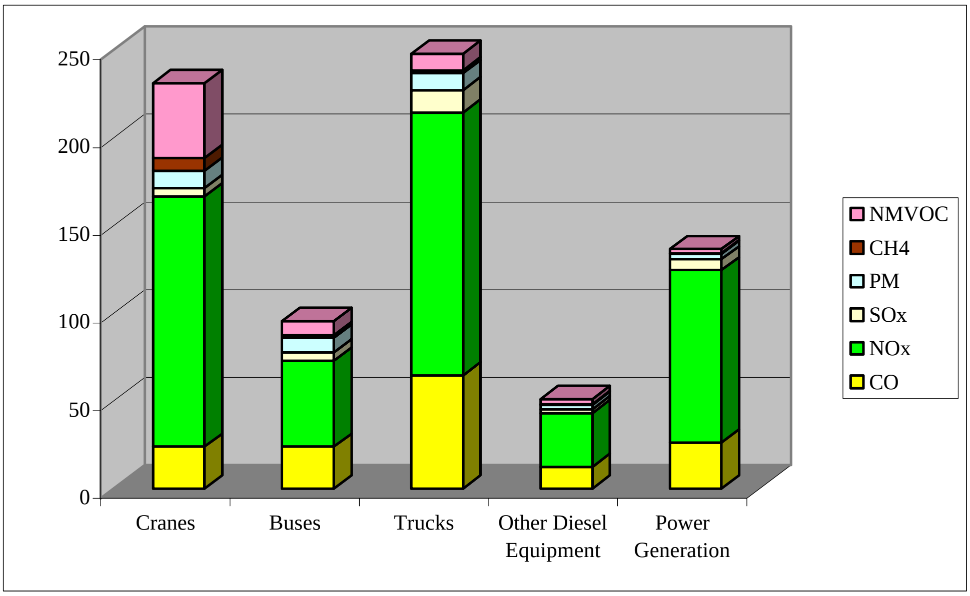
Atmospheric emissions

Estimated emissions to the atmosphere presented in Figures 5.13 through to 5.16 for the onshore construction and assembly of both the PDQ and the C&WP. These emissions are mainly generated by diesel driven equipment such as cranes, trucks and diesel power generators. The emissions were derived on the basis of the following key assumptions:

- the PDQ the work will take place between May 2002-February 2004, however the activity is not expected to last for the whole of this period. Figures 5.13 and 5.14 present a worst case of 22 months of activity;
- the C&WP the work will take place between November 2002 and February 2005 and as with the PDQ, the activity is not expected to last for the whole of this period. Figures 5.15 and 5.16 present a worst case of 28 months of activity;
- A total of 1.75 MW diesel power generation for each of the PDQ and the C&WP;
- The following equipment will be operating daily, for a worse case working day of 12 hours duration, on each of the PDQ and the C&WP;
  - 5 cranes,
  - 20 buses;
  - 10 trucks; and
  - 5 diesel driven compactors.

- It should be noted that the emission estimates for the PDQ and C&WP have been presented separately, however it is possible that these construction activities may partially overlap.

Figure 5.13 Estimated emissions to the atmosphere during PDQ construction/assembly and commissioning activities (tonnes)



Note: gaseous species are combined for presentational purposes only.

Figure 5.14 Estimated CO_2 emissions during PDQ construction/assembly and commissioning activities

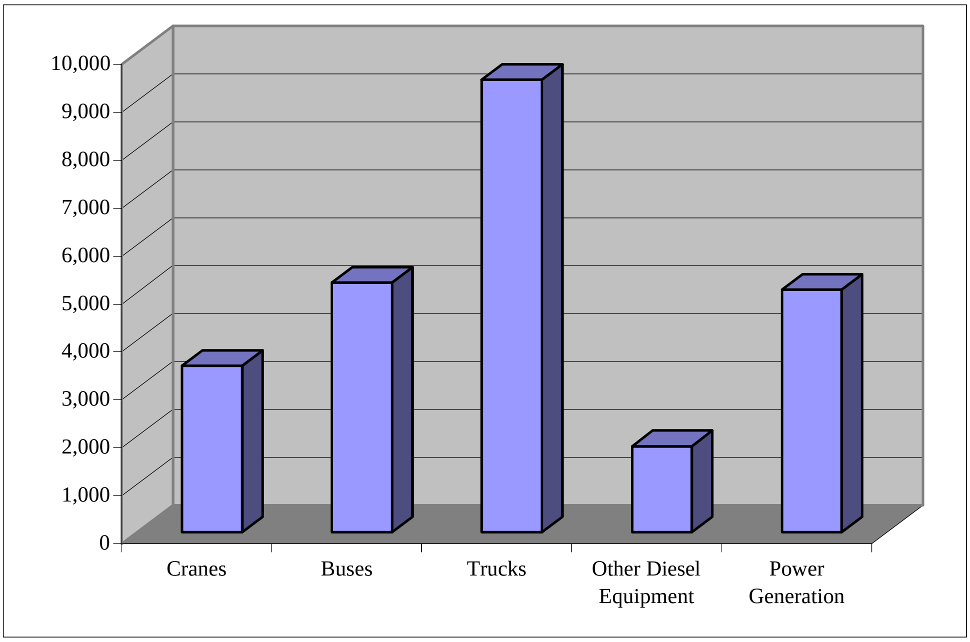
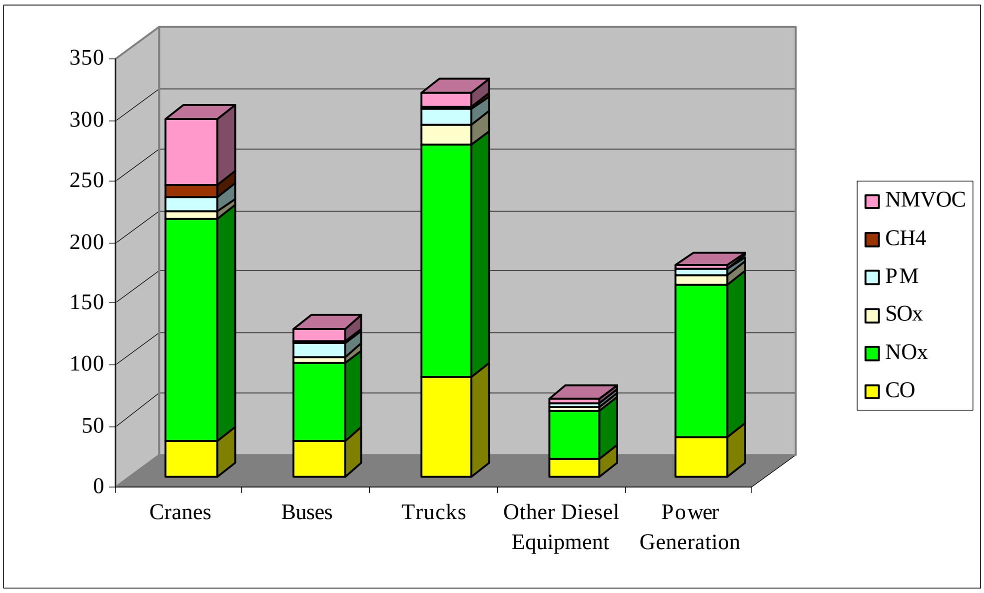
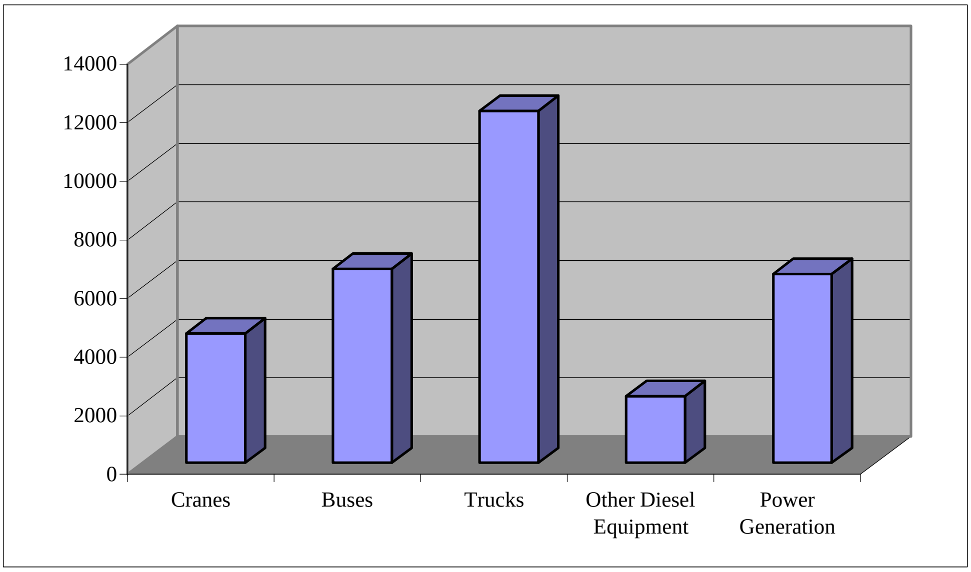


Figure 5.15 Estimated emissions to the atmosphere during C&WP construction/assembly and commissioning activities (tonnes)



Note: gaseous species are combined for presentational purposes only.

Figure 5.16 Estimated CO_2 emissions during C&WP construction/assembly and commissioning activities



Noise emissions during assembly of offshore platforms

The predominant source of noise expected to be associated with the onshore assembly of the platforms at the assembly yard are:

- the operation of heavy plant, hand tools and site vehicles
- delivery vehicles using local access routes
- power generation at the assembly yard

The total number of plant required, by type, was provided as part of this study although neither the sound power level (L_W) nor sound pressure level (L_P) of the listed plant was specified. In the absence of this data, information on the 10m L_{Aeq} (continuous equivalent sound level) was taken from British Standard (BS) 5228 for the listed plant.
BS 5228: 1997 "Noise and Vibration Control on Construction and Open Sites" is the most appropriate standard to follow in this case. It provides a method for the prediction of noise levels from construction work, and provides noise emission data on construction plant and activities.

Where there was more than one type listed in the Standard, the highest noise level or the nearest description to the plant being used as described in the standard was chosen. Several items were not listed in the standard, and consequently no calculations of the estimated noise levels of these items can be made.

The methodology used in the calculations complies with BS 5228. Advantages of this method are that the variations in plant cycle time, interactions between various items of plant during the activity and the consequent overall variation of noise level with time are automatically taken into account.

The calculation procedures take into account the following factors:

- the sound power (or pressure) outputs of the processes of plant;
- the period of operation of processes and plant;
- the distance from source to receiver;

Calculated values have assumed a worst-case operational scenario, i.e. operation of all plant simultaneously, and have not considered:

- the potential for screening by barriers around the construction site; and
- atmospheric or ground-borne attenuation of generated noise.

Other factors such as meteorological conditions (particularly wind speed and direction) and atmospheric absorption may also influence the level of noise received. The estimation of the effects of these factors is complicated, not least because of the interaction between these factors. Generally, at distances less than 50 m, the size of these effects arising from the above factors will be small. Care must be taken when calculating noise at distances greater than 300 m, as air absorption and meteorological factors, and other noise sources may influence the actual noise level.

The data on plant which may operate during the assembly process and estimated noise emission levels (prepared using BS 5228:1997) are presented in Table 5.15.

Table 5.15 Noise emission level of plant

Plant	Sound Power Level (L_W) - dB	Sound Pressure Level (L_P) as 10m L_{Aeq} – dB	BS 5228 Reference
Compactors(x5)	108	80	C3.118
Cranes(x5)	109	81	C6.18
Trucks(x10)	98	70	C7.121
Buses	-	-	No Data available

Sanitary waste

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 listed below:

- the workforce for the PDQ has been estimated at 1,100 and for the C&WP at 1,300
- each construction worker will generate 0.22 m^3 / day of grey water;
- each construction worker will generate 0.10 m^3 / day of black water; and
- BOD at 240 mg/l.

Table 5.16 Estimated amounts of sanitary waste generated during the PDQ and C&WP construction/assembly and commissioning activities

Parameters		**PDQ**	**C&WP**
No. of days		660	840
Grey water (m^3)	Per day	242	286
	Total	159,720	240,240
Black Water (m^3)	Per day	110	130
	Total	72,600	109,200

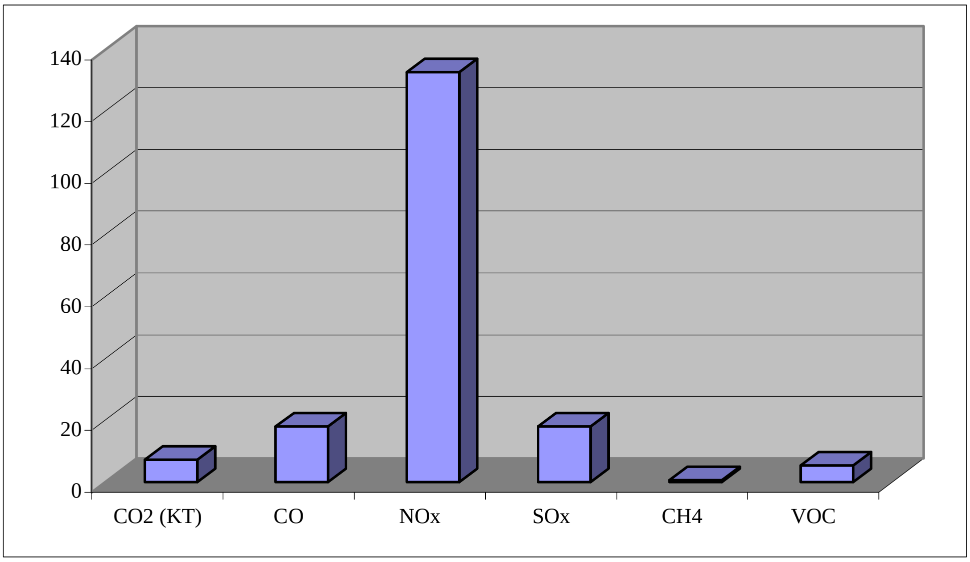
5.4.4.2 Installation

Atmospheric emissions

Atmospheric emissions presented in Figure 5.17 for the installation of the PDQ are mainly generated by diesel driven engines aboard the 80 tonnes tugs. The emissions were derived on the basis of the following key assumptions:

- the duration of the works is expected to be 50 days in total;
- three 80 tonne tugs will be used for towing the flotation barge to the offshore location; and
- each tug has a daily diesel consumption of 15 tonnes.

Figure 5.17 Estimated emissions to the atmosphere during transportation and installation of each platform (tonnes, excluding CO_2 in kilotonnes)



Sanitary waste

Sanitary waste will be generated throughout the duration of the installation activities of the PDQ. The key assumptions for deriving the estimated amounts of sanitary waste generated are listed below:

- a total of 40 boat crew will be involved;
- each boat crew will generate 0.22 m^3 / day of grey water;
- each boat crew will generate 0.10 m^3 / day of black water; and
- the activities will last for 50 days.

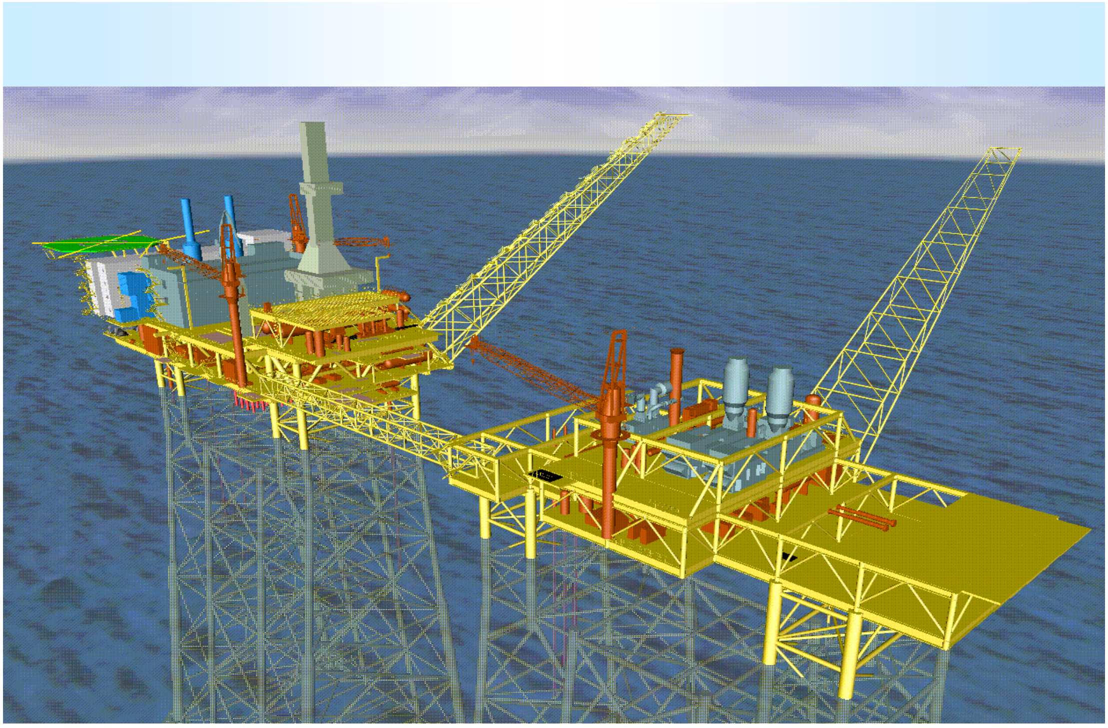
Table 5.17 Estimated amounts of sanitary waste discharged from the the three tugs during the transportation and installation of each offshore platform

Parameters		Sanitary Waste
Grey water (m^3)	Per day	9
	Total	462
Black Water (m^3)	Per day	4
	Total	210

5.5 Offshore production

As discussed, the ACG Phase 1 development will consist of two fixed installations offshore: a production drilling and quarters platform (PDQ) bridge-linked to a compression and water injection platform (C&WP) (Figure 5.18).

Figure 5.18 PDQ (left), bridge and C&WP



It is planned that the PDQ installation and hook-up will be completed by early 2005 and the C&WP will be installed approximately one year later in 2006.

The following section describes the planned operations from these offshore facilities, drilling operations are described in Section 5.3.

5.5.1 Production operations

There will be two trains of well fluid separation on the PDQ. Each will be composed of a two-phase HP separator in series with a three-phase LP separator. Each production well will be connected via a flowline to the production and test manifold on the PDQ. Well fluids will be passed from the wellheads along the flowlines to either the HP or LP production manifolds on the platform. In the early years of field development, all wells will tie-in to the HP manifold. LP manifolds will be brought on-line when reservoir pressure declines and/or produced water breaks through.

Produced fluids that enter the HP separator will be split into gas and liquid (oil/water) phases. Liquids from the HP separator will be passed to the LP separator for further gas removal (and produced water removal when encountered later in well life). Until such time as offshore produced water treatment facilities are installed offshore , all produced water will be sent with the oil to the onshore terminal via the subsea oil pipeline for separation and disposal. The design maximum export water-in-oil content is 5% by volume. When produced water separation facilities are installed, disposal will be via re-injection offshore (see below).

Oil from the LP separator will be pumped to the required pressure level for conveyance to the onshore terminal at Sangachal via a 30" diameter riser and the new 30" pipeline to shore. The pumping system will consist of booster pumps and MOL pumps. Chirag-1 oil will be transported via a new 24" interfield pipeline to the PDQ arriving through a dedicated 24" riser. The Chirag-1 fluid will be routed to the MOL Pump Module where the fluid will enter a common MOL pump suction manifold with the Phase 1 fluids. No further processing of Chirag-1 oil will occur on the PDQ platform.

The split gas stream from the HP separator will be ready for transfer from the PDQ. The gas stream from the two LP separators will be sent to the single, common flash gas compressor for compression to the same pressures as the gas leaving the HP separator. Once equal pressure is achieved, the LP separator gas stream will be mixed with the HP gas stream and transferred off the PDQ. Prior to installation of the C&WP, the gas will be sent via a 24" riser to the 24" subsea pipeline (which is currently in operation conveying oil from Chirag-1 to the Sangachal and will be converted to gas service as part of Phase 1) to the onshore terminal. Part of the produced gas will however, be used on the platform as fuel gas. It is anticipated that future facilities will include the retro-fitting of a second flash gas compressor.

Until the C&WP is installed and operational, separated free gas transported from the PDQ to the onshore terminal will be wet as there will be no gas dehydration facility on the PDQ. To protect the subsea gas pipeline against hydrate formation and corrosion, a methanol injection system will be required to inject methanol and corrosion inhibitor into the gas stream. The chemicals will be added before the gas stream enters the gas riser.

Once the C&WP is operational, all gas received from the PDQ will be passed across the bridge-link for dehydration in a glycol dehydration system. A portion of the dried gas will be sent to the onshore terminal and will depart the C&WP via a 24" riser. The remaining gas will be compressed to injection pressures and sent back to the PDQ for re-injection for reservoir pressure maintenance purposes.

The processes to be carried out on the PDQ and C&WP are shown in Figures 5.19 and 5.20.

The primary export route for gas departing the Phase 1 complex will be from the C&WP which will be subsea tied into the converted 24" gas pipeline. However, the 24" gas riser and pipeline tie-in on the PDQ will remain available following C&WP installation. This results in each of the two platforms being able to flow gas to the terminal and should the C&WP be out of service, gas from the PDQ can still flow to the terminal, although it will not be dehydrated under these conditions. Conversely, the PDQ does not have to be in service to allow gas to flow off the C&WP. This will also ensure that gas can be transported to the terminal from the future Phase 2 Azeri platforms without the Phase 1 PDQ being in service as produced gas from Phase 2 West and East Azeri fields will also be sent to the C&WP for use as injection gas. This gas will be dehydrated on the remote Phase 2 PDQ facilities as there will be no surplus gas dehydration capacity on the C&WP to perform this function.

Figure 5.19 PDQ Process Flow Diagram

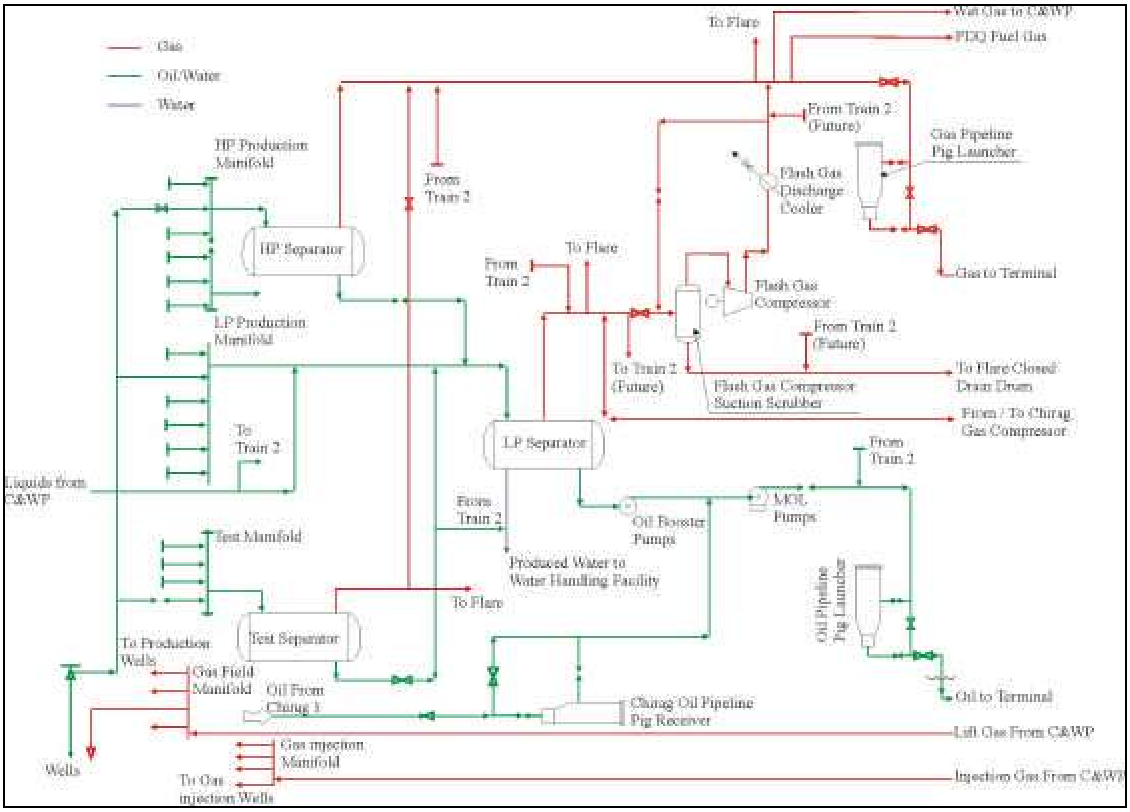
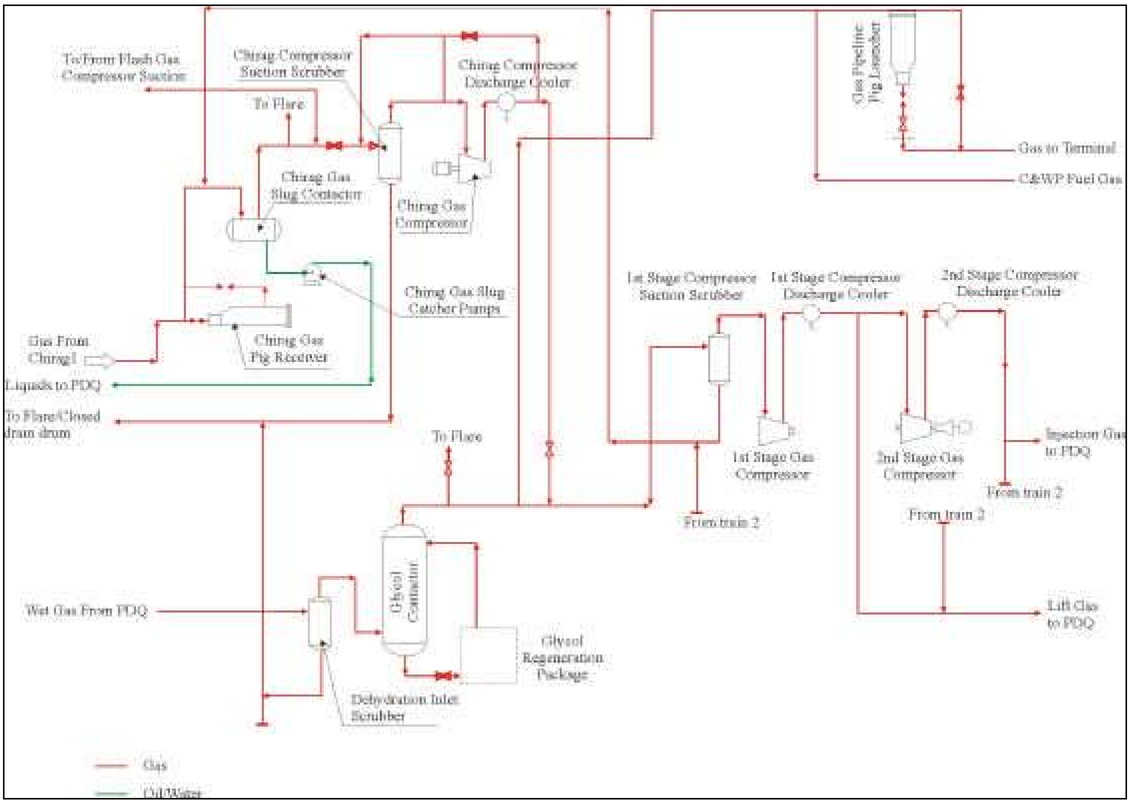


Figure 5.20 C&WP Process Flow Diagram



The C&WP will also host a dedicated gas compressor for gas received from the EOP Chirag-1 Platform. Gas will be received from Chirag-1 via a dedicated 18" gas riser. This gas will be routed to a dedicated slug catcher, and then on to a dedicated gas compressor. Gas discharge from this compressor is at a sufficient pressure to either enter the gas injection compression system or be routed on to the terminal. Gas received from Chirag-1 will have already been dehydrated.

Flow meters will be used for measuring the oil and gas conveyed from the PDQ to the onshore terminal at Sangachal. Accurate offshore metering will also be required for well production allocation, gas flare monitoring, pipeline leak detection and facility material balance calculations.

5.5.1.1 Chemical usage

The injection of some chemicals into the production process will be required to facilitate continuous production, aid the separation process and to protect the facilities equipment from corrosion. AIOC has a policy to select chemical systems of a low known toxicity wherever possible, however under normal operating conditions none of the chemicals used in production will be discharged to the environment. The chemical systems to be used in the production process will be continually evaluated and modified depending on operating conditions. An early list of anticipated chemical usage along with estimated dosing quantities are given in Table 5.18 below.

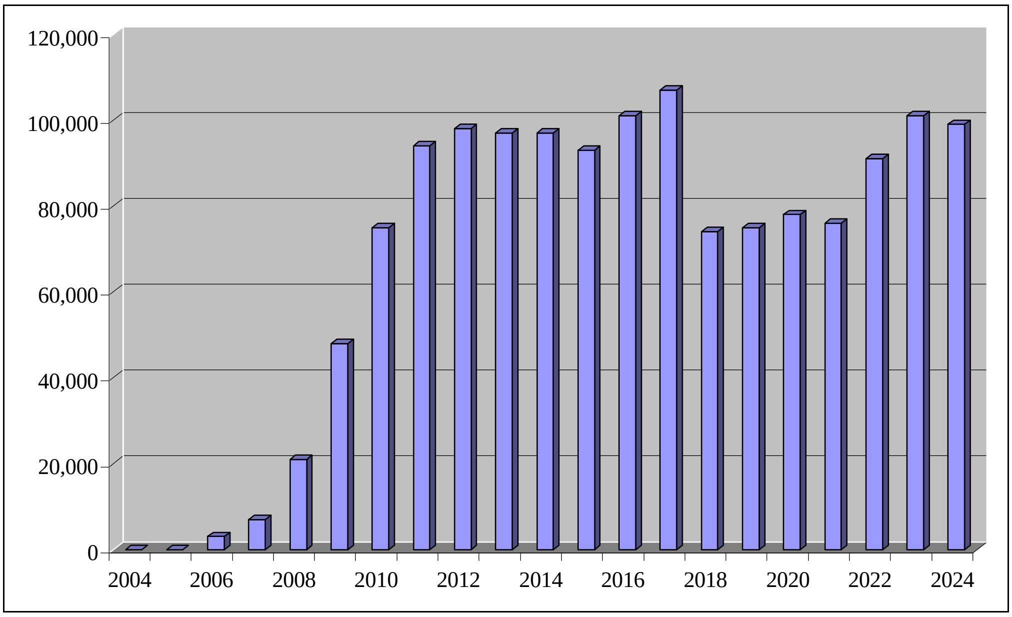
Table 5.18 Estimated production chemical use

Chemical	Estimated Quantity (m^3/day)	Rate
Antifoam (into production manifold)	0.3 - 0.4	Continuous, assuming wellstream fluids have some propensity to foam.
Corrosion Inhibitor (into export oil stream)	0.1 - 0.3	Continuous throughout plant life.
Demulsifier (into production manifold)	1.4 - 2.9	Not until produced water facilities are installed (est. yr 3). i.e. when oil/water separation on platform is started.
Methanol (at wellhead and into gas export)	7.2 - 8.6	For first year only, when gas is exported without dehydration.
Wax Inhibitor / Pour Point Depressant (into production manifold).	0.6 - 0.7	Continuous throughout plant life.
Reverse Demulsifier	0.1 - 0.3	Not until produced water facilities are installed (est. yr 3). Flowrate slowly builds up to design figure as produced water rate increases.
Corrosion Inhibitor (into gas stream)	0.3 - 0.4	For first year only, when gas is exported without dehydration

5.5.1.2 Produced water

Anticipated produced water production rates for the Phase 1 development are shown in Figure 5.21.

Figure 5.21 Phase 1 produced water volume estimates (bpd)



Once the C&WP is installed the base case for produced water disposal is re-injection offshore and therefore there will be no discharge of produced water to the sea under normal operating conditions. The PDQ and C&WP will have provision in the design for commingling all produced water with treated seawater and for pumping of the combined water product to water injection pressure. The produced water will be treated prior to co-mingling with seawater in a produced water treatment package that will be retro-fitted to the PDQ.

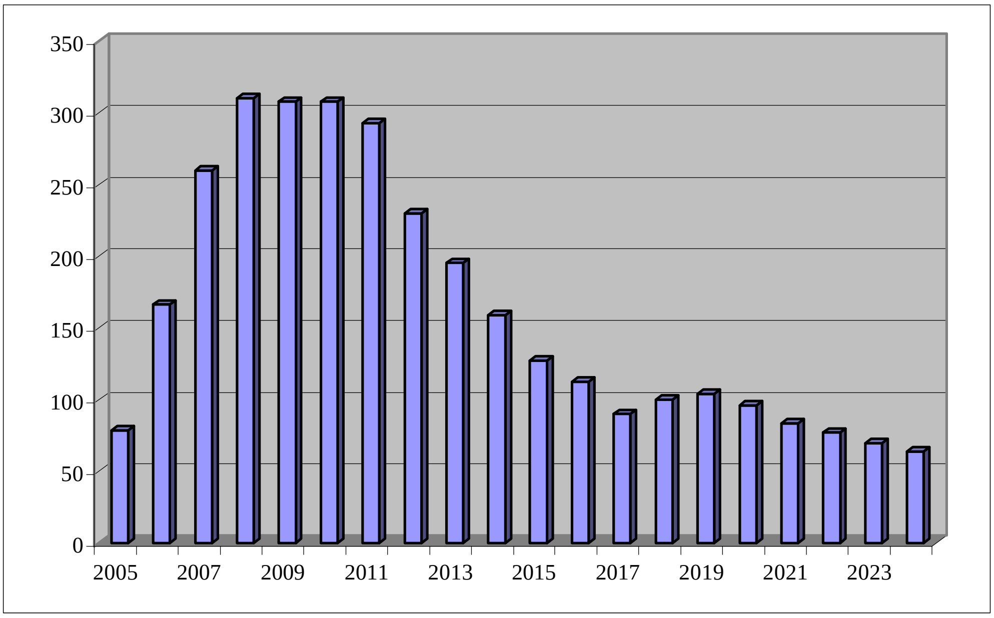
In the event of an upset of the water injection related facilities, the produced water will be released at a minimum sea at a depth of 0.6 m below sea level, to comply with legal standards. IFC Environmental Health & Safety Guideline, Oil and gas Development Offshore, 2000 discharge specifications shall be met (42 mg/l (parts per million) oil in water daily maximum and 29 mg/l monthly maximum average).

5.5.1.3 Produced sand

Produced sand will not be discharged to sea. An online sand removal and concentration system will be installed on the PDQ process separators. The concentrated sand slurry will be sent to the CRI facility for disposal via re-injection downhole. If for any reason the sand cannot be sent to the CRI system, there will be provisions for transferring to ship for transport to shore for disposal.

Based on anticipated sand production volumes of 5 lbs per 1,000 barrels (Figure 5.22), vessel jetting provided on the HP, LP and test separators is expected to be required on a weekly basis. Initially, sand jetting will be done with treated seawater as produced water is not expected to be available on the PDQ for several years. The water will be transferred to the CRI facility for use in the slurrification process and disposal down-hole. The sand handling package will be designed to remove oil from the recovered sand to a nominal level of 1 wt% oil on sand.

Figure 5.22 Estimated produced sand quantities offshore (tonnes per annum)



5.5.1.4 Flaring

Under normal operating steady state conditions, there will be no routine flaring of associated gas for oil production purposes at the Phase 1 facilities. However, in order to maintain purge pressure throughout the system to prevent ingress of air and a subsequent explosive atmosphere, as well as to dispose of leakage from process sources such as compressor seal leaks, passing valves and off-gas from the closed drains system, relatively small volumes of gas will be flared offshore. These volumes have been minimised through the selection of high integrity valve & compressor packing and inert gas compressor seals. In addition, flaring of gas for emergency or safety reasons will be permitted. The flare system design will also allow for continuous flaring in the event that the gas reception facilities cannot receive and process delivered product.

The PDQ will utilise separate HP and LP flare systems. During the first year of production, prior to the installation and commissioning of the C&WP, the volume of gas flared for purge pressure purposes, leak disposal and pilot gas on the PDQ may reach 1 MMscfd. Once the C&WP becomes operational anticipated flaring volumes will be in the order of 2MMscfd. In addition, small volumes of burnt and unburnt hydrocarbons will be released from the flare pilot light on both platforms. Once the C&WP is installed, the two HP flare systems will be connected and the flare loads will be shared between the PDQ and the C&WP HP flare systems. In addition, once the C&WP is operational Phase 1 will eliminate any continuous flaring that may still be taking place on Chirag-1.

As discussed earlier, the Phase 1 gas will be used as a fuel gas or delivered to SOCAR at Sangachal during the first year of operation prior to the installation of the C&WP. Chirag-1 gas will continue, as at present, to be used either as a fuel gas or delivered to SOCAR at Oil Rocks, with any surplus gas flared.

Following C&WP installation the gas produced in association with Phase 1 and Chirag-1 and will normally be managed as follows:

- used for fuel gas to run the operation, both onshore and offshore
- re-injected into the reservoir to support and improve oil recovery

- delivered to SOCAR at the Sangachal Terminal Delivery Point

To provide the necessary assurance that SOCAR will provide facilities at Sangachal to take the gas available, a gas protocol has been signed between AIOC and SOCAR. This protocol is referred to in the Phase 1 project sanction resolution (the formal document signed by AIOC and SOCAR on August 30th 2001).

The gas protocol addresses the following key points:

- defines the delivery pressure and gas specification that AIOC must meet at Sangachal. The gas specification is considered suitable for use directly by consumers without further processing;
- provides estimates of gas deliveries to SOCAR from EOP and Phase 1 to the end of the PSA;
- requires SOCAR to provide facilities to accept delivery of the gas at Sangachal and have them available three months before start-up of oil production;
- defines the minimum capacity of the facilities that SOCAR should install;
- defines where SOCAR will redeliver the gas to, from Sangachal, for use by consumers in Azerbaijan;
- confirms that gas will be used to optimise oil recovery and surplus gas will be delivered to SOCAR;
- confirms that if Chirag-1 gas cannot be delivered to the Phase 1 gas compression platform then Chirag-1 gas can continue to be delivered to SOCAR at Oil Rocks; and
- gives priority of delivery to associated gas over non-associated gas produced within or imported into Azerbaijan.

The protocol gives AIOC the required assurance that its gas deliveries to SOCAR will be properly utilised. Further assurance can be obtained by comparing the demand for gas in Azerbaijan today, which is some three times higher than the likely production from EOP and Phase 1.

During operations there will be occasions when there will be plant upsets and the normal use of gas will be interrupted. If the plant upset is due to equipment not being able to inject gas into the reservoir then deliveries to SOCAR can be increased up to the capacity of the subsea pipeline. If the upset is because SOCAR cannot take the gas then more gas can be injected into the reservoir. The capacities of the facilities are such that at peak oil production, and an assumption of gas-oil ratio that is 25% higher than the solution gas-oil ratio, then gas can still be utilised without the need for flaring.

Experience of oil operations indicates that there will be occasions when plant upsets occur and gas needs to be flared to allow safe repair to equipment or safe restart of equipment. These occasions will be kept to a minimum by designing equipment with sparing capacity, maintaining the equipment and limiting flare quantities.

The overall plant design availability has been based on achieving an uptime of 95%. At the time of writing this document, the best estimate for the split of the amount of flaring offshore and onshore during these periods of equipment unavailability is 86% and 14% respectively.

In the first two years of operation, the estimated plant availability figures will be 70% (year 1) and 82% (year 2) due to commissioning and start-up problems that will occur in the early days of operations. Flaring quantities will decrease with time until the plant design availability of 95% is attained. Thereafter, annual flaring and availability targets will be set on a continuously improving basis.

For the PDQ only mode, before the C&WP is installed (year 1) the main flaring events will result from:

- Terminal Dewpoint Plant outages. The majority of which will result in offshore rather than onshore flaring.
- PDQ Flash Gas Compression outages. These will result in gas flaring offshore.
- Terminal Flash Gas Compression outages. These will result in flaring onshore.
- Oil Process Train outages onshore. These will result in flaring onshore.

Overall the estimated split of the amount of flaring offshore and onshore during periods of equipment unavailability in year 1 is 69% and 31% respectively.

Once the C&WP is installed (year 2 onwards) the main flaring events will result from:

- Terminal Dewpoint Plant outages. This will result in flaring events being split roughly equally both offshore and onshore at the terminal. During these terminal dewpoint outages it is assumed that most gas can be re-injected offshore or sent to Oil Rocks from Chirag rather than being flared.
- PDQ Flash gas Compression outages. This will result in flaring offshore.
- C&WP Injection outages. This will result in flaring offshore.
- C&WP Chirag compression outages. This will result in flaring offshore.
- Terminal Flash Gas Compression outages. This will result in flaring onshore.
- Oil Process Train outages onshore. This will result in flaring onshore.

Overall the estimated split of the amount of flaring offshore and onshore during periods of equipment unavailability in year 2 is 86% and 14% respectively.

Offshore the flare system will be designed to handle the following flare gas rates:

- 482 MMscfd continuous flaring during a process upset from the second year of production (maximum combined C&WP and PDQ gas to be flared);
- 250 MMscfd continuous flaring during a process upset in the first year of production;
- 300 MMscfd (PDQ blowdown rate);
- 250 MMscfd (C&WP blowdown rate); and
- 700 MMscfd (emergency use only).

That is in order to continue production of oil the gas would be flared at a rate of 250 MMscfd prior to installation of C&WP (year 1) or 480 MMscfd for PDQ and C&WP (year 2 onwards).

All gas flaring offshore will be metered and a flaring policy will be defined for the operating phase of the project. The operational flaring policy will be agreed with the AIOC partners and it will stipulate the maximum duration and or gas volumes that may be flared in the event of plant upset or inability of SOCAR to take gas sent to shore, prior to production shutdown. Estimated emissions to the atmosphere from offshore flaring are included in Section 5.4.7.

5.5.1.5 Cooling water

The production processing systems on the PDQ and C&WP will require cooling for normal operation and hence both installations will have an indirect glycol-water (20 wt% Mono-ethylene Glycol) cooling medium system as part of their topside infrastructure. The cooling medium itself will be cooled using treated seawater via plate-frame heat exchangers. At both platforms, seawater will be drawn by pumps from a depth of greater than 100 m below the sea surface and will subsequently be passed to the platform topsides for use. Once passed through the cooling medium on the topside, the heated seawater will be discharged back into the sea via an 800 mm diameter concrete caisson, at a depth of 67 m below the sea surface. The present design for the PDQ cooling system has a base design operational rate of 1,700m^3/hr and the C&WP base design operational rate is 4,200 m^3/hr. This means that the rates of discharge of cooling water will be 1,700m^3/hr and 4,200 m^3/hr from the PDQ and C&WP respectively.

The temperature of the seawater at the take-up point will be approximately 10°C and 7°C in summer and winter respectively. Once passed through the cooling medium, the seawater temperature will have increased to approximately 25°C. At the point of discharge, there will be a temperature differential between the discharged cooling water and the receiving water body at the point discharge of approximately 15°C.

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.

Seawater drawn for use as cooling water will be dosed with antifoulant chemicals to prevent organic build-up in the cooling water system. The system to be used is the BFCC$_{TM}$ copper-chlorine process and controls biofouling by dosing the seawater with very low concentrations of copper and chlorine, typically 5 ppb and 50 ppb respectively. The BFCC$_{TM}$ 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.

In the event that the antifoulant chemical dosing facilities may be out of service, biocides will be added to the cooling water system.

5.5.2 Integrated control and safety systems

Each of the Phase 1 facilities will have an Integrated Control and Safety System (ICSS) installed. The systems will comprise the following distributed functional sub-systems:

- Process Control System (PCS);
- Process Shutdown System (PSD);
- Emergency Shutdown System (ESD);
- Fire and Gas System (F&G); and
- Diverse Path Shutdown System (DPS).

The ICSS for the PDQ and C&WP platforms will be integrated to form a single distributed system. It will be designed for future modification so that when additional phases of Azeri field development are installed, the ICSS on the C&WP will continue to function should the Phase 1 PDQ lose all power. The offshore ICSS will be connected to future platforms or facilities and the Sangachal Terminal via the telecommunications network. Each offshore facility will however, be considered as a "stand-alone" system with respect to the ICSS. The intent is for it to perform its intended functions if communications with other facilities are lost. In addition parts of the process system may be protected by means of a High Integrity Process Protection System (HIPPS). This system will ensure that process equipment is shut in by means of safety valves to prevent damage through overpressure.

5.5.3 Personnel

During routine operation it is anticipated that the offshore operations activities will require approximately 150 personnel. Due to the nature of the work involved a number of the positions will entail shift work and thus whilst approximately 150 positions will be created offshore it will be necessary to employ approximately 300 personnel for the offshore operations. It is envisaged that from day one of operation some 50% of the jobs will be occupied by Azerbaijani nationals. It is hoped that this will increase over time as skills are developed and experience gained, with 75% of positions held by Azerbaijani's after 5 years and 95% after 10 years.

5.5.4 Offshore platform utilities

5.5.4.1 Power generation

Turbine driven main power generators will provide electrical power for the PDQ and C&WP, including loads associated with the drilling rig and living quarters. Two 50% electrical generators will be installed on the PDQ, and one 100% unit on the C&WP. The main power generation of the two facilities will be inter-tied; however, the generator ratings will be selected such that the platforms can be operated independently. Base case design is for two 28 MW dual-fuel capability gas turbine driven generators on the PDQ and one 28 MW dual-fuel capability gas turbine driven generator on the C&WP.

After the C&WP is in operation, the total PDQ and C&WP complex power configuration has a spinning reserve design, to allow the drilling electrical load to be safely managed (shed) in the event of a main generator shutdown. Upon loss of one main generator, the electrical loads associated with production and oil-pumping systems are immediately shed to match available power, while maintaining the drilling electrical load as required. The drilling activities are then suspended in a safe condition; the production systems and oil pumping systems are re-established as before the upset condition.

The main generator sets will be provided with dual fuel capabilities to enable operation using diesel as a fuel prior to the establishment of fuel gas as well as abnormal operations when fuel gas is not available.

Each platform will also be provided with a diesel driven emergency generator. This generator will be sized for platform black start, for restart of the facilities and to provide essential and emergency power in the event that main power generation is not available.

5.5.4.2 Fuel gas system

The normal PDQ fuel gas supply will be obtained from the combined HP separator/flash gas system and will be wet. Fuel gas will scrubbed and heated via electric element heaters then filtered prior to distribution to the various users. Major users include the power generation gas turbines, the flare purge and pilots and tank purging. Two 100% fuel gas trains will be provided to maximise power generation availability and minimise diesel storage requirements onboard. The design fuel gas flow for the PDQ is currently estimated at 13,500 m^3/hr (11.5 MMscfd). This corresponds to both power generators operating at full load.

C&WP fuel gas will be obtained from the outlet of the gas dehydration contactor and will therefore be dry. Fuel gas onboard the C&WP will also be scrubbed and heated via electric element heaters then filtered. Both the PDQ and the C&WP will be able to back flow dry gas for fuel from the gas export system for use during periods when the topsides fuel gas is unavailable. There will only be sufficient fuel to power one generator per platform by this method as the platform gas is fed through a bypass hole in the export line none return valve. Major users will include the power generation gas turbine, the injection compressor gas turbines, the flare purge and pilots, tank purging and stripping gas to glycol regeneration. The design fuel gas flow is currently estimated at 24,090 m^3/hr (20.4 MMscfd). This corresponds to the two injection compressors (14.7 MMscfd fuel gas consumption) and power generator (5.7 MMscfd fuel gas consumption) operating at full load.

5.5.4.3 Diesel systems

Diesel treatment and storage facilities will be provided on the PDQ to provide an alternative supply of fuel to the power generators in the event that fuel gas is unavailable or temporarily interrupted. Situations when fuel gas is not available are expected to be very infrequent and of limited duration, for example, prior to availability of the first well. For this reason, diesel storage provisions will be kept to a minimum.

Diesel will be offloaded by hose from supply boats, filtered and stored in the crane pedestals. A coalescing filter system will be utilised to remove water and particulates from the diesel to meet gas turbine quality specifications.

The main diesel users on the offshore facilities will include:

- main power generators (dual fuel);
- emergency generators;
- cranes;
- lifeboats;
- drilling facilities; and
- firewater pumps.

Diesel requirements for the C&WP will be piped across the bridge link from the PDQ platform.

5.5.4.4 Inert gas

Inert gas on board the PDQ will initially be provided from bottles. When the C&WP is installed, it will provide inert gas to both platforms, generated by a membrane package using wet compressed air.

Inert gas users on board the PDQ include:

- tank blanketing;
- maintenance purging;
- backup to the flare header purge; and
- the flash gas compressor seals will have their own inert gas generator.

On board the C&WP, the inert gas users will include:

- compressor seals; and
- cooling medium expansion tank.

5.5.4.5 Atmospheric vent

The offshore facilities will not have an atmospheric vent collection system. Equipment requiring atmospheric vents will be provided with individual vents that will vent the equipment safely and will be tied to the flare header.

5.5.4.6 Potable/fresh water

Fresh water makers on board the PDQ will be Reverse Osmosis (RO) type, and include membrane cleaning systems. The feed to the RO units will be provided by the seawater lift pumps. A boat-offloading fresh water fill line will serve as backup to the RO unit. Water transferred from boats will be filtered before flowing to the fresh water tank with a storage capacity of 100 m^3. C&WP fresh water requirements will be piped across the bridge link from the PDQ platform.

The main freshwater users on the offshore facilities will include:

- accommodation;
- drilling; and
- utility/HP washdown.

5.5.4.7 Fire water

The firewater distribution system on board the PDQ will be supplied by two 100% diesel engine driven firewater pumps, each with a nominal rating of 2000 m^3/hr at 12.0 barg. The primary firewater demand is for protection of the main areas, Xmas tree, separator and manifold areas. The firewater pumps will provide a dedicated seawater supply on demand via a ring main, normally pressurised by a connection from the seawater lift system. The firewater distribution system will supply seawater to deluge systems, hose reels and monitors. Deluge protection will be provided in the wellhead/manifold, process and drilling areas.

A foam concentrate system will be provided to enhance the effectiveness of deluge water spray protecting the Separator module.

Firewater hose reels will be designed for a nominal capacity of 26 m^3/hr and will be located to provide coverage to all parts of the installation via two jets of water should a fire occur

Two firewater/foam monitors will be provided for helideck protection.

Fire water for the C&WP will be provided from the PDQ.

5.5.4.8 Helicopter refuelling

Helicopter fuel will be brought onboard the PDQ in transfer tanks positioned in a bunded area on the roof of the accommodation module. To refuel a helicopter, fuel will be pumped from the storage unit to the dispensing unit.

5.5.4.9 Drainage

The PDQ open drains will be routed to the drilling drains tank and then on to the CRI unit for injection. Drains at lower levels will be routed to an open drains caisson from where oil will be skimmed and returned to the closed drains drum. Drainage from the helideck will be routed directly overboard as will deluge overflow from deck drain boxes. The C&WP open drains will be collected in the open drains tank from where it will be pumped to the combined

LP flare/closed drain drum. As with the PDQ, deluge overflow from deck drain boxes will be routed directly overboard.

Hazardous and non-hazardous drains will be segregated to prevent migration of vapours.

The basis of design for the open drains system includes the following:

- design storm rainfall rate: 25 mm/hr;
- open drains caisson to separate: 150 micron oil droplets;
- caisson residence time: 30 min at design flow rate; and
- no visible sheen on sea surface.

The PDQ and C&WP will have a combined LP flare/closed drains drum. The closed drains system will be designed to collect residual fluids from equipment located on the PDQ. The equipment will be operated down to the minimum possible level and depressurised prior to opening the drain valves to the closed drains system.

The PDQ and C&WP LP Flare systems will receive the relief and gas blanket flows from the cooling medium expansion drum. In addition, the PDQ LP Flare system will receive flow from manual vents from pig launchers and receivers, process equipment and the rupture disks on the cooling medium side of the flash gas compressor discharge coolers. The C&WP Flare system will also receive flow from the vents from the glycol regeneration package. It is estimated that approximately 0.09m^3/hr glycol will be vented to flare.

5.5.4.10 Sewage system

The sewage treatment package will be sized based on 200 permanent personnel onboard. Up to 300 personnel may be onboard during the hookup & commissioning phase and extra provisions for this period of activity are under evaluation. Early design of the facilities are to discharge effluents that will meet the requirements of the US Coast Guard specifications, however the treatment package is under evaluation and an appropriate treatment plant will be provided that will not rely on maceration only.

5.5.5 Other liquid and solid wastes for shipment to shore

Wastes generated on the offshore facilities will be classified as one of the following categories, segregated and stored in appropriate skips or containers before being sent to shore for disposal:

- non-hazardous combustible solid waste such as waste paper, wood and cardboard;
- non-hazardous, non-combustible waste such as scrap metals; and
- hazardous solid waste such as paint cans and empty chemical containers;
- hazardous liquid wastes such as lubricating oils, solvents, etc.

Estimates for waste generated through operational activities offshore are provided in Table 5.19

Table 5.19 Estimated annual waste quantities on the offshore facilities (PDQ and C&WP)

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		♦		
Office dry waste, packaging			♦	
Non-Hazardous Non Combustible Solid Waste				
Electrical wire	♦			
Scrap metals		♦		
Wire rope, slings, netting	♦			
Hazardous solid waste				
Empty drums		♦		
Filters		♦		
Filtration solids	-	-	-	-
Clean out residues	-	-	-	-
Pig receiver residues	♦			
Activated carbon filter	♦			
Filter residues	♦			
Rags		♦		
Sand/shotblast materials			♦	
Batteries	♦			
Transformers		♦		
Capacitates				
Absorbents (spill clean-up)	♦			
Resins		♦		
Fire fighting agents		♦		
Clinical Waste	♦			
Hazardous liquid waste				
Lubricants	♦			
Diesel	-	-	-	-
Paints	♦			
Greases	-	-	-	-
Hydraulic Fluid	♦			
Oil				♦
Thinners	♦			
Coatings	♦			
Solvents	♦			
Acids	♦			
Alkalis	♦			
Drilling Chemicals			♦	
Rig wash		♦		

Key: - not estimable

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.

5.5.6 Emissions and discharges from the Phase 1 offshore platforms

5.5.6.1 Atmospheric emissions

The main sources of atmospheric emissions from the PDQ and C&WP platforms will include:

- fugitive emissions;
- operation of support vessels including helicopters and supply vessels;
- power generation;
- gas injection compression; and
- flaring.

Fugitive emissions

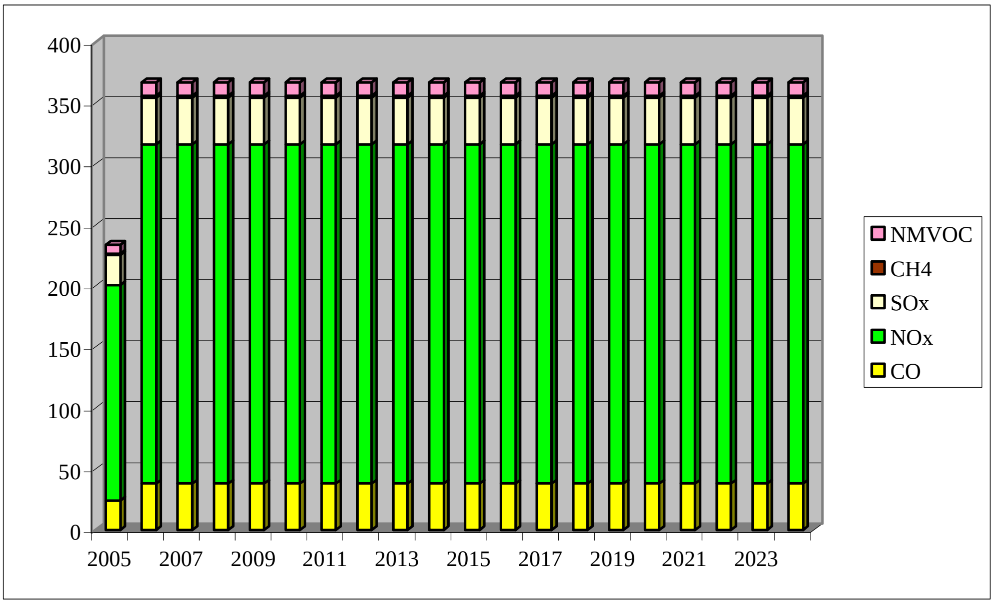
Fugitive emissions from the storage and transportation of produced hydrocarbons and diesel are expected to be negligible as a result of appropriate design and construction control in regards the process train and the implementation of a rigorous maintenance regime. Vented emissions on the offshore platforms will be tied-back to the flare header and hence will not be released as unburnt hydrocarbons to the atmosphere.

Supply and support vessel and helicopter operations

Estimated releases by species and total CO_2 resulting from the operation of offshore support vessels including helicopters and supply and standby vessels are presented in Figures 5.23 and 5.24, respectively. Theses values reflect:

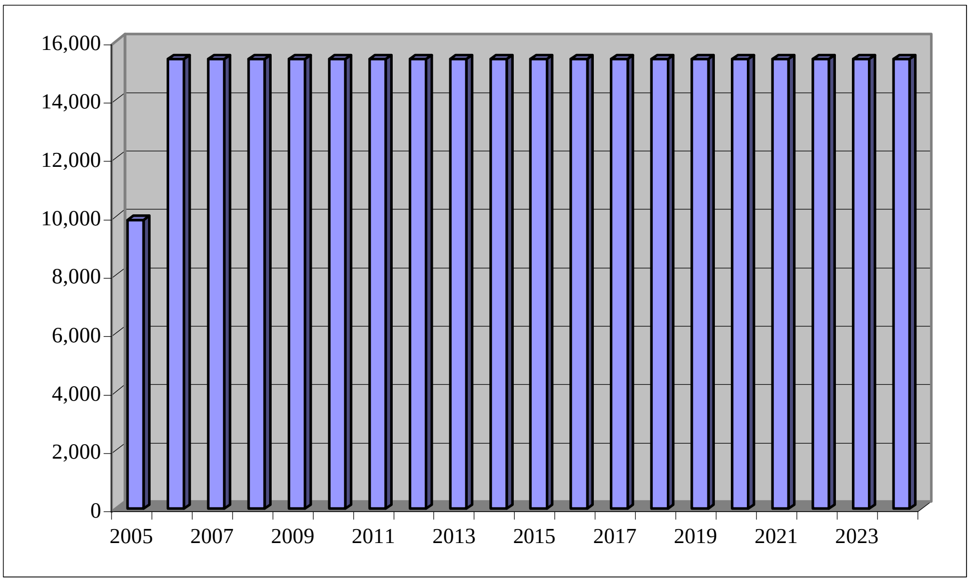
- eight supply vessel trips per week (approximately 6 tonnes fuel per day);
- continuous operation of one standby vessel (3 tonnes fuel per hour); and
- five helicopter trips to the platform per week (0.24 tonnes fuel per hour).

Figure 5.23 Estimated emissions to the atmosphere by species from Phase 1 offshore vessel supply and support operations, including helicopters (tonnes)



Note: gaseous species are combined for presentational purposes only.

Figure 5.24 Estimated CO_2 emissions from Phase 1 offshore vessel supply and support operations, including helicopters (tonnes)

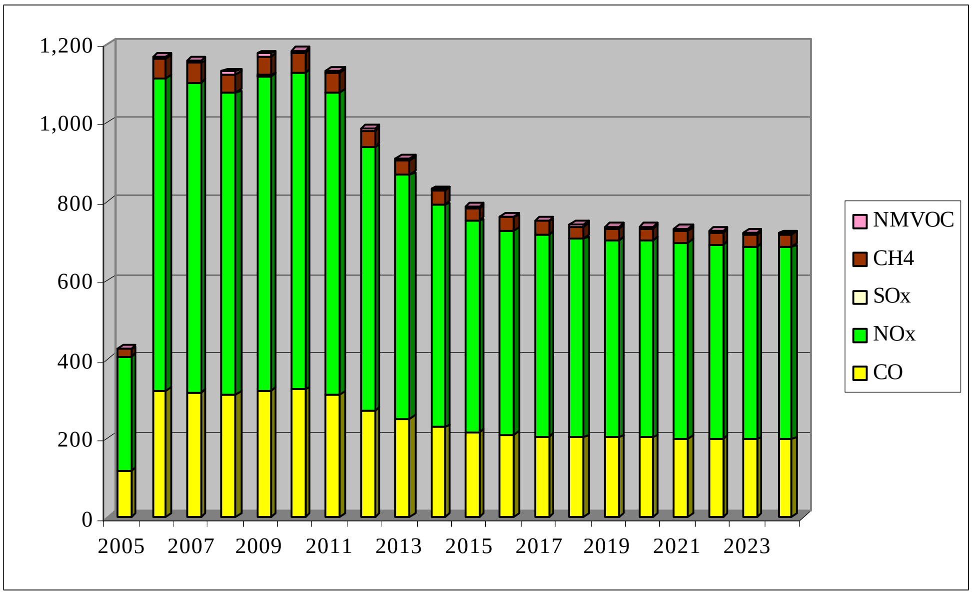


Power generation

Estimated fuel combustion emissions by species and for total CO_2 resulting from power generation on the PDQ and C&WP are presented in Figures 5.25 and Figure 5.26. Estimates are based on the fuel gas required for the operation of:

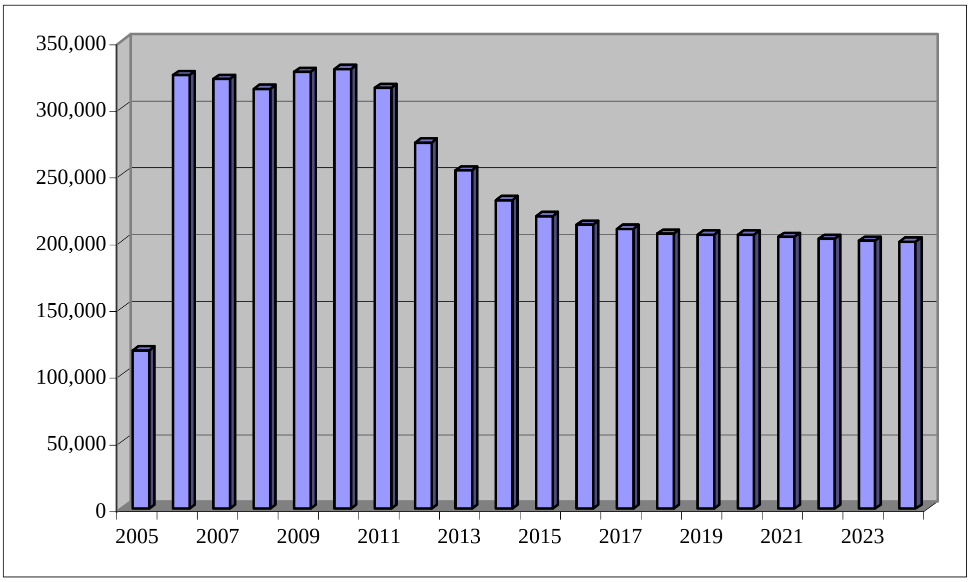
- 2 x 26MW gas turbines on the PDQ; and
- 1 x 28MW gas turbine on the C&WP.

Figure 5.25 Estimated emissions to the atmosphere by species from Phase 1 offshore power generation on the PDQ and C&WP (tonnes)



Note: gaseous species are combined for presentational purposes only.

Figure 5.26 Estimated CO_2 emissions from Phase 1 offshore power generation on the PDQ and C&WP (tonnes)

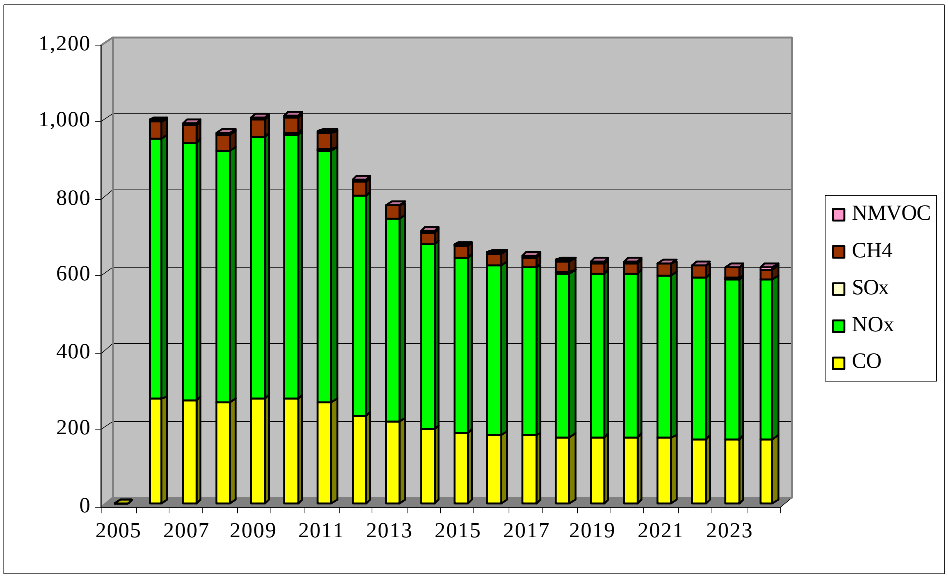


It should be noted that the decrease in the power generator combustion emission levels illustrated in the above graphs is attributable to a decrease in the power requirement for drilling later in the Phase 1 programme.

Gas compression

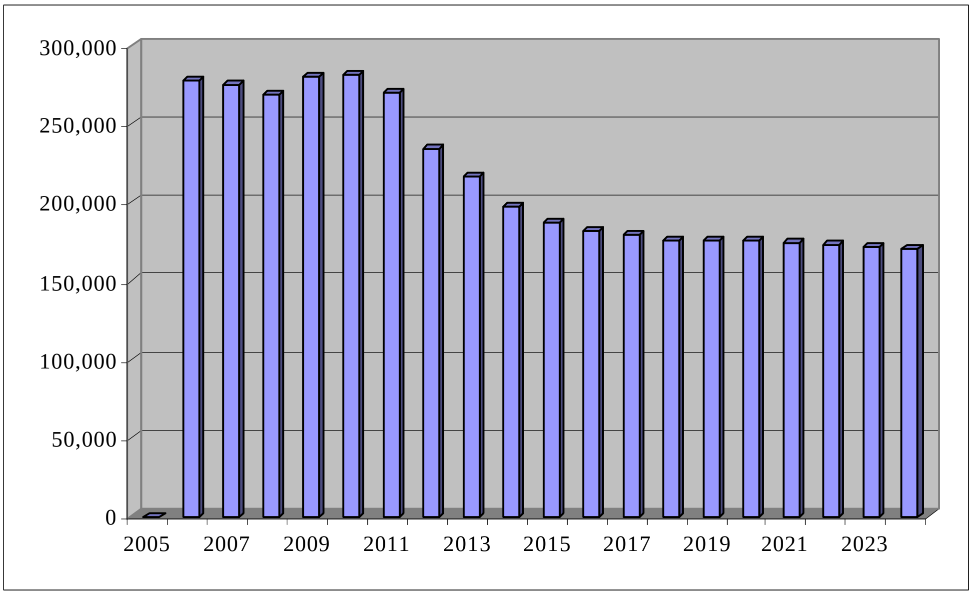
Estimated fuel gas combustion emissions by species and total CO_2 from the C&WP gas compressors are presented in Figures 5.27 and 5.28 respectively. These estimates have been calculated on the compressor fuel gas requirements derived by subtracting the fuel gas required for power generation from the total fuel gas consumption for the PDQ and C&WP platforms.

Figure 5.27 Estimated emissions to the atmosphere by species from the C&WP gas turbine driven gas compressors (tonnes)



Note: gaseous species are combined for presentational purposes only.

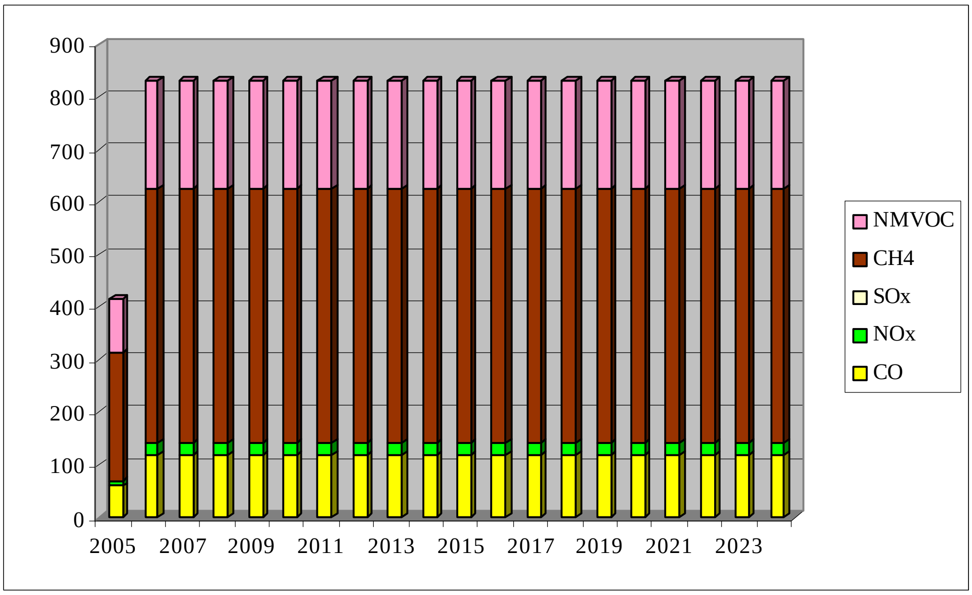
Figure 5.28 Estimated CO_2 emissions from the C&WP gas turbine driven gas compressors (tonnes)



Routine flaring

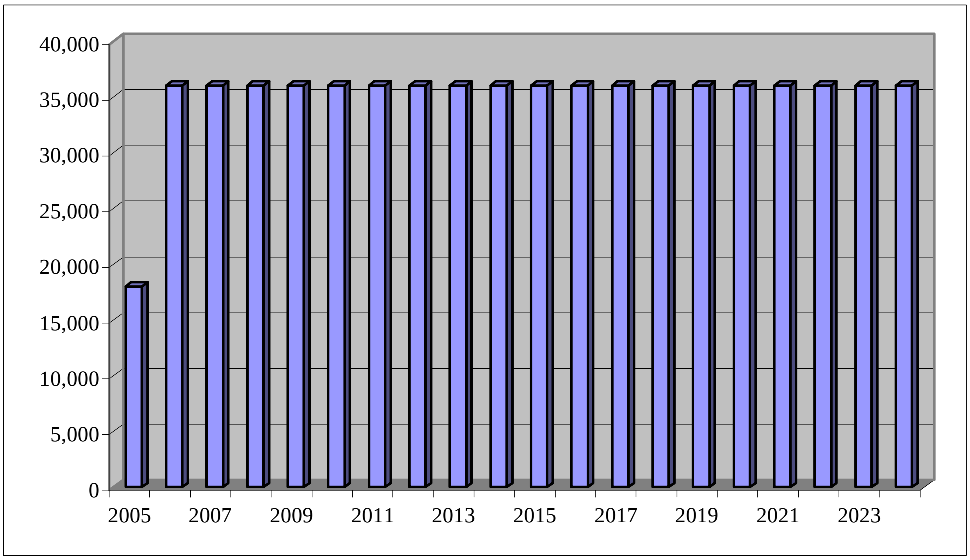
Estimated emissions to the atmosphere by species and for total CO_2 for routine flaring operations offshore are presented in Figures 5.29 and 5.30. Estimates have been calculated on the assumption that 1 MMscfd will be flared for the first year of operation from the PDQ and a total of 2 MMscfd from combined operations from the PDQ and C&WP (worst-case) during the lifetime of the project.

Figure 5.29 Estimated emissions to the atmosphere by species from routine operational flaring on the PDQ and the C&WP (tonnes)



Note: gaseous species are combined for presentational purposes only.

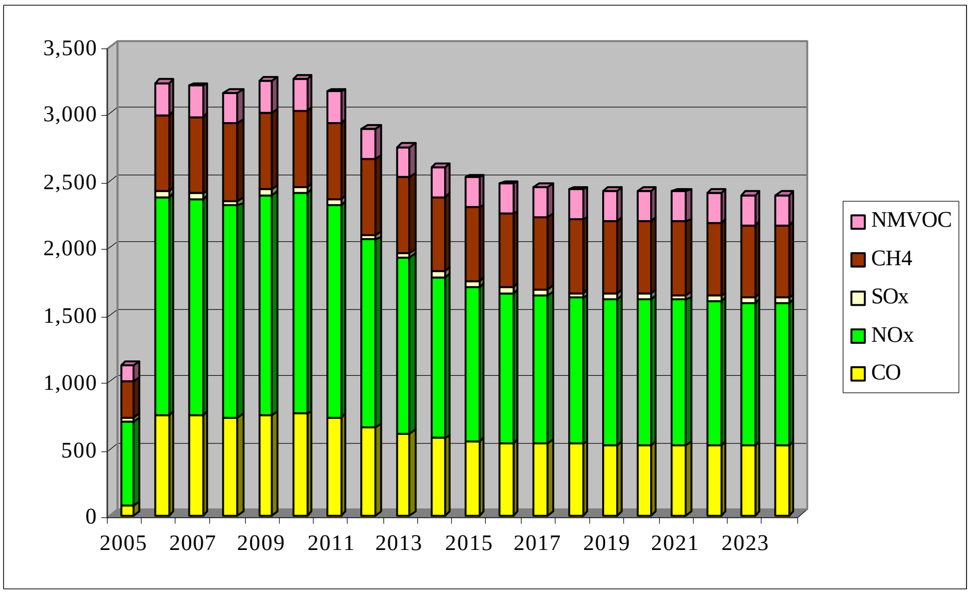
Figure 5.30 Estimated CO_2 emissions from routine operational flaring on the PDQ and the C&WP (tonnes)



Total routine emissions

Figure 5.31 and 5.32 present the estimated total emissions to the atmosphere as a result of Phase 1 offshore operations at the PDQ and C&WP by species and for total CO_2 respectively. Green house gas emissions are shown in Figure 5.33. The estimates include support vessel operations. The data above indicates that the largest contributors to routine emissions to atmosphere are from offshore power generation (gas turbines) and the gas driven gas compressors on the C&WP.

Figure 5.31 Total estimated emissions to the atmosphere by species from Phase 1 routine offshore operations on the PDQ and the C&WP (tonnes)



Note: gaseous species are combined for presentational purposes only.

Figure 5.32 Estimated total CO_2 emissions from Phase 1 routine offshore operations on the PDQ and the C&WP (tonnes)

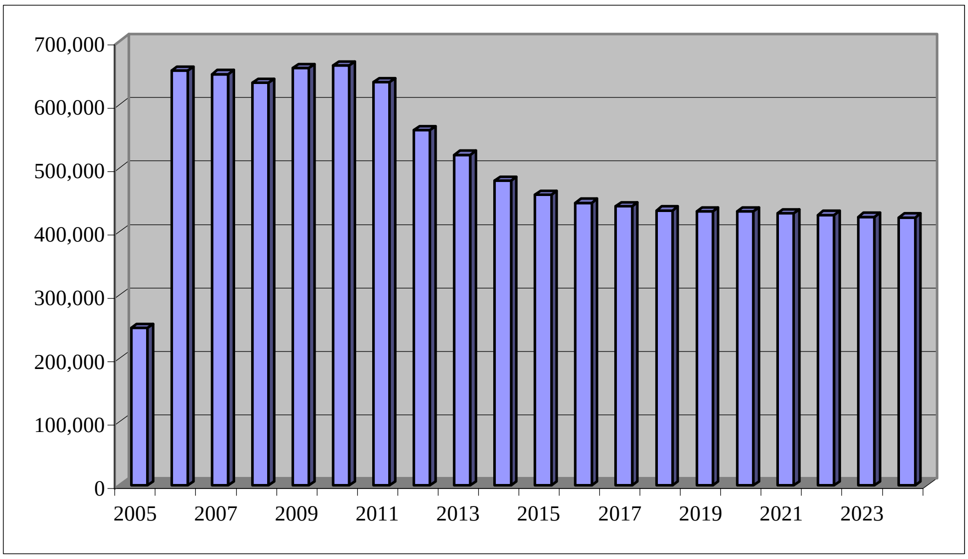
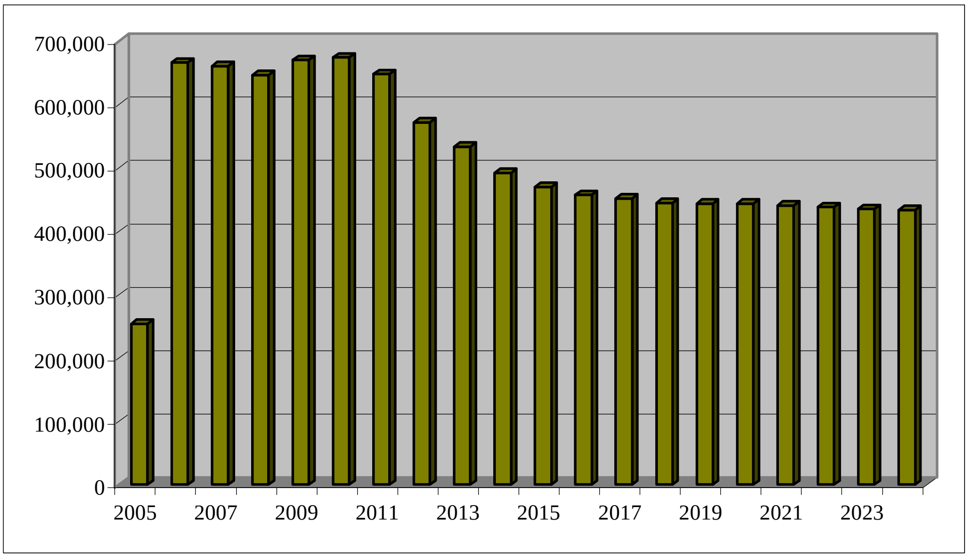


Figure 5.33 Estimated total greenhouse gas emissions from Phase 1 routine offshore operations on the PDQ and the CW&P (Tonnes CO_2Eq)

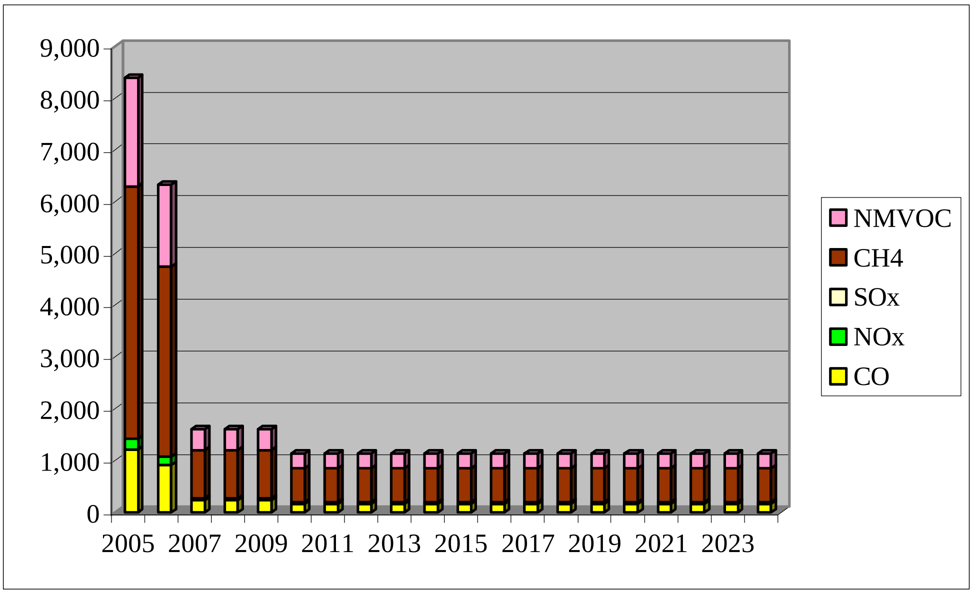


Non-routine emissions to atmosphere

In the event that there is process failure or downtime for maintenance on the offshore platforms, gas separated from the product stream would need to be flared. Estimated emissions to the atmosphere by species and total CO_2 from these non-routine flaring events per annum are presented in Figures 5.34 and 5.35 respectively, estimated green house gas emissions are shown in Figure 5.36. The emission levels have been calculated based on a plant design availability of 95% from year 3 of the project onwards. In years 1 and 2 plant availability has been assumed at 70% and 82% respectively due to commissioning and start-up (Section 5.5.1.4). Emission estimates have assumed flaring the following gas volumes flared and offshore/onshore flaring splits for each year:

- Year 1 (70% availability) - 10.1 bcf (billion cubic feet) gas flared, 31% onshore and 68% offshore, 6.97 bcf flared offshore
- Year 2 (82% availability) – 6.1 bcf gas flared, 14% onshore and 86% offshore, 5.25 bcf flared offshore
- Year 3 onwards (95% availability) – 1.55 bcf gas flared, 14% onshore and 86% offshore, 1.33 bcf flared offshore

Figure 5.34 Total estimated emissions to the atmosphere by species from non-routine flaring on the PDQ and the C&WP (tonnes)



Note: gaseous species are combined for presentational purposes only.

Figure 5.35 Estimated CO_2 emissions from non-routine flaring on the PDQ and the C&WP (tonnes)

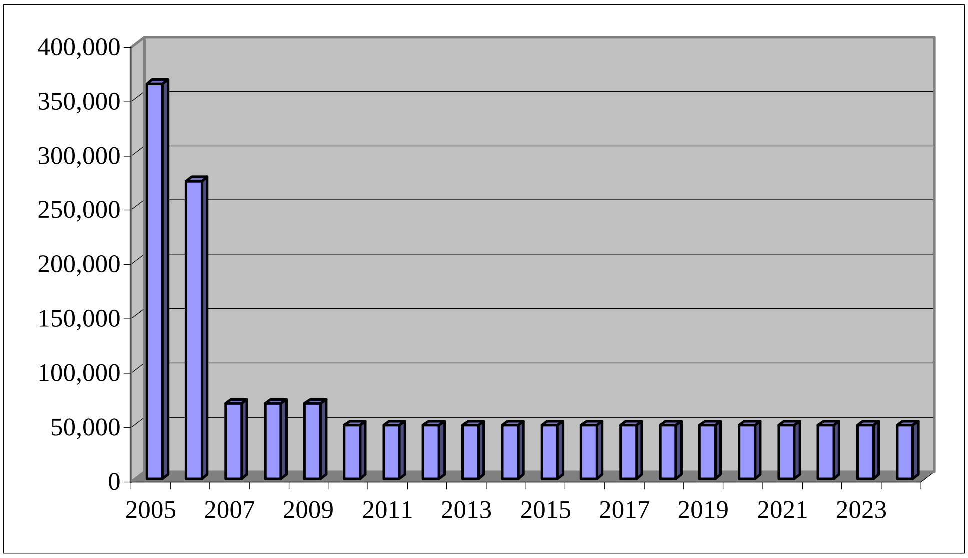
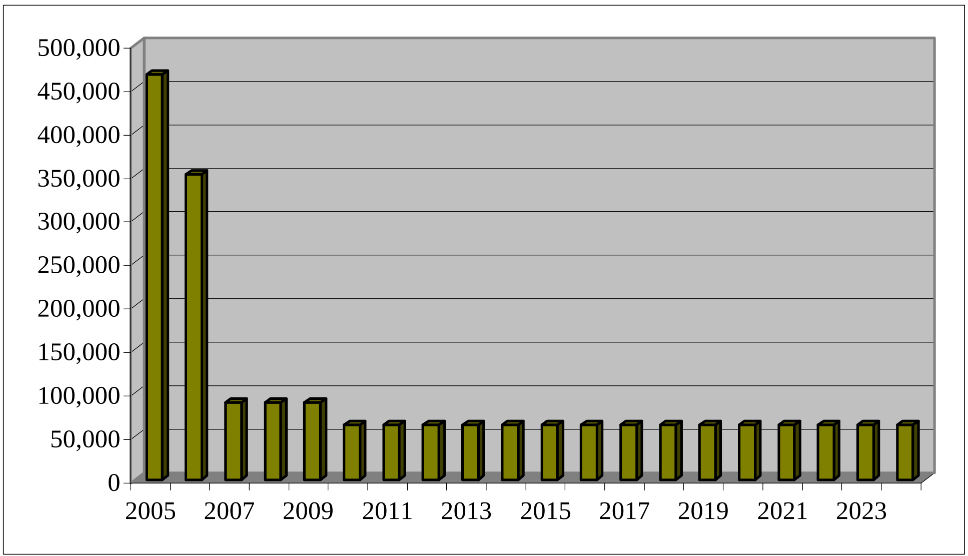


Figure 5.36 Estimated greenhouse gas emissions from non-routine flaring on the PDQ and the C&WP (Tonnes CO2Eq)



5.5.6.2 Discharges to sea

The discharges to the sea from the offshore platforms during production operations will include:

- cooling water;
- sewage and food waste;
- drainage water; and
- produced water during operational down-times.

Cooling water

Cooling water will be discharged via a sub-surface caisson at a depth of –67 m.at the following rates:

- PDQ: 1,700 m^3/hr (14,892,000 m^3/yr); and
- C&WP: 4,200 m^3/hr (36,792,000 m^3/yr).

Sewage

The estimated annual amount of sanitary wastes that would be generated during the Phase 1 offshore operations are shown in Table 5.20. The following assumptions have been use:

- 200 people on board (POB);
- vessels have a compliment of 15 POB;
- grey water: 0.22 m^3 per day per person;
- black water: 0.1 m^3 per day per person; and
-

Table 5.20 Estimated annual amounts of sanitary waste generated from the PDQ and support vessels

Parameters		PDQ	Support Vessels
Grey water (m^3)	Per day	44	3.3
	Total	16,060	6,270
Black Water (m^3)	Per day	20	1.5
	Total	7,300	547

Drainage

Based upon an annual average rainfall of 800 mm and site capture areas on the PDQ and C&WP of 2,500 m^2 and 2,000 m^2 respectively, estimated annual rainwater runoff would be:

- 2,000m^3 for the PDQ platform; and
- 1,600m^3 for the C&WP platform.

Other, minor and infrequent aqueous wastes would comprise:

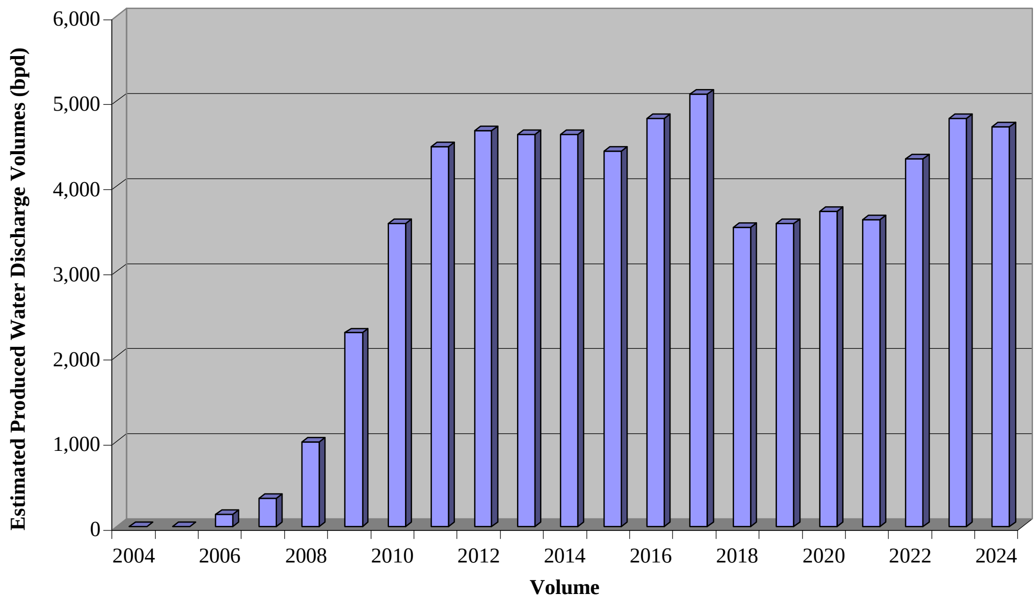
- tank draining;
- equipment blowdown including coolant fluids;
- hosing of process areas and washing equipment; and
- firewater in the event of a fire.

Produced water

As discussed in Section 5.5.1 produced water generated in year 1 of the offshore production operations will be sent to with the oil to the onshore terminal. Export oil-in-water content will be 5% by volume. Following installation of the C&WP the produced water will be separated from the product stream, mixed with seawater, treated and re-injected for reservoir pressure maintenance. Water remaining in the oil stream will be separated at the terminal where it will be sent to a dedicated onshore injection well for disposal.

In the event that the produced water re-injection system is unavailable as a result of equipment failure or maintenance downtime, treated produced water will be discharged to sea. The project base case plans for a maximum downtime of 5% of operational time. As a worst-case scenario therefore, 5% of total water produced offshore will be discharged. Figure 5.37 illustrates the estimated volumes of produced water that would discharged to sea from the Phase 1 offshore facilities

Figure 5.37 Estimated produced water volumes discharged to sea assuming 95% re-injection equipment availability (bpd)



5.6 Pipelines

5.6.1 Introduction

Oil and gas will be transferred from the offshore location to shore and between the PDQ and Chirag-1 and the C&WP and Chirag-1 by means of subsea pipelines. A new 30" diameter pipeline will export crude oil from the PDQ to the terminal at Sangachal. This pipeline will be approximately 188 km in length and will follow the route of the existing EOP 24" oil pipeline from Chirag-1 to shore. It is intended to export gas to shore through the existing 24" oil pipeline from Chirag-1 to the EOP terminal at Sangachal by converting it from oil to gas service as part of the Phase 1 development. As intended, the conversion of the EOP 24" oil line would require the installation of three interfield pipelines between Chirag-1 and both the PDQ and the C&WP platforms as follows:

- one 24" diameter approximately 11.5 km interfield oil pipeline from Chirag-1 to the PDQ platform;
- one 24" diameter approximately 11.5 km interfield gas pipeline from the PDQ platform to an existing 24" wye near to Chirag-1; and
- one 18" (possibly 24") diameter 11.5 km interfield gas pipeline from Chirag-1 to the C&WP installation.

As discussed in Chapter 4 (Options Assessed), an additional subsea export pipeline option is under consideration for Phase 1 at present. This option includes continuing with the installation of the new 30" oil pipeline, but retaining the existing EOP 24" pipeline in oil service. In addition, under this option a new 30" gas line from Phase 1 to shore would also be installed. The installation of this dedicated gas line and retention of the existing line is being considered in order to provide additional oil and gas export capacity. This represents an acceleration of the installation of the gas line originally planned for the ACG Phase 3 development. This option remains under review and a final decision is not expected until a later date.

The following section describes the base case option for the pipelines and includes a description of the installation programme, commissioning and operations as well as a description of the method of converting the existing EOP line to gas service.

5.6.2 Design details

Pipelines will be constructed of carbon steel and have been designed with consideration of the following environmental parameters:

- temperature (seawater, atmospheric);
- seawater properties (level fluctuations, density, salinity);
- sediment characteristics (elasticity, sheer stresses);
- marine fouling (loading on riser structures from marine growth);
- wave and current characteristics (velocity forces, storm stresses, wind stresses, pressure forces); and
- geohazards (mud volcano, seismic activity, and effects of fault displacement).

Stability analyses have been conducted using these parameters to ensure that the pipelines are suitable for the environmental conditions in the development area.

The outer wall of each pipeline will have a factory applied coating to provide corrosion protection, details of the coatings that will be used are shown in Table 5.21 and will be either a three layer polypropylene or polyethylene coating or both. In addition, each pipeline will be externally coated with concrete to provide mechanical protection against impact, and the weight required to 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. The existing 24" EOP pipeline is not included in this table as the structure is already in place and is within the operational lifetime incorporated into its original design.

Table 5.21 External pipeline coatings

Pipeline	Wall thickness (mm)	Coating
30" oil export	24.5 & 20.6	3 layer polypropylene and Polyethylene
24" oil interfield	17.5	3 layer polypropylene
24" gas interfield	17.5	3 layer polypropylene
18" gas interfield (possibly 24")	14.3	Asphalt enamel (Polyethylene)

Additional external corrosion protection has been incorporated into the pipeline design through the use of sacrificial anode protection. These anodes corrode preferentially in the event of anti-corrosion coating damage or breakdown. Conventional 'half shell bracelet' type aluminium-zinc-indium anodes will be used and attached to the pipeline at regular intervals and secured by copper cored insulated cables.

Despite external corrosion protection measures, the nature of the material that the pipelines will transport has the potential to corrode the internal structure over the lifetime of the development. Internal coating combined with additional wall thickness to provide internal corrosion allowance will ensure that the integrity of the pipelines will not be compromised. A 3 mm internal corrosion allowance has been incorporated for the new 30" and 24" oil and gas pipelines and a 1.5 mm allowance incorporated for the 18" gas pipeline.

5.6.2.1 Other materials

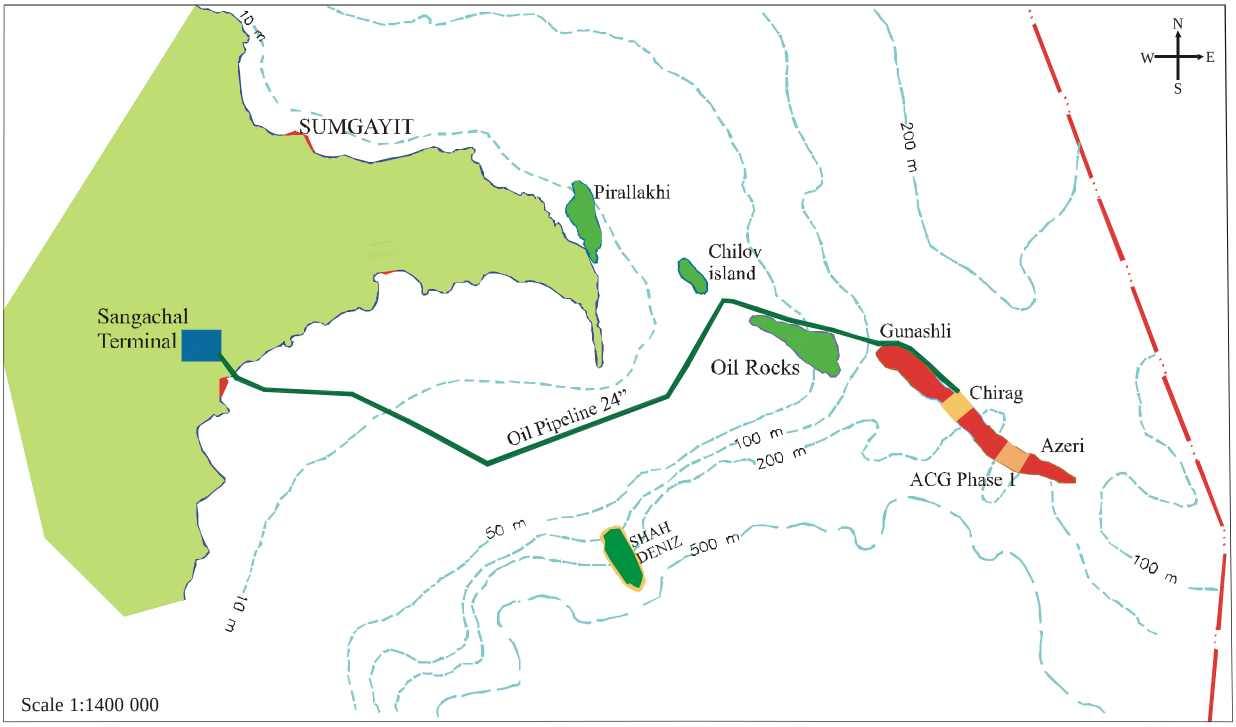
The pipeline joints will be welded to and fitted with various valves, flanges and wyes. For example, the design of the 30" oil pipeline includes two subsea wye assemblies for future tie in to the Phase 2 and Phase 3 developments. These are all standard units and will be designed inline with the relevant international industry standards.

5.6.3 Proposed route and crossings

The new 30" oil pipeline will run from the PDQ platform initially northwest to Sangachal following the existing 24" pipeline route from Chirag-1 to Sangachal north and parallel to it from kilometer point (KP) 13 to KP 92. At approximately KP 92 the 30" oil pipeline crosses the 24" pipeline and from this point the pipeline runs parallel and south of it onward to the shore approach and landfall.

Selection of the existing EOP 24" pipeline corridor route for the 30" pipeline eliminates the requirement for additional data collection on the seabed characteristics along the route. Previous surveys have been conducted along the route to evaluate the geotechnical data, seabed morphological features, platform approaches and other design criteria. Environmental baseline information for the seabed conditions along the route have also been conducted and these are discussed in Section 6. The route is illustrated in Figure 5.38.

Figure 5.38 Proposed Phase 1 offshore pipeline route



Along the route, the following known pipeline and cable crossings will be required:

- two crossings of Oil Rocks to Dubendi oil export pipelines. One crossing of the 14" line (KP 75.06) and one crossing of the 20" line (KP 75.45);
- one crossing of the Oil Rocks to Zhiloy Island abandoned gas pipeline (KP 75.59);
- one crossing of an unidentified 10" coated pipeline (KP 79.47);
- future crossing of the new 20" export pipeline (Oil Rocks to Bahar) (KP 90.01);
- one crossing of the 20" export pipeline (Oil Rocks to Garadag) (KP 90.06);
- one crossing of the 24" oil Chirag to Sangachal pipeline (KP 91.84); and
- one crossing of the Krasnovodsk telephone cable (KP 104.27).

On arriving at the landfall the pipeline route will run directly to the terminal facility onshore for a distance of approximately 1.7 km and will cross the following existing facilities:

- one crossing of the road (Baku to Astara highway);
- one crossing of the railway; and
- multiple crossings of third party pipelines/service lines and facilities.

Both the interfield 24" gas pipeline from the PDQ to the Chirag wye and the 24" oil pipeline from Chirag to the PDQ will follow the same route. The route is approximately 11.5 km in length and has been selected to avoid, as much as possible, geotechnical hazards identified in the area. The route has the additional benefit of being relatively homogeneous in topography and water depth (between 124-152 m). Once at the PDQ the design of the 24" gas interfield pipeline includes a wye piece for future tie in to the C&WP platform. The 18" (possible 24") diameter 11.5 km interfield gas pipeline will run from Chirag-1 to the C&WP installation, again selecting an appropriate route to avoid hazards in the area as much as possible.

There are no pipeline crossings on the interfield pipelines for Phase 1, only spoolpiece crossings.

5.6.4 Installation of pipelines

It is intended to install all of the Phase 1 pipelines in 2003 and 2004. The exact timing and schedule for the pipelines will be determined during detailed planning and will be designed to avoid the most environmentally sensitive times of the year for each phase of the installation programme. The requirement to take account of the Shah Deniz Upstream and ACG Phase 2 projects may mean that pipe laying in Sangachal Bay may take place during either January and February or in May. The schedule remains to be confirmed. The whole offshore installation phase is planned to occur over a period of 30 months, with the onshore installation between the landfall and the terminal expected to take approximately 8 months in total.

The pipelay vessel selected for the installation of the pipelines is the 'Israfil Guseinov' (Figure 5.39). This vessel has to date laid a maximum pipe diameter of 24" and so requires upgrading to be able to handle the new 30" line proposed for oil export. This involves upgrading the pipe rollers and tensioners on the vessel, as well as performing an overhaul of all other equipment to ensure appropriate performance. Upgrading of the pipelay vessel will take place at the SPS yard (Section 5.5.2).

Figure 5.39 Pipelay barge, Israfil Guseinov

The Israfil Guseinov will be supported by a number of vessels. These vessels are listed in Table 5.22, together with the anticipated duration of operation.

Table 5.22 Laybarge and pipelay support vessels

Type/description of vessel	Number of vessels	POB (approx)	Duration of operation (approx days)
Lay-barge/Saturation diving support	1	210	300
Anchor handling vessel	3	15	300
Pipe-haul barges and tugs	4	14	180 (2 tugs for 300)
Air Diving Support vessel	1	26	Periodic support
Survey vessel	1	26	300

The majority of these vessels will be sourced from KMNF Alliance Companies in Baku and all vessels will meet MARPOL and SOLAS requirements.

5.6.4.1 Installation method of pipelines offshore

Marine installation operations will occur within the existing exclusion zone that extends for 1,000 m across the existing EOP pipeline corridor. During installation, exclusion buoys placed around the laybarge installation area for the new 30” export line will indicate that the area is an exclusion zone and will ensure that other vessels do not encroach upon the area of activity. As pipelaying progresses the exclusion buoys will be moved along the route. These will remove the need for a chase boat to be deployed during the installation period.

The lay-barge will be used to install pipelines in all water depths from the PDQ to the beach surf zone at Sangachal (8 m water depth). The lay-barge is fitted with welding stations, an inspection station where the integrity of the weld is examined and field-joint coating stations. As discussed above, the pipeline will also have an existing coating of concrete to give negative buoyancy and mechanical protection.

During installation the pipeline will be deployed 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. 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 and the barge moved forward to repeat the process.

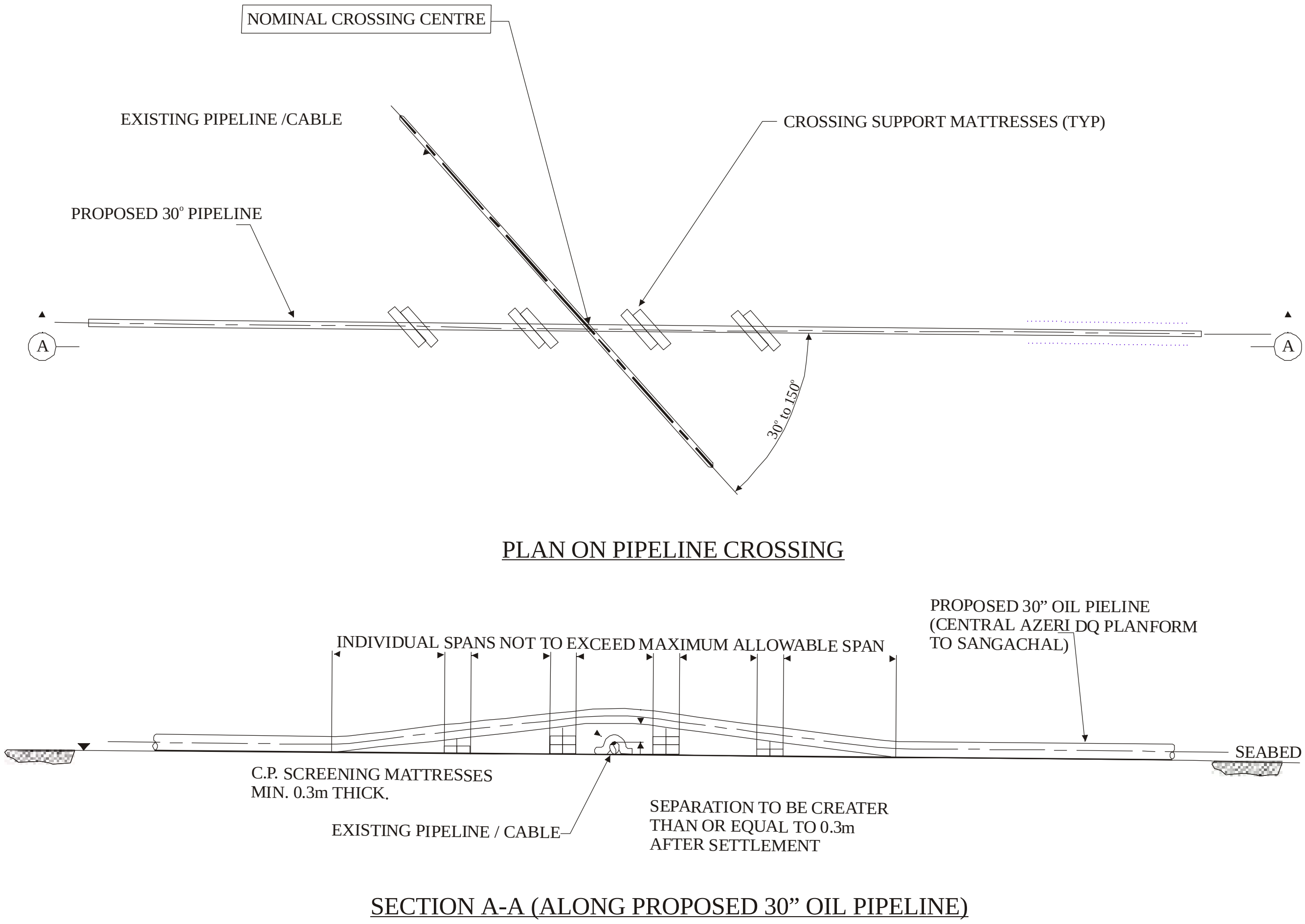
The tensioning system on the lay-barge maintains a controlled and constant deployment rate, whilst reducing bending stresses that could threaten the pipeline structure. As the pipeline is deployed, it is supported by the stinger to control the installation curvature of the pipeline.

The pipelaying operation is continuous with the barge moving progressively forward as sections of the pipe are welded, inspected, coated and deployed. The Israfil Guseinov is held in position by 8-10 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 pipelaying proceeds, the anchors are periodically moved forward. A total of two anchor handling tugs (with one more on standby) will assist the pipelay barge and will pick up and move the anchors along the route as pipelaying proceeds. The distance of this varies but is typically every 500-600 m of pipeline length. The anchor spread of the pipelay barge is typically 600 m to 700 m either side of the pipeline, depending upon the water depth. Pipehaul 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 pipelay vessel, including sewage sludge, and transport these wastes to shore for disposal.

The offshore sections of the pipeline will generally be laid directly on the seabed and will not be trenched except in the nearshore area and possibly through any areas of mud flow. Stability of the sections that are laid directly on the seabed will be provided by the concrete coating and concrete mattresses (or similar) where required.

At locations where the pipeline route crosses existing services the services will be flanked on either side by concrete pipe supports to ensure minimum separation distances are maintained between the existing pipelines/cables (Figure 5.40).

Figure 5.40 Typical crossing methodology offshore



5.6.4.2 Installation vessel utilities

All vessels proposed for use in the installation programme will be equipped with certified sewage systems capable of treating effluent to International 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 it 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 per 100 ml (Most Probable Number) prior to discharge (World Bank and EXIM standard).

Sewage sludge from all operational vessels will be transported to shore on board the pipe haul barges to a designated reception facility.

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 less than 25 mm diameter.

Other wastes generated onboard the operational vessels (pipelay barge, supply and support vessels) will be segregated according to the following categories and stored appropriately for onshore treatment and or disposal:

- 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.

It is not possible to quantify exactly how much waste will be generated during the pipeline installation programme, however wastes types and volumes given in Table 5.23 have been estimated for a six month pipelaying programme.

Table 5.23 Estimated waste types and volumes for a 6 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)

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 3 main drainage routes, accompanied by manual/mechanical clean up where appropriate:

- 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 onboard the pipeline laybarge will be provided by 5 diesel generators rated at 1150 kW each.

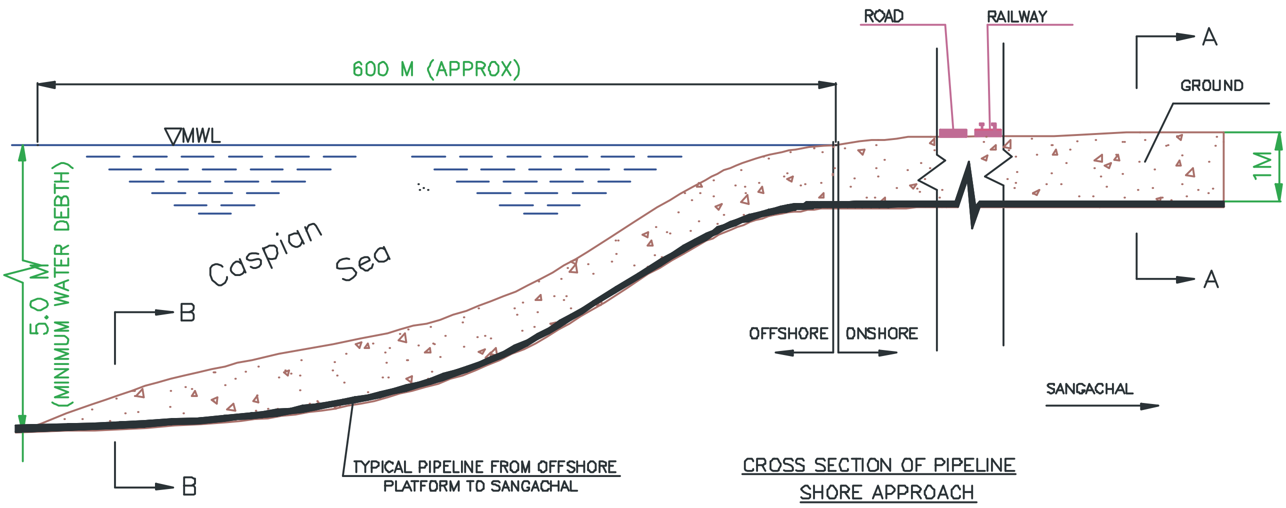
5.6.4.3 Installation of pipelines in the nearshore

Marine installation will begin in the nearshore zone and move offshore. The draft of the pipelaying barge restricts the operation of the vessel in shallow water and, as mentioned previously, the laybarge will only operate in water depths of greater than 8 m. Therefore a number of works will be required to bring the pipeline ashore. Pipeline pull onshore will occur from the laybarge using a shore-based winch. The pipeline is kept afloat during this shore-pull exercise by means of floatation pontoons attached to the pipeline. This means that the pipeline can only be pulled until it is grounded. In order to maximise the distance that the pipe can be pulled ashore, a temporary channel will be dug into the shoreline and this will be allowed to flood. This will allow the pipeline to be pulled across the nearshore and into a part of the shore that is not normally covered by the sea. The trench will be backfilled leaving the shoreward end of the pipe uncovered and creating an earth “cofferdam”. This “cofferdam” or pit will be pumped dry and the shore section of the pipeline will be trenched to meet the end of the pipeline in the “cofferdam”. 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.

Trenching

The nearshore section of the pipeline will be trenched for two reasons. The first is that it will afford some protection to the pipeline, in particular from vessels grounding on it. The second reason for trenching is that it will assist in the pipelaying operation since the pipeline can only be pulled ashore as long as it floats. In order to ensure the maximum distance the pipe can be pulled, a trench will create the necessary depth of water. The base case plan for trenching is to excavate a trench to the 2 m water depth mark and jet the pipeline beneath the seabed from the 2 m water depth mark in waters out to a depth of 5 m (approximately 650 m offshore, but dependant on the natural fluctuation of the Caspian Sea level). Overall, the trench will be no more than 3 m wide and will be left to naturally backfill. A typical pipeline shore approach is shown in Figure 5.41.

Figure 5.41 Typical pipeline shore approach



Finger Pier

A finger pier will be built in Sangachal Bay, to allow access for an excavator to enable the trench excavation activities to the 2 m water depth mark in the Bay. 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 loading lorries/trucks and other vehicles (eg 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 4-5 m and will extend out to approximately the 2.5 m water depth contour (a distance of between 250 and 300 m). The current base case option is to remove the pier after pipeline installation of the pipeline if it is found to be detrimental to sediment transport mechanisms in the bay.

Once installation of the pipeline in the nearshore zone is complete, all materials deposited at the area (aggregate, sheets piles and other material) will be removed from the site to a designated disposal area.

5.6.4.4 Installation of the pipelines onshore

The onshore section of the pipeline 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 trench 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 pipelay operations.

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 is capable of withstanding all construction loads (materials, equipment and vehicles). 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. 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 route 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 5.42

Where the pipeline is to cross existing services, reinforced concrete protective slabs shall be placed over the pipelines at the crossing point. These will extend beyond the pipe 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 5.43.

Figure 5.42 Phase 1 pipeline road and railway crossing methods

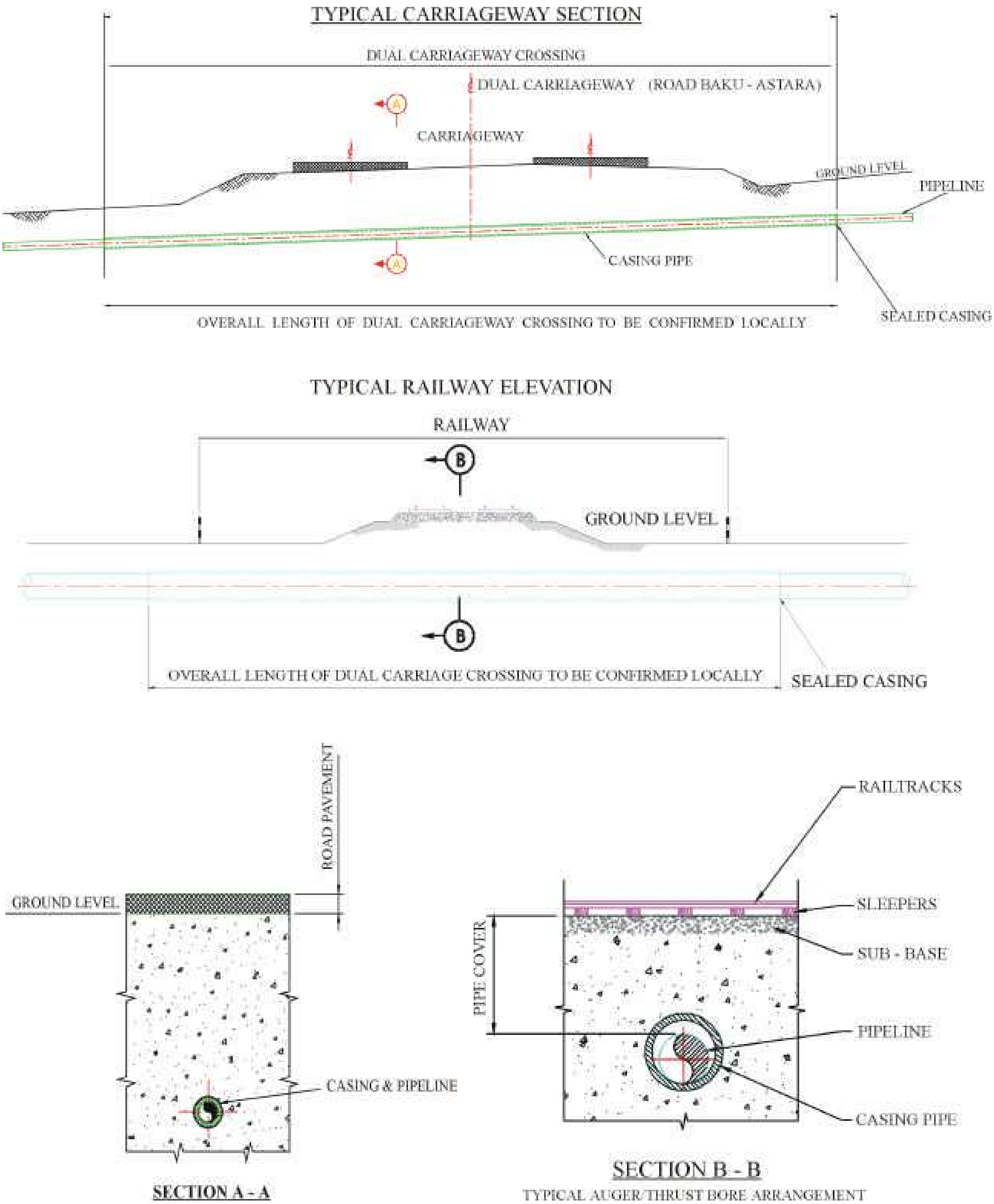
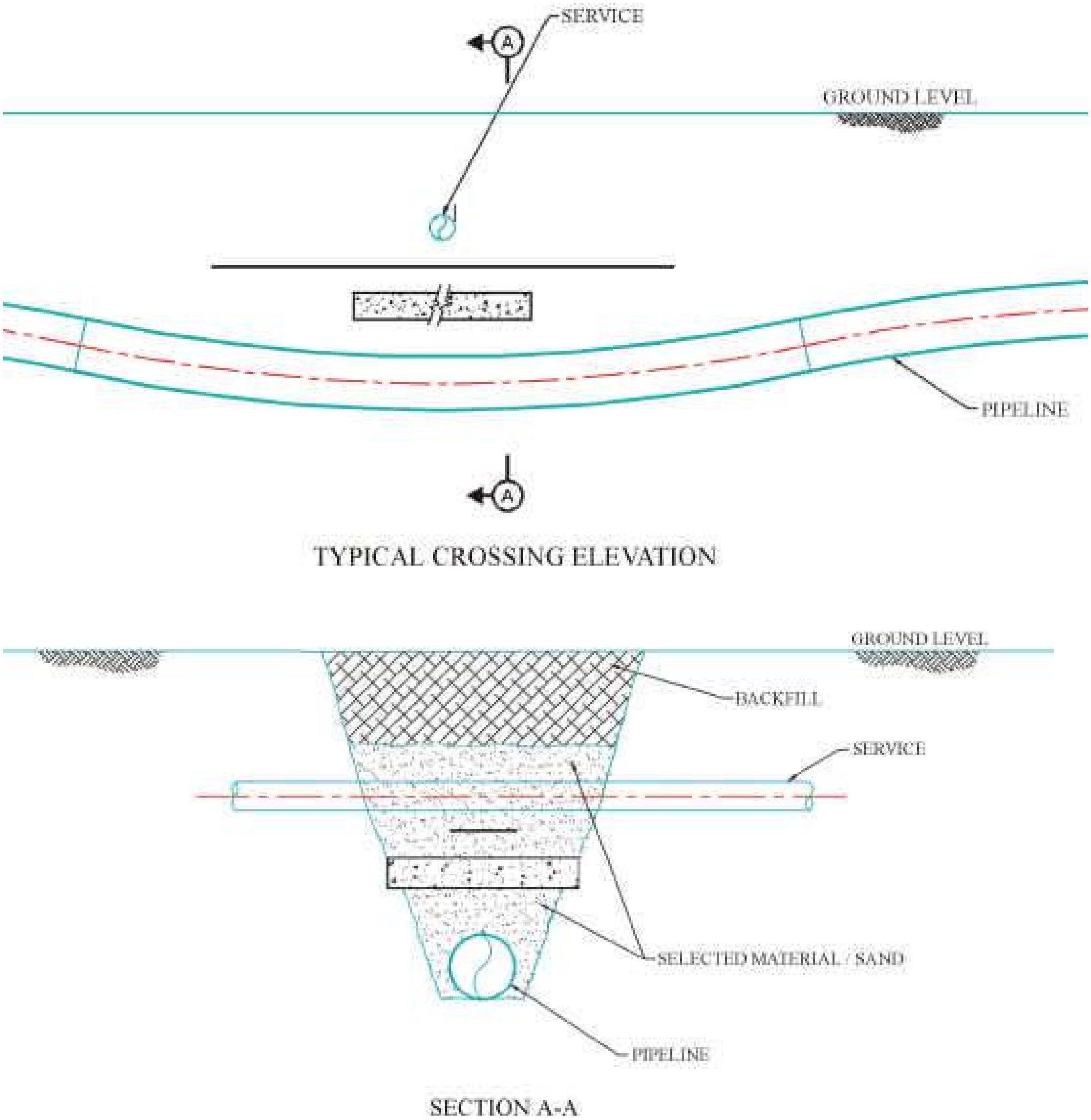


Figure 5.43 Phase 1 service crossing method



5.6.5 Pre-commissioning

Installation of the pipeline 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 pipeline 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
- hydrotesting 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 pipelay barge. 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 finalised, but these are expected to include an oxygen scavenger and a biocide.

The 30" pipeline will be flooded with test water and fitted with three pigs, positioned in the laydown head and each actuated by valves such that the pigs can be released individually when required for the purposes of cleaning and gauging. The 24" oil and gas and 18" gas interfield pipelines will be flooded and cleaned by running pigs through the pipeline from the construction/pipelay barge, with any installation wastes removed, segregated and stored for treatment and disposal. The pipeline 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 1.5 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 1 year until the offshore facilities are in place. This procedure applies to new pipelines only and so does not refer to the conversion of the existing oil pipeline to gas service.

5.6.6 Tie in and commissioning

Once the topsides are floated out, installed onto the jacket and prior to start up there will be various hook up activities to complete. The offshore pipelines will be tied-in to the pre-installed risers on the jacket structure and the jacket riser to the topsides riser/well heads (it should be noted that new pipeline risers will be retrofitted to the Chirag-1 platform jacket for this purpose). Carrying out these operations may require the use of a number of vessels, possibly including the lay barge. 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.

Once the pipeline system is connected, the entire system will again be hydrotested for a minimum hold period to check for leaks. Pending a successful integrity test and as the pipeline is brought into service the hydrotest waters will be, in a controlled manner, pneumatically driven from the platform to the onshore terminal.

The volumes of hydrotest water required for the Phase 1 pipelines are shown in Table 5.24, based on the pipeline design and specifications.

Table 5.24 Phase 1 offshore pipelines hydrotest water volumes

Pipeline/diameter	Length (km)	Volume of hydrotest water (m^3)
30" oil export from ACG	188	85,746
24" oil interfield (Chirag-1 to PDQ)	12	3,503
24" gas interfield (PDQ to Chirag-1)	12	3,503
18" gas interfield (Chirag-1 to C&WP)	12	1,970
Total	**-**	**94,722**

The disposal options for hydrotest water are currently under evaluation and have not been finalised but the base case option is for injection into a dedicated deep disposal well onshore or possibly transfer to the Garadagh Cement Plant for use in the cement manufacturing process. The best environmental solution for disposal of hydrotest water will be used in alignment with the terms of the PSA.

5.6.7 Conversion of the Existing 24" Oil Line to Gas Service

Conversion of the 24" EOP oil pipeline to gas service will require the oil to be dosed to promote the removal of wax from the structure. This will be repeated in order to break down any wax accumulation over the operational life of the pipeline. The line will then be cleaned by a series of pigs, with the wax removed at the terminal where it will be contained for disposal.

The pipeline will then be disconnected from the existing facilities on board the Chirag-1 platform and the new interfield lines connected to the existing EOP wye that was installed in 1997. The line will then be brought into service by controlled introduction of the gas. Residual oil will be received at the terminal where it will be removed, treated and disposed of in accordance with hazardous waste practices.

5.6.8 Pipeline operations

The Phase 1 PDQ will export oil by means of the new 30" oil line and will export gas by means of the 24" Chirag-1 oil pipeline that will be converted to gas service. The corrosion integrity of the 30" line is assumed through the use of the line to transport oil although periodic inspection will confirm this integrity. During this first year of operation, in order to minimise corrosion potential and hydrate formation, methanol, at a rate of 5.33 litres/min, and a proprietary corrosion inhibitor, at a rate of 0.197 litres/min, will be injected into the line. This inhibitor is likely to be a quaternary ammonium compound in ethylene glycol or water. The pipelines are designed to require very little maintenance, however a pipeline integrity management system will be developed for these pipelines. This will include:

- side scan sonar and visual inspection surveys by ROV with onboard camera;
- 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 30" pipeline will require frequent pigging to remove accumulated wax build up from the crude. Azeri crude has a relatively high wax content, and as a result, pigging operations will be required to push the wax to reception facilities at the terminal. The options for treatment and disposal of wax are discussed in Section 5.10.

5.6.9 Emissions and discharges from pipeline installation and commissioning

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:

Pipeline installation, hook-up and commissioning:

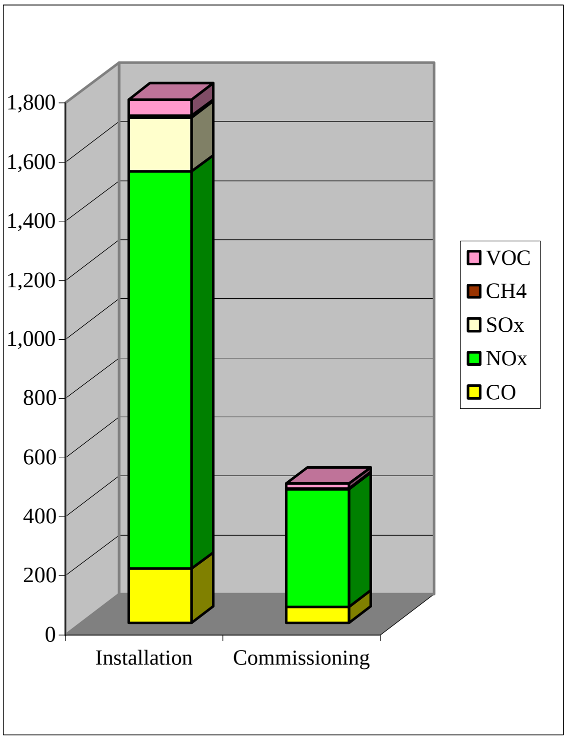
- 1 lay- barge / saturation diving support vessel (210 POB) requiring 15 tonnes daily diesel consumption will be used for 300 days;
- 3 anchor handling vessels (15 POB each vessel) requiring 6 tonnes daily diesel consumption (each) will be used for 300 days;
- 4 pipe haul barges (14 POB each vessel) and tugs requiring 15 tonnes daily diesel consumption (each) will be used for 300 days, 2 tugs will be used for 180 days;

- 1 air diving support vessel (26 POB) requiring 6 tonnes daily diesel consumption for periodic support; and
- 1 survey vessel (15 POB) requiring 6 tonnes daily diesel consumption will be used for 300 days.

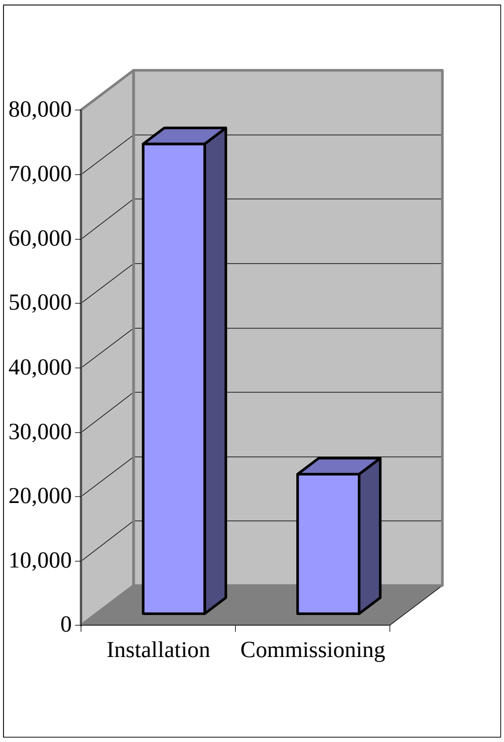
Estimated emissions to the atmosphere by species and for total CO_2 for routine during the pipeline installation and commissioning operations are provided in Table 5.23 and presented in Figures 5.44 and 5.45 respectively.

Figure 5.44 and 5.45 Estimated emissions to the atmosphere by during pipeline installation and commissioning operations offshore (tonnes)

By species



CO_2



Note: gaseous species are combined for presentational purposes only.

Sanitary waste will be generated throughout the duration of the pipeline installation and commissioning operations offshore. The key assumptions for deriving the estimated amounts of sanitary waste generated are listed below:

- each crew member will generate 0.22 m^3 / day of grey water;
- each crew member will generate 0.10 m^3 / day of black water; and
- BOD at 240 mg/l

Table 5.25 Estimated amounts of sanitary waste discharged to sea during pipeline transportation, installation and commissioning operations offshore

Parameters		
Grey water (m^3)	Per day	70
	Total	21,050
Black Water (m^3)	Per day	32
	No days	300
	Total	9,568

The short length of the pipeline onshore; 1.7 km, indicates that the atmospheric emissions associated with the installation and commissioning operations will be minimal when compared with similar activities offshore, hence these emissions have not been quantified.

5.6.10 Summary of atmospheric emissions from offshore operations

Estimated total routine and non-routine emissions to the atmosphere are shown in Figures 5.46-5.48.

Figure 5.46 Total estimated emissions to the atmosphere by species resulting from all routine and planned non-routine offshore operations (tonnes)

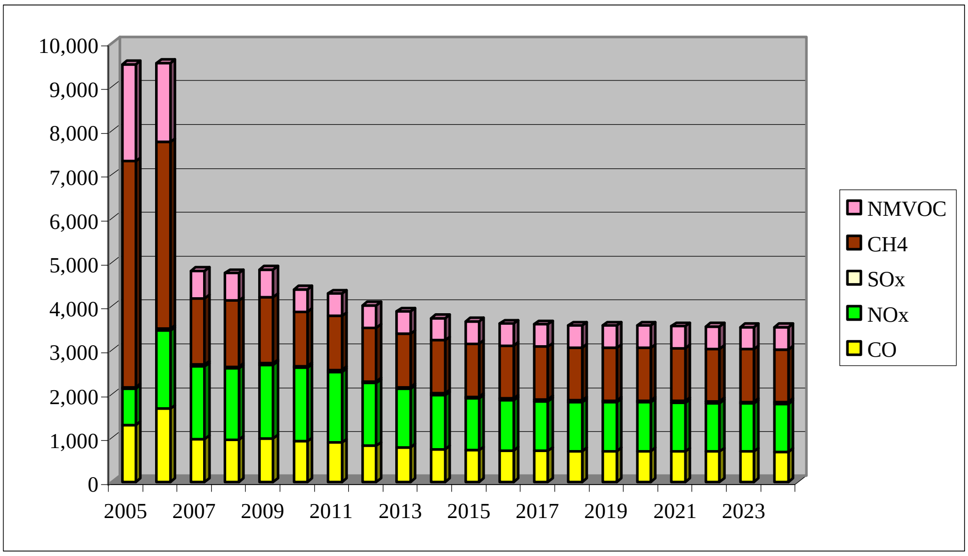


Figure 5.47 Total estimated CO_2 emissions resulting from all routine and planned non-routine offshore operations (tonnes)

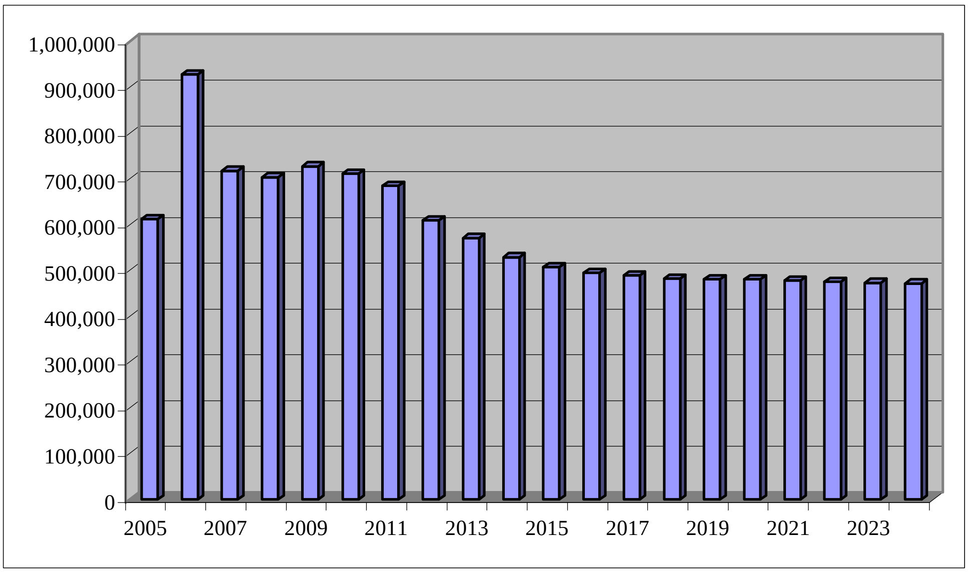
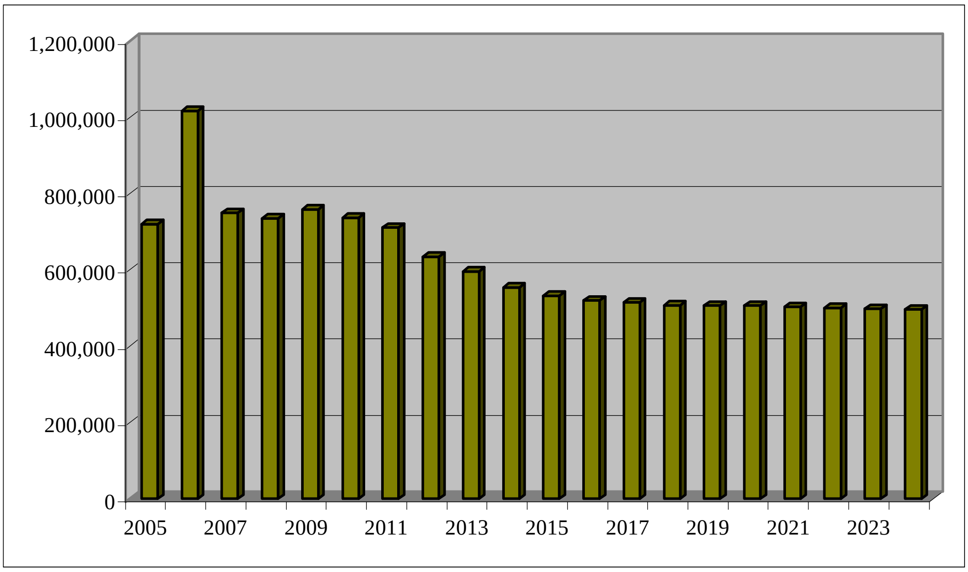


Figure 5.48 Total estimated greenhouse gas emissions resulting from all routine and planned non-routine offshore operations (tonnes CO_2Eq)



5.7 Terminal

5.7.1 Introduction

The existing EOP onshore terminal at Sangachal will be expanded with new facilities to accommodate production from Phase 1. Phase 1 expansion will be designed to operate in parallel to the existing facilities and will comprise new oil reception and processing facilities to stabilise the crude oil received at the terminal prior to export. Reception facilities for gas will be minimal and will consist of gas reception and gas dewpoint facilities.

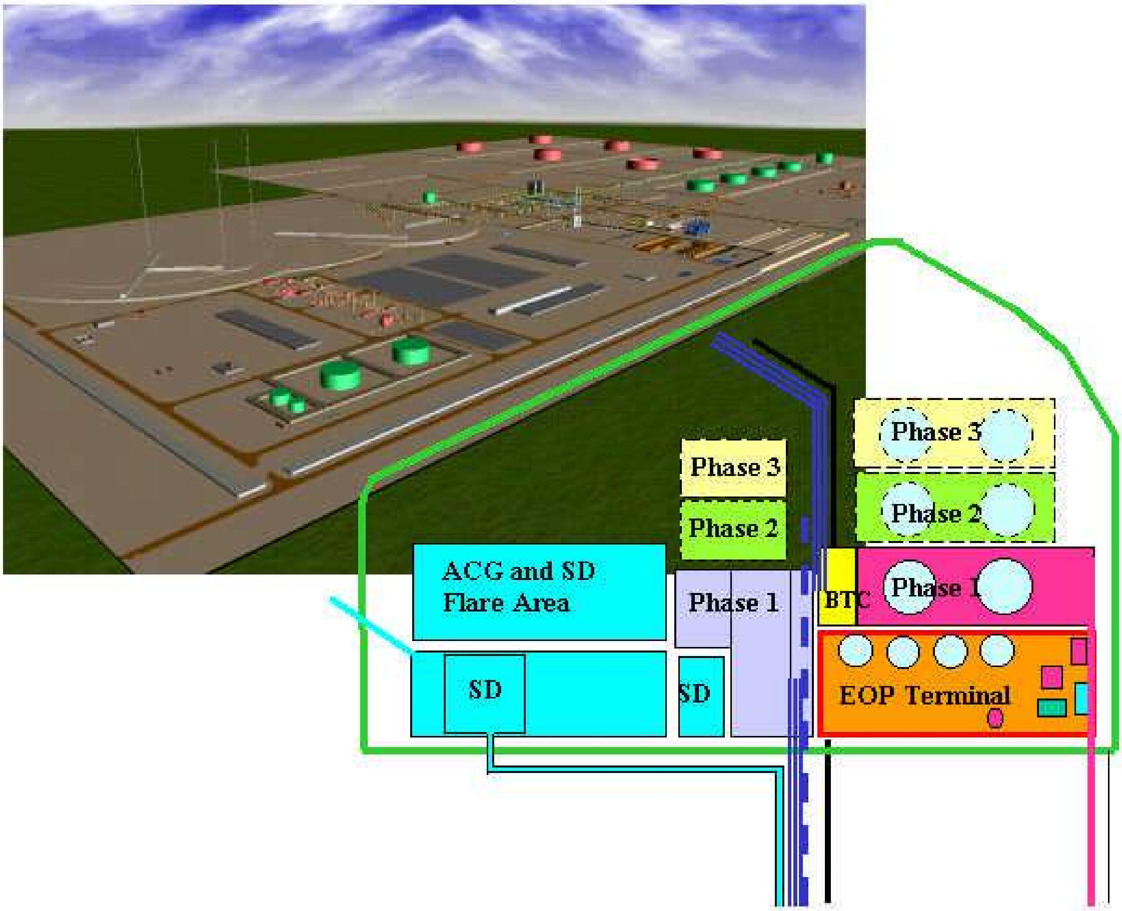
Two new oil production trains are planned for the Phase 1 terminal, resulting in an additional throughput of oil at the terminal site of 360,000 bpd. Added to the current EOP processing train, the combined terminal will be able to receive and process up to 490,000 bpd in total. Two new oil storage tanks will be constructed, each, as a base case, with a capacity of 500,000 bbl. This, when added to the four existing EOP oil storage tanks, will increase the total oil storage volume at the site to approximately 1.5 million barrels. An option of increasing the size of the new oil storage tanks to 800,000 bbl is under consideration. An off-spec crude oil tank with a capacity of 30,000 bbl will also be provided to store non-stabilised crude for re-run through the process.

Facilities to handle the associated gas exported to shore from the field will consist of reception and dewpoint control sized for 250 MMscfd. The gas system will also consist of gas pressure control. Gas received from offshore will be co-mingled with gas recovered during the oil stabilisation process where it will undergo dewpoint control before delivery to SOCAR at the boundary of the terminal site.

In the event that the Shah Deniz project is sanctioned, the Sangachal terminal will have a layout that places the Shah Deniz gas and condensate processing terminal adjacent to the AIOC terminal facilities. BP will operate both projects, and there are some benefits that can be obtained in the construction, design and operation of the terminal, to the benefit of both projects. It is also proposed that the pumping and metering facilities for the Baku-Tbilisi-Ceyhan (BTC) oil pipeline be constructed immediately adjacent to the ACG facility, within the landtake area and boundary of the expanded terminal.

The relationship between the existing EOP terminal and the proposed ACG Phase 1 along with the Shah Deniz terminal facilities and BTC pump station is illustrated in Figure 5.49. Notably, the layout design has allowed for future development phases of ACG with land set aside for further expansion to the north of the existing EOP terminal.

Figure 5.49 Proposed terminal layout



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 5.26 presents the actual planned areas in hectares for each component of the terminal facilities.

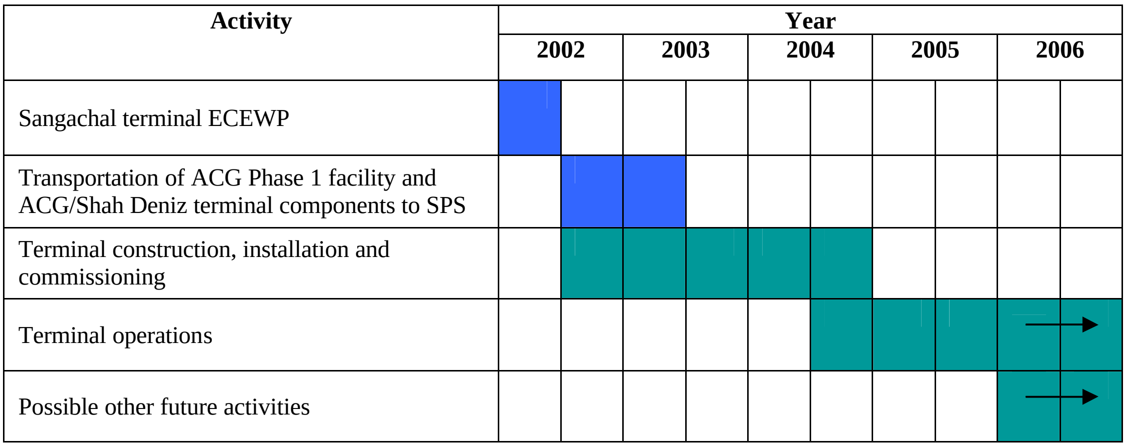
Table 5.26 Proposed terminal facilities land-take area breakdown

Terminal Areas	Areas (ha)
Existing EOP	40.5 ha
ACG Phase 1 terminal facilities	41.8 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 2 facilities	24.1 ha
ACG Phase 3 facilities	24.7 ha

Construction activities for Phase 1 will start with an early civil engineering work programme (ECEWP) that will prepare the site in readiness for the construction of the terminal facilities. Although, the timeline for Shah Deniz project is, at the time of writing, subject to negotiation between the relevant PSA partners, it is planned that the ECEWP will be undertaken in preparation for the ACG Phase 1 and Shah Deniz terminal facilities. It is also possible that construction of the Shah Deniz terminal may begin whilst construction of the Phase 1 facilities is ongoing.

The anticipated schedule of activities for the Phase 1 terminal are shown in Figure 5.50.

Figure 5.50 Schedule for the ACG Phase 1 terminal



This Chapter describes the construction of, and operations at the Phase 1 terminal facilities. The early civil engineering work programme (ECEWP) was the subject of a separate ESIA submitted in October 2001 (AIOC, 2001). A summary of the ECEWP is included below for completeness.

5.7.2 Early Civils Engineering Work Programme (ECEWP)

The ECEWP will be carried out prior to, the construction of, and on behalf of both, the ACG Phase 1 and Shah Deniz Stage 1 terminal facilities. Work is anticipated to start in January 2002, lasting for a period of between six and seven months. The programme will include a number of activities including:

- 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.

The award of the ECEWP contract is planned for late 2001.

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.

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. Depending on the contractor selected a small temporary accommodation camp may be required to house expatriate staff and it is anticipated that no more than 50 personnel would be accommodated at the work site should a camp be required. The sourcing of employment for the ECEWP construction programme is to be determined by the selected contractor which to date has not been identified. As such, it is not possible to provide an accurate and detailed breakdown of the total number of jobs that may be generated as a result of the construction programme. It is understood however, that the ECEWP contractor will only source labour from the international market where the local labour force cannot supply the skills required for the programme.

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 and discussions with the water company are underway to ensure that the water use requirements for the ECEWP will not affect the supply to current users. The largest volumes of water required will be used for watering down the site for dust suppression purposes during earth moving operations, with some also required for potable drinking water for the work force and to supply the temporary workers camp if applicable.

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’ methods using dozers, earthmoving trucks, graders and compactors. Vegetation clearance will occur in areas where the land is to be levelled for terminal construction only.

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 therefore represent 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 using an excavator, dozers and earthmoving trucks to a 2 m depth 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.

Measures will be in place around the terminal to monitor activities that may impact terminal security and prevent unauthorised access to the facilities. 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 to Alyaty 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:

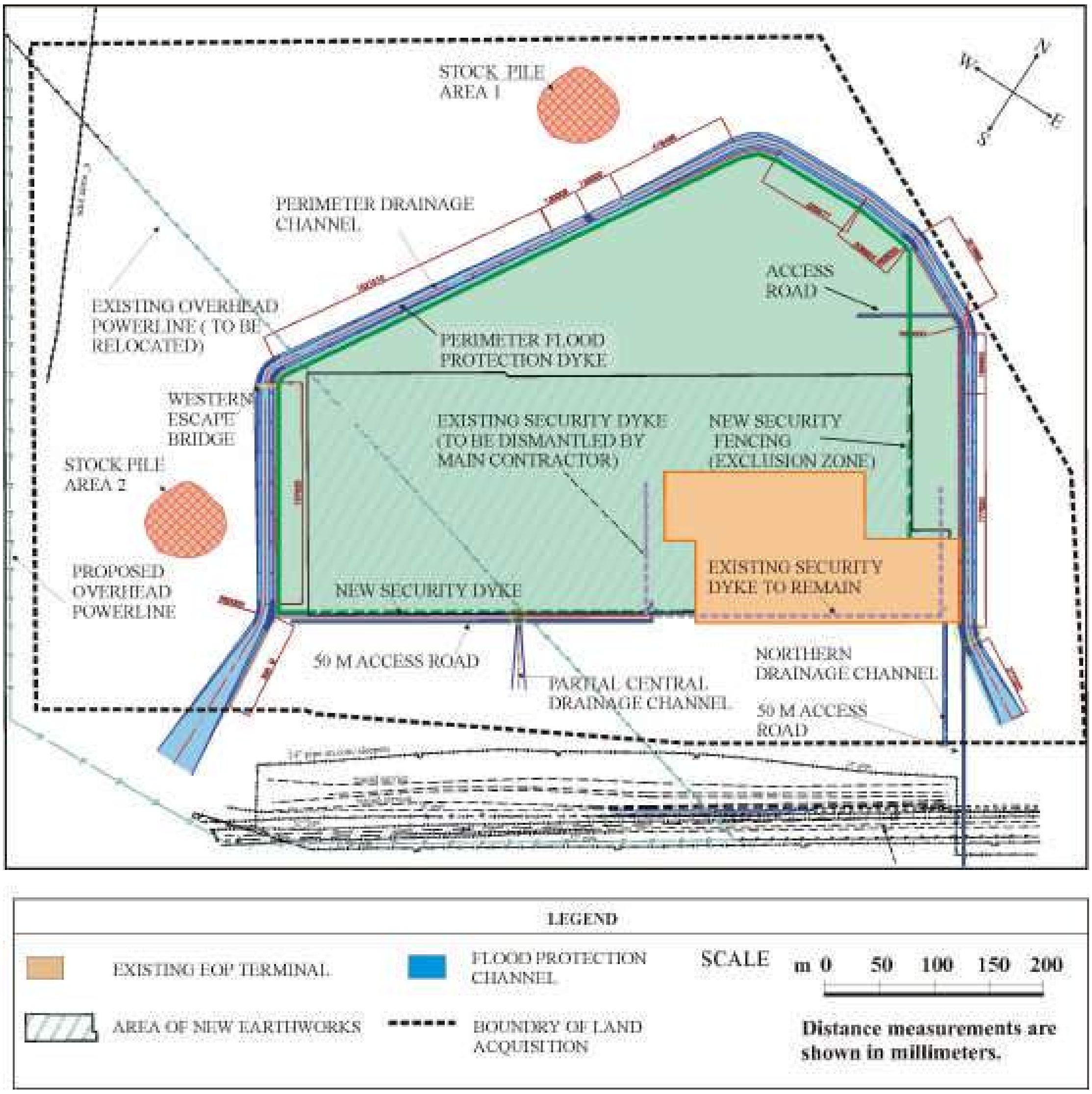
Vegetation clearance and ground levelling for the ACG Phase 1 terminal expansion facilities, Shah Deniz terminal facilities, ACG/Shah Deniz flare area and BTC pump station:	112.3 ha
Construction of the drainage channel (c. 5 ha outside the terminal land take area):	27.5 ha
Construction of the new access road (c. 5 ha outside the terminal land take area):	7.5 ha

Note: 1 hectare (ha) = 10,000 m2

In addition, between 10 and 15 ha will also be affected as a result of materials lay down, bund wall and fencing construction.

The location of ECEWP activities are illustrated in Figure 5.51.

Figure 5.51 Early Civil Engineering Work Programme activities



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 may be 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 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.

5.7.2.1 Wastes

Potential waste streams generated during the ECEWP 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; and
- hazardous liquid wastes such as liquid oily wastes.

It is not possible to quantify the majority of these wastes as tenders to perform the ECEWP are under evaluation. All waste materials 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.

5.7.2.2 Sanitary waste and food waste

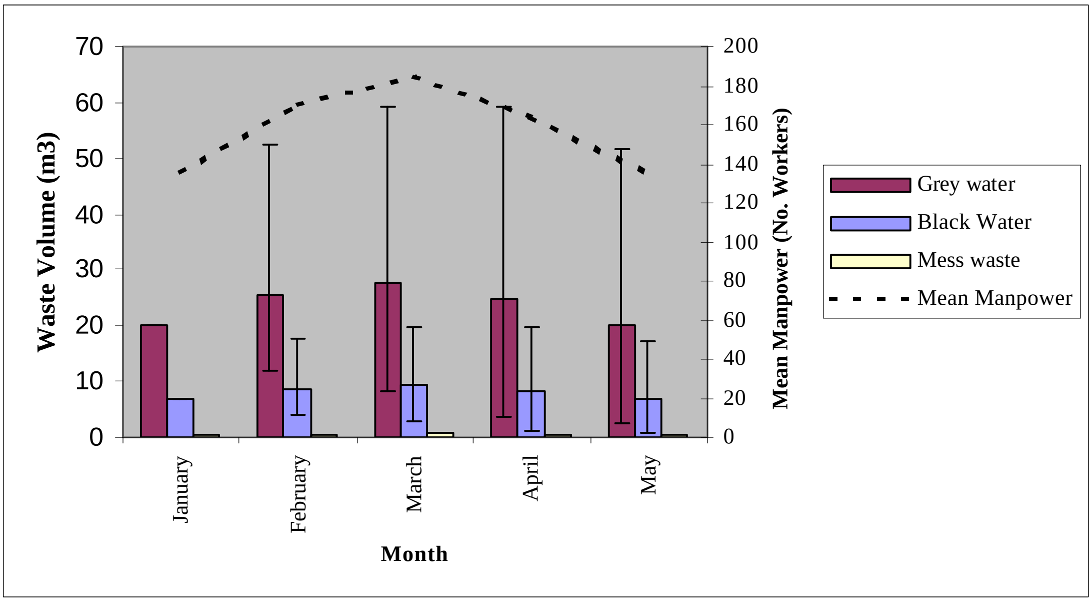
Based on the manpower levels provided by the tendering companies, it is possible to provide an indication of sewage levels during the ECEWP. These are detailed in Figure 5.52.

Grey water, noted in the chart below, represents all washdown and domestic waste waters. . Black water represents sewage, and mess waste represents food wastes (putrescible). The amount of sewage water generated and discharged from the ECEWP depends on the number of personnel present. 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.

Values shown represent mean wastes generated from proposed manpower numbers presented in tenders, which are currently being considered. The range of wastes between tenders is demonstrated as the hi-low bars on the chart. Mean estimated manpower is also included.

Sewage from the ECEWP will be routed to a designated sewage treatment facility. This facility will be used for sewage treatment during the long term operation of the terminal and is discussed in more detail in a later section.

Figure 5.52 Estimated sanitary waste volumes generated during the ECEWP (based on manpower predictions)



5.7.2.3 Emissions to the atmosphere associated with the ECEWP

Atmospheric emissions

The principal emissions to the atmosphere associated with the ECEWP are expected to include:

- airborne particulates (or soil dust) from earth moving operations;
- emissions from mobile construction equipment e.g. cranes, excavators, dumper trucks and delivery vehicles; and
- emissions from stationary sources, e.g. diesel generators.

Plant and mobile plant

Power will be supplied by diesel generators. The construction camp (if required) will have its own generators to ensure a regular power supply.

The following assumptions and equipment requirements have been used as a basis for atmospheric emission estimates :

- 6 month work duration;
- 10 cranes (1m^3 bucket capacity);
- 10 trucks (6 wheeler dump trucks);
- 10 trucks (10 wheeler dump trucks); and
- 5 other main diesel driven equipment.

It was also assumed, as a worst case, that the construction activities will be continuous throughout the early civils works programme with operations lasting for a maximum of 12 hours per day.

The estimated total emissions to the atmosphere are shown in Figure 5.53. Estimated emissions by source are shown in Figures 5.54 and 5.55. As a number of tenders are being considered at this stage of the project development, emissions from construction plant presented below represent a mean value between proposed plant numbers / composition, with the range in emissions presented as high low bars.

Figure 5.53 Estimated total emissions to the atmosphere during ECEWP (tonnes, excluding CO_2 kilotonnes)

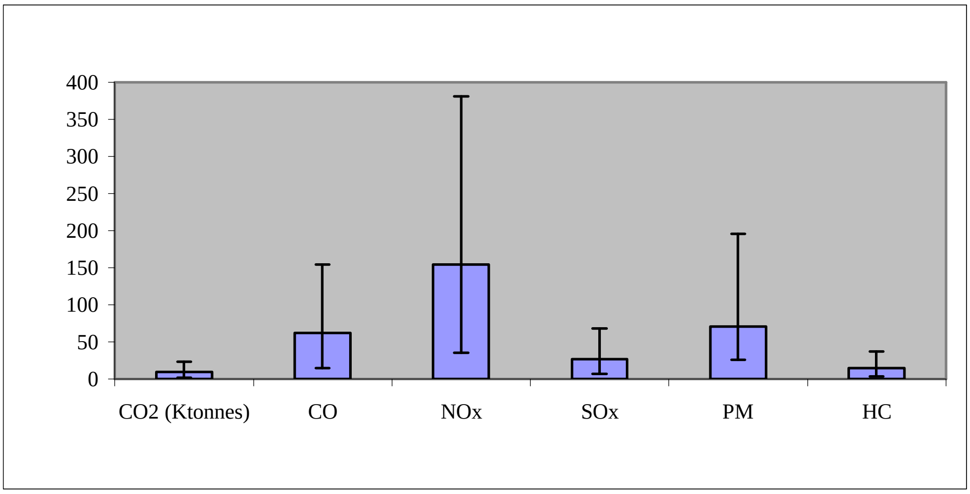
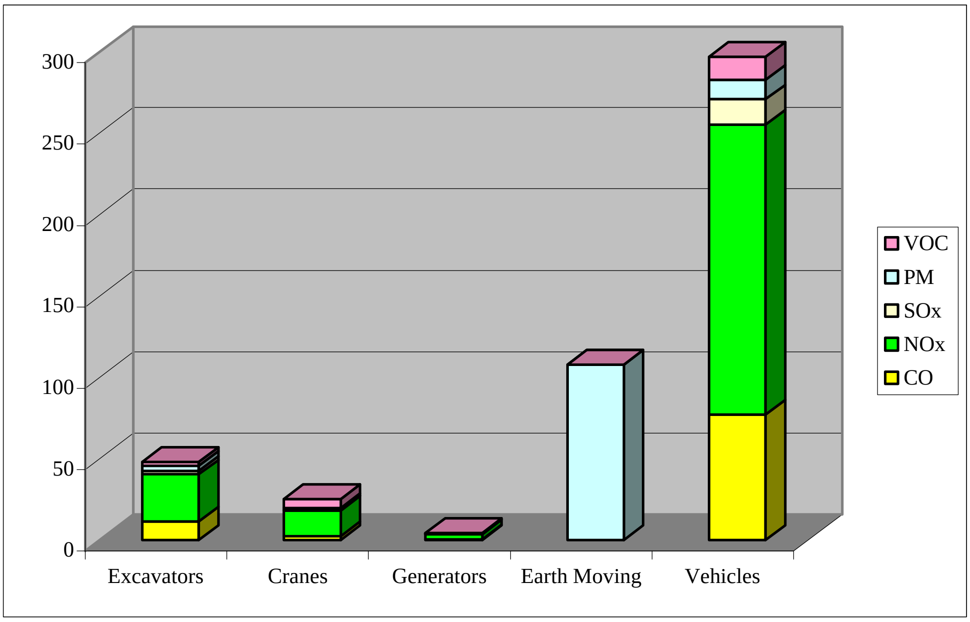
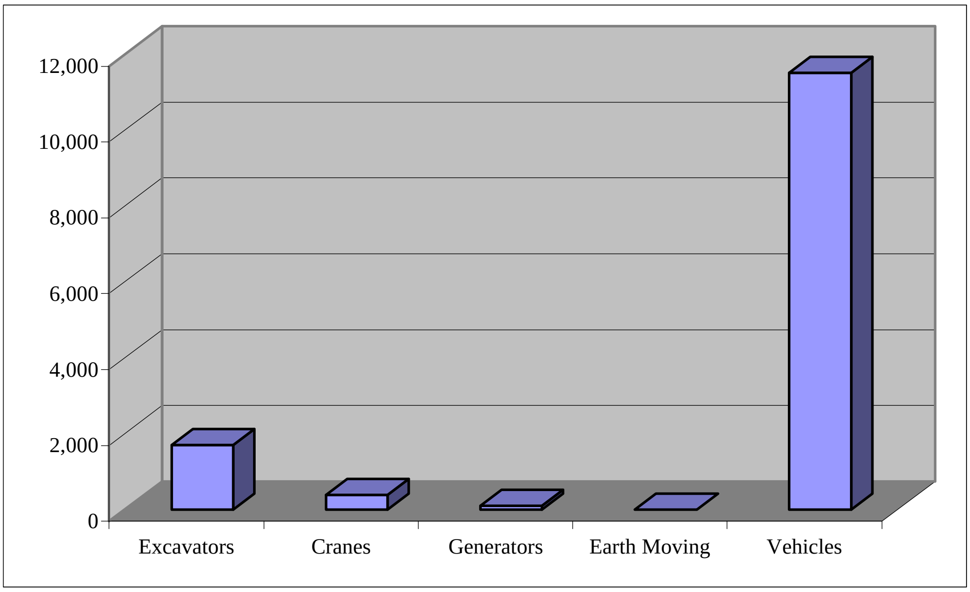


Figure 5.54 Estimated emissions to the atmosphere by species during ECEWP attributed by source (tonnes)



Note: gaseous species are combined for presentational purposes only.

Figure 5.55 Estimated CO_2 emissions during ECEWP attributed by source (tonnes)



Emission factors for each vehicle type were derived from the US EPA Non-road Engine and Vehicle Emission Study Report (NEVES), in addition to the Corinair Atmospheric Emissions Inventory Guidebook. These documents provide internationally recognised and accepted factors, which provide an overestimate (i.e. worst case) of actual emissions in most instances.

Vehicle emissions are anticipated to represent the greater source of emissions to atmosphere. These releases, however, would be distributed over a relatively large geographical area, and would occur over the entire anticipated construction period.

Noise

Noise emissions associated with the ECEWP will arise from a number of sources, including:

- vehicle activity;
- plant and equipment operations;
- earthworks;
- water pipeline laying operations;
- fence piling; and
- road construction.

Noise levels for plant data were calculated using the methodology specified in Section 5.4.4.2 and presented in Table 5.27 below.

Table 5.27 Noise levels for plant proposed for use in the ECEWP

Plant/Activity	Lw[1]	Lp[2]	Plant/Activity	Lw[1]	Lp[2]
Dozer D8	120	92	Loader	111	83
Loader 966	112	84	Dump truck	110	82
Grader 140	112	84	Grader	112	84
Tandem Roller 14t	121	93	Loader	112	84
Crane 20t	116	88	Vibratory loader	102	74
Excavator 214	96	68	Tandem roller	106	78
Excavator 320	108	80	Plate compactor	108	80
Backhoe loader JCB 3X	104	76	Concrete mixer	104	76
Auger attachment 30 cm diameter	-	90	Concrete pump	109	81
Truck 10m[3]	-	82	Concrete vibrator	112	-
Tanker truck 15t	109	81	Water pump	112	84
Gantry crane	109	81	Diesel generator	107	79
Generator	107	79	Mobile crane	109	81
Ambulance	-	-	Truck with crane	116	88
Agricultural tractors (Europe)	99	71	Compressor	100	85
100KVA gensets	110	82			

Notes:
1: Lp - Sound Pressure Level, SPL (Ref 2x10^-5 Pa). Sound pressure measured on the decibel scale. Sound pressure is caused by fluctuations in the steady atmospheric pressure created by sound. It is influenced by external sources, and is what is 'measured' in the field by a normal sound level meter, and what is 'perceived' by a person.

2: Lw - Sound Power Level, (Ref 10^-12 W). Sound power measured on the decibel scale. Sound power is the acoustic power (W) radiated from a sound source. This power is essentially independent of the surroundings, while the sound pressure depends on the surroundings (reflecting surfaces) and distance to the receiver. If the sound power is known, the sound pressure at a point can usually be calculated, while the reverse is true only in special cases (e.g., in an anechoic or reverberation room). So, the sound power is very useful to characterize noise sources and to calculate sound pressure.

New plant and machinery often specify their sound power levels. This is normally displayed as, e.g. "Lw 102dB(A)" within a hexagonal sign. This data is then used to determine the sound pressure level at a certain point. Its major benefit in that the level given is independent of influences, and the data can be used to predict noise levels.

5.7.3 Terminal construction

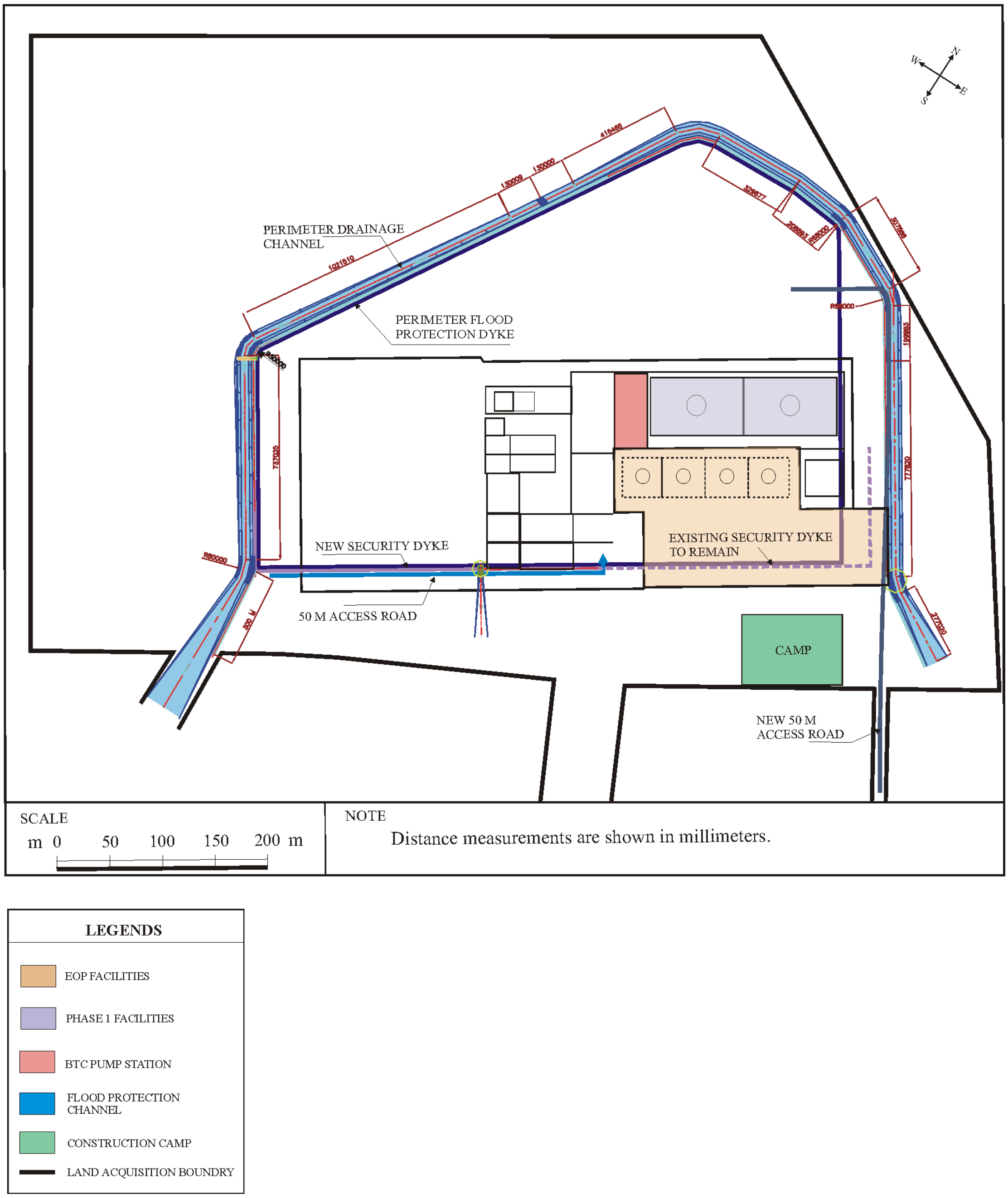
5.7.3.1 Introduction

This section describes the construction and commissioning of the Phase 1 terminal facilities. At the time of writing this document, the construction contractors had not been selected and therefore the proposed construction methods to be used were not available. What follows is a summary of the proposed activities.

5.7.3.2 Construction activities

The proposed layout of the Phase 1 terminal facilities in relation to the existing EOP terminal is shown in Figure 5.56.

Figure 5.56 Proposed layout of Phase 1 terminal facilities in relation EOP terminal



Prior to any construction work at the site a geotechnical survey will have been carried out to determine the foundations requirements for each built up structure, which will be erected at the site.

The majority of the steel, process vessels, pipework and equipment will be manufactured outside of Azerbaijan and will be imported by rail or via rivership through the Russian canal system. Construction materials will be sourced from local Azerbaijani sources wherever possible, assuming suitable cost effective options exist.

The construction work will immediately follow the early civil engineering work programme and is anticipated to begin in June or July 2002. The underground services such as the fire water ring main and the sewer systems, will be constructed first to eliminate any interference from these activities with the above ground activities and allow easy access for the movement of construction vehicles. No underground piping for hydrocarbons are required.

Foundations will then be laid, at this stage it is expected that all foundations for buildings and equipment will consist of spread concrete slabs with the exception of the storage tanks which will require concrete ring beams. The concrete bases for the process plant will then be poured and formed.

Following the installation of the concrete foundations the pipe-racks and structural steel work installation will begin in preparation for the addition of pre-fabricated process equipment and components. Power generation equipment and process equipment will then be installed. Individual pieces of equipment will be installed in the allocated locations and hooked up after installations.

As the structural support preparation continues, the prefabricated components will arrive by road from a variety of sources. As mentioned above, many of the vessels and larger pieces of equipment will be fabricated in Europe and brought into Azerbaijan. As these pre-fabricated components are brought on site they will be positioned and secured in each appropriate location. As more plant is installed, the interconnecting pipe-work, electrical installation and instrument installation will proceed.

Built up structures such as control rooms and administration buildings will be erected at the same time as the mechanical equipment.

Installation of electrical systems and control systems will take place after completion of the mechanical systems as most control equipment needs to be fully integrated with mechanical or process equipment.

Process modules will be commissioned prior to transportation from the terminal site, however, at various stages during the construction of the terminal, non-destructive test methods and inspection will be used to confirm the integrity of the equipment. The hook-up operations at the terminal will be carried out as the mechanical completion takes place and will consist of integration of mechanical, electrical and control systems and testing of the connections. Further to hook-up all equipment will be pre-commissioned (tested in isolation from other equipment) and finally commissioned together with directly associated equipment. Pressure vessels, storage tanks and piping runs will be hydrotested and pump installations checked. Hydrotest waters used for testing and commissioning of the facilities that contain any additives will be contained.

During the testing and commissioning of these facilities, hydrotest water will be moved from tank to tank to reduce the total volume of test water required. It is considered that approximately 8,500 m^3 of hydrotest water (fresh water) will be used and stored in the main storage tanks.

The disposal options for hydrotest water are currently under evaluation and have not been finalised but the base case option is to for injection into a dedicated deep disposal well onshore or possibly transfer to the Garadagh Cement Plant for use in the cement manufacturing process.

Temporary storage facilities may be required to accommodate water if oil storage tanks are not available.

Equipment will be installed at the new terminal in a controlled south to north progression across the new land area. This enables existing operations to be unaffected by confining construction activities to designated areas and has the additional benefit of progressing away from the nearest village into ACG Phase 2 and Phase 3 areas.

5.7.3.3 Construction personnel

Whilst the contractor has not been chosen for the construction of the terminal, it is possible to estimate that the construction workforce numbers will peak at approximately 800 personnel. Employment will gradually build from January 2002 to September 2002, when it will continue at peak levels until February/March 2004. The composition of the workforce will change during the construction programme but it is likely that the proportion of Azerbaijan nationals will represent approximately 75% at the early stages of construction, dropping to approximately 65% towards the end. All attempts will be made to adopt the skill development training programme to maintain a 70-75% Azerbaijani employment ratio.

Tenders are currently being evaluated and specific numbers and sources of personnel cannot be confirmed. However, it is a requirement of the conditions of the contract that a large proportion of the workforce is made up of Azerbaijani national, with people likely to be sourced from the local communities (including Sangachal, Primorsk and Umid camp), as well as from the Baku area and wider Azerbaijan. Additional construction personnel will be sourced internationally with approximately 300 experienced third country nationals (TCN) expected to be required.

The Azerbaijani workforce from the local communities will live in their own homes while working at the terminal construction site. These staff will be transported to and from the site to their home towns. Up to three buses and one minibus will travel daily to and from Primorsk. In addition, one bus will travel to and from Sangachal and two buses and two minibuses will travel to and from Baku.

Personnel from other areas, including expatriates and TCNs will be housed in an accommodation camp to be constructed in a dedicated site within the land acquisition area and to the south of the existing EOP terminal (Figure 5.56). The camp will be sized for a maximum of 500 workers and will be fully equipped with office block, storage area, training facility comprising classroom and outside training area, residential quarters, medical facilities, recreational facilities and will be available for the start of the main construction activities.

The terminal acquisition area will be maintained as a restricted access area after site clearance. The bund and drainage ditch built during the early civil engineering programme 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 seaward side of the terminal will be bounded by a security wall also built during the early civil engineering programme. 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.

5.7.3.4 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, however a back-up supply will 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 and these will be installed during the early civil engineering work programme. The 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 waste water

Wastewater will be collected in a sump (septic tank) and a macerating pump will be used to transfer wastewater to camp waste stabilisation ponds for the life of the construction. It should be noted that the terminal during operation will require wastewater treatment facilities for up to 100 people following FFD and for a period of potentially over 40 years. The construction camp, however, will require treatment facilities for up to 1,000 people over an anticipated period of two to three years for Phase 1 and a further five to six years for ACG Phase 2 and Phase 3 terminal construction activities. It is not feasible for a wastewater treatment plant (WTP) designed to treat wastewater from 1,000 people to subsequently be 'turned-down' to treat wastewater from only 100 people or less (even if several parallel units are used).

The WTP will be designed to treat sewage and waste water effluent to a standard as to ensure that the following levels are not exceeded; BOD of 25 mg/l, COD of 150 mg/l, 400 MPN/100ml total coliforms, 0.1 mg/l phenol, 0.35 mg/l sulphide, 10 mg/l ammonia, 3 mg/l total toxic metals, 0.2 mg/l residual chlorine, 19 mg/l oil and grease daily average and 10 mg/l monthly average. The building of the construction camp together with its WTP will be one of the first construction activities to be undertaken. It is proposed that during the life of the construction camp the terminal wastewater be pumped to the camp WTP thereby allowing the installation of the WTP for the terminal to be delayed until the construction camp and its WTP are no longer required.

Isolated toilets and washing facilities would drain to local cess tanks which would be drawn down by tanker every two to three months for discharge into the terminal sewage treatment plant (with appropriate dilution and flow balancing).

The project environmental design standards dictate that the WTP produces an effluent of good standard and there are several wastewater treatment options that could satisfy these requirements. However, simplicity of operation and suitability for long-term operation with minimal maintenance and with minimum risk to effluent quality are key factors in choice of plant for Sangachal and these factors strongly influence the recommended process. Additionally, it is important that plant operatives be able to operate the plant with no more than a basic knowledge of the treatment process.

With construction, operation and maintenance simplicity in mind and taking into account both sludge handling/disposal and effluent disposal the following is the option under consideration for treatment and disposal of wastewater from the construction camp:

- wastewater treatment by a waste stabilisation ponds system;
- water effluent disposal by:
  - trickle irrigation of trees and shrubs either in a plantation area or around the terminals and/ or the construction camp; and
  - dust suppression during the terminal construction phase (with chlorination because of increased likelihood of worker contact).

When the camp has less than 500 people i.e. at the commencement of construction, or if the camp's anticipated full occupation is not achieved, then only one pond stream need be put into use. The second stream, if constructed, would serve as standby and need only be put into use when the camp occupancy exceeds 500.

For a population of 1,000 people, two parallel streams comprising three ponds in each would be adequate. The first (facultative) ponds in each stream would be a nominal 70 m x 20 m. Inflow should be passed through a coarse bar screen for capture of large debris. Grit removal is not normally required. The subsequent (maturation) ponds would be a nominal 20 m x 20 m each. The location of the ponds are likely to be adjacent to the construction camp.

Sludge would accumulate in the first ponds and would require removal after about five to six years or longer. The sludge would be well stabilised and may be suitable for spreading on agricultural land. An alternative to sludge removal on this timescale would be to construct replacement first pond(s) and leave the sludge to dry out for future utilisation.

5.7.3.5 Other solid and liquid 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 AIOC's Waste Management Procedure.

5.7.3.6 Terminal construction emissions and discharges

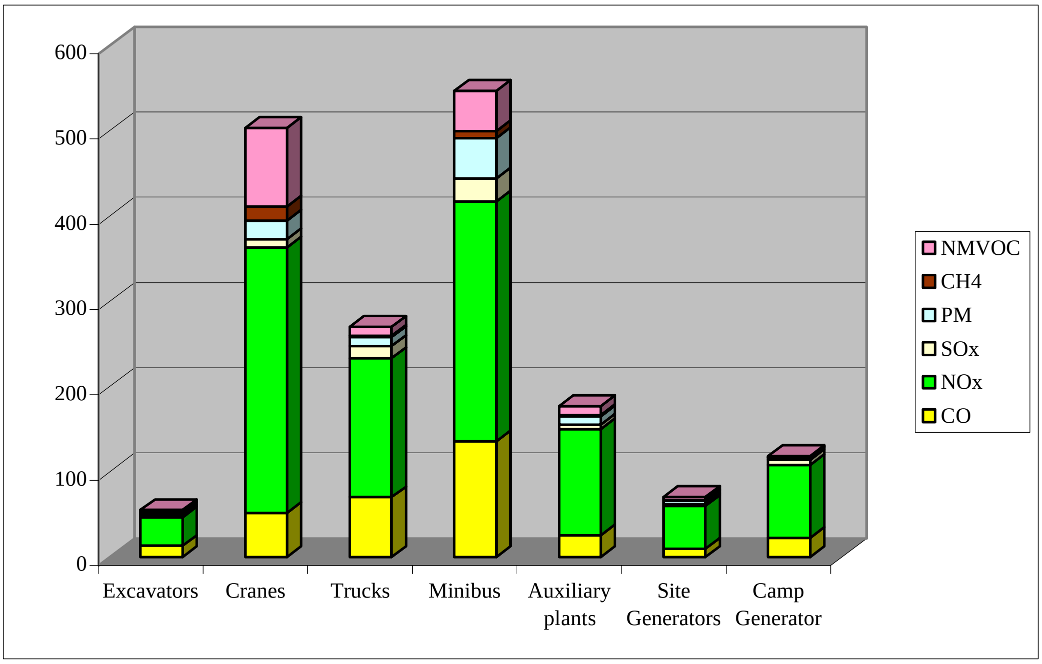
Atmospheric emissions

The principal atmospheric releases associated with the Phase 1 terminal construction activities are expected to include emissions from:

- earthmoving operations;
- construction and delivery vehicle emissions (diesel powered equipment, cranes, excavators);
- cranes;
- power generation at construction camps;
- welding fumes and paint fumes; and
- construction power generation.

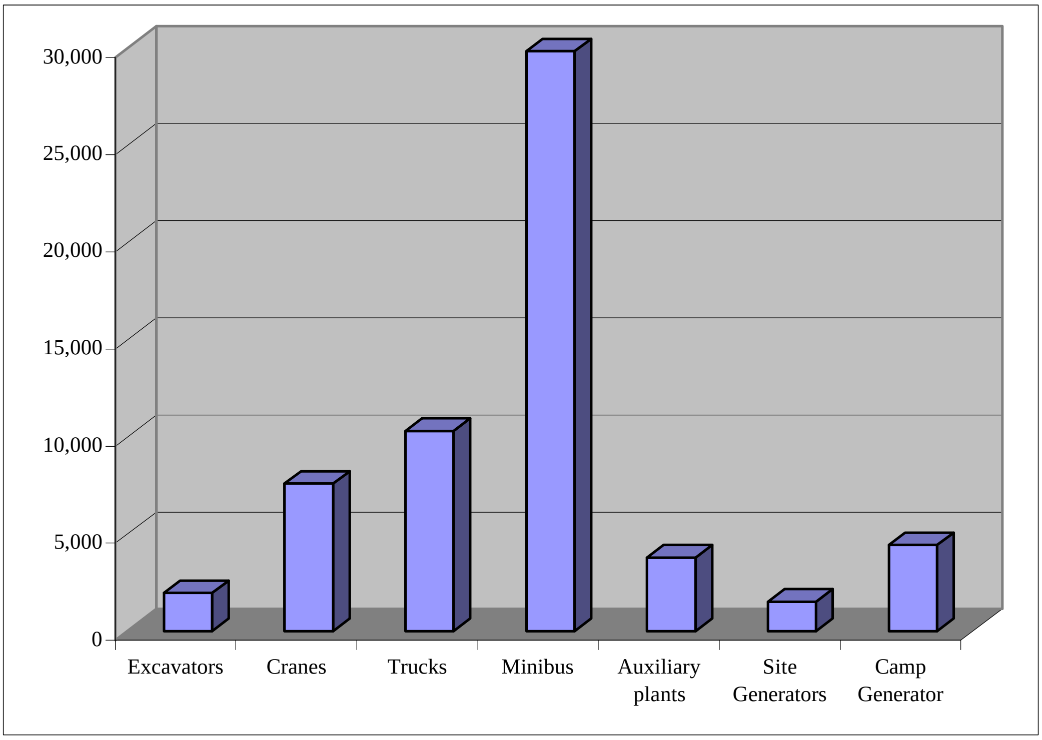
The estimated emissions to the atmosphere for all plant and facilities engaged in the construction programme are presented in Figures 5.57 and 5.58.

Figure 5.57 Estimated total emissions to the atmosphere by species during the Phase 1 terminal construction programme attributed by source (tonnes)



Note: gaseous species are combined for presentational purposes only.

Figure 5.58 Estimated total CO_2 emissions during the Phase 1 terminal construction programme (tonnes)



Construction dust

The movement of soils during the ECEWP and terminal construction activities are predicted to lead to the generation of soil dust. The occurrence and significance of dust generated by earth moving operations is extremely difficult to estimate and depends upon meteorological conditions at the time in addition to the location of earth moving.

Noise emissions

Noise emissions associated with the Phase 1 terminal construction activities will arise from a number of sources including:

- site grading;
- foundations and underground services installation;
- building access roads and parking areas;
- building construction; and
- operation of the construction camp.

The number of plant and their respective sound power and sound pressure level, according to BS 5228, is provided in Table 5.28 below.

Table 5.28 Noise emission level of plant

Plant	Sound Power Level (L_W) - dB	Sound Pressure Level (L_P) as 10m L_{Aeq} – dB	BS 5228 Reference
Cranes(x5)	109	81	C6.18
Trucks(x10)	98	70	C7.121
Trucks(x10)	105	77	C3.59
Compactors(x5)	108	80	C3.118
Excavators(x5)	109	81	C3.89
Generators(x4) 500Kva	104	76	C7.49
Pick-ups(x10)	-	-	No Data available
Buses(x5)	-	-	No Data available
Cars(x20)	-	-	No Data available
Auxiliary plant(x10)	-	-	No Data available

Sewage wastes

Sanitary waste will be generated throughout the duration of the terminal construction activities. The key assumptions for deriving the estimated amounts of sanitary waste generated are listed below:

- an average 600 construction workers on site throughout the duration of the works;
- 30 months construction activities;
- each construction worker will generate 0.22 m^3 / day of grey water;
- each construction worker will generate 0.10 m^3 / day of black water; and

Table 5.29 Estimated amounts of sanitary waste generated construction operations

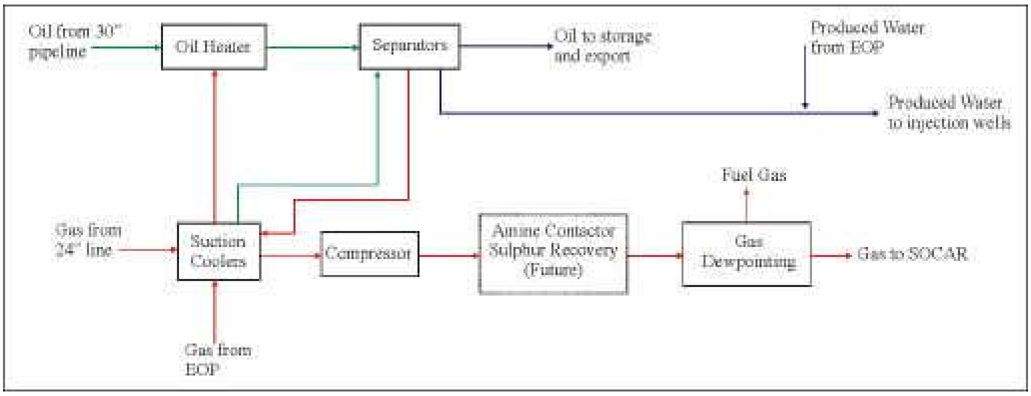
Parameters		Emissions
No of days		**900**
Grey water (m^3)	Per day	**132**
	Total	118,800
Black Water (m^3)	Per day	60
	Total	54,000

5.7.4 Terminal operations

The Phase 1 terminal expansion facilities will comprise of oil reception and new processing facilities to stabilise the crude oil received at the terminal prior to export. Reception facilities for gas will be minimal and will consist of gas reception and gas dewpoint facilities. The process at the terminal site is described below.

A simplified process flow diagram illustrating the terminal process is shown in Figure 5.59.

Figure 5.59 Simplified Phase 1 terminal process flow diagram



5.7.4.1 Oil process

The expansion will consist of two new oil stabilisation and a dewpoint plant that will operate in parallel to the existing facilities installed as part of the EOP. The additional oil processing facilities will comprise oil reception, water removal and oil stabilisation. An off-spec crude oil tank is provided to store wet or under stabilised crude for later re-run through the process. Additional oil storage tanks will be installed to store the stabilised crude oil prior to metering and export.

The two new parallel oil processing trains will have a nominal capacity of 175,000 bpd per train and each train will consist of the following major equipment:

- direct fired heater;
- Medium Pressure (MP) separator (2-phase);
- Low Pressure (LP) separator (2-phase)
- electrostatic coalescer (liquid filled, 3-phase)
- crude oil pumps;
- crude oil rundown air coolers;
- produced water pumps; and
- a potential stripping column for H_2S removal.

The direct fired heaters will be utilised to heat up the incoming fluids from the subsea oil pipeline to the temperature required for efficient stabilisation and water removal from the crude oil.

The MP separators will be the first stage of flash separation in the stabilisation process. These vessels will also be equipped with online sand jetting internals to allow removal of sand that settles out of the received pipeline fluids as a result of the temperature increase/oil viscosity reduction provided by the heaters. The operating pressure of the second stage suction flash gas compressors will be set to correspond to the pressure in the MP separator.
The LP separators will be the second stage of flash separation in the stabilisation process. The operating conditions of these vessels dictate the final vapour pressure of the stabilised crude product. The LP separators must also effectively degas the crude to allow for efficient operation of the downstream liquid filled electrostatic coalescers.

The electrostatic coalescers are liquid filled oil-water separators that reduce the inlet water content to meet the final required crude product spec. These vessels utilise a combination of residence time and electrostatic fields, which coalesce small water droplets to assist their removal via gravity settling. The coalescers are also required to remove most of the entrained oil from the separated produced water phase to reduce the "oil loading" on downstream produced water handling/disposal facilities.

Oil will be delivered into onsite storage tanks, prior to pipeline transport. The facilities will enable flow of processed oil from either of the two Phase 1 oil stabilisation trains and the EOP oil stabilisation train into any oil storage tanks. As a base case two new 500,000 bbl capacity crude oil storage tanks, equipped with external floating roof tanks and low loss fittings, will be installed. An option for two 800,000 bbl capacity tanks are being considered. In addition the existing three EOP oil storage tanks (nominal 160,000 bbl each) will be retained in oil service, giving a total oil storage volume of approximately 1.5 million barrels of oil. The oil storage and export booster pumps will be manifolded to provide maximum export flexibility and allow the flow of oil from any oil storage tank into any of the three crude oil export pipelines.

A 30,000 bbl storage tank with 15,000 bpd rerun pumping capacity will be provided to process off-spec crude from the back end of the oil processing trains. No extra allowance has been included in the sizing of the oil trains for rerun capacity. This off-spec tank can also be used as a "dump tank" to allow temporary diversion from the terminal inlet in the event of a train shutdown, to minimise disturbance/shutdown of the offshore producing platform(s). This tank will service both Phase 1 oil trains and the EOP oil train. The existing EOP dump/off-spec tank will no longer be required for this service.

5.7.4.2 Flash gas compression

Flash gas recovered from the Phase 1 oil processing trains, as well as the flash gas from the EOP oil treating facilities, will be handled using two 50%, 3-stage, 7.0 MW, electric motor driven flash gas compressors with a nominal capacity of approximately 25 MMscfd each (net flow after final discharge scrubber). Due to the potential uncertainty surrounding the amounts of the relatively small volumes of flash gas that will be liberated from the oil, a margin of 15% (each) will be added to the simulation flash gas volumes and liquid recycles for compressor sizing. Flash gas will be compressed and combined with the free gas from the subsea gas pipeline. The combined gas stream will undergo a dewpoint control process by refrigeration treatment to meet the required gas delivery specification prior to handover to SOCAR at the terminal boundary limit. Facilities will be sized to handle a flow rate of 250 MMscfd.

The mechanical refrigeration plant will recover C4+ liquids from the combined gas stream in order to achieve the hydrocarbon dewpoint specification. Recovered liquids will be stabilised and blended with crude product from the oil trains upstream of the crude storage tanks. The refrigeration plant will also dehydrate the feed gas to the required specification via low temperature operation and ethylene glycol injection. Glycol still vapours will be tied into the LP flare system, which will allow subsequent recovery of these vapours via the flare gas recovery system.

5.7.4.3 Chemical injection

Dedicated chemical storage tanks will be installed at the terminal with skid mounted injection pumps provided. Chemical storage tanks will be refilled from road tankers/barrels or tote tanks and Intermediate Bulk Containers.

The following chemical injection facilities will be provided:

Chemical	Dose (ppmv)	Tank (vol m^3)	No of Days Supply
Methanol	200 l/h	4.5	Start-up
Demulsifier	20	22	14
Antifoam	5	4.5	14
Corrosion Inhibitor	50	1.5	7

It should be noted that methanol will only be required during start-up. Spare facilities are also provided for wax inhibitor and scale inhibitors if these are required.

5.7.4.4 H_2S treatment

Hydrogen Sulphide (H_2S) has been detected in earlier wells drilled in the ACG field (wells GCA-2 and GCA-6) and because of this terminal design has considered the possibility of encountering the presence of H_2S in the fluids arriving onshore. The terminal design includes space requirements for provision of future installation of H_2S removal facilities if and as required. H_2S concentrations will be defined from well tests planned for during the template well drilling programme to determine whether an H_2S removal facility and sulphur recovery plant will be required. It is anticipated that, if required, gas sweetening will use a selective amine process on the combined gas stream to satisfy gas delivery specifications. The sulphur recovery system has yet to be evaluated.

5.7.4.5 Produced water

The base case option for the disposal of produced water, recovered as part of the oil stabilisation process, is injection via dedicated deep injection wells and/or by transferring it to the Garadagh Cement Plant for use in the cement manufacture process. A storage tank is provided with a capacity of 125,000 barrels, oil skimming facilities are provided. This equates to more than five days of produced water storage assuming the presence of a maximum 5% water in the oil inlet to the Sangachal Terminal, and a maximum flow rate from the offshore oil pipeline of 490,000 bpd. Produced water will undergo only primary separation treatment prior to disposal.

At peak Phase 1 oil production, the produced water generated at the terminal from the oil stabilisation process is anticipated to be approximately 19,000 bwpd with a cumulative disposal for the life of the project of up to 61 million barrels. Disposal by injection onshore envisages injecting the produced water into the aquifer of the Lokbatan field via two dedicated disposal wells. Studies are underway to identify the exact location of the injector sites.

The concept for disposal is to collect and store the produced water in a single tank at Sangachal Terminal, and transport it by an overland pipeline (to be installed) to injection wells drilled on the southern flanks of the Lokbatan structure. The produced water will be injected into the sandstones of the Balakhany and Pereriv Suites at depths of between approximately 2,300 – 3,000 m. The reservoir quality of the Balakhany and Pereriv sands is excellent and is suitable for produced water injection. Injection will be via “high pressure” dedicated water disposal wells, which will be positioned as far from existing wells as possible, to minimise any interaction between the water disposal activity and the oilfield itself.

At the disposal site, additional wellhead pumping facilities may be constructed to initially hydrofracture the reservoir and then to supply sufficient down hole pressure to accommodate the anticipated volume of produced water.

The produced water pumping system will be installed with one pump spare on standby. The overall system availability will be designed to be running for 95% of the time in any given year, consistent with the oil processes both offshore and onshore.

At the time of writing, the detailed design of both the surface and downhole disposal well completions have not been concluded. On completion of the drilling, fracture initiation is likely to be performed by a pump. Once the formation has been broken down, subsequent fracture opening should occur at a lower pressure (assuming that the rock had some tensile strength to begin with). Injection pressures at surface will be controlled by a series of pumps installed at each well head. Where possible, surface and downhole injection pressures will be kept to a minimum. The required downhole disposal flow rate and the hydrogeological properties of the aquifer will control the magnitude of these injection pressures.

5.7.4.6 BTC pump station

The proposed BTC facilities within the terminal plot will include a metering pump station, pig launcher and local utilities.

Booster pumps located in the terminal will deliver the ACG crude oil from storage via metering and pipeline flow control systems to the initiating pump station, situated within the boundary limits of the terminal.

Crude oil metering is required for custody transfer and leak detection. Each custody metering facility will comprise four turbine meter runs, plus one operational spare run.

5.7.4.7 Personnel

During routine operation it is anticipated that approximately 20 positions will be created at the terminal, requiring approximately 35 personnel as there will be some elements of shift work.

5.7.4.8 Transport

It is anticipated that personnel will travel to the site by car or possibly minibus and the projected levels of transport are between 20-30 vehicles travelling to site each day. In addition to this regular personnel transport there will be a requirement for goods delivery on a regular basis for the provision of spare parts, chemicals, consumables, office equipment and stationary and food etc. In addition there will be a requirement for regular transport from the site of waste, to an approved waste disposal facility.

5.7.4.9 Terminal utilities

Terminal utilities to support the processing requirements for both the oil and gas facilities will be required. Some of these utilities will tie-in to the existing EOP facilities as appropriate, where there is spare capacity in the EOP utilities, or a given utility is required on an intermittent basis only, these utilities will be utilised to supply Phase 1 terminal requirements

New central control room

The new control room will be used for the operation of the Phase 1 terminal facilities, Western Export Route (WER), Northern Export Route (NER) and EOP control functions and will have the ability to control BTC operations. Should the Shah Deniz project be sanctioned, the scope of the new control room may also be expanded to include the control of the Shah Deniz facilities.

Power generation and distribution

Power for the terminal will be generated by three 28 MW 50% gas turbine driven generators. The gas turbine generators will be dual-fuel capability machines designed to allow retro-fitting of waste heat recovery units. The gas turbines are designed to run on HP fuel gas or diesel. The option to retrofit to gas only Dry Low Emission (DLE) NOx turbines at a major engine change out will be incorporated. In addition, a 2 MW emergency generator, driven by diesel engine, is supplied for essential electrical loads.

Fuel gas

Export gas with a High Compression dewpoint specification will be supplied at high pressure to the fuel gas system. The HP gas is pressure regulated, superheated, filtered and supplied to the power generation gas turbines. Fuel gas will be supplied for EOP and Phase 1 users.

The HP fuel gas system will supply the LP fuel gas system via a pressure reduction station. The LP fuel gas system users will include:

- oil heaters;
- flare pilots;
- off spec crude oil tank blanket;
- closed drains drum blanket;
- produced water storage tank blanket;
- glycol regeneration package within gas dewpoint plant; and
- heating medium heater (dewpoint plant).

All equipment and controls for the HP fuel gas system will have 100% standby units to ensure availability. The fuel gas drum will be sized for 30 seconds demand by two off power generators at peak load to provide time to switch to alternative fuel source (diesel) should the main fuel gas supply fail. The fuel gas drum will not be spared, to ensure availability the fuel gas drum will have a bypass line to facilitate internal inspection for pressure system regulations. Should the supply of dew-pointed export gas be unavailable, terminal fuel gas will be obtained upstream from the subsea gas pipeline outlet. Peak fuel gas consumption is expected to be 45 MMscfd.

Diesel

The existing EOP diesel system will be employed. Diesel storage will be provided to supply one off power generation for the gas turbines for 48 hours at peak load. Diesel is also supplied to the Emergency Power Generator Day Tank and for flushing of closed drains lines from the pig receiver.

The diesel will be offloaded from road tankers by hose and stored in a 400 m^3 storage tank. A diesel treatment facility will be provided to improve the local diesel quality for use in the gas turbines. The diesel treatment facility is capable of continuous supply of treated diesel to the two gas turbines at peak load. Diesel supply capacity will be 16 m^3/hr under normal conditions.

In addition, the Phase 1 system will be cross-connected to allow the supply of treated diesel to the EOP and Shah Deniz diesel systems as required.

HP & LP flare systems

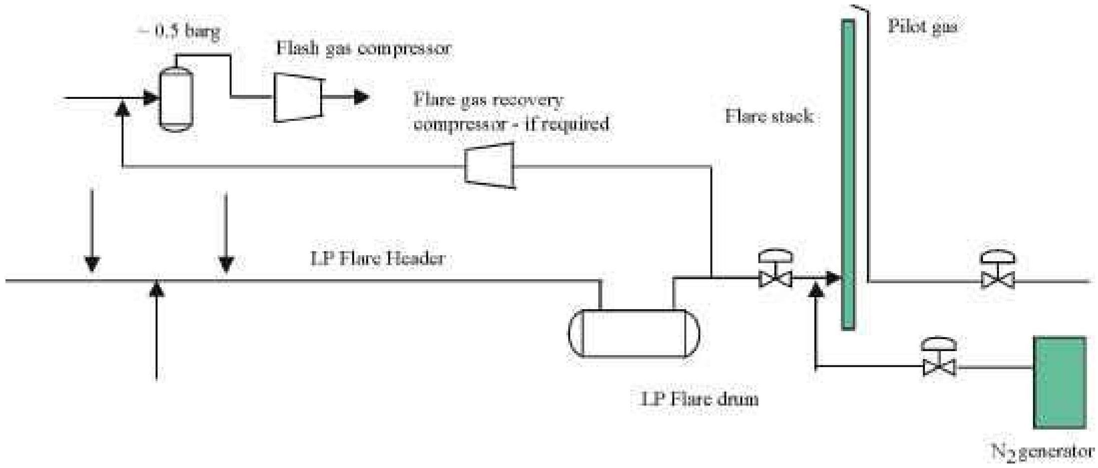
The HP flare system maximum flaring capacity at the terminal will be 100 MMscfd, which is the anticipated onshore associated gas rate for ACG FFD. There will be no routine flaring at the terminal under normal operating conditions. Non-routine flaring may be required due to some or all of the processing facilities being out of service or running at different conditions from the normal operating design, this may include periods of whole or partial plant start-up or shutdown and in the whole event of loss of the gas export route to SOCAR oil production may continue and associated gas could be flared, subject to flaring limits to be defined in an operational flaring policy.

The HP flare system operates at slightly higher pressure than the LP separator. A flare gas recovery system will be installed which will direct recovered gas that would normally be flared (for example from vents, drains, valves and seals) to the 1st stage gas compressor's suction.

The LP flare system capacity will be 70 MMscfd, based on flaring from one separator train due to gas compressor maintenance and a second compressor tripping. A flare gas recovery compressor will discharge into the 1st stage gas compressor's suction.

All liquids will be recovered in a Flare Knock Out Drum and will be pumped to the Closed Drains Drum and from there to the LP Separators or Off Spec Crude Oil Tank. To minimise emissions associated with fuel gas purging, the flare headers/stacks downstream of the flare gas recovery systems will be purged with inert gas. A flaring policy will be defined for the operating phase of the project. This policy will be agreed with the AIOC partners and will stipulate the maximum duration, or annual limit of gas flared, in the event of a plant upset or inability of SOCAR to take gas sent ashore, prior to production shut down. The flare gas system is illustrated in Figure 5.60.

Figure 5.60 Onshore flare gas system



Atmospheric vent

There will be no atmospheric vent system. Non-hazardous utility systems will have local vents to atmosphere, which will be located in positions that are safe for all personnel.

Potable/fresh water

Potable water users will be supplied from the existing EOP potable water system. The Phase 1 system will comprise distribution piping only with a cross connection fitted to supply potable water to Shah Deniz in the future. The potable water distribution system will be designed to be readily expandable to accommodate ACG FFD. The main potable water users will include:

- the new control building;
- Phase 1 (and Shah Deniz) safety showers/eyewash units;
- laboratory, kitchen and toilet facilities;
- Phase 1 (and Shah Deniz) utility stations; and
- BTC head pump station utility stations.

Fire water

The existing EOP firewater pumps will be used to supply the ringmain extension for Phase 1. Shah Deniz will also be supplied with firewater by extension of the Phase 1 ringmain with connections provided to accommodate ACG FFD. The capacities of the existing pumps are adequately sized for the Phase 1 and Shah Deniz facilities. EOP has two firewater storage tanks, each with a capacity of 4,700 m^3. A new firewater storage tank will be installed for Phase 1 giving an additional 5,000 m^3 of firewater storage. All firewater tanks will be re-filled using the existing EOP raw water supply line. In addition, foam systems will be provided adjacent to the crude oil storage tank area for tank seal fire fighting.

Instrument and plant air

Compressed air will be provided by two 100% air compressors to the plant air, instrument air and inert gas systems. A plant air (wet) receiver will be provided to smooth any step changes in demand. Instrument air will be dried by a heatless regeneration air drier package and supplied via an instrument air (dry) receiver. The compressed air supply to the instrument air system will be prioritised under pressure control, plant air and inert gas systems will be isolated on low instrument air pressure. The compressed air systems will supply Phase 1 and

BTC pipeline loads and the systems will be designed to be readily expandable to accommodate future ACG FFD.

The instrument air system may be connected to Shah Deniz in the future via a normally open crossover line. An automatic shutdown valve will be provided to protect ACG supply in event of low pressure in Shah Deniz. The plant air system may also be provided with a crossover line to Shah Deniz in the future but the line will be closed under normal operations.

Inert gas

Inert gas will be generated on demand by a membrane package using wet compressed air. The system will be designed to be readily expandable to accommodate future ACG FFD. Main inert gas users will include:

- compressor seals;
- methanol tank;
- utility stations; and
- flare stack purge.

Waste heat recovery/heat medium

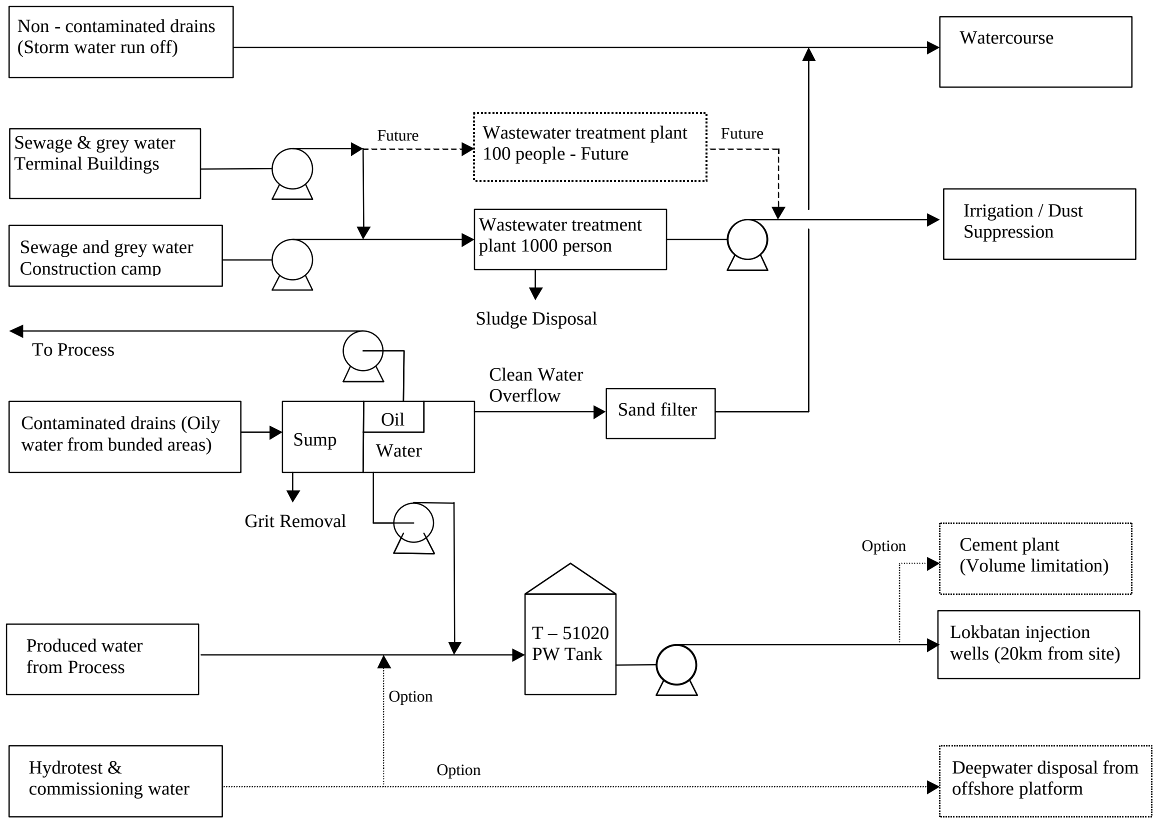
The hydrocarbon dewpoint control plant will require 10 – 15 MMBtu/hr of reboiler heat input for the depropaniser column. This heat is best supplied via a heat medium system, for example, hot oil. Another potential heat medium user is the ethylene glycol regenerator, which will be part of the dewpoint plant. Total potential heat load is estimated at 13 – 18 MMBtu/hr. Additional future users could include an amine unit and sulphur plant, if significant concentrations of H_2S are found in the hydrocarbon streams.

The heat source for the heat medium system could be obtained from either a dedicated, fired heat medium heater, or waste heat recovery from the terminal power generation exhaust. Due to the relatively low heat requirements that are currently defined for the hydrocarbon dewpoint plant, as well as the low anticipated incremental impact of the additional fuel gas consumption required, a dedicated fired heat medium heater has been selected in the base case design at this time. If future information indicates the requirement for H_2S treatment and sulphur recovery, the preferred option for total process heating requirements will likely be waste heat recovery from the power generation gas turbines.

Sewage treatment

The present sewage treatment facilities for the EOP terminal will not be sufficient to treat the increased sewage volumes anticipated during operations, and a new water treatment plant will be constructed and commissioned. The new plant will service the main terminal buildings. The disposal route for treated effluent will be irrigation or disposal to a licensed facility. A flow diagram illustrating the recommended wastewater treatment system for the terminal is shown in Figure 5.61.

Figure 5. 61 Recommended wastewater treatment system



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 EU standards as a minimum for the operational phase.

Drainage

Closed drains

All drains from systems containing hydrocarbons will be routed to the closed drains system. The Closed Drains Drum will be designed with a working volume of 10 m^3, sized to accommodate the maximum drainage volume from a single item of equipment, except for the Off Spec Crude Oil Tank and Coalescer drainage volumes, as these are very large. Drainage rates will be controlled by the Operator.

The liquid from the Closed Drains Drum will be pumped back into the LP Separators with an alternative route to the Off Spec Crude Oil Tank. Two Closed Drains Drum pumps designed to pump 15 m^3/h each will be installed. The Closed Drains Drum will contain a sand jetting system and will have a fuel gas blanket and is connected to the LP Flare system.

Open drains

Open drains will collect wash down and run off water from all paved process equipment areas in the terminal. All non-contaminated drainage will be diverted to the drainage channel constructed at the terminal.
The design philosophy for open drains is that contaminated water sump sizing basis is to contain the first 10 minutes of water during design rain storm (25 mm/hr), this "first flush"

water will be classified as contaminated. Following the 'first flush' the rainwater will be classified as non-contaminated and will pass through the sump and into the non-contaminated drains system via a sand filter.

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.

The drains management philosophy for the terminal design is as follows:

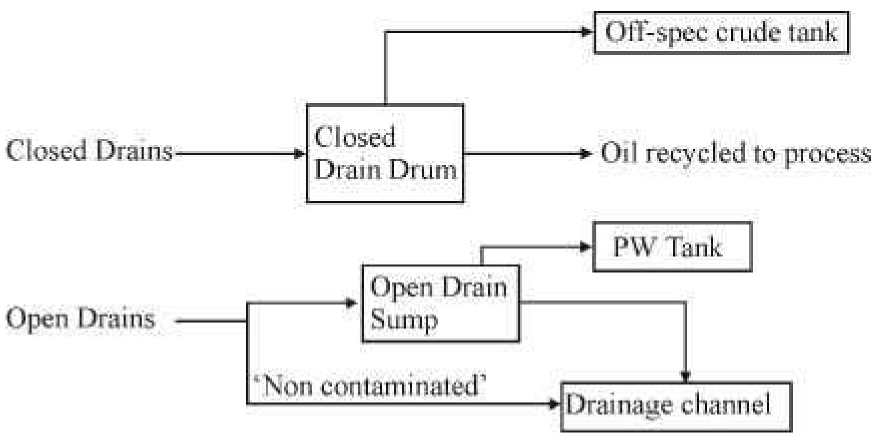
- small amounts of oil or chemicals left in bunds will be considered to be removed by "first flush" during design rain storm;
- bunded areas containing significant amounts of water soluble chemicals will be manually isolated from contaminated drains system;
- large spills of chemicals will be trapped 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;
- release of water from bunded chemical handling area following heavy rain to be manually controlled;
- 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. Release of water following rain to be manually controlled.

These will be implemented through operational procedures.

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. 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 5.62.

Figure 5.62 Terminal drainage system



5.7.4.10 Solid and liquid wastes

Wastes generated by the terminal operations will be classed into one of the following categories and stored in appropriate skips or containers before being sent off-site for disposal:

- 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.

Table 5.30 Estimated waste types and volume (tonnes)

Category/Waste type	Annual Waste Generated			
	<1 Tonne	<10 Tonne	<100 Tonne	>100 Tonne
Non-Hazardous Combustible Solid Waste				
Paper and cardboard	¨			
Wood		¨		
Non-Hazardous Non Combustible Solid Waste				
Inert (e.g. building rubble)		♦		
Scrap metal		♦		
Wire rope, slings, netting	♦			
Electrical wire	♦			
Hazardous solid waste				
Sand/shotblast materials			♦	
Absorbents (spill clean-up)	♦			
Batteries	♦			
Transformers		♦		
Capacitors	♦			
Clinical waste	♦			
Radioactive	♦			
Empty drums (metal and plastic)		♦		
Filters		♦		
Rags		♦		
Resins		♦		
Hazardous liquid waste				
Greases		♦		
Hydraulic fluid			♦	
Oil				♦
Lubricants			♦	
Diesel		♦		
Paints	♦			
Thinners	♦			
Coatings	♦			
Solvents	♦			
Acids	♦			
Alkalis	♦			
Firefighting agents		♦		

Liquid waste will also be generated during the terminal operations. Liquid waste such as lubricating oil and residual oil from the oil / water separator will be stored on site prior to disposal. Other liquid waste such as detergents used for cleaning purposed (i.e. turbine blades washing waste) will also be temporarily stored prior to disposal offsite.

5.7.5 Terminal operations emissions and discharges

5.7.5.1 Atmospheric emissions

Emissions to the atmosphere resulting from operations at the terminal are anticipated to arise through:

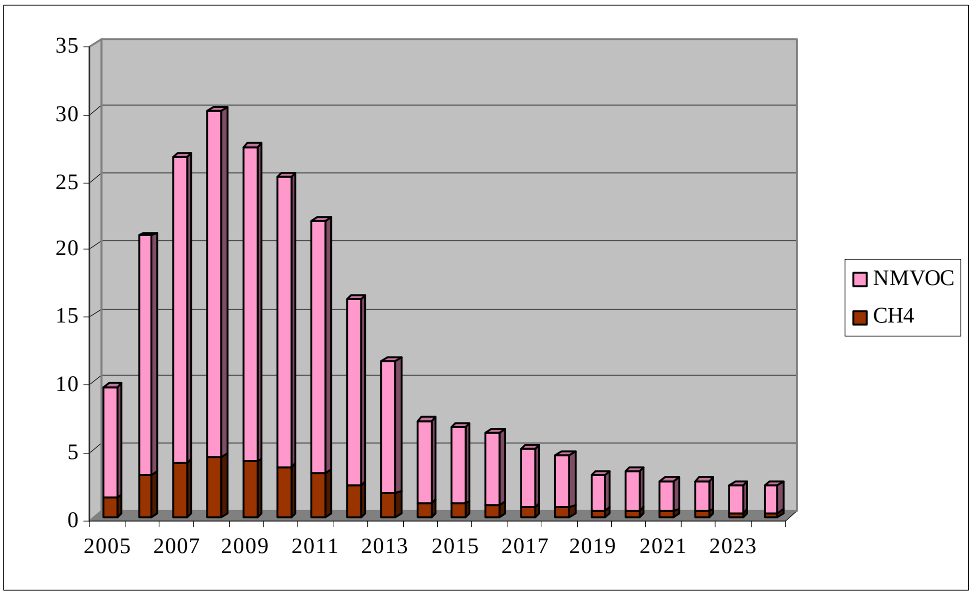
- fugitive emissions from crude oil storage;
- heater treaters;
- power generation (turbines);
- flaring.

These are discussed below.

Fugitive emissions

Fugitive emissions are generated by "working" and "breathing" losses from storage tanks at the terminal and have been derived from production profiles. Estimated emissions by species are presented in Figure 5.63.

Figure 5.63 Estimated fugitive emissions to the atmosphere from the terminal (tonnes)

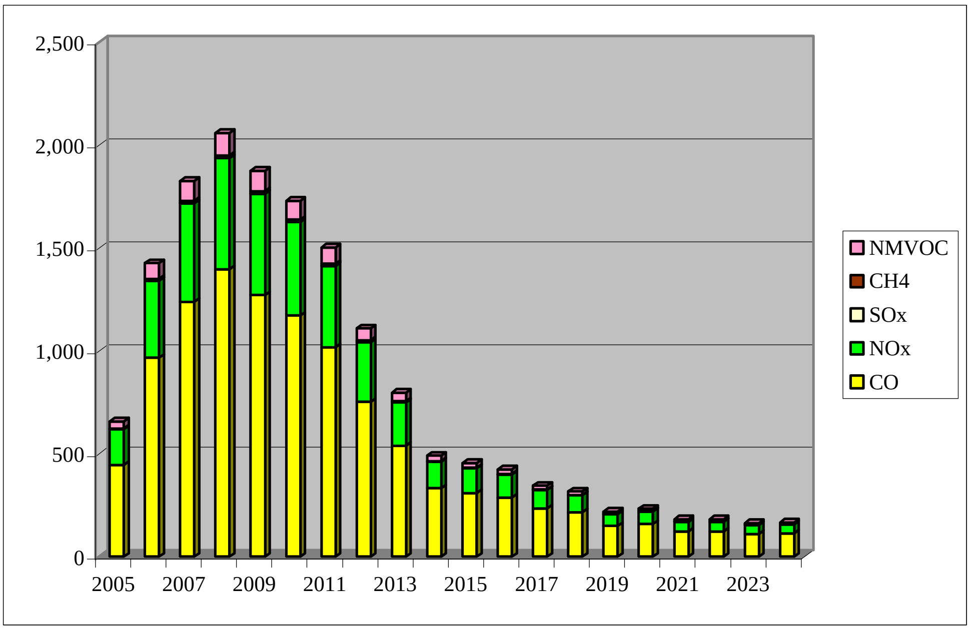


Note: gaseous species are combined for presentational purposes only.

Heater treaters

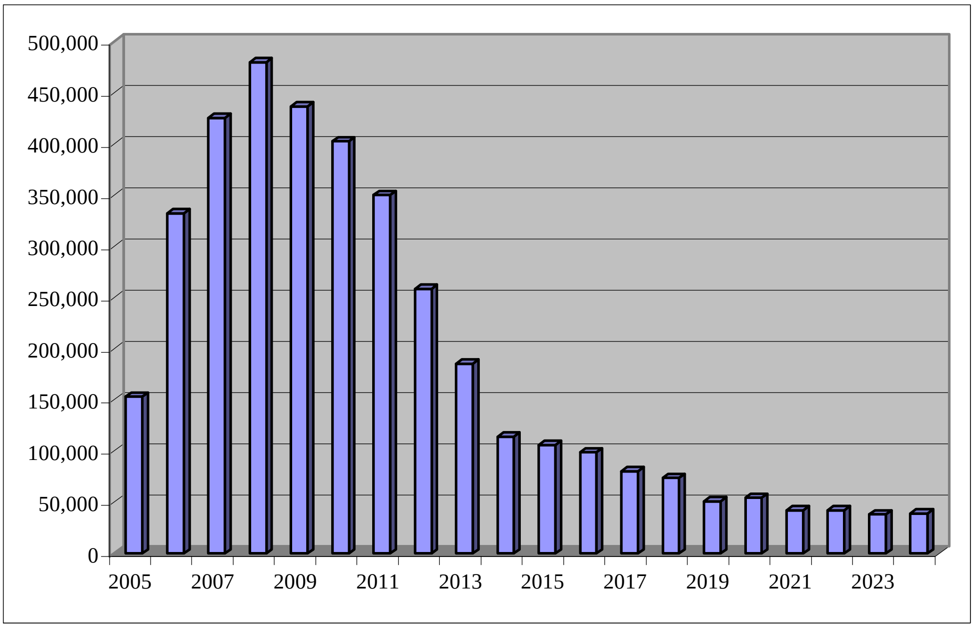
Estimated emissions to the atmosphere from the terminal heater treaters have been calculated on the assumption of peak fuel gas consumption of 25.06 MMscfd and continuous operation of the heaters operating. Assigned heater emissions have been derived by extrapolation from production profiles. Emissions estimates by species and total CO_2 are presented in Figures 5.64 and 5.65 respectively.

Figure 5.64 Estimated emissions to the atmosphere by species from the terminal heater treaters (tonnes)



Note: gaseous species are combined for presentational purposes only.

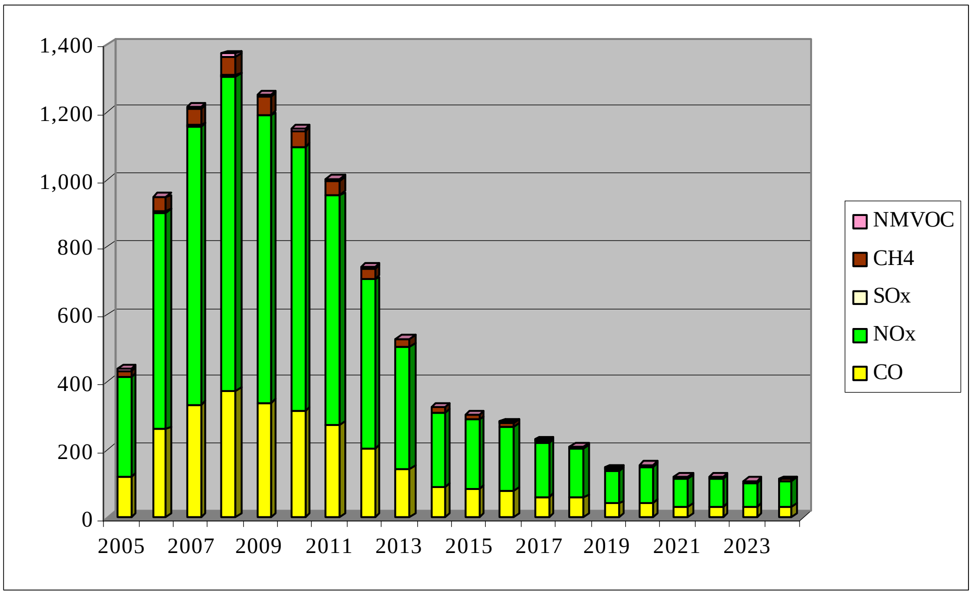
Figure 5.65 Estimated total CO_2 emissions from the terminal heater treaters (tonnes)



Power generation

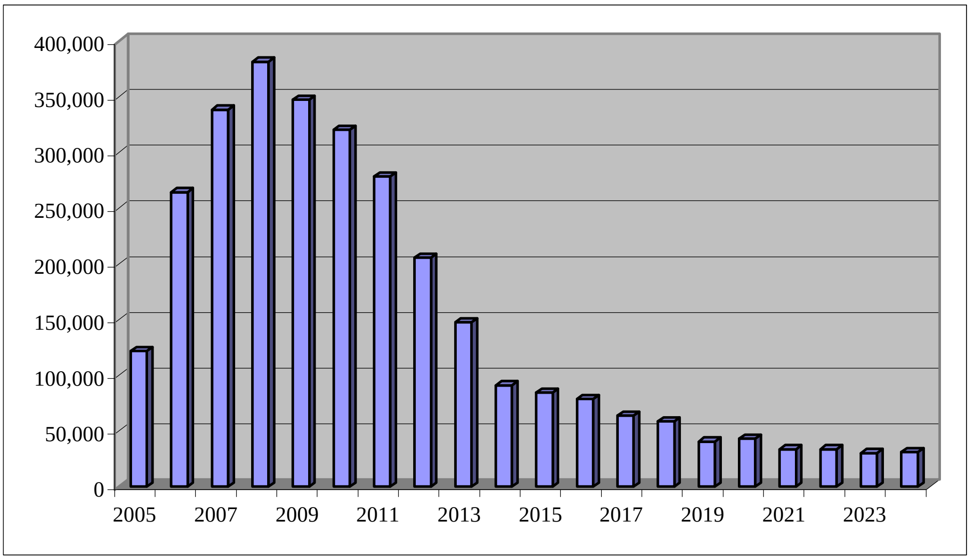
Estimated emissions to the atmosphere resulting from terminal power generation have been calculated based on the assumption of a peak power generation fuel gas consumption of 19.93 MMscfd and one 26 MW gas turbine. Assigned power generation emissions have been derived by extrapolation from production profiles at the terminal. Emission estimates by species and total CO_2 are presented in Figures 5.66 and 5.67, respectively.

Figure 5.66 Estimated emissions to the atmosphere by species from terminal power generation (tonnes)



Note: gaseous species are combined for presentational purposes only.

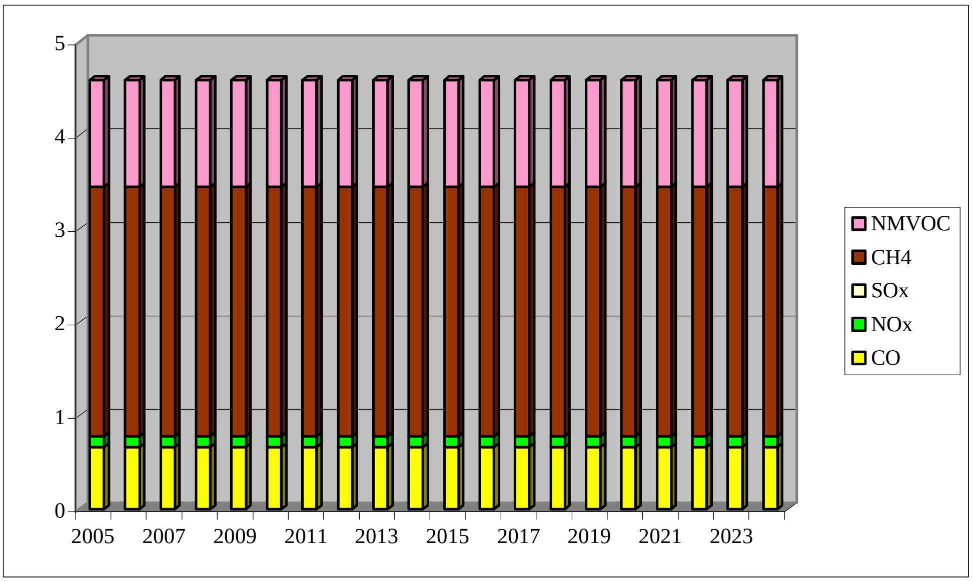
Figure 5.67 Estimated total CO_2 emissions from terminal power generation (tonnes)



Routine flaring

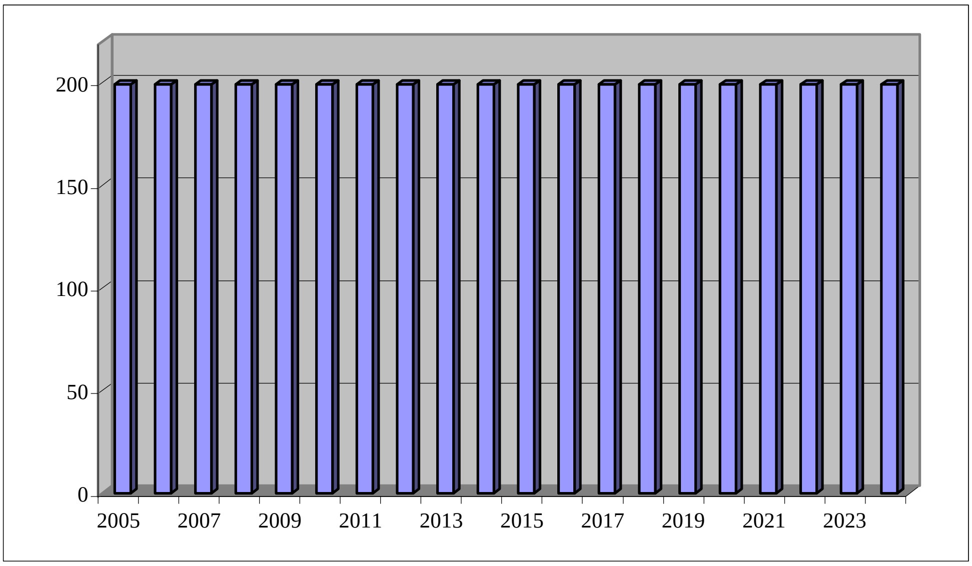
The only routine emission from flaring at the terminal will be as a result of the continually lit pilots (4 MMscfy). Estimated emissions to the atmosphere by species and for total CO2 are presented in Figure 5.68 and 5.69, respectively.

Figure 5.68 Estimated emissions to the atmosphere by species from the terminal flare pilot light (tonnes)



Note: gaseous species are combined for presentational purposes only.

Figure 5.69 Estimated total CO_2 emissions from the terminal flare pilot light (tonnes)



Total routine emissions

Figure 5.70 and 5.71 present the estimated total emissions to atmosphere as a result of terminal operation by species and for total CO_2 respectively. Greenhouse gas emissions are shown in Figure 5.73. The estimates include combustion processes emissions, fugitive and routine flaring emissions. The data above indicates that the largest contributors to routine emissions to atmosphere are the power generation gas turbines and the process heater treaters.

Figure 5.70 Estimated total emissions to the atmosphere by species from routine terminal operations (tonnes)

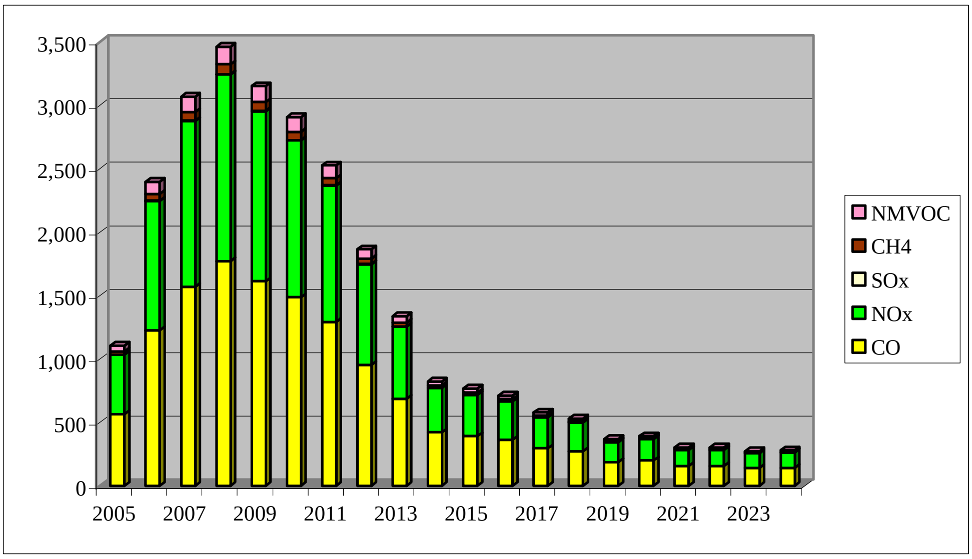


Figure 5.71 Estimated total CO_2 emissions from routine terminal operations (tonnes)

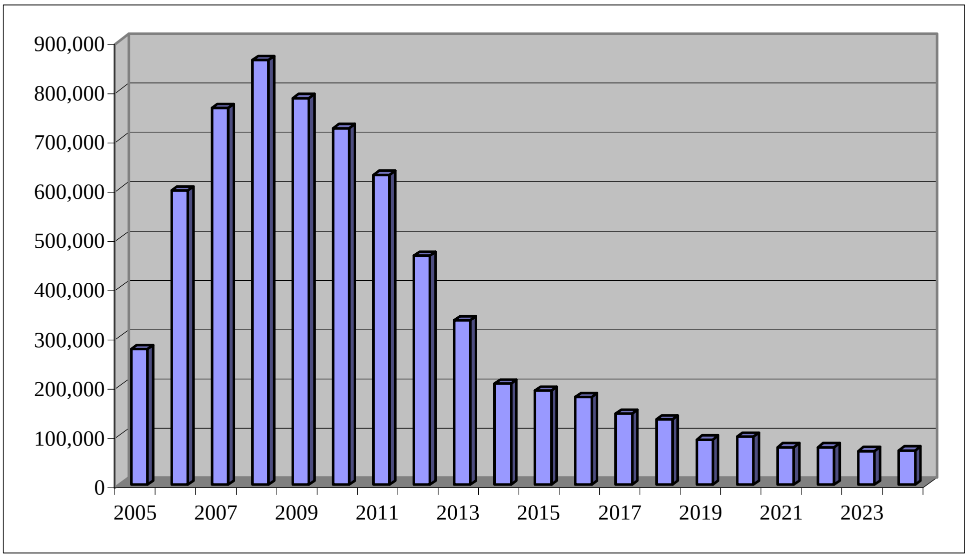
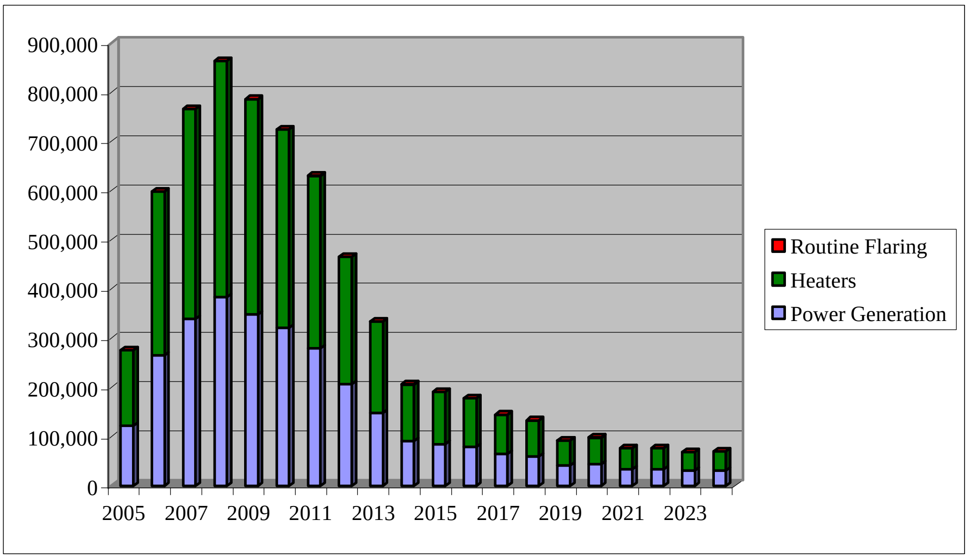


Figure 5.72 Estimated total greenhouse gas emissions from routine terminal operations (tonnes CO_2Eq)



Non-routine emissions to atmosphere

In the event that there is process failure or downtime for maintenance on the Phase 1 facilities, gas separated from the product stream would need to be flared. Estimated emissions to the atmosphere by species and total CO_2 from these non-routine flaring events per annum are presented in Figures 5.73 and 5.74 respectively, estimated green house gas emissions are shown in Figure 5.76. The emission levels have been calculated based on a plant design availability of 95% from year 3 of the project onwards. In years 1 and 2 plant availability has been assumed at 70% and 82% respectively due to commissioning and start-up (Section 5.5.1.4). Emission estimates have assumed flaring the following gas volumes flared and offshore/onshore flaring splits for each year:

- Year 1 (70% availability) - 10.1 bcf (billion cubic feet) gas flared, 31% onshore and 68% offshore, 3.131 bcf flared onshore
- Year 2 (82% availability) –6.1 bcf gas flared, 14% onshore and 86% offshore, 0.85 bcf flared onshore
- Year 3 onwards (95% availability) – 1.55 bcf gas flared, 14% onshore and 86% offshore, 0.22 bcf flared onshore

Figure 5.73 Estimated emissions to the atmosphere by species from non-routine flaring at the terminal (tonnes)

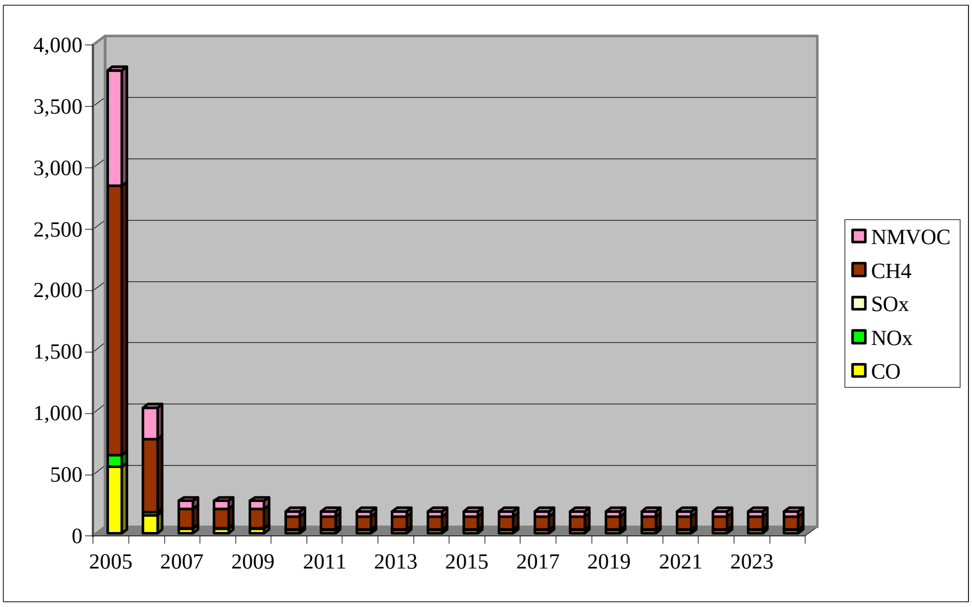


Figure 5.74 Estimated CO_2 emissions from non-routine flaring at the terminal (tonnes)

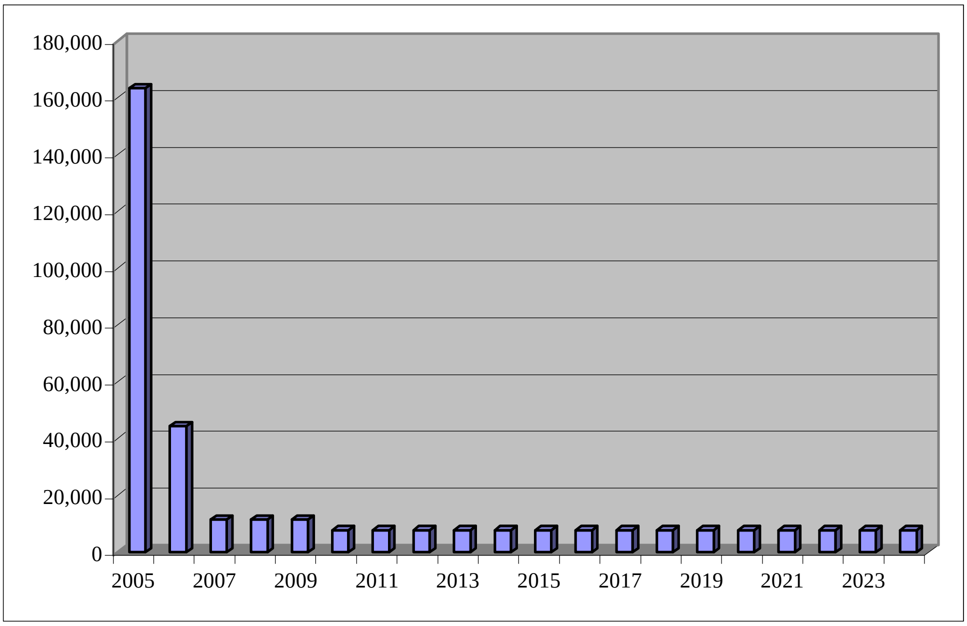
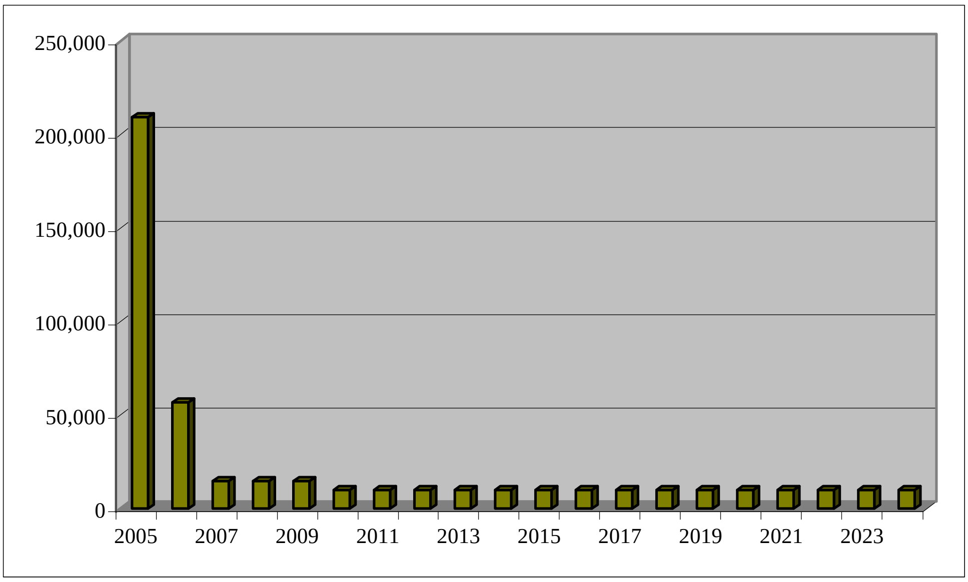


Figure 5.75 Estimated total greenhouse gas emissions from non-routine flaring at the terminal (tonnes CO_2Eq)



5.7.5.2 Summary of atmospheric emissions from onshore operations

The contribution to atmospheric emissions from the various onshore activities associated with the Phase 1 project have been presented above. Figures 5.76-5.78 show a summary of the total contribution to atmospheric emissions from these onshore activities.

Figure 5.76 Total estimated emissions to the atmosphere by species resulting from all routine and planned non-routine onshore operations (tonnes)

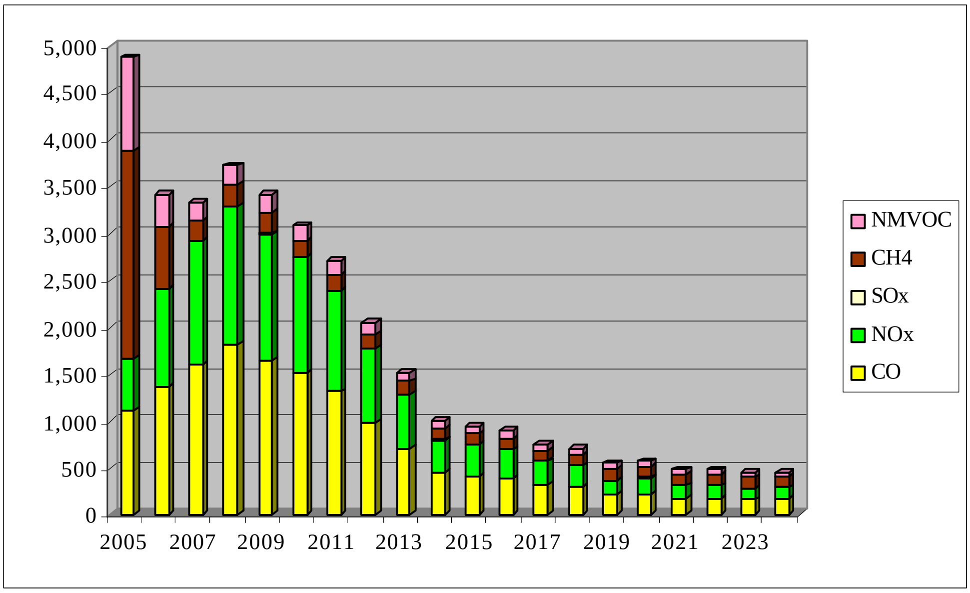


Figure 5.77 Total estimated CO_2 emissions resulting from all routine and planned non-routine onshore operations (tonnes)

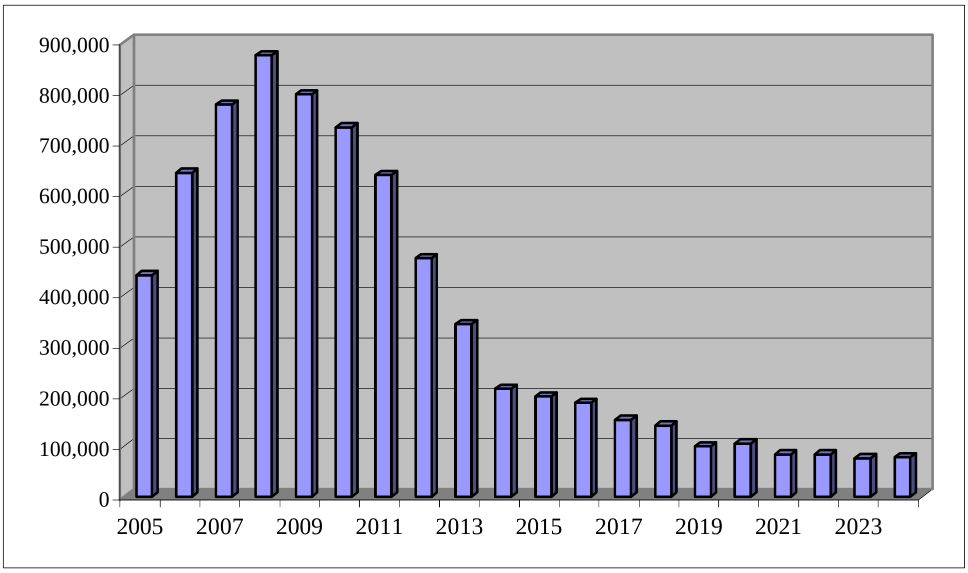
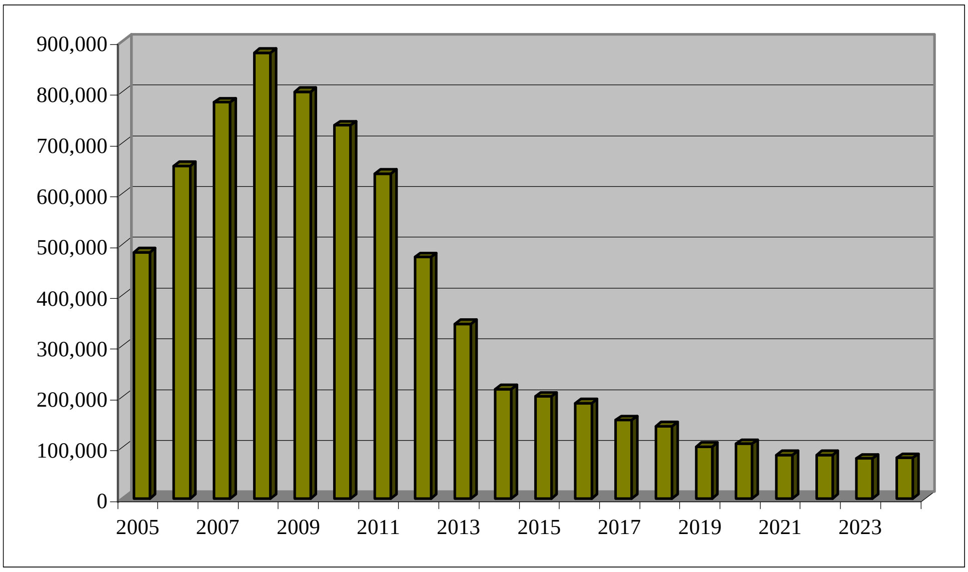


Figure 5.78 Total estimated greenhouse gas emissions resulting from all routine and planned non-routine onshore operations (tonnes CO_2Eq)



5.7.5.3 Noise emissions

Plant which would operate at the proposed terminal facility, which are likely to produce significant noise levels are as follows:

- two gas turbine driven generators, with a diesel driven emergency back-up system (diesel will be supplied from the existing facilities);
- fuel gas system;
- instrument/utility air; and
- flare.

Best Industry Practice would be adopted during the operation of the terminal facility with respect to noise control, and plant would be selected, operated and maintained in a manner that would minimise noise emissions.

Interim noise modelling has been undertaken for the above sources of noise to explore the propagation of operational noise from the proposed terminal facility as well as cumulative noise from ACG and Shah Deniz. The results of this work to date are included in the Socio-economic Impact Assessment chapter (Chapter 11) and the Cumulative Impacts chapter (Chapter 12).

5.7.5.4 Sanitary wastes

Sanitary waste will be generated during the terminal operation activities. The key assumptions for deriving the estimated amounts of sanitary waste generated are listed below:

- 34 employees (27 permanent & 7 support);
- Each construction worker will generate 0.22 m^3 / day of grey water;
- Each construction worker will generate 0.10 m^3 / day of black water; and

Emission estimates are presented in Table 5.31 below.

Table 5.31 Estimated annual amounts of sanitary waste generated during terminal operations

Parameters	Quantity	
Grey water (m^3)	Per day	7
	Total	2,730
Black Water (m^3)	Per day	3
	Total	1,241

5.8 Transportation and logistics

5.8.1 Introduction

As mentioned in previous sections, many of the ACG Phase 1 project components and materials will be fabricated or obtained outside of Azerbaijan and will need to be imported. A number of detailed transport and logistics studies have been undertaken on behalf of AIOC since 1995. Although Azerbaijan is virtually landlocked, there are a number of transport options for modules, pipes, equipment and other supplies. These 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 5.79.

Figure 5.79 Transportation route options for ACG Phase 1

BP has endeavoured to promote transport synergies with its other potential concurrent Caspian project, the Shah Deniz Gas Export project, wherever schedules allow. 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 Phase 1 project components:

- offshore development;
- sub-sea pipelines; and
- onshore components.

At the time of writing, many of the project 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.

5.8.2 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 to Azerbaijan by road, rail or river.

Excluding sea freight in the Caspian, transportation by ocean going vessel is not covered within this document.

5.8.2.1 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 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. However weather and border crossing delays can 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 United Arab Emirates 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.

5.8.2.2 Rail

The most viable option for rail transport into Azerbaijan is via the Black Sea port of Poti in Georgia; other rail routes into the country are subject to potential 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-eight days from Poti to Baku.

There is also an alternative railway route into Azerbaijan through Russia. Cargo to be transported along this route can be collected at the port of Riga.

5.8.2.3 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 riverships 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 riverships are able to make the entire trip without any off-loading required. However, there are operational restrictions for these riverships in European and Mediterranean waters.

Transit time through the Baltic-Volga system is typically 11 – 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 would be 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 in the winter months 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.

5.8.3 Phase 1 project transport options

As part of the project procurement strategy, preliminary analysis of transport requirements for Phase 1 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, i.e. offshore components, pipelines, terminal and other. As discussed, transport options may be refined as the project schedule and requirements are further defined..

5.8.3.1 Offshore development components

The PDQ and C&WP tubular elements, or cans, for the platform jackets will be prefabricated in international yards to be determined and will require transport to the SPS assembly/construction yard south of Baku for construction and assembly. In addition, topsides modules, piping and steel will also require transport to Azerbaijan.

The viable routes available for transportation of the pre-fabricated components into Azerbaijan in order of preference include:

- sea/river freight via the Baltic-Volga and Don-Volga canal/river route to the Caspian;
-
- sea freight to Poti, Georgia or Turkey and road/rail;
- road transport from Europe to Baku via Turkey/Georgia (or alternatives of Russia or Iran); and
- airfreight to Baku.

There are seasonal restrictions on the preferred option of transportation by rivership on the inland river system to the Caspian. As the delivery schedule is from January 2002 until July 2002. Rail transport via Poti will be used for the four winter months over this proposed schedule (January to April) that the river system is closed. Once the inland river system opens, transportation of these components will continue via either the Baltic-Volga or the Don-Volga systems.

The components will be transported directly to SPS assembly yard. The SPS yard has docks for handling barges and is also linked to the main road and railway networks of Azerbaijan.

In addition to the larger components, it will be necessary to transport mechanical gauge equipment and supplies such as piping and other bulk material. It is anticipated that these items will be transported via international trailer although the origin of the shipment is not known at this stage of project design. It is also possible that some smaller equipment could also be sent via rivership over a year's period beginning in June 2002.

5.8.3.2 Pipelines

The grade of marine steel required for pipeline construction is not available in Azerbaijan and as a result the pipe sections, wye pieces and associated protection structures and check valves will be fabricated outside of Azerbaijan and transported to a laydown yard in Azerbaijan in readiness for installation.

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. Therefore the total number of vessels, vehicles or rail carriages required for transportation varies, depending upon the number of sections that may be carried in one load. There is an option to concrete coat the pipeline at a facility in Azerbaijan and this has the added benefit of reducing the size of the pipe units and the transportation requirements.

Two main options are currently being evaluated for the transportations of the pipeline sections to Azerbaijan river and rail transportation. Road movement of pipeline section is only anticipated 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 the laydown yard in Azerbaijan is expected to be by road.

River transportation

Pipe section transportation by rivership is expected to begin in June 2002 and will continue until the river system closes for the winter in October/November, after which time, transport will commence by rail from Poti. As mentioned above, it has not yet been determined whether the pipe sections will arrive coated or uncoated, which will influence the number and type of transport. If the pipeline is transported to Azerbaijan uncoated it is estimated that 50 rivership transports will be required. Coated pipeline will require 84 rivership transports, due predominantly to increased weight handling requirements. It is anticipated this phase of transportation will be complete by January 2003. Each vessel, or fleet of vessels, will require approximately six weeks for delivery from origin to destination at the appropriate laydown area in Azerbaijan.

Rail transportation

The movement of the all pipe sections for the new 30" oil line by rail would require 2,856 rail carriages, based on a worst case of coated pipe sections. This equates to 64 block trains, each consisting of 45 gondola rail wagons.

5.8.3.3 Onshore terminal

The Phase 1 terminal equipment that is fabricated outside of Azerbaijan will be palleted and transported into the country from the equipment manufacturers works. Transportation methods and routes are under evaluation but again the most likely route is via rail transportation from Poti to the SPS yard for laydown, although it is anticipated that transport by rivership via the Russian canal system will also be used. Equipment will be sent in large containers, offloaded and then transferred to smaller containers for onward transport to the construction site.

Transfer to the terminal construction site will be by road. Transfer to the site may initially be by means of a series of large convoys, with between 15-20 large convoys envisaged, if large convoys were to occur, it is proposed that they take place in the early morning to minimise disturbance to other road users, with the lead and rear vehicles accompanied by police escort. Other traffic use of the route will not be prohibited. A transport management plan will be developed for the programme of equipment transfer and construction works.

5.8.4 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 United Arab Emirates. As it is not yet known where these items will be procured, no route can be finalised at this time. There are two main routes under assessment; Turkey to Iran and Azerbaijan and Russia to Daghestan and Azerbaijan. The Turkey-Iranian route is the preferred option.

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5.9 Decommissioning

5.9.1 Introduction

The 1989 International Maritime Organisation (IMO) Guidelines for Offshore Installations Removal state that structures in waters deeper than 100 m must be removed to give a clear water column of 55 m for safety of navigation. In addition, all structures installed after 1998 must be designed so as to be feasible for complete removal.

At this stage in the development, it is not possible to state with accuracy how, or to what extent, the facilities will be removed and therefore, this decommissioning description relies on general descriptions of decommissioning options that may be applied to the ACG facilities, both offshore and onshore.

According to the terms of the PSA, BP is required to produce a field abandonment plan one year prior to the completion of 70% production of identified reserves. At this time, all partners involved in the project are required to contribute a proportionate share of the decommissioning costs to an “Abandonment Fund” such that the monies can be accrued against the eventual decommissioning costs. Thereafter, the abandonment plan will be considered and reviewed in discussion between the operator and the authorities. This timing will allow consideration of the most appropriate decommissioning options and may allow for changes in the management of the field in order to facilitate the best abandonment options, for example through the reservoir and well management plan.

This decommissioning section considers what options are available for the eventual removal of production facilities in terms of technical options and waste handling.

The following Phase 1 structures are considered:

- PDQ;
- C&WP;
- the subseaexport pipelines and the interfield lines; and
- the ACG components of the Sangachal Terminal.

5.9.2 Decommissioning of the PDQ

The PSA for this project extends as far as 2024, after which time the responsibilities for operation and eventual decommissioning all facilities pass to SOCAR. Therefore the discussion below is tentative. The decommissioning of the offshore PDQ facilities has been split into five stages as follows:

- well plug and abandon;
- topsides preparation;
- topsides removal;
- jacket decommissioning; and
- onshore dismantling/disposal.

5.9.2.1 Well plugging and abandonment

There may be up to 48 wells to be plugged and abandoned as part of the PDQ platform decommissioning operation. Well abandonment requires the isolation of individual productive intervals to prevent cross-flow of either hydrocarbons or high pressures from one interval to another and the prevention of any fluid flowing to surface. The clearing of any obstruction from the seabed is generally taken as requiring sub-sea wellheads to be cut off 10 m below the seabed. The method of abandonment of individual platform wells cannot be described with precision at this time since the wells have not yet been drilled. In addition, the approach adopted for abandonment may be either a batch process conducted at the end of field life or an opportunist approach in which redundant wells are abandoned when appropriate equipment is available on the platform (e.g. after a coiled tubing intervention campaign on the platform). In any event, the preferred approach is to use platform utilities wherever possible to plug and abandon platform wells and thus reduce the requirement for additional vessels with attendant cost and environmental disturbance and emissions.

The first stage of well abandonment is to remove the production string from the cased well bore. The well bore is then plugged with cement at several depths to ensure that the reservoir is isolated from the well bore and from the environment. The conductor casing of wells is then typically cut 10 m below the seabed.

The production tubulars, or injection tubulars as appropriate, and the conductor casing that is removed, will have to be shipped to shore for disposal. These tubulars will have to be de-contaminated prior to disposal. It is likely that following decontamination, the most appropriate means of final disposal for these tubulars will be as steel foundry feedstock.

5.9.2.2 Topsides preparation

Taking the platform from its operational state to being ready for removal requires the following:

- production decommissioning;
- installation of temporary equipment;
- topsides deconstruction;
- topsides removal; and
- jacket decommissioning.

Production decommissioning

Hydrocarbon and associated production contaminants must be removed from the process systems. Upon completion of decommissioning the process systems will be made inert to allow the deconstruction work to be carried out safely. This means that any sand, sludge and scale produced during this phase of preparation will have to be removed for disposal. If the decommissioning is done in a phased manner from the platform, prior to well abandonment and decommissioning, then it is possible that some or all of this waste can be re-injected into wells. If this approach is not taken then the waste will have to be disposed of at an onshore location.

Installation of temporary equipment

It will be necessary to install temporary equipment to provide power, lighting and fire fighting facilities during and after the period when the platform power is switched off. It is likely that power generation will be provided by diesel generators, although it is not possible to say now how many or how much power will be required. It is anticipated that the platform power supply, gas turbines, will be used for as long as possible. Those turbines that can run on dual fuel may continue to be used following cessation of production. There will come a point however when these power units are no longer available and portable power generation will be required.

Topsides deconstruction

The extent to which topsides deconstruction is required depends on how much of the topsides can be removed by a reversal of the installation process. If a reverse float-over is envisaged, then there will be minimal topsides deconstruction offshore. It is likely that there will be a requirement for some reversal of the hook-up process, whereby the platform will be broken down into modular sections, by disconnection of the tie in spools and electrical connections. In addition, components such as the flare boom and the drilling derrick on the PDQ platform may need to be removed prior to a reverse float-over.

Production decommissioning and initial preparation work can be supported by the existing platform accommodation. Should extensive offshore deconstruction be required, then it may be necessary to mobilise floating accommodation to support the main deconstruction phase. During this phase, there will be a steady stream of waste generated as a result of the deconstruction activities and which will have to be handled, decontaminated, stored and either reused or disposed of onshore.

Topsides removal

The topsides removal of the float-over structure will most likely be a reversal of the installation process in which the transportation barge will be ballasted and positioned below the structure prior to de-mating of the topsides from the jacket. The transportation barge can then be de-ballasted such that it rises and lifts the topsides clear of the jacket. The transportation barge can then be towed to an onshore location and the topsides skidded onto a quayside in preparation for further dismantling operations. Preparatory work required on the platform for the lifting operations will include cutting of structural steel and installation of rigging, guides and bumpers. Prior to topsides removal, the required marine spreads will be mobilised and grills and sea-fastening required for transportation of the platform topsides components will be fabricated and installed. Transportation barges will then be mobilised and lifting points will be installed to facilitate cutting of the platform into liftable components. Components of the topsides can then be cut into liftable components or modules, if this is required, and these will be lifted by crane onto a transportation barge.

Jacket decommissioning

There are four options for decommissioning of the jackets as follows:

- topple in situ;
- float, reposition and dump;
- partial removal; and
- total removal and onshore dismantling/disposal.

Topple in situ

In order to topple a platform *in situ* it is necessary to cut part of the structure, usually the main legs and bracing, below sea-level in such a way as to ensure that the structure will fall in a predetermined direction. The actual toppling may be assisted by means of marine vessels, such as tugs, pulling on the structure to ensure that the structure falls in the manner required for the decommissioning plan. Once toppled, the structure may be further cut by means of underwater blasting in order to increase the overall clearance above the structure. This option however, would be unlikely to meet the requirements of the IMO Guidelines.

Float, reposition and dump

Some structures are constructed such that they may be re-floated and thus, repositioned. The platforms can then be disposed of in another area, for example in deeper water. It is thought that this option is not a likely possibility for the Phase 1 platforms as they have not been designed with sufficient flotation to allow re-float. This option would be unlikely to meet the requirements of the IMO.

Partial removal

Partial removal involves a 'piece small' process that requires successive cutting and removal of the jacket structure until complete, or partial, removal is achieved. The advantage of this method of removal is that relatively small crane vessels can be used to perform the work. However, a major disadvantage is that the method requires numerous underwater explosive cuts to free the small pieces of jacket to be removed. With the partial removal option, part of the platform would be left *in situ*. However, although this option would meet with the 1989 requirements of the IMO Guidelines, it would not meet with the 1998 amendment to the Guidelines.

Total removal and onshore dismantling/disposal

Total removal would involve lifting the jackets with a crane vessel and removing the jacket to an onshore disposal site for deconstruction. It is likely that the jacket would be removed in sections rather than being lifted in its entirety since it would be difficult for a crane barge to be able to lift an entire jacket sufficiently high enough to subsequently carry the structure any significant distance. Furthermore, at present there is no crane vessel in the Caspian capable of making such a lift. It is probable that total removal would involve either 'piece small' or 'piece medium' removal of components of the jacket. The 'piece medium' process is similar to the 'piece small' process described above, under partial removal, but involves removal of larger pieces of the structure and consequently heavier lifts. The limiting factors on the size of pieces that can be removed are the crane lifting capacity, transportation barge capacity and the onshore reception facilities. However, from the point of view of disturbance caused by underwater explosive cutting, the larger the pieces removed the better.

It is most likely that the jacket will be cut into liftable components using explosive and mechanical cutting techniques. A barge-mounted crane is attached to the component to be removed and that component is then cut from the remainder of the jacket. In this way, a series of components are removed from the jacket and the overall structure gradually reduced in size. As the components are removed, they will be lifted directly onto a transportation barge. The components are then transferred to onshore disposal facilities either to be re-used or further broken down and scrapped. There is little waste generated in this phase, other than the component pieces of the jacket. The number and proximity of the vessels will be relatively extensive and these vessels will cause physical obstruction and disturbance during mobilisation and operation. The eventual method of disposal will depend on the Abandonment EIA, Best Practicable Environmental Option and consultation with the authorities.

5.9.3 Decommissioning of the C&WP

The decommissioning of the C&WP facilities will follow a very similar pattern to the techniques adopted for the PDQ. However, in the case of the C&WP there are no wells to be plugged and abandoned. Thus, the decommissioning of the C&WP can be split into the following four stages:

- topsides preparation
- topsides removal
- jacket decommissioning
- onshore dismantling

5.9.3.1 Topsides preparation

The decommissioning of the C&WP topsides will be similar to the PDQ decommissioning described above. There may be synergies in decommissioning the C&WP at the same time as the PDQ since there may be re-injection facilities available on the PDQ to dispose of waste from the C&WP.

5.9.3.2 Installation of temporary equipment

The requirement for temporary equipment to provide power, lighting and fire fighting facilities may be met using the synergy, either of decommissioning the C&WP while the PDQ is still operational or by using one set of equipment to service both facilities. The sequence of decommissioning and the synergies arising from the fact that there are two facilities bridge-linked depends very much on the intended relative timing for the decommissioning of the facilities

5.9.3.3 Topside deconstruction

As described above, for the PDQ, is most likely that the topsides will be removed by the process of reverse floatover. In preparation for this activity however, some offshore deconstruction will be required. Not the least of this will be the removal of the bridge. This will be removed in a reverse of the installation process with the bridge structure being secured to a crane and the connecting joints at either end being disconnected. The utilities that are shared between the two platforms such as power, and the product flowlines will also have to be disconnected at either end. The bridge, once fully disconnected at both ends can then be lifted on to a transportation barge and transferred to an onshore dismantling yard. Thereafter various other components may need to be removed prior to the topsides being removed from the jacket

5.9.3.4 Topsides removal

Since the installation of the C&WP topsides will be by floatover, then the removal will most likely be a reverse floatover, as described above for the PDQ.

5.9.3.5 Jacket decommissioning

The options for jacket removal are described above for the PDQ. Given the requirements of the IMO, it is likely that the entire jacket will be removed and this will be done by using a ‘piece small’ process.

5.9.4 Pipeline decommissioning

There are fundamentally two options for decommissioning the export pipelines:

1. abandon *in situ*; and
2. complete removal.

5.9.4.1 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. The pipeline landfalls are trenched for protection and theses 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.

5.9.4.2 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 then removal of the cut sections. This is either performed with a reverse of the installation using a J-lay or 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 made inert 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.

5.9.5 Terminal decommissioning

Following decommissioning of the process on the Sangachal terminal, the terminal may 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 made inert, 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 any spillages resulting from 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 below. 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 and pneumatic drills.

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.

5.9.6 Onshore facilities dismantling and waste disposal

Once the modules and jackets from the PDQ and the C&WP platforms and the onshore terminal components have been removed from the field, they can be transported by barge, or road or rail for disposal.

As barges carrying components, removed in the offshore field, come alongside to a quay at, or near, the dismantling facility, large components are skidded off the transportation barges onto the quayside. The modules, structural sections and process components are then placed on a lay-down area that allows 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. Some components such as valves, pumps etc may be re-usable and can potentially be salvaged for re-sale. However, the potential for this is small because the components may be outdated, worn or the specification may make them unsuitable for re-use. The principle value of the components is in re-cycling. Material such as steel can be re-cycled through a steel foundry with an overall energy saving through negating the need for refining ore. The structural steel from platforms is of particular value because it is a high quality.

The dismantling process therefore involves separating the various materials into the categories of re-use, recycle or waste disposal. Once structures are off loaded and positioned in a decommissioning area, the cleaning operation can commence. Topsides, modules and process components are more liable to contain any hazardous materials than jackets, but the following cleaning operation applies to all of these:

- inspection, monitoring and sampling of structural materials;
- hazardous material identification and containment;
- LSA, if present, contained and transported to licensed site (Topside Modules);
- other hazardous material removed; and
- wash down of structure using high pressure water / solid CO_2.

Modules can be deconstructed by a reverse process of the construction. Equipment is removed from the modules and they are stripped of equipment and cabling until a bare shell remains. During this process, any contaminated components are identified, removed, tagged and isolated. The dismantling of the actual structures is performed by teams using gas axes, electrical saws or mechanical shears. Structural steel is reduced in size to pieces approximately $1m^2$ which can be fed into a furnace. Some components can be reused in different forms; for example, it is possible to remove flat plate that, along with structural sections and pipe lengths, has a higher market value. Furthermore, in order to achieve the best market price, the steel must be cleaned of coatings.

The jacket structure is reduced in size in a similar way to the modules in the sense that the objective is to separate materials and reduce the component size to pieces that can be handled and processed. Marine growth must first be removed, contained and disposed of. This organic material can be used as a nutrient source for bio-remediation of oil-contaminated soil and any such use should be considered in order to maximise the beneficial effects or conversely to minimise adverse effects.

Cutting methods for the larger steel components include mechanical shears, water jetting and gas cutting. Table 5.32 below shows a comparison between different cutting methods in terms of the implementation, environmental factors, safety, energy usage and the practical application. The selection of the preferred option(s) will be confirmed prior to beginning the decommissioning process.

Table 5.32 Decommissioning dismantling options

Method	Implementation	Environmental	Safety	Energy	Application
High Pressure Water Jet	Not suitable for hand held therefore use is limited to areas where a track guidance system can be installed	No contaminants or hazardous materials, grit can be re-cycled	Semi-automatic, protective equipment required.	Low - medium energy	Tank sections. Large cuts. Hydrocarbon areas
Cold Cutting	Machine controlled, diamond wire Set-up time high	No contaminants, hydraulic powered	Automatic system, mechanical equipment risk	High energy	Piping systems with hydrocarbons. Limited use
Compressed Air/Nitrogen Plasma	Piped system, Low equipment lifespan	High levels of ozone and nitrous oxides. Not a clean system	Fumes are toxic	High energy	This is not a preferred option abut can be used for hydrocarbon contaminated equipment
Oxygen/Fuel gas	Flexible, hand held, experience available	Clean, CO_2 and CO produced	Hazard from the use of explosive gases. Mitigation through established procedures	Medium energy	Manual cutting. on small items, and for reducing to furnace size
Shearing	Mobile excavator mounted, some hand held, heavy equip, internal use limited	Uses diesel as power source. No external products from the shearing.	Hazard from heavy plant. Mitigation through established procedures.	Medium energy	Large scale reduction of the structural sections/ pipes

5.10 Waste management

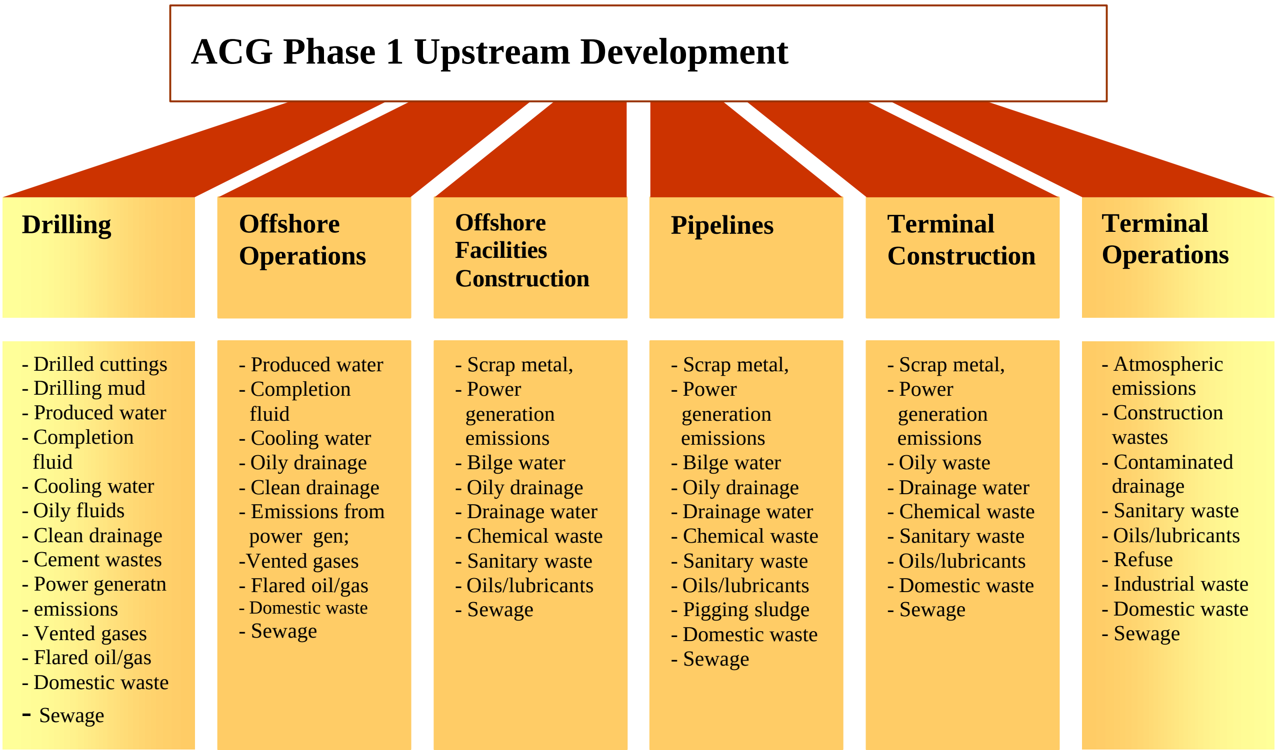
A large number of waste sources arising from the ACG Phase 1 development have been identified. Routine waste streams generated during each of the stages of the development through construction, installation and commissioning activities to operations and finally decommissioning have been identified and their preferred disposal route discussed in each relevant section of this Chapter. These are summarised in Table 5.33

Table 5.33 Summary of Phase 1 routine discharge disposal options

	Template well Drilling (Dada Gorgud)	Platform Well Drilling (PDQ)	Construction of offshore facilities (SPS)	PDQ	C&WP	Pipelines	Terminal Construction	Terminal Operations
WBM drilled cuttings	Discharge to sea	Discharge to sea	N/A	N/A	N/A	N/A	N/A	N/A
NWBM drilled cuttings	Ship-to-shore initial two wells. CRI with ship-to-shore as back-up.	CRI with ship-to-shore as back up	N/A	N/A	N/A	N/A	N/A	N/A
Produced Water	N/A	N/A	N/A	Re-injection offshore with discharge following treatment as back up. Remainder sent to terminal with the oil stream	N/A	N/A	N/A	Down-hole injection through dedicated injection wells at Lokbatan. Garadag Cement Plant
Hydrotest water	N/A	N/A	Down-hole injection through dedicated injection wells at Lokbatan. Garadagh Cement Plant	N/A	N/A	Down-hole injection through dedicated injection wells at Lokbatan. Garadagh Cement Plant	Down-hole injection through dedicated injection wells at Lokbatan. Garadagh Cement Plant	N/A
Un-contaminated drainage waters	Discharge to sea	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 soakaway	Treatment then discharge to sea	Treatment then discharge to sea	N/A	Treatment then discharge via soak away	Treatment then discharge via soak away
Sewage waters	Treatment then discharge to sea	Treatment then discharge to sea	Treatment and transfer to municipal system	Treatment then discharge to sea	N/A	N/A	Water treatment plant to retention pond. then irrigation	Water treatment plant to retention pond, then irrigation

Additional wastes will be generated during the Phase 1 programme. These are included in the relevant section of this Chapter and a summary of these is given in Figure 5.80 below.

Figure 5.80 ACG Phase 1 waste streams



5.10.1 Waste Management Strategy

- As noted in Table 5.33, there are a number of disposal options being utilised by the ACG Phase 1 project:

- disposal to CRI wells offshore;
- disposal of produced waters and hydrotest waters down-hole at Lokbatan (or at the Garadag Cement Plant);
- discharge via a soak away;
- discharge, after treatment, to sea;
- transfer, after treatment, the municipal system; and
- water treatment plant to retention pond then irrigation.
-

Those waste streams remaining offshore will be shipped to shore for disposal and these along with the wastes arising from onshore activities will be segregated and stored for treatment and disposal. All wastes will be controlled by means of careful documentation, handling and transportation and a detailed Waste Management System will be developed.

These wastes can be classified into five main waste streams as follows:

- non-hazardous (domestic wastes) such as paper, cardboard and packaging;
- non-hazardous non-combustable 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
- NWBM drilled cuttings.

The AIOC Waste Management Strategy and guidelines addresses all of the waste issues associated with the ACG Phase 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 those 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 Plan has been developed for BP Caspian Sea (BPCS). The report comprehensively appraises the waste streams generated by existing BPCS operations in the Caspian region. 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 ACG Phase 1 development and subsequent Phases of the FFD programme. At the time of writing this document, commitment by all AIOC partners to the provisions of the draft IWMP was subject to discussion.

The draft IWMP 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/or
  - 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.

5.10.1.1 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.

5.10.1.2 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.

5.10.1.3 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 Garadagh Cement Plant (GCP) 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. Waste waters could be sent for disposal down-hole through a dedicated injection well with the produced water stream or to GCP. Tyres would be recycled wherever possible but could be sent to the GCP kiln. Fluorescent tubes will be crushed using a tube crusher followed by transfer of the residues to a hazardous waste 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).

5.10.1.4 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 pigging waxes and other hazardous liquids such as glycols. An alternative to the liquid waste incinerator is to send these wastes to the GCP 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 GCP. Liquid oily wastes would be recycled in the Sangachal terminal process.

5.10.1.5 NWBM drilled cuttings (hazardous)

The NWBM cuttings that are not re-injected offshore (Section 5.3.1.1) due to unavailability of either the re-injection well or the re-injection facilities will be shipped to shore for treatment and disposal. A number of options are under consideration for the treatment of these cuttings.

The options include:

- construction of a thermal desorption plant;
- bioremediation using biopiles or landfarming at a designated facility;
- transfer to the GCP cement kiln; and
- soil washing.

Oily sand and any contaminated soils removed from construction facilities will also be treated with the cuttings.

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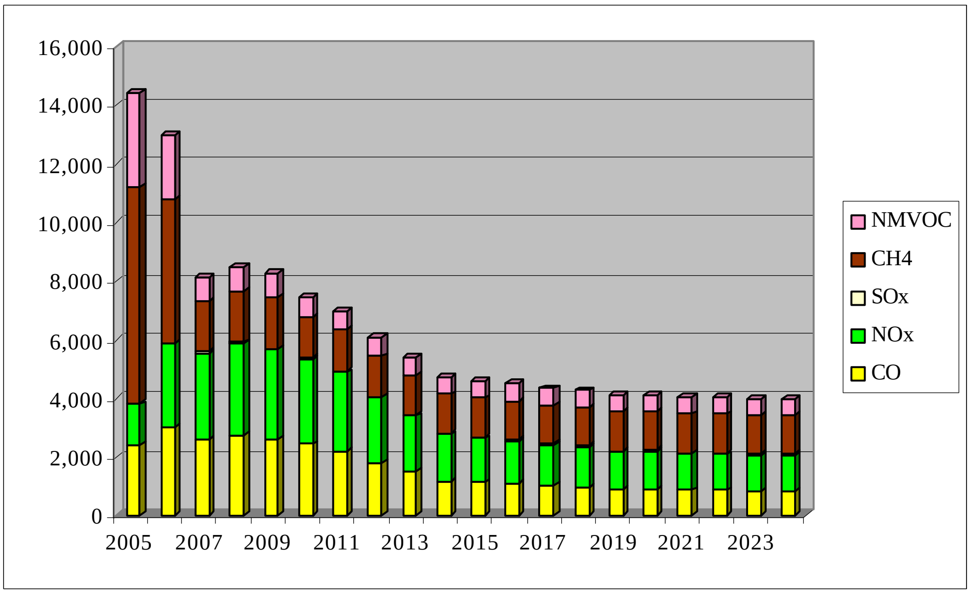
5.11 Atmospheric emissions summary

Figure 5.81 Estimated total emissions to the atmosphere by species over the life of the Phase 1 project (tonnes)



Note: gaseous species are combined for presentational purposes only.

Figure 5.82 Estimated total CO_2 emissions over the life of the Phase 1 project (tonnes)

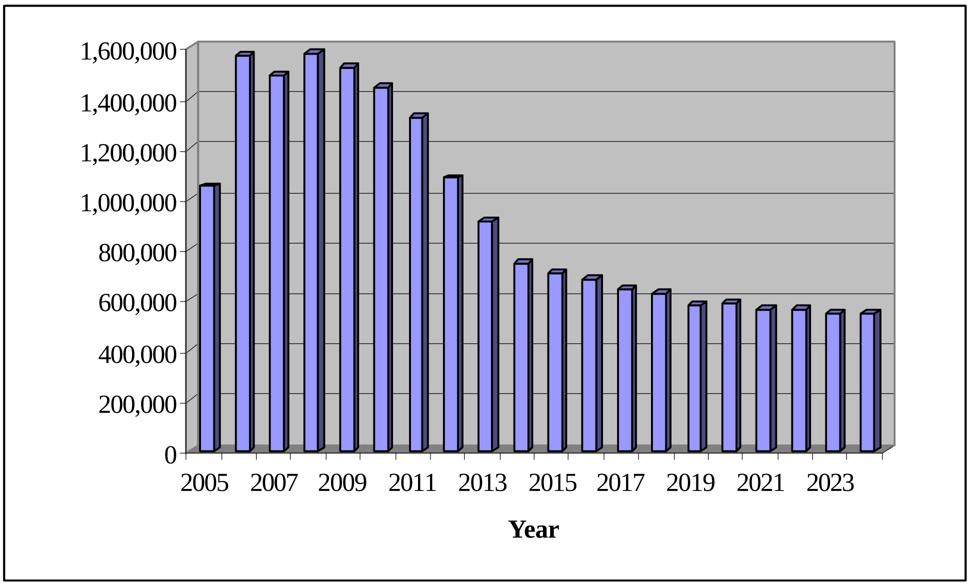


Figure 5.83 Estimated total greenhouse gas emissions over the life of the Phase 1 project (tonnes CO_2Eq)

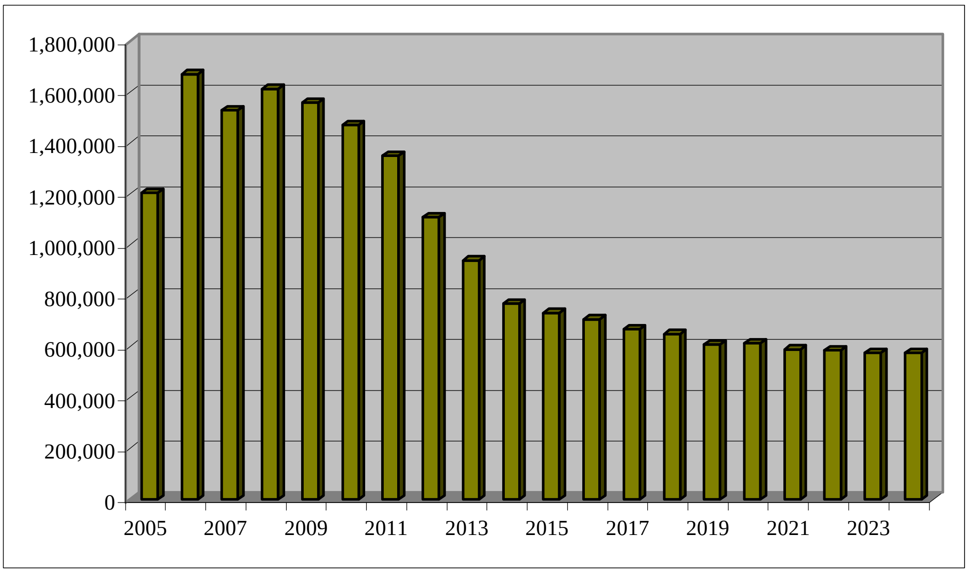


Figure 5.84a Percentage contribution of Phase 1 activities for estimated total emissions over the life of the project (including CO_2)

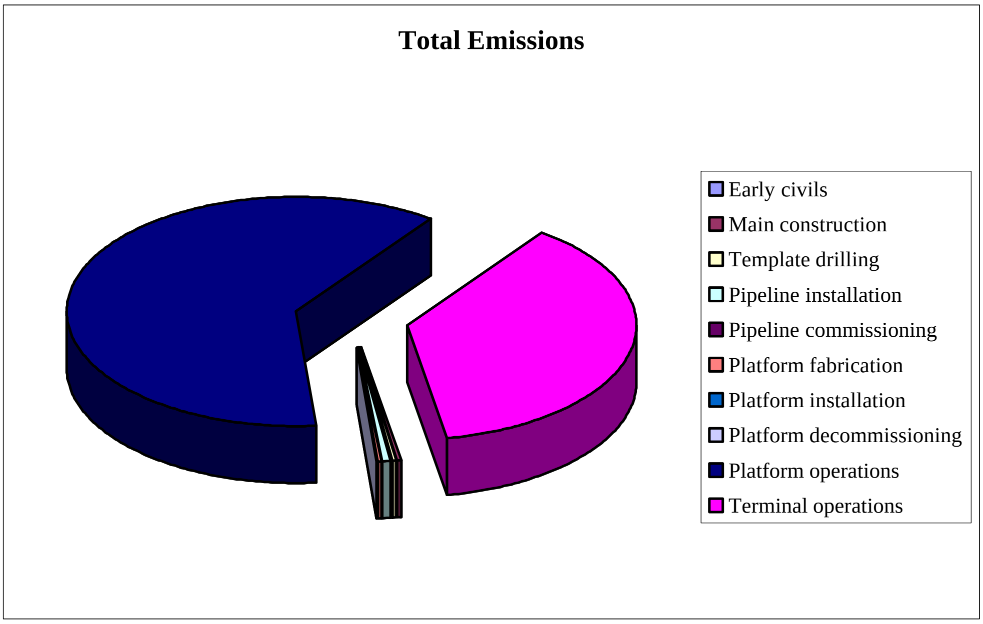
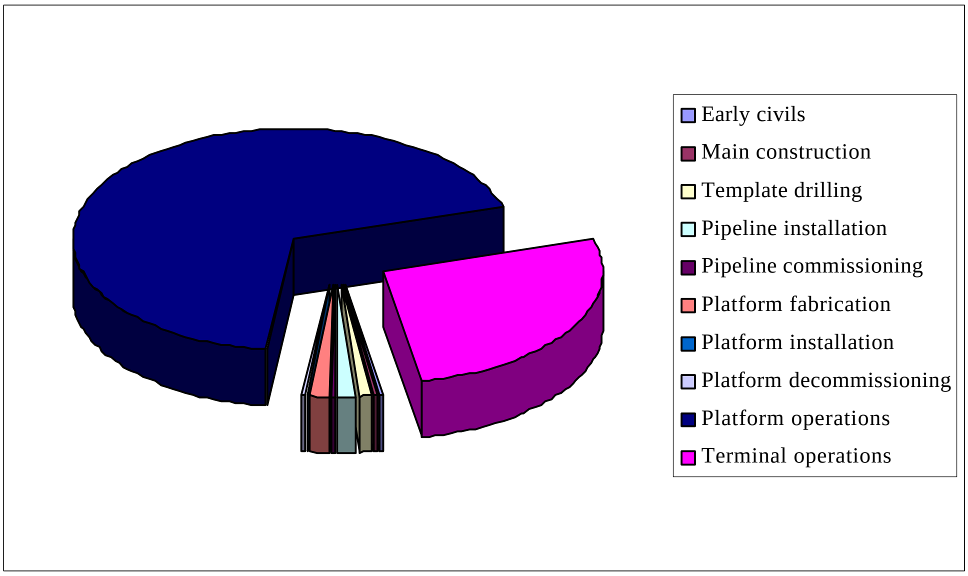


Figure 5.84b Percentage contribution of Phase 1 activities for estimated total emissions over the life of the project (excluding CO_2)



It can be seen from Figures 5.84 that the main contributors to atmospheric emissions are the terminal operations and offshore operations components of the project. It should be noted that the above figure includes the non-routine planned flaring from these operations.

6 Description of the environment

6.1 Introduction

Central to the environmental assessment process is establishing an understanding of the features and processes that characterise the environment. In the case of the areas potentially affected by the development of the ACG oil fields, many of these have already been described in detail for previous environmental assessments and related studies.

This section provides a general description of the environmental conditions in the ACG Contract Area and the surrounding region. A more detailed description from recent environmental surveys of the Phase 1 platform and the sub-sea pipeline route is also provided as well an overview of post operational surveys. Following the description of the offshore environment, the nearshore environment is presented in Section 6.3 and the coastal and terrestrial environment in Section 6.4.

6.2 Offshore environment

6.2.1 Data sources

This section reviews information available on the offshore marine environment. The environmental conditions of the ACG Contract Area and surrounding regions are well documented in a number of key reports, outlined below. Existing information on the environmental conditions of the ACG Contract Area includes:

- A baseline survey of the proposed Phase 1 location completed in 1998;
- An environmental baseline study: review of existing scientific literature applicable to the AIOC Contract Area (1995); and
- An environmental baseline survey of the ACG Contract Area in September and December 1995.

A number of monitoring surveys have also been completed around the Chirag 1 platform and at the appraisal well locations.

The data used for this report are summarised below in Table 6.1.

Table 6.1 Summary of Information available for ACG

Date	Title
1995	Environmental baseline study: Review of the existing scientific literature applicable to AIOC contract area
1995	AIOC Offshore Environmental Baseline Survey 1995, September and December
1996	AIOC Contract Area Long Term Monitoring Stations 1996
1996	AIOC Appraisal Well 1 Pre and Post Appraisal Drilling Seabed Environmental Survey 1996
1997	AIOC Appraisal Well 1 Pre and Post Appraisal Drilling Seabed Environmental Survey 1997
1997	AIOC Appraisal Well GCA No. 3 and Appraisal Well GCA No. 4, Post Appraisal Drilling Seabed Environmental Surveys, 1997
1998	AIOC Chirag 1 mid drilling environmental survey, 1998
1998	AIOC Phase 1 environmental description 1998 (draft)
1998	Phase 1 Platform 1a and 1b environmental baseline surveys
1999	Review of AIOC environmental monitoring, 1999
2000	Chirag 1 post saraline survey 2000
2000	GCA 5 and 6 post well survey, 2000
2000	Chirag - Sangachal sub sea pipeline survey, 2000

6.2.2 Location

The ACG Contract Area is situated in the offshore waters of the Middle Caspian, 60km east of Shahdilli Spit at its closest point. The Contract Area is approximately 40km in length and has a maximum width of 11.5 km occupying an area of 430 km^2. The existing pipeline route from the contract area to the Sangachal terminal is approximately 180 km long. The majority of this length is located in the offshore environment with a small percentage within the inshore area of Sangachal Bay. Figure 6.1 shows the location of the ACG contract area with details of specific installations shown in Figure 6.2

Figure 6.1 Location of ACG contract area in relation to the Apsheron Peninsula

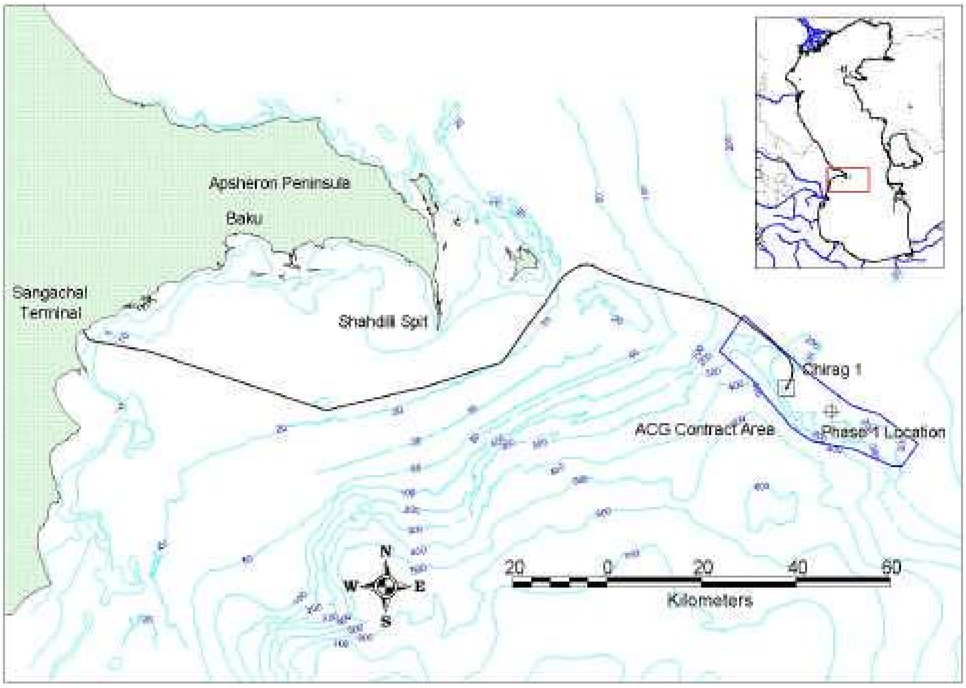
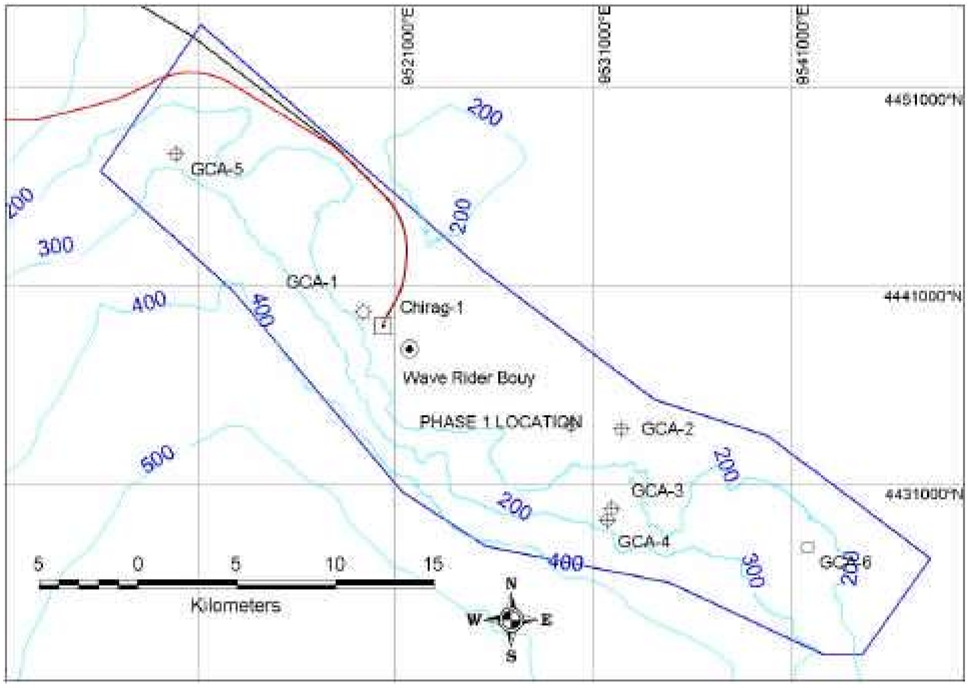


Figure 6.2 ACG Contract Area with installation locations



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.

Table 6.2 Monthly mean air temperatures of offshore Apsheron Peninsula (°C) (Woodward Clyde, 1995)

Aspect	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

Figure 6.3 Monthly mean air temperatures of offshore Apsheron Peninsula (°C) (Woodward Clyde, 1995)

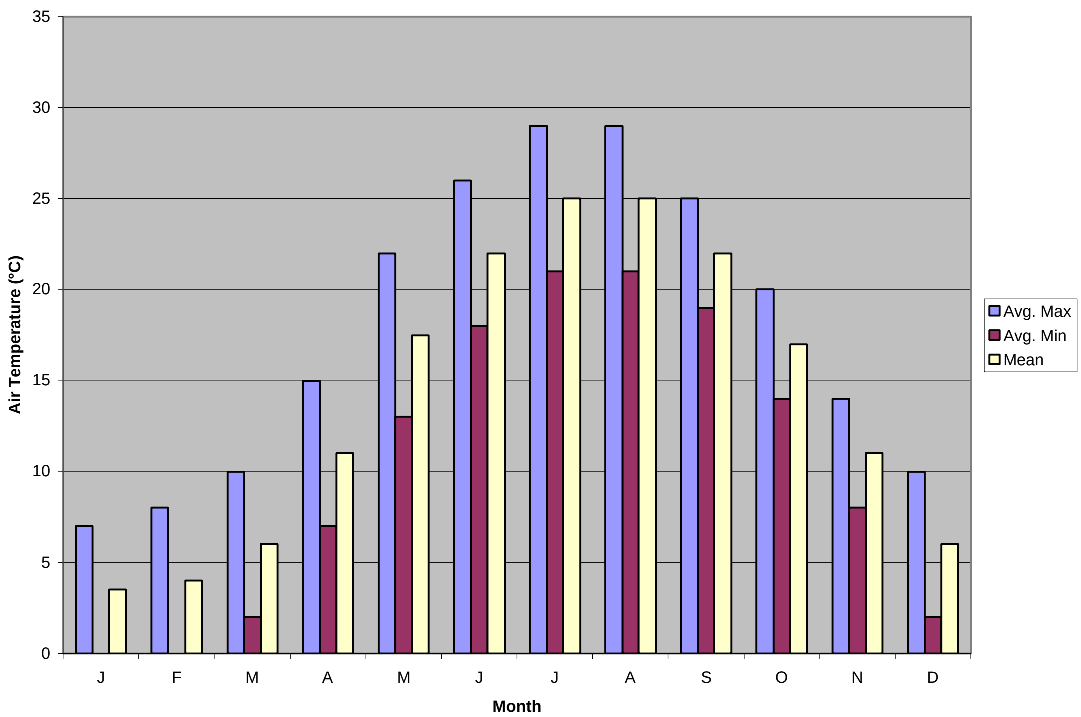
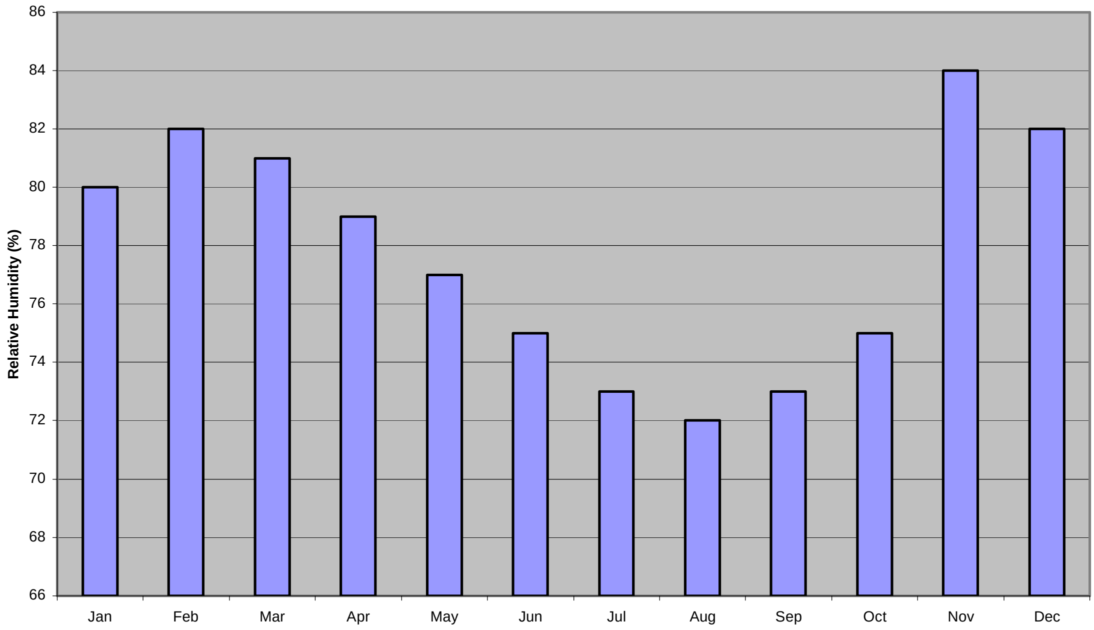


Figure 6.4 shows the relative humidity for the area, which increases marginally in the winter months and is lower in the summer months (Woodward Clyde 1995).

Figure 6.4 Average relative humidity in the Caspian (Woodward Clyde 1995)



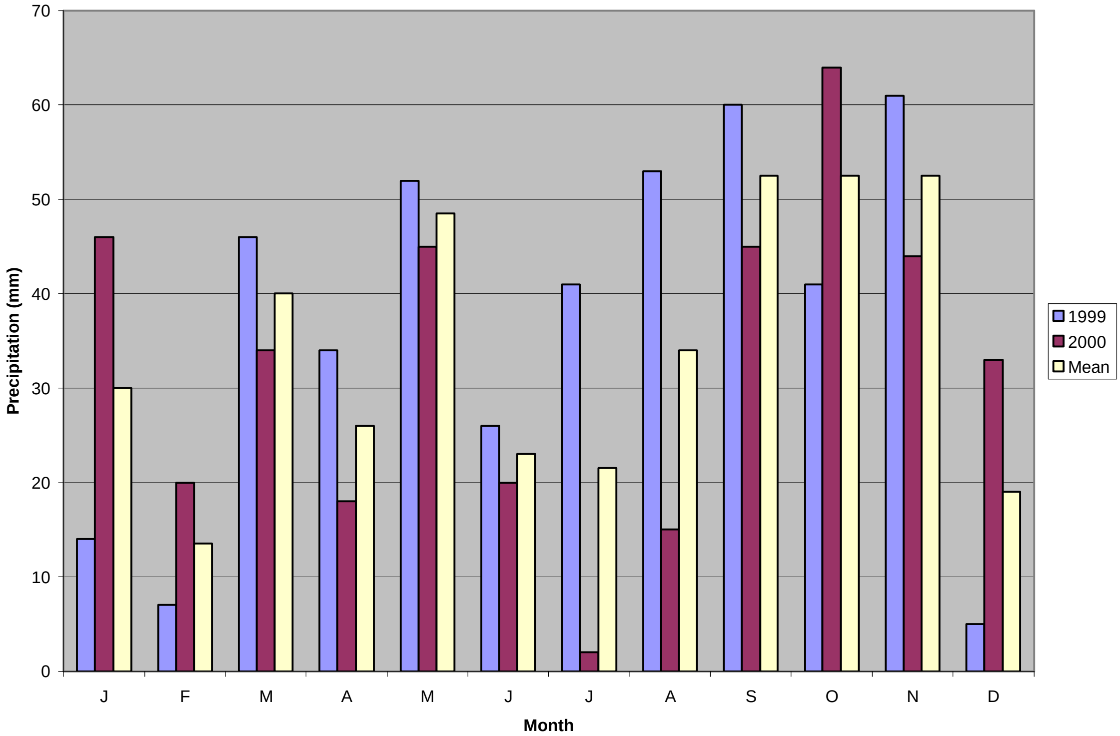
6.2.3.2 Precipitation

The Apsheron Peninsula experiences relatively dry summers and winters with rainfall increasing in the spring and autumn months. Figure 6.5 shows annual rainfall for the area for 1999 & 2000. It is expected that rainfall in the ACG Contract Area would be similar to the data listed in Table 6.3.

Table 6.3 Apsheron Peninsula 1999 and 2000 rainfall data (mm) (FAO, 2001)

Year	Month												
	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

Figure 6.5 Apsheron Peninsula precipitation for 1999 and 2000 (mm) (FAO, 2001)



6.2.3.3 Wind Regime

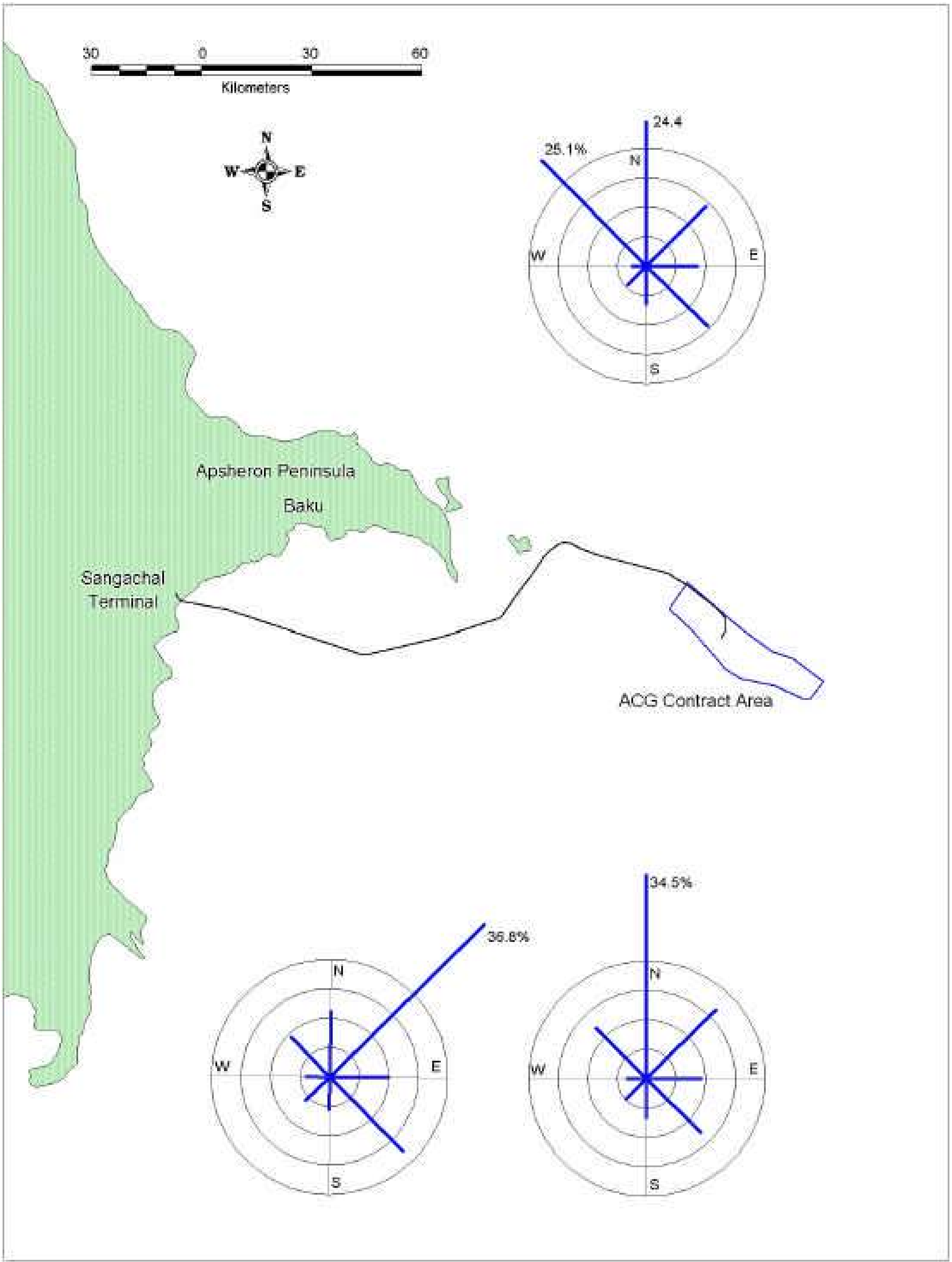
The Apsheron Peninsula experiences high annual average wind speeds of 6.2 - 8.0 ms^{-1}. Storm winds are frequent, with wind speeds in excess of 15 ms^{-1} being recorded on 60-80 days per year; to other areas of the Caspian, in comparison , experience only 20-30 days per year of storm winds. Storm winds are most common in winter and mid-summer (Table 6.4).

Table 6.4 Seasonal wind frequency of the Caspian Sea (Koshinsky, 1975)

Wind	Seasonal Percentage Occurrence				
Direction	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

Figure 6.6 shows a summary of geostropic wind computed from isobars on weather maps from 1980-1989. The figure shows 3 wind vectors for 3 locations, representing the relative frequency and direction of the wind over this period.

Figure 6.6 Relative frequency and direction of winds around the ACG contract area



6.2.3.4 Fog and Visibility

Moisture saturated air which can result in fogs can be found within the ACG contract area during the winter months. There is approximately a 10 % chance of these conditions occurring and a fog forming. (Woodward Clyde, 1995)

6.2.4 Offshore Oceanography

6.2.4.1 Bathymetry

The North Caspian Sea covers about 25 % of the Caspian Sea's total area, whilst the Middle and South are about equal in size, at 37 % each. However, the water depths and thus the water volumes contained in the three parts differ greatly. The whole Caspian Sea contains approximately 79,000 km^3 of water, with the North, Middle and South Caspian Sea areas containing respectively, 0.5 %, 33.9 % and 65.6 % of the total sea volume. The corresponding mean water depths are 4 m, 181 m and 350 m respectively.

The ACG contract area tends to slope from a depth of about 100 m to approximately 400 m toward its southwestern limit (Figures 6.1 and 6.2.). The seabed topography throughout the area is very irregular especially in the vicinity of mud volcano vents present in the shallower parts.

6.2.4.2 Sedimentology

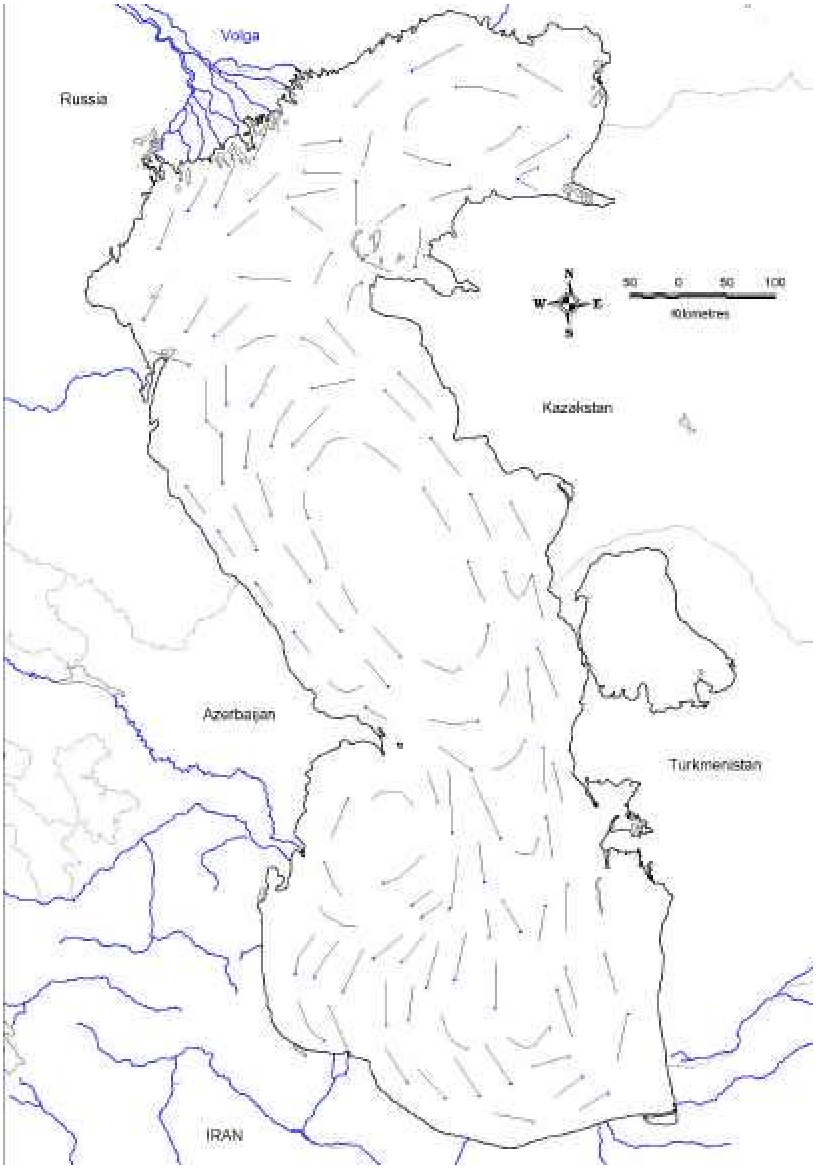
The Caspian is landlocked and consequently tidal movements are much less significant than in oceanic areas. Currents in the Caspian are principally wind driven and tend to be small and transient. Nevertheless, surficial seabed sediments do indicate areas where bottom currents are periodically strong 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.

6.2.4.3 Residual currents

The late spring river flows, particularly from the Volga, create a southwards flow down the west coast of the Middle Caspian (Kosarev & Yablonskaya, 1994). This may also drive counter currents up the east coast and set up a residual circulation in the South Caspian. However, wind driven circulation is the principal feature in the Caspian. Figure 6.7 shows the pattern of residual currents in the Caspian.

Figure 6.7 Residual current pattern in the Caspian Sea (Woodward Clyde, 1995)



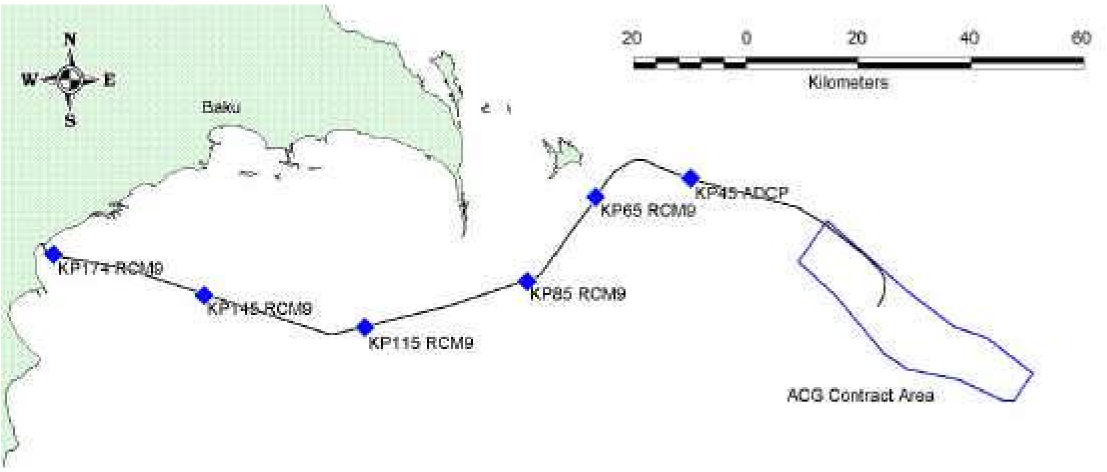
6.2.5 Wind driven and subsurface currents

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. Thus, with winds from the north, a southern surface current generally prevails. Similarly with southeasterly winds, the resulting surface currents are usually in a northwest direction. These currents are also greatly influenced by the configuration of coastlines and bottom relief.

Measurements of water currents were made from October to December 1996. Results indicated that most of the time currents were weak (90 % of the time below 0.2 ms^{-1}). Maximum currents detected were 0.65 ms^{-1}, but these were recorded at a depth of 50 m. Maximum surface currents were 0.4 ms^{-1} and mean surface currents around 0.1 ms^{-1}.

Near seabed current speed and direction data was collected at six sites along the proposed pipeline route between Chirag and Sangachal in the Caspian Sea from October 1999 to May 2000. Figure 6.8 shows the locations of the current meters.

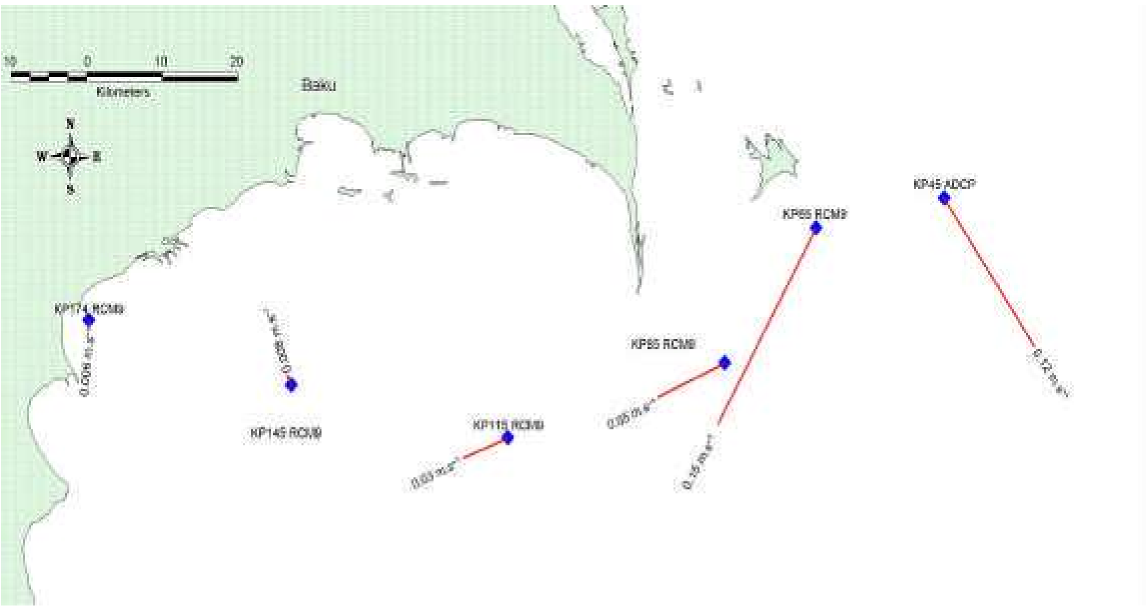
Figure 6.8 Current meters deployed along existing pipeline route



The monitoring indicated that current speeds generally decrease from Chirag to Sangachal, with the mean current speed falling from about 0.17 ms^{-1} at the offshore sites to about 0.08 ms^{-1} at the inshore sites. Highest current speeds (maximum of 1.26 ms^{-1}) were measured at site KP65, where the speeds were noticeably higher than at adjacent sites. The direction of the flow was predominantly southward at the offshore sites, with southward flow events typically lasting for several days separated by periods of northward flow. Closer inshore, the flow was more evenly distributed, with northward flow persisting for longer periods than further offshore.

Storm surges are a common event, causing temporary rises in sea level. These events are associated with persistent strong winds causing water to pile up along the coast.

Figure 6.9 Mean current vectors showing mean speed and direction along the existing pipeline route during the period October1999 to May 2000



6.2.5.1 Waves

Due to the size of the land-locked Caspian Sea the predominant waves are small compared to open oceans, with little build up of swells. 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 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 south east of Sangachal. Data on the seasonal variation of wave heights is from measurements taken at Oil Rocks.

Table 6.5 Directionality of waves at Bulla Island, Israilov A (1977)

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

Table 6.6 Seasonality in wave heights at Oil Rocks, Tambovtseva L P. (1975)

Wave height (m)	Days/ month												Days /year
	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

The 100 year wave height data give a maximum measured wave height of 16.7 m. A 1996 storm modelling study carried out on behalf of AIOC confirmed this (AOIC EIA for the Appraisal drilling, 1996).

6.2.5.2 Sea Temperature

During the winter the surface water temperature in the ACG Contract Area will fall to 5 - 6 °C. In exceptional circumstances the ACG contract area may experience freezing conditions, but this phenomenon has not been observed recently. Water temperature reaches its maximum during July and August when values of 25 to 26 °C are common in the Contract Area. Temperatures at depth in the South Caspian remain at about 6 °C all year round. In extreme winters dense cold water is believed to flow from the North Caspian to the Southern Caspian, under warmer and less dense surface waters.. If this flow is sufficiently strong it may continue southwards, rise over the Apsheron threshold and replenish the deeper waters of the South Caspian.

During the summer months a stratified water column develops, with a thermocline at water depths of between 20 and 60 m. The depth of the thermocline increases during the summer months as surface water temperatures increase. As the autumn turbulence increases and sea surface temperatures decrease, this 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.

6.2.5.3 Salinity

The average salinity of the South Caspian Sea is approximately 12.9 ‰. The lowest salinity (<5‰) is found in the shallow North Caspian. For offshore areas of the Middle and South Caspian 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 of the South Caspian, salinities may reduce to 12 ‰ and in shallow bays on the eastern coast values can reach 14 ‰ due to increased evaporation.

6.2.5.4 Sea Water Chemistry

The Caspian contains waters of oceanic origin, which have been diluted and changed by 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. The waters of the open areas of the South and Middle Caspian differ from oceanic waters in the absolute values of the main ionic ratios, but retain a constancy of ratios, which is typical for seawaters.

Offshore areas of the Caspian, 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 lowering of oxygen levels below the thermocline.

6.2.6 Offshore Physical Environment

6.2.6.1 Seabed geomorphology

The dominant morphological feature in the ACG Contract Area is the Apsheron Sill that runs southeast across the Caspian Sea from the tip of the Apsheron Peninsula. The ACG Contract Area straddles the western end of the sill.

During a baseline survey carried out in 1995 (Woodward Clyde, 1995) seven geomorphological provinces were identified in the Contract Area (Figure 6.10). These were designated on the basis of seafloor bathymetry, seabed features and geological processes. The provinces are:

- **The Back Ridge province**. This area slopes to the northeast and is characterised by natural gas seeps, gas charged sediments and large scale polygonal seabed features.

- **The Ridge Crest province**. Situated on the Apsheron ridge, this area is chiefly characterised by ridges with positive relief of up to 5 m and generally spaced between 75-100 m apart.

- **The Mud Volcano Complex province**. This area contains three large mud volcanoes (Gunashli, Chirag-Azeri and Azeri-1). The largest is Gunashli, which is approximately 150 m high and 300 m in diameter. In addition, there is a buried volcano structure (Azeri 2), two small volcanoes (Azeri 3 and 5), and a subsidiary mud volcano on the flanks of Azeri 1.

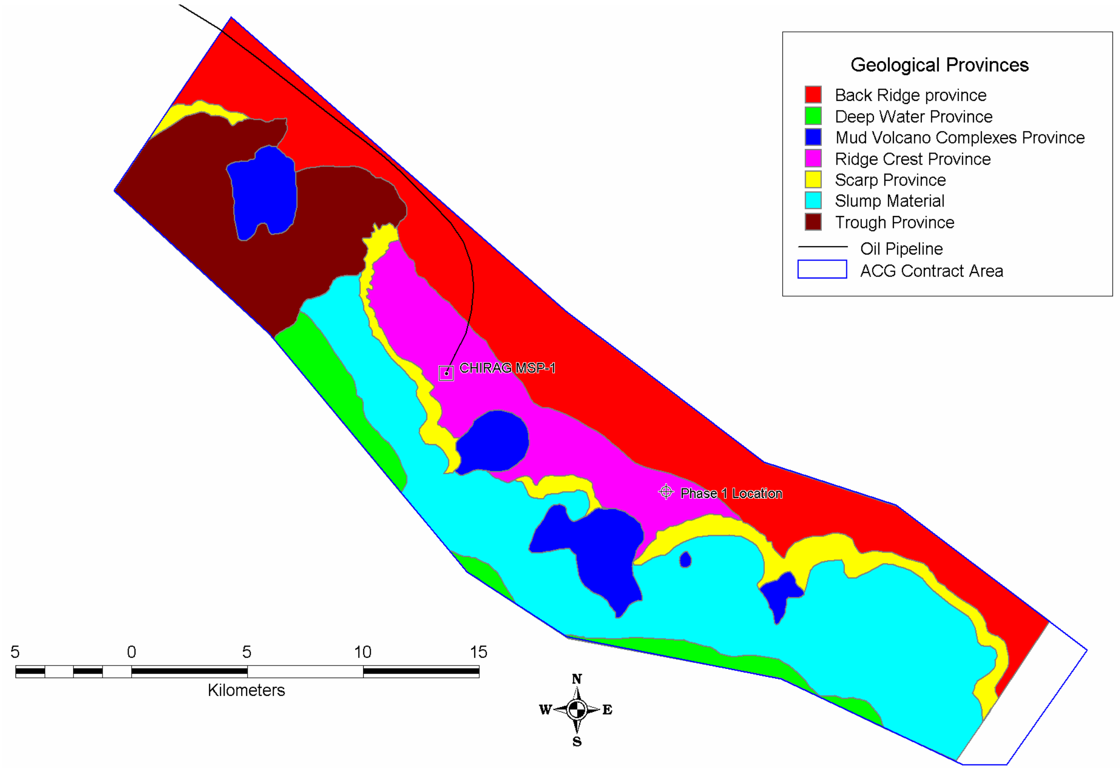
- **The Scarp province**. This province consists of a narrow elongated area lying along the central axis of the Contract Area, which slopes steeply to the southwest. The main seabed feature is the presence of slump scarps and debris flows.

- **The Slump Material and Debris Flow province**. This area is sub-divided into three zones:
  - **The North Slump province.** This dips steeply to the southeast. Gully channels and debris flows are observed at the proximal end of the area.
  - **The Central Slump province**. This is located between the Azeri 1 and Azeri 2 mud volcanoes. It is a broad concave slope, and in addition to the features observed in the North Slump province, carbonate concretions associated with gas seeps are present.
  - **The South Slump province**. This is located between the Azeri 2 mud volcano and the southwestern corner of the Contract Area. It is a relatively featureless area, which varies between 1 and 5 km in width.

- **The Trough province**. This area is characterised by fault scarps, exposed and truncated bedding planes and slumping, sliding and debris flows. The central and distal regions of the Trough province were found to be relatively featureless, although some evidence of mudflows was recorded.

- **Deep Water province**. There is insufficient geotechnical data gathered for this province to characterise it with any degree of confidence.

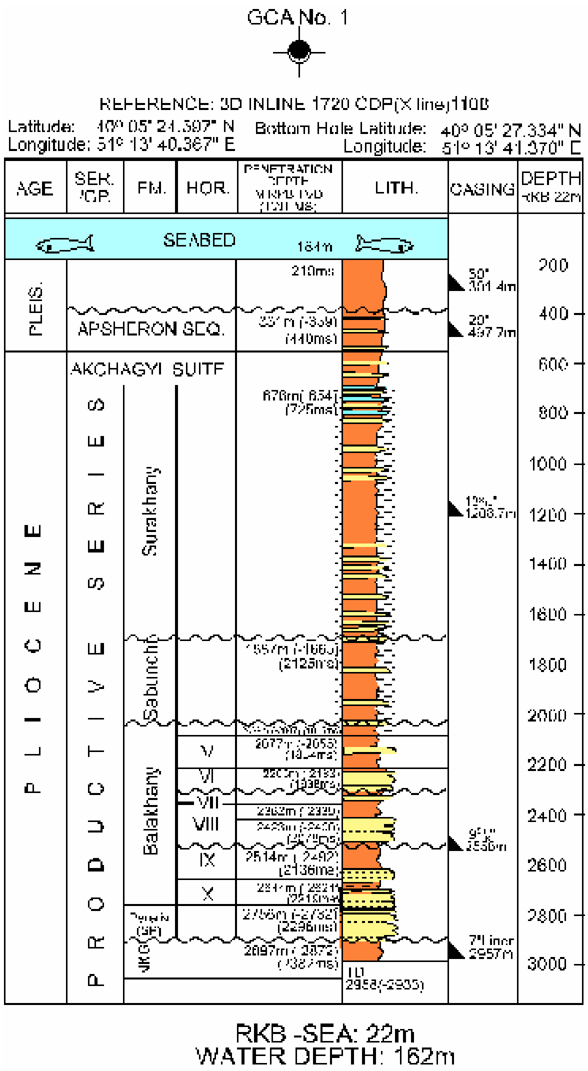
Figure 6.10 Seabed Morphology of the ACG Contract Area



6.2.6.2 Geology and Geomorphology

The Azeri field lies adjacent to a mud volcano and extensive shallow faulting is present in the Surahkany formation and above, at the top of the anticline structure. The lithology from a drilled well in this area (GCA-1) is shown in Figure 6.11. The top of the Surakhany formation, marked by a 3m-thick cap-rock of gypsum, is composed predominately of yellowish-brown and grey-green claystone with thin beds of gypsum and anhydrite and fine-grained argillaceous sandstone. In addition, subordinate halite has been noted from traces found in claystone cuttings in association with the evaporite-sandstone beds. The claystone is moderately calcareous and dolomitic, with occasional thin dolostone stringers found in conjunction with gypsum beds. The lower part of the section consists of olive-grey to yellowish-brown claystone with thin interbedded grey-white siltstones and sandstones that increase in frequency to the base of the formation.

Figure 6.11 Lithology Column at Well GCA-1



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.

The Balakhany formation is sub-divided into six horizons, Balakhany V through X, with formations VI to IX being reservoir potential. The top of the Balakhany formation is marked by a thick grey-brown, olive-grey, brownish-grey to grey claystone that is blocky and firm, moderately calcareous, and earthy. It becomes progressively more silty and sandy with depth to the Balakhany V horizon.

The Balakhany V interval is composed of a claystone and siltstone sequence with thin sandstone stringers. The claystone/siltstone is grey-white, grey-brown, olive-grey, brownish-grey and is firm, blocky, earthy and moderately calcareous. The sandstone is clear, loose, very fine to fine-grained, locally medium-grained, and sub-angular with an argillaceous calcareous matrix. This formation has tested gas and been shown by wire-line logs to be water wet.

The Balakhany VI is composed primarily of yellowish to dark olive-brown, olive-grey, brown and rare purple-grey claystones that are soft to moderately hard, swelling, sub-blocky, earthy and moderately to highly calcareous. The claystone is also silty to sandy and sticky in parts. The formation becomes increasingly arenaceous with several, thin, stacked sandstone units interbedded with claystone and siltstone. The siltstone is medium-grey to purplish-grey, olive-brown, soft to firm, sub-blocky, argillaceous, and grades to very fine-grained sandstone with traces of pyrite. The sandstone is translucent brown, translucent grey, white to grey, very fine to fine-grained, unconsolidated, sub-angular to sub-rounded, and moderately well sorted quartz with a grey-white calcareous matrix. The sandstones show fair to good inter-granular porosity. Trace oil shows and some gas is present.

6.2.6.3 Seabed Sediments

The wide range of geomorphological features found in the ACG Contract Area are reflected in the heterogeneous nature of sediments that have been recorded during previous environmental surveys. Overall two general groupings of sediments have been identified;

- Uni-modal, well sorted silts, and
- Poly-modal, poorly sorted mixtures of mud, sand, and shelly gravel.

In addition, some areas of laminated calcareous concretions can be found. These are associated with shallow natural gas deposits in the sediments. Reference to the seabed conditions around the proposed platform location is detailed later in this section.

Total hydrocarbon content of the sediments sampled during the environmental surveys of the ACG Contract Area range from 19 $\mu g g^{-1}$ – 10,291 $\mu g g^{-1}$. The highest concentration was found close to the rim of the active mud volcano Azeri 1. Elsewhere in the contract area, the general level of total hydrocarbons was in the range 41 – 3,860 $\mu g g^{-1}$. During the 1995 baseline survey of the Contract Area, fresh (unweathered) hydrocarbon material was found in surface sediments in the vicinity of mud volcanoes and in the north western end of the Contract Area.

Sediment trace metal concentrations have been determined in samples from a number of Contract Area surveys conducted between 1995 and 2000 (Table 6.7). The ranges for most metals are similar between surveys, and the majority of higher values (especially for mercury, iron and zinc) appear to be associated with the impact of drilling activities on a small number of stations. The concentration ranges reported in Table 6.7 are, overall, very similar to those reported from recent baseline surveys in other parts of the South Caspian, and thus appear to be typical for the wider South Caspian area. Some caution should be observed in making detailed comparisons, however, since the data have not been normalised to any consistent sediment parameter and sediment structure can vary considerably between locations.

Table 6.7 Summarised ranges of sediment trace metal concentrations reported in surveys conducted in ACG Contract Area between 1996 and 2000, together with typical ranges reported from North Sea baseline and monitoring surveys

Metal	Trace metal concentrations in sediments (µg.g dry weight^{-1})								
	GCA 3 & 4, 1997		Appraisal well 1 (GCA 1), 1997		Long-term monitoring stations, 1996	Chirag Phase 1 baseline, 1998	Chirag 1 mid-drilling survey, 1998	Chirag 1, 2000	Typical North Sea background[1]
	GCA 3	GCA 4	Predrill	Postdrill					
Barium	351-2394	189-1560	506-7430	209-7060	213-4970	930-2960	450-2945	1232-11000	100-500
Cadmium	<1-1	<1-2	0.07-1.13	0.08-1.17	0.05-0.88	0.19-0.44	0.08-0.33	<1.25	0.01-0.05
Chromium	37-52	31-48	13-71	13-80	23-82	30-42	26-57	27-71	5-20
Copper	21-46	15-47	8-35	9-46	15-56	20-39	16-40	14-32	5-15
Iron	18730-33410	14320-23690	12700-62000	11700-88300	12400-76900	15060-24210	14610-40060	19166-61460	2500-10000
Lead	12-68	14-489	9-18	9-20	7-25	26-43	14-40	15-32	5-15
Mercury	0.02-0.24	0.1-0.31	0.05-0.2	0.12-0.24	0.06-0.18	0.02-0.07	0.01-0.1	0.02-0.05	0.005-0.02
Nickel	32-46	12-45	12-60	12-97	17-64	33-45	28-54		5-10
Zinc	<1-28	16-34	25-74	22-85	33-116	53-111	37-158	74-155	10-20

[1] ERT Ltd, collated unpublished data

A comparison of the reported ranges for Contract Area locations with survey data collated for the North Sea indicates that South Caspian sediment metal concentrations are consistently much higher. It is not possible to conclude from the available data whether this is a general natural characteristic of Caspian sediments or whether it represents the consequence of historical diffuse contamination.

Only very low concentrations of metals were measured in surface sediments collected in 1995. Elevated strontium concentrations were noted from areas of coarse sediments. This is likely to be related to strontium being substituted for calcium in shell materials. Further support for this interpretation was given by two additional observations from this survey. Firstly, very low levels of calcium were identified from the Contract Area. Secondly, the levels of strontium were found to decrease with depth in sediment cores at locations close to Chirag, and increase in level with depth from cores taken from outside this area. Elevated levels of barium were also observed in areas where appraisal and production drilling has occurred, except at Appraisal Well 1. A weak gradient of increasing sediment vanadium concentration was noted towards the north-western end of the Contract Area. As vanadium is a known component of oil this suggests some petrogenic contamination in the area, possibly due to activities in the nearby Gunashli field. This pattern is also mirrored by sediment hydrocarbon levels.

Recent gamma spectroscopy analysis carried out on surface sediment samples collected from a number of locations along the existing oil export pipeline from Chirag 1 to Sangachal and from a number of locations in the ACG Contract Area found a range expected for uncontaminated surface marine sediments (ERT 2001). In most cases, ^{210}Pb activities exceed those of ^{226}Ra, again consistent with no radioactivity contamination. Any contamination with tailings, or scale, containing radium would be apparent as a significant excess of ^{226}Ra activity over that of ^{210}Pb or excess of ^{228}Ra over ^{212}Pb.

6.2.7 Offshore Biological Environment

6.2.7.1 Plankton

Plankton data collected in the ACG Contract Area is limited to that collected during the 1995 baseline survey and a survey of the Chirag 1 platform, GCA 5 and GCA 6 in 2000. The data from these surveys show changes in phytoplankton and zooplankton composition in the Contract Area. Differences in species composition and abundance should be treated with caution due to the paucity of available data.

In 1995, offshore phytoplankton samples were numerically dominated by the diatom *Pseudosolenia* (*Rhizosolenia) calcar-avis* and the dinophytes *Gymnodinium* and *Prorocentrum.* The diatoms *Skeletonema* and *Thalassionema* were also abundant and there were occasional ‘patches’ of blue-green algae. The overall abundance at this time was typically of the order of 5000 cells.l^{-1}. In phytoplankton samples collected in 2000, blue-green algae were very abundant at most stations and overall phytoplankton abundance was in the range of 30,000-100,000 cells.l^{-1}. *Chaetoceros*, *Thalassionema* and *Skeletonema* were the most abundant diatoms in 2000. Thehe dinophyte *Prorocentrum* was abundant. The available data are limited in both spatial and temporal resolution, and it is not possible to draw conclusions with respect to the differences observed between samples collected in 1995 and 2000.

6.2.7.2 Zooplankton

Zooplankton samples from the 1995 baseline surveys were numerically dominated by the copepods *Acartia clausi* (alien species) and *Eurytemora grimmi* (native species), with the larger native copepod *Limnocalanus* also being abundant at some stations. Total zooplankton abundances were low and ranged from 113-10,218 organisms per cubic metre. In 2000 zooplankton abundances were much lower than in 1995, with only a few organisms m^{-3}. These samples were dominated by *E. grimmi* and *Limnocalanus*. The alien predatory ctenophore *Mnemiopsis* was also present in small numbers at various stations. The common trends for zooplankton across the Contract Area were very low abundance, biomass and diversity. However, zooplankton samples were generally dominated by the copepod species *Acartia clausi*, *Eurytemora grimmi and Limnocalanus*, all of which are species common in the South Caspian.

6.2.7.3 Benthic Communities

The general characteristics of the benthos in the Contract Area, inferred from surveys conducted between 1995 and 2000, are summarised in Table 6.8. Over most of the area surveyed, the recorded number of species (48-65, with the exception of GCA 3 & 4) represents good diversity in the context of the Caspian.

The benthos in the northwest of the Contract Area, around the GCA 5 well site (Figure 6.2) at a depth of 280 m, was characterised by an abundant fauna numerically dominated by crustacea, in particular six to seven species of amphipods. Polychaetes are also abundant but not as diverse. The abundance of gastropods and oligochaetes was low.

Toward the centre of the Contract Area at a depth of approximately 130 m, the fauna around Chirag 1 (Figure 6.2) was dominated by amphipods and oligochaetes. Polychaetes are present but in lower numbers than in the northern part of the Contract Area though the overall abundance of benthos in this part of the Contract Area was generally high.

Around GCA 3 (approximately 240m) and 4 (approximately 260m) the benthos was numerically dominated by oligochaetes and polychaetes, in generally silty sediments. Amphipods are not a major component of the community, in contrast with locations to the north. Bivalves (*Mytilaster* and *Didacna*) are abundant at GCA 4 but not at GCA 3. This was associated with presence of suitably hard coarser sediment allowing the bivalves to settle in the vicinity of GCA 4 location. The overall abundance here was moderate, and lower than at Chirag 1. A similar pattern was observed around GCA 6.

Benthic abundance was in the range 5-30 $g.m^{-2}$ in the areas surveyed within theACG Contract Area. Lower recorded biomass values are generally associated with stations impacted by drilling activities, and values in the range of 20-30 $g.m^{-2}$ are more representative of much of the area. There was a trend for amphipods to be dominant in the northwest and for a transition through an amphipod/oligochaete-dominated community to an oligochaete/polychaete community across the area towards the southeast. This could also be described as a transition from crustacean-dominated communities in the northwest to annelid-dominated communities in the southeast. Benthic biomass during the summer months was sufficiently high that it could play an important role in the life cycle of local fish stocks.

Table 6.8 Summary of macrobenthic biological data from surveys conducted in the ACG Contract Area between 1995 and 2000

Item	**Chirag 1, 2000**	**Phase 1, locations 1a and 1b, 1998**	**Chirag 1 mid-drilling, 1998**	**GCA 3 & 4 1997**	**AIOC 1 (1996)**	**AIOC 1 (1997)**	**AIOC 2 (1995)**	**AIOC 2 (1996)**
Total taxa	55	48	54	25	55	57	60	64
Number of Indivs.m^2	74-5222	221-4104	6-4734	26-1696	4650-9414	234-7776	34-3712	54-6160
Dominant species in survey area	*Psammoryctes deserticola, Hypania invalida, Stylodrilus* sp, *Isochaetides michaelseni (Annelids) Gammarus* spp *(amphipod)*	*Psammoryctes deserticola, Hypania invalida (Annelids) Pandorites podoceroides (Gammarid amphipod)*	*Psammoryctes deserticola, Hypania invalida, Aktedrilus svetlovi (Annelids) Pandorites podoceroides (Gammarid amphipod)*	*Psammoryctes deserticola, Hypania invalida (Annelids) Schizorhynchus eudorelloides (cumacean) Tubifex acapillatus (annelid)*	*Manayankia caspica, Stylodrilus spp (Annelids); Gammarid amphipods*	*Stylodrilus spp (Annelid); Gammarid amphipods*	*Gammarid amphipods, Hyrcanocuma sarsi (cumacean)*	*Schizorhynchus scabriusculus (cumacean), Tubificidae sp AIOC95#45 (Annelid)*
Total biomass (g.m^{-2})	4.2-29.2	10.28	28.98	ND	ND	ND	ND	ND

AIOC 1. **AIOC appraisal well 1 pre- and post-drilling seabed environmental surveys, July 1996 and January 1997 (ERT, 1998a)**
AIOC 2. **AIOC environmental baseline survey, September 1995 and contract area long term monitoring stations, July 1996 survey (AIOC, 1996 and ERT, 1997)**

6.2.7.4 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, classified by their feeding and reproductive strategies:

- ‘marine’ fish which spend their entire life cycle in the Caspian Sea. These include 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. This group includes 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. These include the cessan carp (*Cyprinus carpio*), zander (*Stizostedion lucioperca*), Caspian bream (*Abramis brama orientalis*), sabrefish (*Pelecus cultratus*), and vobla orroach (*Rutilus rutilus caspicus natio*); and
- freshwater fish which spend their entire lifecycle in the riverine and delta areas. These include the sheatfish or 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 largely 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.

6.2.7.5 Commercially important fish found in the Contract Area

A number of resident and non-resident fish species inhabit the Contract Area, several of which are of commercial importance. The most important commercial species include: 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 list provides an outline of the vertical distribution of fish based on the literature.

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 -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. Spawning grounds include parts of the ACG Contract Area. 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, where the larvae hatch.

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 50-200 m. Availability of its main food, 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 Contract Area. Anchovy kilka spawn from May until December. The main part of the spawning population (80%) spawns in western part of the South Caspian from October until December. Spawning occurs both in the coastal waters at depths of 20-25 m, and at 200 m in offshore areas.

Big eye shad (*Alosa saposhnikovi*)

Although big eye shad migrate through the Contract Area in the spring from the south, 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 from 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 1-6 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 Contract Area. These fish spawn in the south and middle Caspian during the summer months of June and July. However, no mullet spawning grounds have been identified in the Contract Area. These fish will then over winter in the middle Caspian, which include the waters of the ACG Contract Area. Mullet are omnivorous with no particular food preferences, feeding on detritus, periphyton, and smaller benthic organisms.

Sturgeon (Acipenseridae)

Sturgeon abundance in the ACG Contract Area is at its peak during the spring and autumn. During the spring these fish pass through the Contract Area as they migrate from over wintering areas in the south to spawning areas in the north Caspian. In autumn, the sturgeon species *Acipenser guldenstadti* (Russian Sturgeon), *Acipenser guldenstadti persicus* (Persian Sturgeon) and *Huso huso* (Beluga) migrate from the north and return to over wintering areas in the southern Caspian.

6.2.7.6 Recent fisheries data

CERL (Complex Environmental Research Laboratory) has carried out seasonal (April, August, October, December) surveys in the waters of the Gunashli field between 1999-2001. 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 20-30 metres for six hours. Catch size, length, and weight statistics were compiled for each survey, and a subsample of fish (usually 5 individuals of each species) was examined for histopathological abnormalities.

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 (roughly 50-100). In both years, numbers were in the approximate range of 10-50 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 2-3 years in the April-October surveys. In 2000, age was reported as 2 years in April and August and 1-2 years in October and December. Fish in the April 2001 catch were recorded as 1-2 years old.

There was limited evidence of change in average length of kilka and shad over the period of the surveys, but 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 overfishing, 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 populations in the Gunashli area. 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 here.

6.2.7.7 Results of fish tissue analysis

During the September1995 and December 1995 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 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 6.9.

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. However, a significant UCM was observed in GC 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.

Table 6.9 Results of fish tissue analysis

Parameter	**September 1995**	**December 1995**
	Concentration (μg.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		
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

6.2.7.8 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 Sea 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 includes the Contract Area. They feed here until September when the majority of them migrate to the north. The late January survey of 1996 (AIOC 1996b) 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 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 (about 10%) 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).

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 canine distemper virus (CDV) infection was the primary cause of this massive die-off.

In addition to CDV mortality among the Caspian seal, pesticides and industrial pollutants are the cause of severe habitat destruction and poisoning. Not only is their environment and food source affected, so too 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).

Long term systematic surveys of offshore seal populations and behaviour have not been completed in the ACG Contract Area. Anecdotal observations made during environmental surveys and from workers on the Chirag 1 platform indicate that seals are commonly found in the Area.

6.2.7.9 Marine Reptiles

No data are currently available on the abundance and species of reptiles in offshore areas.

6.2.8 Seabed environmental characteristics in the vicinity of the Phase 1 platform

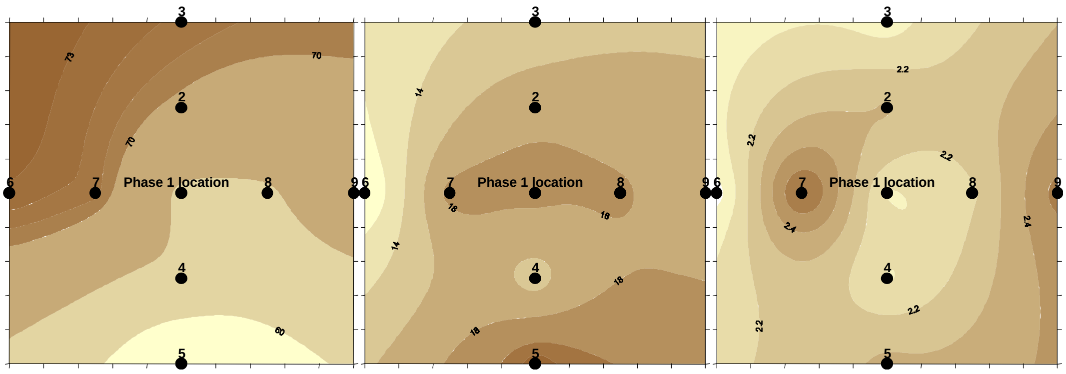
In 1998 a baseline survey was carried out to determine the environmental conditions around the proposed phase one platform location, so that future monitoring could ascertain the affects of drilling in the area.. Sediment samples were collected from both proposed locations for biological, chemical and grain size analysis.

6.2.8.1 Particle size and organic matter

All samples collected at the proposed Phase 1 platform location were classified as being either medium or very coarse sands and very poorly sorted. A study of particle size distribution indicated that the predominant particle classes were the very coarse fractions (<2 mm), probably originating from shell material, and the very fine (silt/clay) fractions. An average mean particle diameter of 595 µm was recorded. This sediment type, comprising a wide range of relatively fine particles with a high proportion of large shell debris, was commonly encountered in the baseline and long term monitoring surveys of the Chirag Contract Area carried out in 1995 and 1996

The carbonate content provides an approximate indication of the proportion of the sediment derived from shell material, which ranged from between 55 to 73%. The only geographical trend in sediment characteristics was a slight increase in the distribution of finer material in the southwest of the proposed platform location; however, spatial trends based on a small number of samples within a small area should be interpreted with caution. Figure 6.12 depicts the findings of the study.

Figure 6.12 Carbonate, silt/clay and organic content of sediments near the Phase 1 platform location – values give on contours, scale marks = 100m



Carbonate (%) Silt/Clay (%) Organic (%)

The heterogeneity of sediments at the Phase 1 location indicates at least two distinct sources of material; biologically derived carbonate (shell material) and geologically derived silt and clay.

6.2.8.2 Trace metal content

Sediment metal concentrations around the platform location are similar to background and baseline levels found previously in the ACG Contract Area (Table 6.7) and other offshore contract areas operated by BP (Inam and Shah Deniz). The concentrations of all metals are, however, substantially higher than those reported from open sea areas (e.g. North Sea))

6.2.8.3 Hydrocarbon content

Total hydrocarbon sediment concentrations were relatively homogeneous on the seabed around the proposed platform location where levels ranged between 20.8 to 50.4 $\mu g g^{-1}$ (mean value 42.4 $\mu g g^{-1}$). These values are similar to levels previously recorded in AIOC Contract AreaIt is possible that some of the background hydrocarbon content might derive from geological features such as natural oil seeps and mud volcanoes.

The hydrocarbon material present was characteristic of heavily degraded petrogenic contamination, the sources of which cannot be directly discriminated.

6.2.8.4 Macrobenthic community composition and structure

The area was dominated by annelid worms and crustaceans (Table 6.8). Molluscs were also common, but were less abundant. The polychaete *Hypania invalida*, the oligochaete *Psammoryctes deserticola* and the amphipod crustacean *Pandorites podoceroides* accounted for between 54 % to 80 % of the total number of individuals. The number of organisms associated with the seabed around the platform location ranged between 1,016 and 4,104 organisms.m^{-2}, and the average biomass for the Phase 1 platform location stations was 10.28 g.m^{-2}.

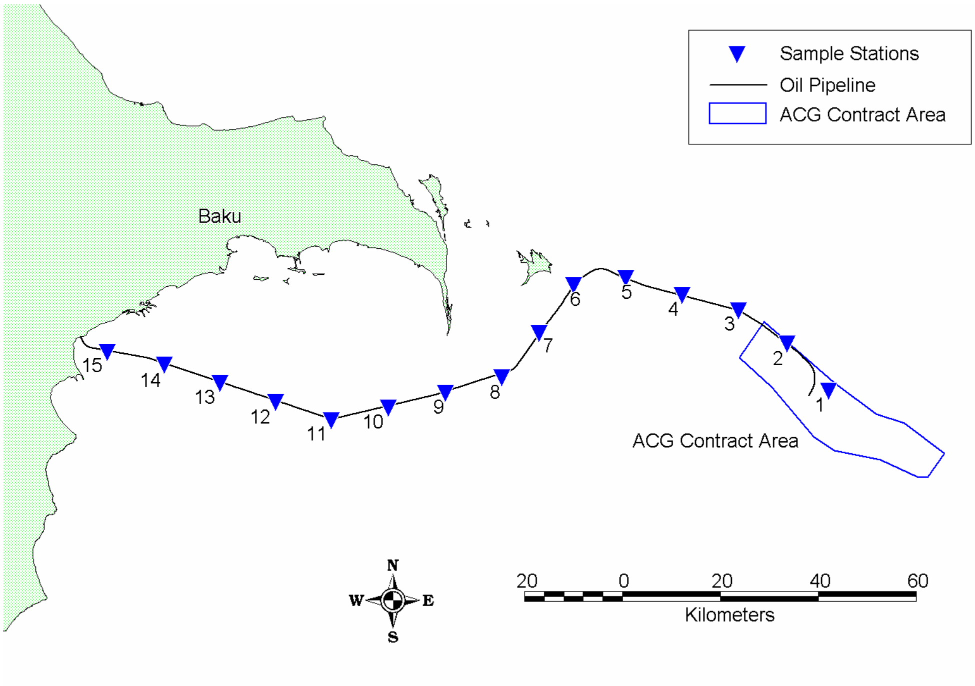
A total of 48 taxa were identified in the area, mostly to species level. Species richness varied between 18 and 29 species.m^{-2}. In terms of the numbers of taxa, the fauna was dominated almost equally by crustaceans (52 %) and molluscs (40 %), with annelid worms and insect larvae contributing 6 % and 2 % respectively. Of the total number of species, only a few were found at all or most of the stations; most species were present at only a small number of stations.

In summary, the seabed around the proposed location of the Phase 1 platform is biologically relatively homogeneous. The fauna of the area was characterised by three species: the oligochaete (*Psammoryctes deserticola)*, the polychaete (*Hypania invalida)* and the amphipod crustacean (*Pandorites podoceroides).* Diversity, species richness and biomass values were in the range expected for undisturbed sediments for this depth in the AIOC Contract Area.

6.2.9 Seabed environmental characteristics along the existing pipeline route from Chirag-1 to Sangachal.

A survey of part of the pipeline route was carried out in November 2000. Sediment samples from 15 stations were collected for macrobenthic identification and statistical analysis, sediment geochemistry and particle size analysis (Figure 6.13). Water samples were also taken for plankton identification and water quality analysis. The results of the water quality analysis were inconclusive, the majority of parameters measured were near the limits of detection and could not therefore be quantitatively interpreted with confidence.

Figure 6.13 Pipeline sampling stations



6.2.9.1 Plankton

Phytoplankton

A total of 23 species were identified in samples collected at 5 stations during the November 2000 environmental survey. Near surface-samples (NIOS water bottle) were collected at 5 m depth at all 5 stations, and samples were also taken at 10m depth at 2 stations.

The phytoplankton community was well represented in abundance and diversity by diatoms (10 species), blue-green algae (7 species) and dinophytes (5 species). A single species of chlorophyte was recorded in three samples (stations 5, 12a and 12b). Diatoms were most abundant in the majority of samples. Between 8 and 14 species were present in each sample (diatoms 5-9, blue-green algae 1-5, dinophytes 1-2 and 1 chlorophyte).

The community was numerically dominated by four species, which were present and abundant in all samples (the diatoms *Chaetoceros wighamii,and Thalassionema nitzschiodes, plus the dinophytes Prorocentrum cordata,and Prorocentrum scutellum*). Two other species, the diatom *Nitzschia tenuirostris* and the dinophyte *Prorocentrum obtusum*, were also abundant and were both present in all but one sample. The most abundant and frequently occurring blue-green alga was *Phormidium thermophilum*¸ which was present in 5 of 7 samples at abundances of up to 24,000 cells.litre^{-1}.

Two classes (dinophytes and diatoms) dominated the phytoplankton biomass in all samples. Ten species (one blue-green, four diatoms and five dinophytes) accounted for most of the biomass at all stations. Two diatoms (*Chaetoceros wighamii* and *Thalassionema nitzschioides)* were present in quantity at 6 or 7 stations, while three species of the dinophyte genus *Prorocentrum* were similarly important in terms of biomass. Two species of the diatom genus *Rhizosolenia* made a significant contribution to biomass at five stations; one of these species, *Pseudosolenia* (*Rhizosolenia) calcar-avis*, dominated the biomass at four stations by virtue of its very large cell size. Total phytoplankton biomass ranged from 0.19 to 0.41 mg.m^{-3}.

Zooplankton

Zooplankton samples were taken by vertical net haul from near-bottom to surface, using a conical net. This method has the merit that it can provide a comprehensive qualitative list of species, but suffers the limitations that:

a) it can underestimate actual plankton densities since it integrates high- and low-population density horizons; and
b) it can provide a misleading picture of community composition since samples may contain assemblages of species which do not spatially co-occur.

Zooplankton abundance, diversity and biomass were very low at all stations and depths sampled. Thirteen taxa were identified in eight samples taken at five stations. Of these, seven species were endemic cladocera, and three species were endemic (or native) calanoid copepods. Three species (two copepods and one ctenophore) were alien species which probably originated from populations in the Black or Azov seas. In a single sample 12 specimens of the ctenophore *Mnemiopsis* were present. The presence of *Mnemiopsis* was not reported in the 1995 baseline survey.

Of the taxa identified to species only three were present at most stations: the native cladoceran *Polyphemus exiguus),* the native copepod *Eurytemora minor*, and the alien copepod *Calanipeda aquae dulcis*. Of these, only the last was present consistently in more than single-figure abundance. The majority of taxa recorded were present in only a few samples and in abundances of less than 10 m^{-3}. Biomass was correspondingly low.

6.2.9.2 Physical and chemical characteristics of sediment

Sediment samples were collected at 15 stations along the pipeline route in November 2000. Sediments close to the shore, (stations 14 and 15 on the existing ACG pipeline), were composed of coarse grained silt, with higher carbonate content and lower silt/clay and organic content. Further offshore the sediment becomes increasingly finer grained, with higher silt/clay and organic contents and lower carbonate content. The sediments along the remainder of the route were fairly heterogenous; sediments closest to the peninsula were composed of coarse sand to very fine gravel but with varying amounts of carbonate and silt.

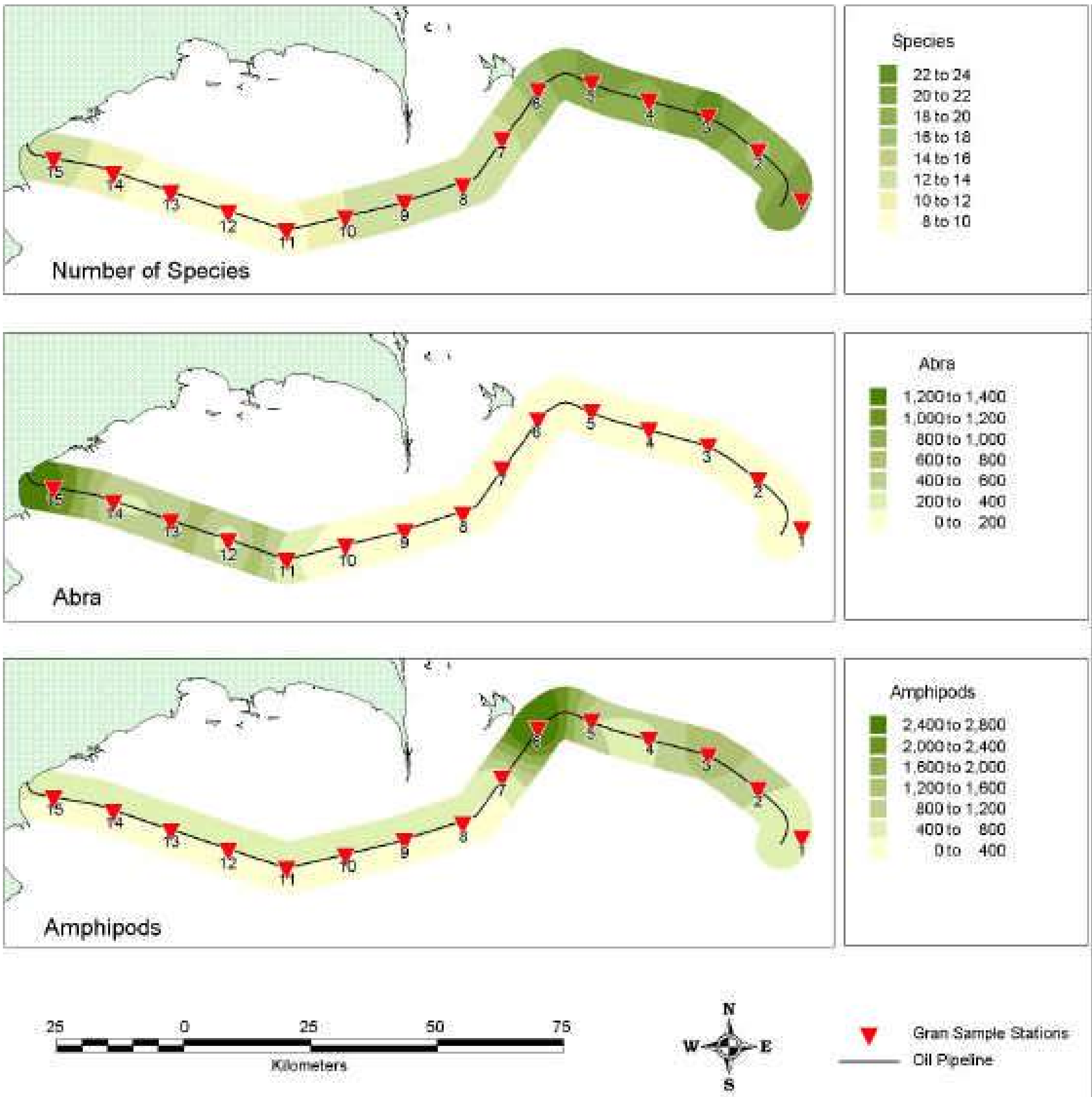
The concentrations of several metals (chromium, mercury, lead, and zinc) showed a general trend of increasing concentration from west to east along the pipeline route. In contrast, copper and iron concentrations displayed a patchier distribution, with low concentrations in the coarse sediment at station 6 (chromium concentrations were also low at this station). Barium concentrations exhibited a general trend of decreasing concentration from east to west.

Average total hydrocarbon concentrations along the pipeline route in 2000 ranged from 14 to 552 $ug.g^{-1}$. Lowest concentrations were observed in sediments from stations 1-7, located at the outer end of the survey transect (closest to the Contract Area), while highest concentrations were observed at stations 11 to 15 at the nearshore end of the transect. The UCM concentration increased in proportion to the total hydrocarbon concentration, and consequently accounted for a similar percentage of total concentration (72 to – 88 %) at all stations. The patterns of PAH and phenol concentrations were similar to that of total hydrocarbons. The highest concentrations of THC, UCM and PAH were observed in sediments collected from station 13, located in shallow water close to Sangachal.

6.2.9.3 Macrobenthic community composition and structure

A total of 50 taxa were identified in 15 samples. The majority of taxa occurred infrequently, and only four taxa (*Isochaetides michaelseni, Nereis diversicolor, Hypaniola kowalewskii* and *Abra ovata*) were present at 10 or more of the stations. The most diverse groups overall were the amphipods and molluscs, represented across the survey area by 14 and 13 (8 gastropods and 5 bivalves) taxa respectively. Polychaetes and oligochaetes were represented by 6 taxa each, and four cumacean taxa were also identified. The number of taxa (species richness) recorded at each station ranged from 8 to 23. Abundance ranged from 517 to 10905 individuals.m^{-2}. The pattern of abundance did not correspond to that for species richness. In general the number of species decreased from east to west across the survey area, whilst abundance was more strongly associated with localised patches (most particularly at stations 5, 6 and 12). Diversity reflected the interaction of these different patterns, with a degree of patchiness combined with a general trend towards higher diversity at stations in the east of the survey area.

Figure 6.14 Macrobenthic gradients along the pipeline route (units = number of individuals)



There were distinctive biological gradients along the pipeline route (Figure 6.14). Oligochaetes were most abundant in the east of the survey area, especially in stations with greater water depth. The distribution of amphipod abundance was similar, but more absolute; 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.

Biomass varied widely between stations, ranging from 3.13 $g.m^{-2}$ to 468 $g.m^{-1}$ High biomass was invariably associated with the presence of molluscs (biased by the inclusion of shell weight in biomass measurements) and/or crustaceans; annelid biomass exceeded 10 $g.m^{-2}$ only at one station, where a high abundance of *Nereis* coincided with large numbers of the oligochaetes *Isochaetides* and *Stylodrilus* and the presence of the polychaete *Hypaniola kowalewskii* . Biomass estimates included mollusc shell weight, and it should be noted that the highest total biomass values were invariably associated with stations where bivalve abundance was high.

Overall, the macrobenthic data indicates a transition from a native community in the east of the survey area (dominated by endemic gastropods and amphipods, and consistent with the biology of the northern part of the contract area) to a community in the west dominated by alien species (polychaetes and bivalves). Earlier pipeline corridor surveys (1995)did not have sufficient spatial resolution to discriminate this transition clearly.

6.2.10 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. The summarised biological data from a number of such surveys in the Contract Area have been included in Table 6.8. This section briefly summarises the impact ‘footprints’ observed in such surveys, and picks out any salient observations with respect to biological impacts.

Post-drilling seabed surveys have been conducted on seven occasions in the ACG contract area. Not all of the recent work (ie, that carried out at the end of 2000 or during 2001) has been completed and reported. However, sufficient work has been completed to date to justify a brief summary of the observed impacts of single-well drilling with water-based muds (WBM), synthetic-based muds (SBM) or a combination of both types of drilling mud.

The majority of post-drilling surveys summarised below have been single, small-scale and near-field. They thus 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.

6.2.10.1 Appraisal well 1, 1997

This well was drilled with WBM only. No changes in sediment chemistry were detected at stations in the vicinity of the wellsite at the time of the survey, but localised effects on the benthic community were inferred within a radius of 100 m of the wellsite. The primary biological effect was a reduction in the numbers of the oligochaete *Stylodrilus*, the polychaete *Hypania*, and the amphipod *Pandorites*. Pre- and post-drilling barium concentrations were similar, and there was no coherent pattern related to the location of the well site.

6.2.10.2 GCA 3 & 4, 1998

These wells were drilled with WBM and the synthetic mud Petrofree (ester-based mud). Localised smothering with drill cuttings was observed within 50m of the well-centre, with low amounts of synthetic based drilling fluid observed at GCA 4. No evidence of recent drilling fluid deposition was detected at GCA 3. Highly localised effects associated with the discharges of cuttings were detected in the benthos, although this might have been because the natural communities at these locations were very sparse.

6.2.10.3 Chirag 1 mid-drilling, 1998

The biological communities at this location were dominated by oligochaetes and amphipods. The physical footprint of drilling discharges extended up to 250m from the platform, and consisted primarily of measurable quantities of drill cuttings and base fluid. Biological effects were also observed within the limits of the physical footprint, with a reduction in the numbers of oligochaetes and (more markedly) amphipods.

6.2.10.4 Chirag post-Saraline drilling, 2000

Although there was no overall increase in hydrocarbon contamination or sediment concentration around the Chirag platform between 1998 and 2000, base fluids were detectable in sediments up to 1000 m from the platform. A clear physical footprint was evident up to 250 m from the platform, with a more patchy footprint detectable up to 500 m. The biological community was still dominated by oligochaetes and amphipods, as in 1998. Amphipods were absent, or present in reduced abundance, at sediment hydrocarbon concentrations of greater than 100 $mg.kg^{-1}$. Overall benthic abundance and diversity were reduced within 250 m of the platform. Toxicity tests carried out on samples from the benthic survey stations indicated that hydrocarbon concentrations of more than 100 $mg.kg^{-1}$ were moderately toxic (ie, they caused between 20 and 50% mortality in tests conducted with the amphipod *Pontogammarus maeoticus*) , and this suggested that some of the observed biological impact could be due to chemical (as opposed to physical) effects.

6.2.10.5 Overall assessment

The post-drilling observations summarised above are mainly from surveys conducted after the drilling of single wells, the exception being Chirag. As might be expected, the footprint of drilling discharges from Chirag extends more widely than the footprint from the drilling of single exploration or appraisal wells. In general, the surveys were spatially very limited, and the reported conclusions were equally limited. The single-well surveys were not repeated, so no defensible conclusions on rates and extent of recovery are possible. Some general conclusions can be drawn:

- WBM discharges have no, or very limited impact. Where this can be observed, it appears to be entirely due to physical smothering and habitat alteration by cuttings, and is limited to stations where there is a substantial deposit of cuttings. There is no evidence of chemical effects associated with WBM cuttings discharge.
- the overall footprint of SBM cuttings discharge appears to be limited to less than 250m radius in most instances, and possibly up to 500m in the case of Chirag 1 platform. The cohesiveness of SBM cuttings may enhance any smothering effect. However, there is some evidence that elevated hydrocarbon concentrations associated with these discharges could be moderately toxic. This is consistent with the observation that a common aspect of impact is the reduction in abundance of amphipods, a group of crustacea widely recognised as sensitive to hydrocarbon exposure.

6.2.11 Summary of environmental sensitivity

A summary of the environmental sensitivities is provided in Figure 6.15. The key environmental sensitivities in the ACG 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 serves as an important stopover for migrating birds;
- the presence of seals during the summer and spring and autumn migration periods; and
- spring time benthos and plankton recruitment and increased in productivity.

Figure 6.15 Summary of sensitivities

Plankton

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Low	Low	Low	High	High	Moderate	Low	Low	Moderate	Moderate	Low	Low

Within the Contract Area *Rhizosolenia calcar-avis* dominates the phytoplankton population. (75-96% of the total biomass) Zooplankton often dominated by copepods *Acartia clausi* (introduced) and *Eurytemora grimmi* (native species), with the larger native *Limnocalanus* also present. Peak productivity occurs in spring as ambient temperature and light levels increase.

Benthos

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
High	High	High	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low

A large portion of the western part of the South Caspian is distinguished in the summer by high benthic biomass levels from 100 - 1000g.m^{-2}. Contract Area biomass observed in the range 20-30 g.m^{-2} highest in spring and summer and declining in winter. Highest sensitivity in late winter and spring, lowest in summer and autumn.

Fish

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Low	Moderate	Very high	Very high	Very high	Moderate	Moderate	High	High	High	Moderate	Low

The majority of the fish species found in the Contract Area over the course of the year are present during spawning and wintering migration periods in the spring and autumn. The spring migration is the most sensitive period for the Contract Area as during this period fish abundance levels are at their greatest.

Birds

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Very high	Very high	Very high	High	High	High	Moderate	Low	Moderate	High	Very high	Very high

The majority of bird species can be found on the Aspheron peninsula during the winter and early spring as they overwinter and feed in the nearshore areas. The peninsula also acts as an important stopover during spring and autumn migrations.

Seals

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Low	Low	Moderate	High	Very high	Very high	Very high	Very high	High	High	Low	Low

From mid March the seals migrate south from pupping, breeding and moulting sites in the north Caspian to feeding areas in the southern and middle Caspian, moving offshore to feed on kilka during the summer. From October and November 90% of the population start their northward migration again. 10% remain in the area and may be encountered in the Contract Area.

Fishing

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Low	Moderate	Very high	Very high	Very high	Moderate	Moderate	High	High	High	Moderate	Low

The most important commercial fish species in the Contract Area are the Big Eye kilka, Anchovy, Mullet and Big Eye shad. Fishing for these species is greatest in the Contract Area during spring and autumn.

KEY

Very high | High | Moderate | Low | No data

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 found in 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 ^{0}C. 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 ^{0}C (recorded in July). Historically, the lowest recorded air temperature at Alyat is -16 ^{0}C (recorded in January) whereas the mean minimum air temperature in January is 0 ^{0}C.

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 ms^{-1}) 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 ms^{-1} blow approximately 37 % of the time and winds greater than 10 ms^{-1} occur 18% of the time (ERT, undated). At Alyat, some 30 km south of Sangachal, the average wind speed is 3.6 ms^{-1} and for up to 100 days a year, wind speeds exceed 15 ms^{-1}. Under storm conditions, wind speeds greater than 25 ms^{-1} have been recorded.

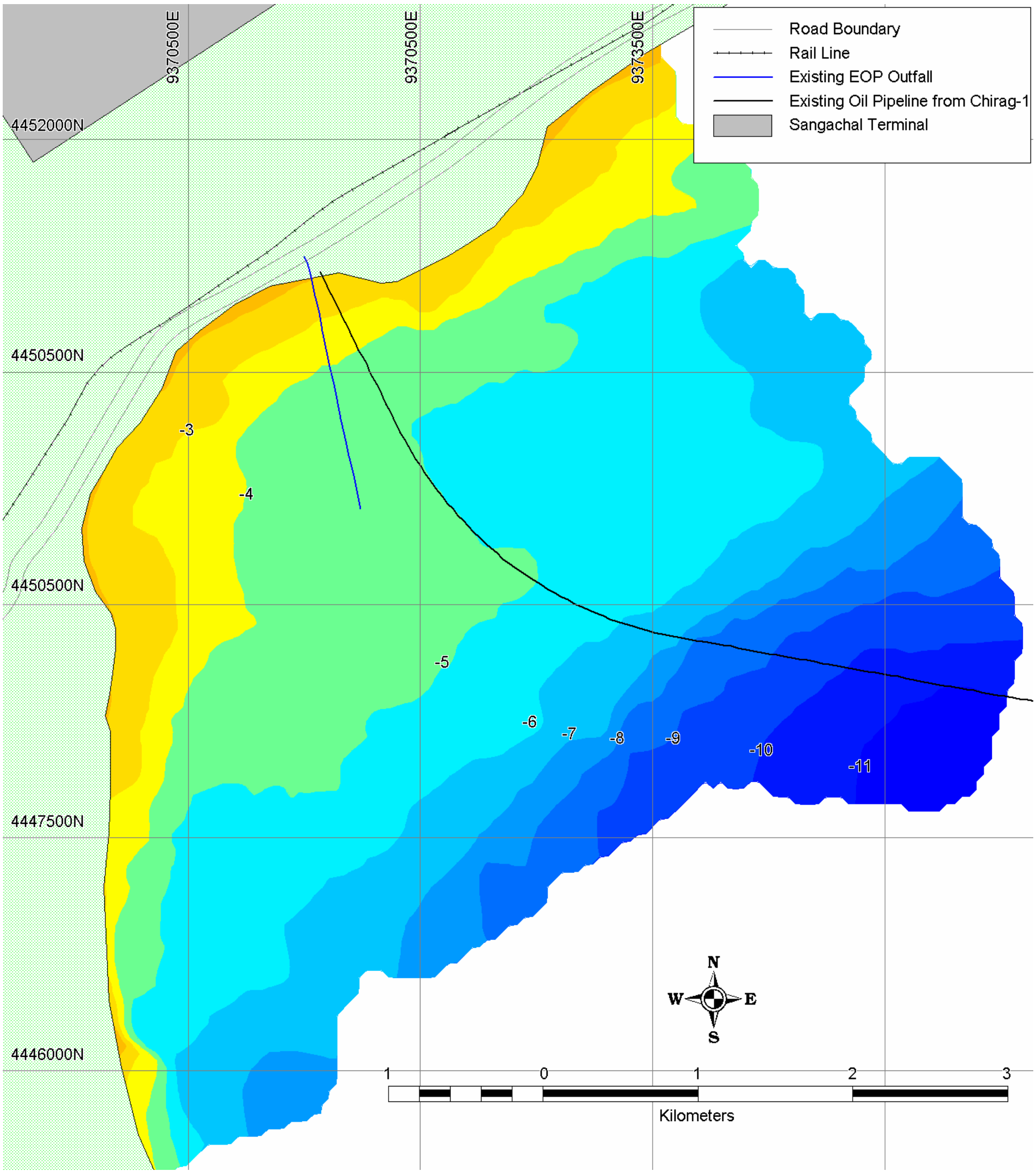
An analysis of wind records for the period 1980 to 1989 indicates that northeasterly winds blow for approximately 50% of the time and southeasterlies for approximately 17 % of the time. For the remaining time winds are of variable speed and direction.

6.3.2 Oceanography in Sangachal Bay

6.3.2.1 Bathymetry

Sangachal Bay is a shallow bay which 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 which acts as a sediment sink. The recent acoustic survey of Sanagchal Bay has provided the bathymetry chart shown in Figure 6.16. A detailed description of the sediment types, metal and hydrocarbon contaminants and the associated biological communities is provided Section 6.3.4.

Figure 6.16 Bathymetry of Sangachal Bay (depths in metres)

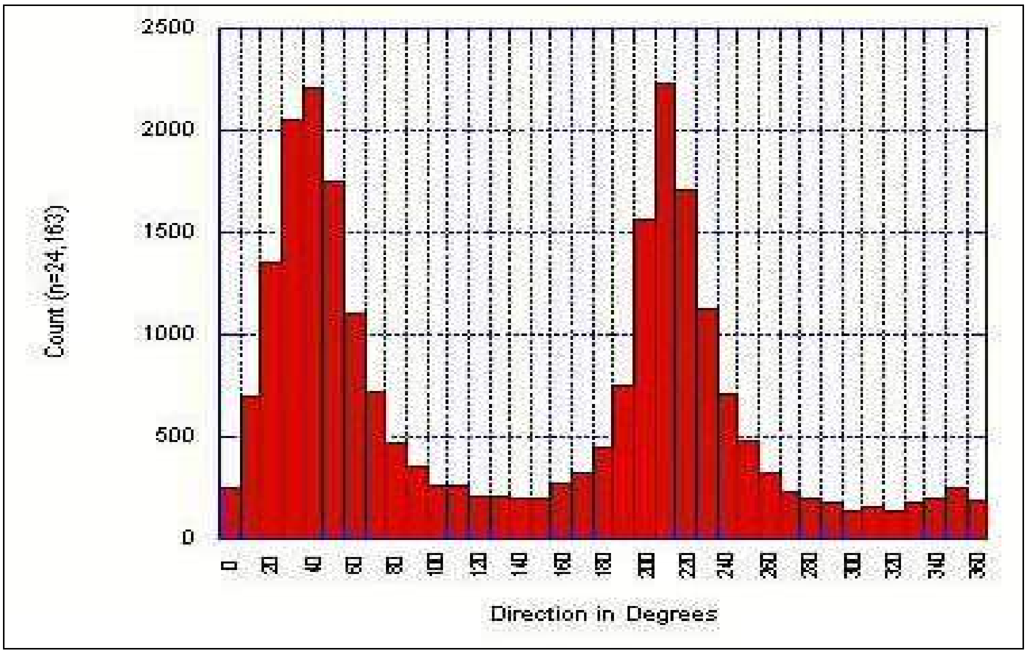


6.3.2.2 Currents and Water Circulation

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 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 6.17).

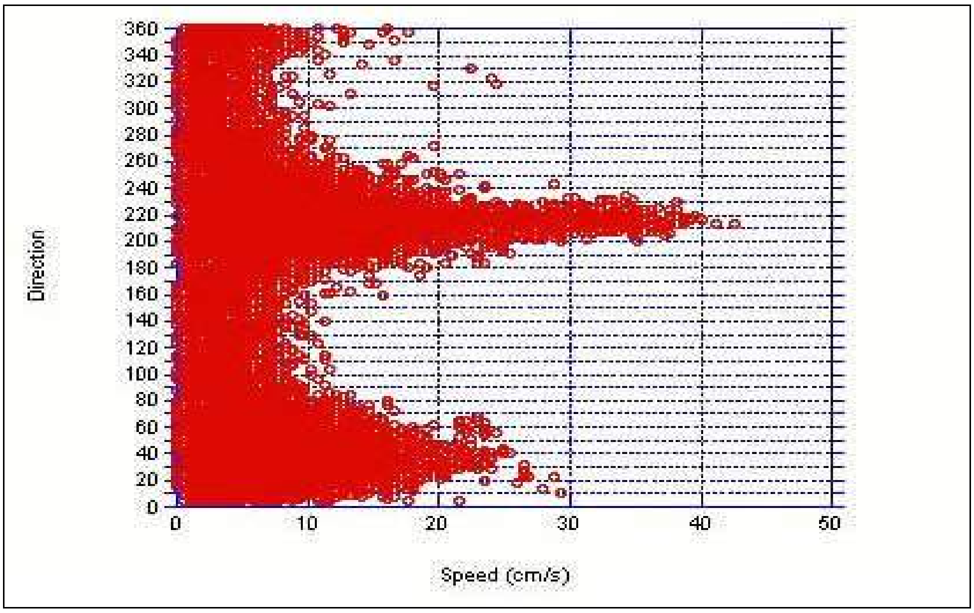
Figure 6.17 Distribution of current direction over complete NESA by record



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 6.18). Higher current speeds were associated with the southwesterly direction currents.

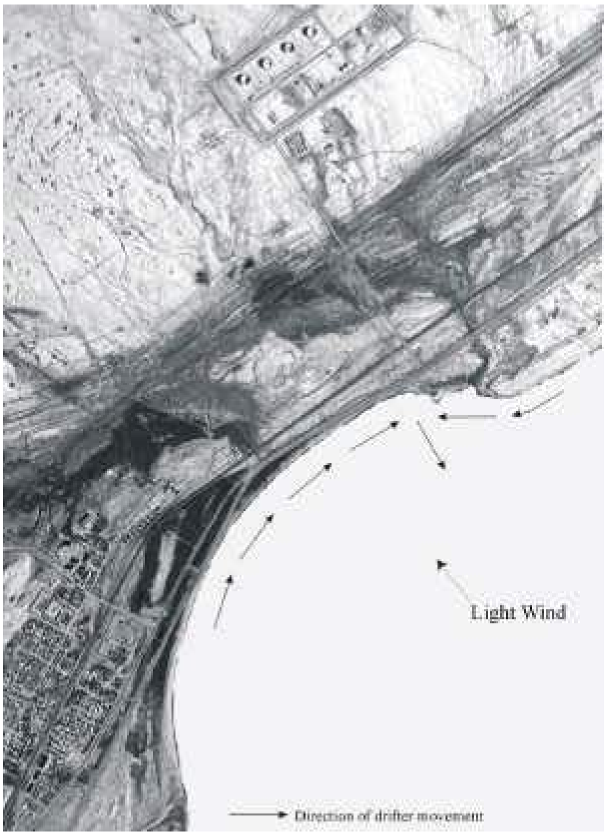
To develop a better appreciation of the oceanographic regime in the coastal area (i.e. that area where water depths are in the order of a few meters), two drifter studies were completed at seven and four (repeat) locations along the Sangachal Bay coast on separate days in June 2001. During the first 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 6.18 Distribution of current speeds per direction



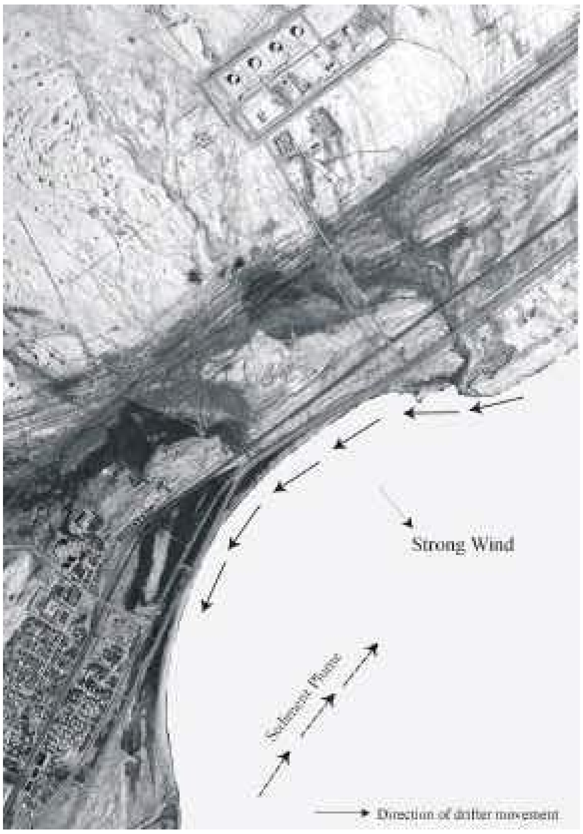
The results of the first drifter exercise indicate that a complex nearshore circulation pattern operates in the limited space of Sangachal Bay. The direction of drift was unexpected in that drifters released in the northern part of the Bay moved northwards and those released in the southern part of the Bay, southwards (Figure 6.19).

Figure 6.19 Inferred current direction – light southeast winds



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 wave action.

Figure 6.20 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 6.20). However, a large sediment plume approximately 100 to 200 m offshore was 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

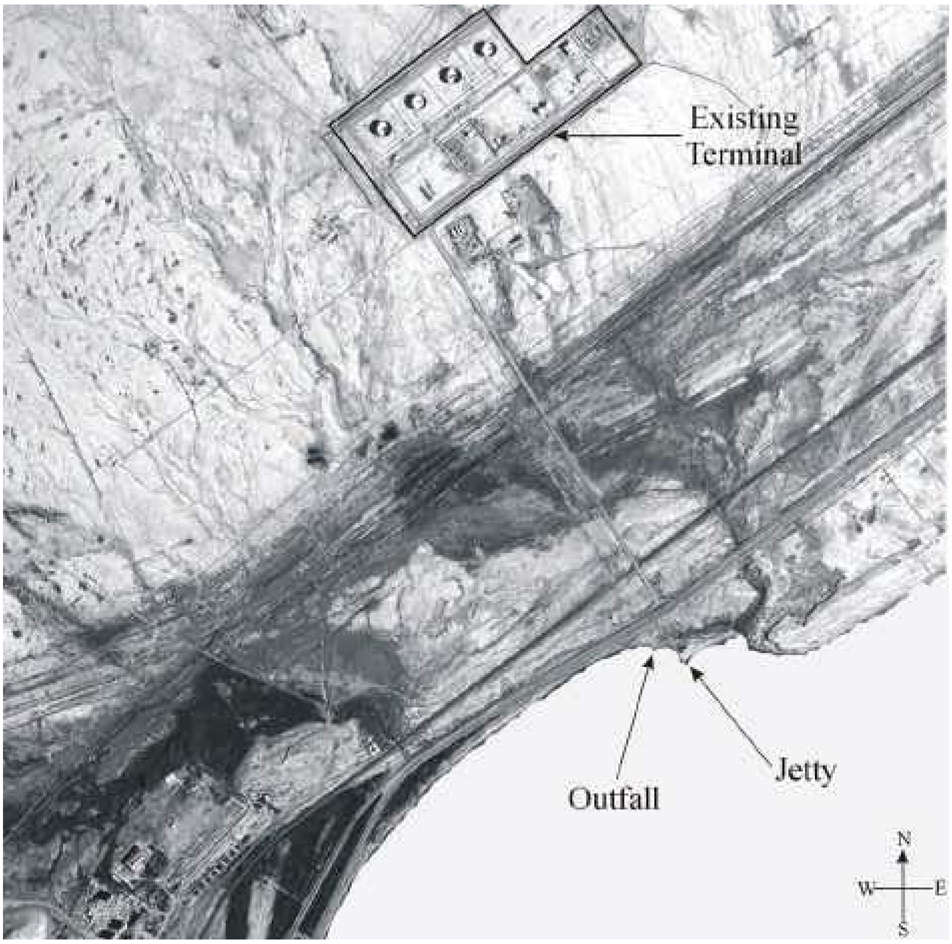
Seawater salinity of nearshore waters adjacent to the terminal recorded by ERT during the 1996 baseline survey were lower than those commonly quoted in published literature for the Caspian Sea (11.2-11.6 ‰, rather than 12-13 ‰), but are consistent with those recorded from surface waters in other recent surveys offshore (ERT, unpublished data). Limited measurements of ionic concentrations in Sangachal Bay indicated the salt content to be fairly typical of open sea 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.

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, 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 6.21.

Figure 6.21 Location of jetty and outfall structure in relation to existing terminal



The jetty location was chosen for the study as it was widely reported 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-February 2001 photos (Figures 6.22 – 6.26). 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 conditionsmore difficult in some instances.

6.3.3.5 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 6.22 shows a comparison of the beach area looking west towards the jetty from its eastern side between January-February 2001 and June 2001. Figure 6.23 shows a comparison of the beach area looking northeast away from jetty. In both figures the accumulation of seagrass can be seen in June.

Figure 6.22 Sangachal coastline east of jetty looking west (at jetty)


January-February 2001 June 2001

Figure 6.23 Sangachal coastline east of jetty looking east (away from jetty)


During the June survey the coast directly adjacent to the jetty consisted solely of shells with little or no sand. Figure 6.24 shows the difference in the beach profile near the jetty between January-February and June 2001.

Figure 6.24 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 6.25.

Figure 6.25 Erosion at base of jetty – eastern side

January-February 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 6.26 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 6.26 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 6.26 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-February 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 6.27) 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 6.27 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-February 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.

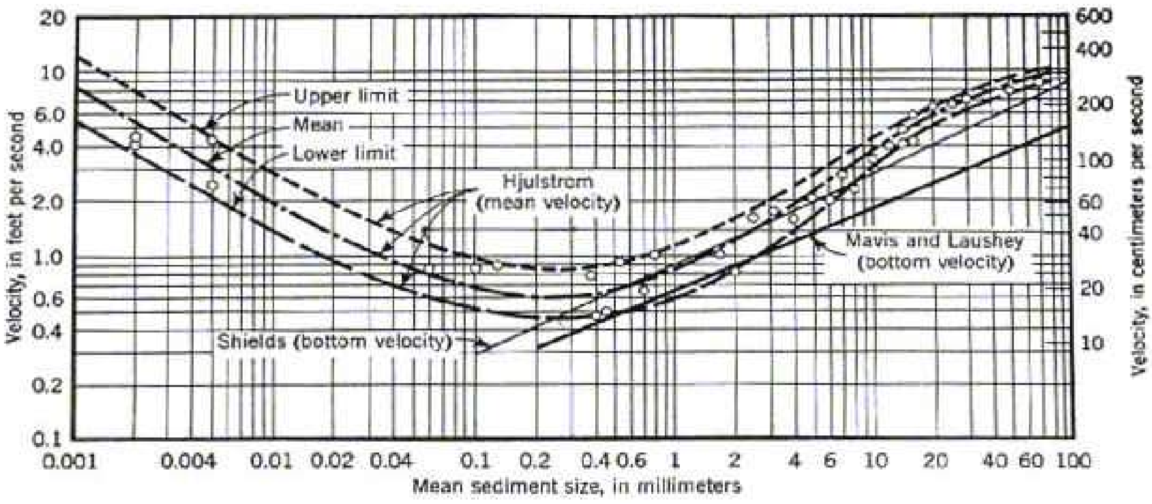
A comparison of evidence from historical photos (January-February 2001) to the results of the June 2001 field investigation into beach profiles and shoreline sediment distribution indicates that considerable change has occurred to the shoreline's configuration over a short period of time. Some of this 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.

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 6.28 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 6.28 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 m wave with a 5 second period (ERT, undated), can be very important in the movement of larger diameter particles.

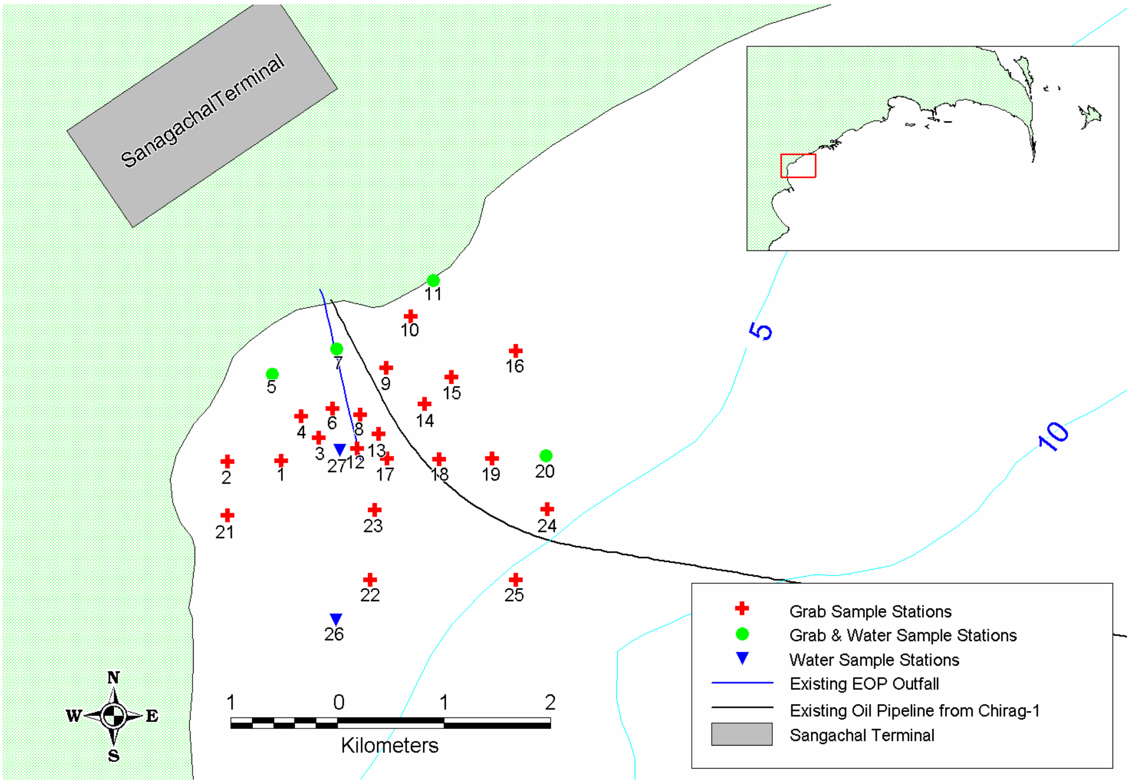
Figure 6.28 Critical velocities for quartz sediments as a function of grain size



6.3.4 Results of environmental surveys

A baseline environmental survey of the nearshore sediments and waters adjacent to the 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 6.29. The results of these environmental surveys are summarised below.

Figure 6.29 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 6.10. 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 μgl^{-1}) only at station 5. Surfactant concentrations were above the detection limit (100 μgl^{-1}) at stations 5, 7, 11 and 27, ranging between 110 and 170 μgl^{-1}.

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 μgl^{-1}). The average concentration at station 11 was approximately twice as high, at 9.1 μgl^{-1}.

Table 6.10 Summary of physical and chemical analysis of Sangachal water samples, 2000 baseline survey

Station number	5	7	11	20	26	27
Nitrite (mgl^{-1})	0.24	0.18	0.12	0.11	0.13	0.10
Nitrate (mgl^{-1})	4.15	3.04	<2.0	<2.0	<2.0	<2.0
Ammonia (mgl^{-1})	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Phosphate (mgl^{-1})	0.41	0.21	<0.15	<0.15	<0.15	<0.15
Phenols (mgl^{-1})	0.0105	0.002	0.002	<0.002	0.002	<0.002
TPH (μgl^{-1})	4.3	9.1	4.9	3.5	4.1	4.6
PAH ($mg1^{-1}$)	10.45	7.45	10.5	6.85	12.8	14.55
Surfactants (mgl^{-1})	0.15	0.155	0.13	<0.10	<0.10	0.135
Chlorophyll *a* (μgl^{-1})	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 (mgl^{-1})	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 μgl^{-1}, 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 resuspended bottom sedimentary material in these samples. Iron concentrations of 264 μgl^{-1} at station 26 and 109 μgl^{-1} 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 $\mu g.l^{-1}$ 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 present, however. 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, of which 21 were diatoms ,6 were dinophytes and 3 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, 9 were present at 2 or 3 stations, and only 6 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 6.11).

Table 6. 11 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^{-1} and 75,800 cells.l^{-1}.

6.3.4.4 Zooplankton

A total of 9 zooplankton taxa were recorded in surface and bottom samples collected from six stations during the Sangachal 2000 survey. These comprised 5 species of Cladocera, 4 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.

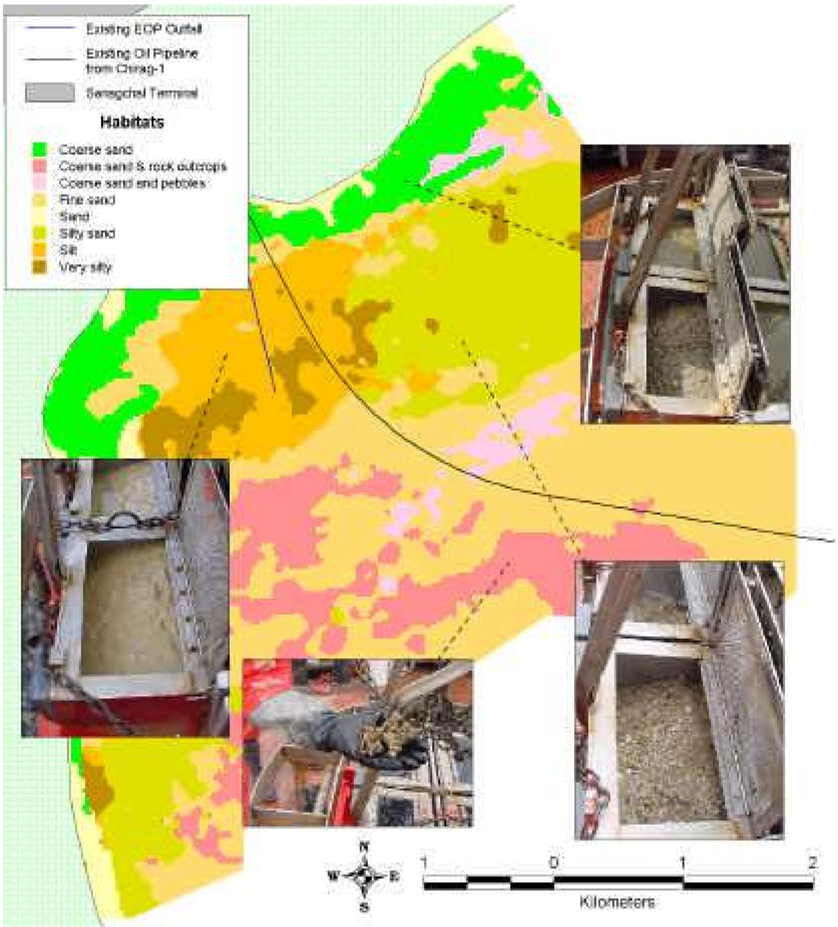
Total zooplankton biomass ranged from 277.4 mgm^{-3} to 6.3 mgm^{-3}. *Mnemiopsis* accounted for between 71 % and 91 % of zooplankton biomass at all stations. The size and character of Mnemiopsis is such that it will inevitably be this much, or more, of the biomass.

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, however, the seabed consists 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 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 6.30 shows the types of seabed within Sangachal Bay surveyed during June 2000, with photographs of samples collected from various habitats.

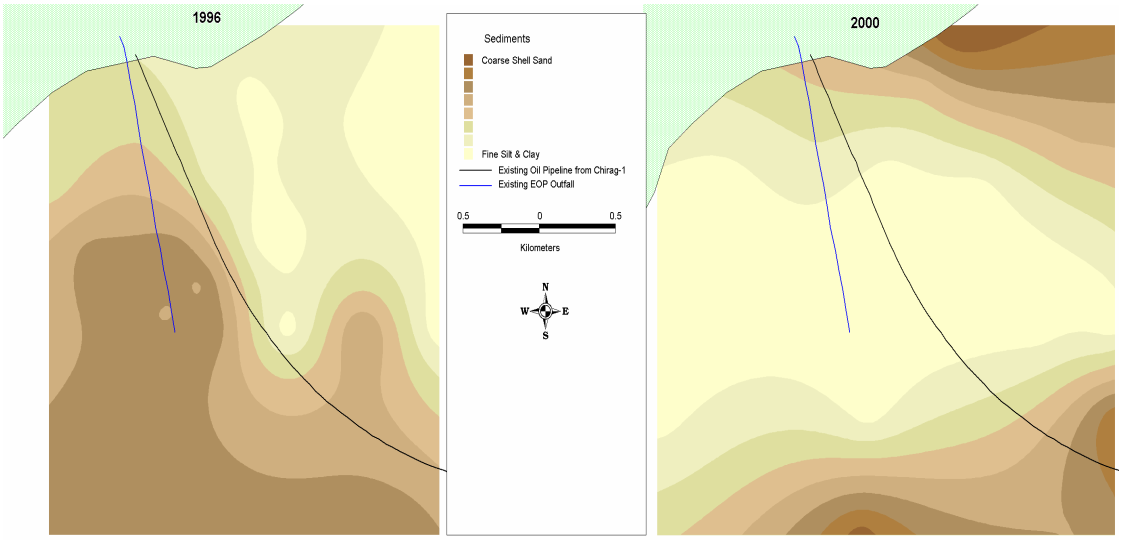
A comparison of the distribution of sediment mean particle diameter between 1996 and 2000 (Figure 6.31) indicates that there has been a substantial change during the intervening period. In the 2000 survey, there was a central band of fine sediment with coarser material nearshore and to the south. In 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 6.30 Ground types in 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 is discussed in Section 6.3.3.

Figure 6.31 Comparison of mean sediment particle diameter between the 1996 and 2000 Sangachal surveys



6.3.4.6 Marine Flora

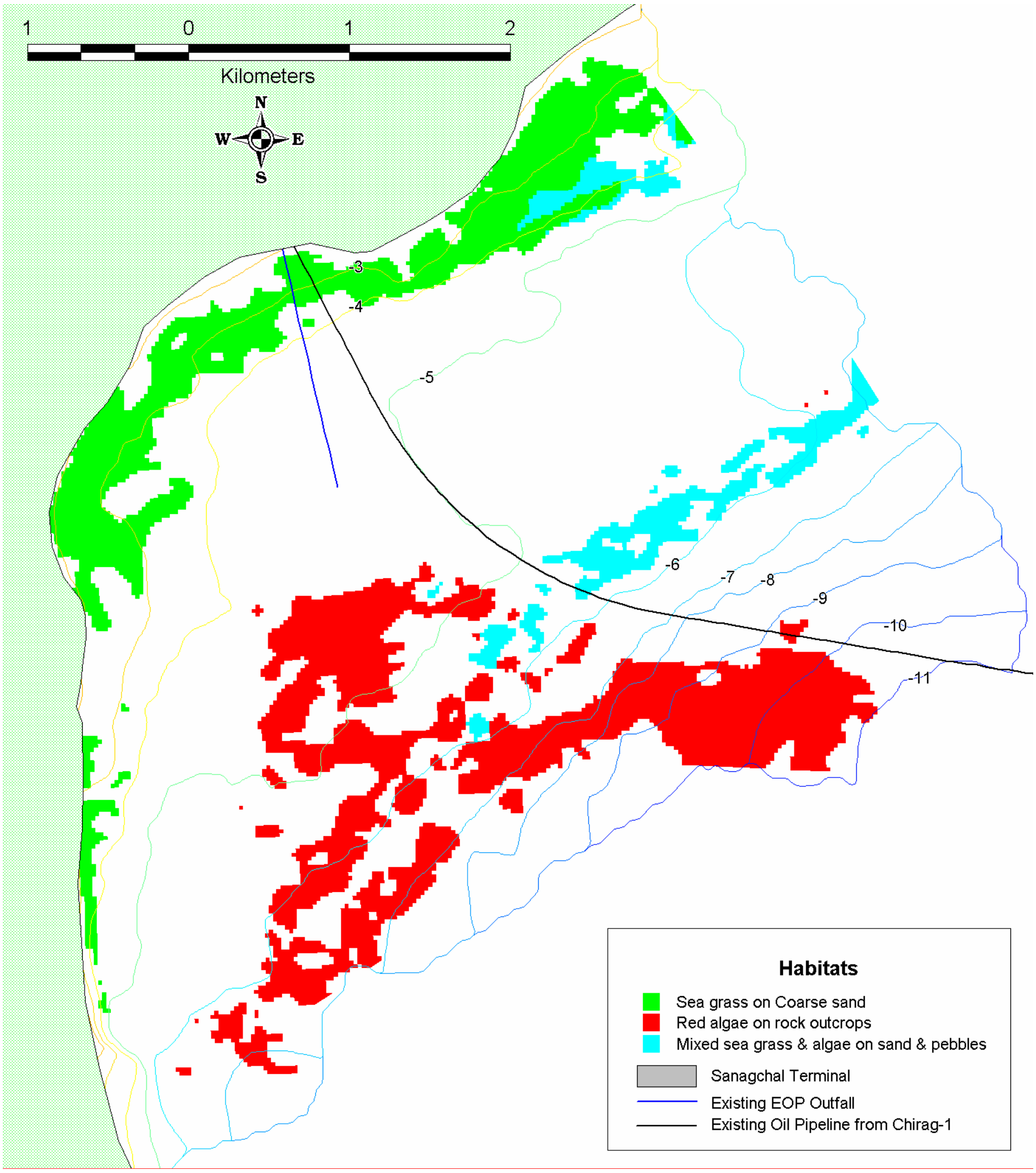
Algae and seagrasses are important because they are one of the most productive components of the marine ecosystem, supporting a rich fauna and used as nursery areas for fish and foraging areas for birds. A seabed mapping survey was completed in June 2001 of the nearshore waters of Sangachal, and samples of algae and seagrass were collected for identification. The distribution of the seagrass and algae was patchy and primarily influenced by sediment type, Figure 6.32.

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 5 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.

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 6.12). 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.

Figure 6.32 Seagrass and Red Algae distribution in Sangachal Bay



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 6.12 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 c. 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 10-11 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 does not allow the use of the video footage to support/disprove this theory. However, given the high turbidity observed during surveys, it can perhaps be assumed that algae are light-limited at depth.

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. 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 (Zn, Cu, Cr) are closely associated with Fe 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 with high levels of mercury also being recorded in the western part of the survey area. However, not enough data exists 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 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 6.13.

Table 6.13 Comparison of sediment hydrocarbon concentrations (ugg^{-1})

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 ugg^{-1} to 26.4 ugg^{-1}. 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: 3 species of mollusc, 4 polychaetes, 5 oligochaetes and 1 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 8 stations, polychaetes at 2 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 6.14). 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 6.14 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 gm^{-2}, while the biomass of crustacea (where present) ranged from less than 0.01 gm^{-2} to 98.94 gm^{-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 The 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. However, anecdotal sightings have 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. However it is widely known that water snakes and turtles are present in the area. Further information can be found in Section 6.4.3 and 6.4.4. inhabit lengths of coastline where conditions are suitable for feeding and shelter. 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 to avoid large predatory fish. This species is non-poisonous.

6.3.4.11 Sangachal fish population studies

In order to provide up-to-date and comprehensive information on the status of resident fish populations at Sangachal a series of seasonal surveys was initiated in July 2000. Four surveys have been completed at the time of writing. Detailed information is available for the July and October 2000 surveys. The data acquired from surveys carried out in late winter and spring 2001 are currently being processed.

The survey programme focused on resident species as these are considered

a) most vulnerable to any impacts arising from the Phase 1 development; and
b) to provide the most consistent data in the event of any impact arising.

Two catch methods were employed:

- hand trawl nets deployed from shore at six beach stations; and
- fixed nets.

More than 18 species of fish were caught and identified in the first two surveys of the series. In most instances the trawl net catches were larger than the corresponding fixed net catches. The former are of smaller mesh and are deployed in shallow water hence the catches are probably biased towards smaller and younger specimens of all species. The composition of the catch in July and October 2000 is summarised in Table 6.15 below. In both surveys the catch was dominated by a small number of species:

- Vobla (*Rutilus rutilus kurensis*)
- Goby (*Neogobius fluviatilis pallasi*)
- Sandsmelt (*Atherina mochon caspia*)
- Mullet (*Liza sp*)

The majority of other species were captured only in small numbers. The average length and weight of the most abundant species (Table 6.16) indicates that the catch methods were most successful in collecting smaller fish. Overall, the size range of fish caught in trawl nets was 3-11 cm. The weight range was larger, from a minimum of 0.2 g to a maximum of 55 g.

Generally the fish populations at Sangachal were in good health, with no evidence of gross pathological problems. Condition factors (estimated from the relationship between length and weight) were good for all species.

Table 6.15 Summary of catch statistics, July and October 2000 surveys

Species/family	July 2000				October 2000			
	Trawl	Fixed nets	Total	%	Trawl	Fixed nets	Total	%
Rutilus rutilus kurensis	453	7	460	23.0%	187	166	353	23.3%
Rutilus frisii kutum	6	12	18	0.9%	21	33	54	3.6%
Cyprinus carpio	1	-	1	0.0%	-	6	6	0.4%
Neogobius fluviatilis pallasi	176	-	176	8.8%	141	-	141	9.3%
Neogobius melanostomus	67	-	67	3.3%	2	1	3	0.2%
Neogobius kessleri gorlap	32	-	32	1.6%	-	2	2	0.1%
Proterorhinus marmoratus	1	-	1	0.0%	6	-	6	0.4%
Atherina mochon caspia	946	-	946	47.3%	613	-	613	40.4%
Mugilidae	86	-	86	4.3%	250	5	255	16.8%
Vimba vimba persa	17	-	17	0.8%	-	7	7	0.5%
Chalcalburnus chalcoides	-	-	0	0.0%	-	3	3	0.2%
Stizostedion lucioperca	-	-	0	0.0%	-	2	2	0.1%
Clupeidae(g.Alosa)	2	-	2	0.1%	3	42	45	3.0%
Clupeonella delicatula caspia	26	-	26	1.3%	9	7	16	1.1%
Acipenser stellatus	-	1	1	0.0%	-	-	0	0.0%
Syngnatus nigrolineatus caspius	169	-	169	8.4%	-	-	0	0.0%
Pungitius platygaster	-	-	0	0.0%	10	-	10	0.7%
Total	1982	20	2002		1242	274	1516	

Physiological measurements were made to examine the health of resident species (gobies and roach) more closely. Blood albumen measurements were highly variable, but suggested that some individual fish might be slightly stressed. Fish blood cells were examined for evidence of genotoxic effects (micronucleus formation). Micronucleus incidence was more than two orders of magnitude higher in July specimens than in October specimens (the latter being typical of unstressed 'background' values). Whilst it is too early to draw firm conclusions, a comparison of the two survey data sets suggests that the very high water temperatures during the July survey could have been a contributory factor.

Table 6.16 Average length and weight of most abundant fish species

Taxon	Length (cm)		Weight (g)	
	Average	Range	Average	Range
Rutilus rutilus kurensis	6.78	4.50 - 11.00	5.63	1.20 - 22.70
Neogobius fluviatilis pallasi	7.31	5.00 - 11.00	5.85	1.70 - 19.90
Atherina mochon caspia	6.8	3.0-9.0	2.9	0.2-5.0
Liza sp.	6.1	3.9-15.5	3.7	0.7-55.0

The survey data obtained thus far indicate that there are healthy and abundant resident populations of a number of fish species at Sangachal, and that this area appears to be used as a nursery area by these species. Relatively few of the individuals collected in the first two surveys were of commercial size, so it is not possible at present to estimate the significance of the nearshore Sangachal environment to local commercial fisheries. It can be concluded, however, that the local environment at present is capable of supporting healthy fish populations.

6.3.4.12 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, the majority of these species can be 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 km. 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 3 to 5 and 10 to 11 years, when the coldest winters occur, the number of individuals can increase a few times, especially of swans, pelicans and geese.

Table 6.17 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 6.17 Bird count data from the Apsheron peninsula

Location	**Cormorant**	**Herring gull**	**Common tern**	**Sandwich tern****	**Total**
	Phalacrocorax carbo	*Larus argentatus*	*Sterna hirundo*	*Sterna sandvicensis*	
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

Migration, Feeding and Nesting Patterns

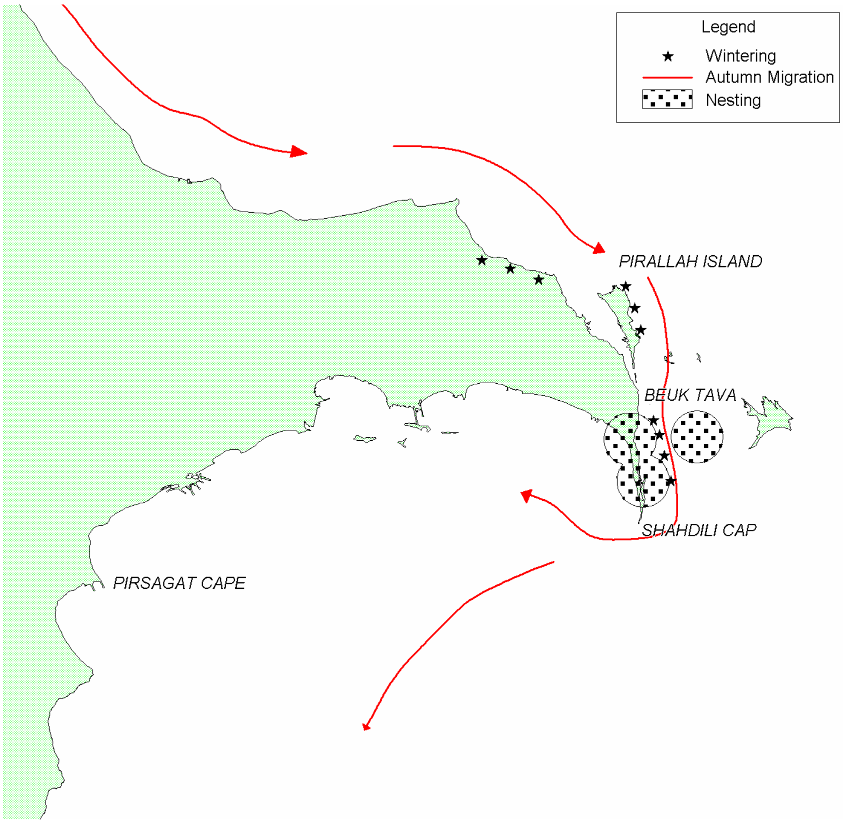
The majority of the species found in the Apsheron Peninsula (41 %) use the area during the migration period. 34 % are resident species, whilst the remaining 25 % are use the area for over wintering purposes. Bird species residing in the Apsheron Peninsula can be categorised according to their feeding habits:

- Birds feeding on fish – grebe, cormorant, gull, tern, egret;

- Birds feeding on plants or invertebrates – grebe (partially), swan, goose, duck, coot, stint; and
- Predators that feed on birds or relatively large fish – white tailed eagle, 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 and little egrets (*Ardea alba*, *Egretta garzetta)*, and 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 6.33.

Figure 6.33 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 is 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. Table 6.18 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 6.18 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

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, 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 6.34. The 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, and the majority of the annual recruitment occurs during this period.

Figure 6.34 Seasonal changes in sensitivity

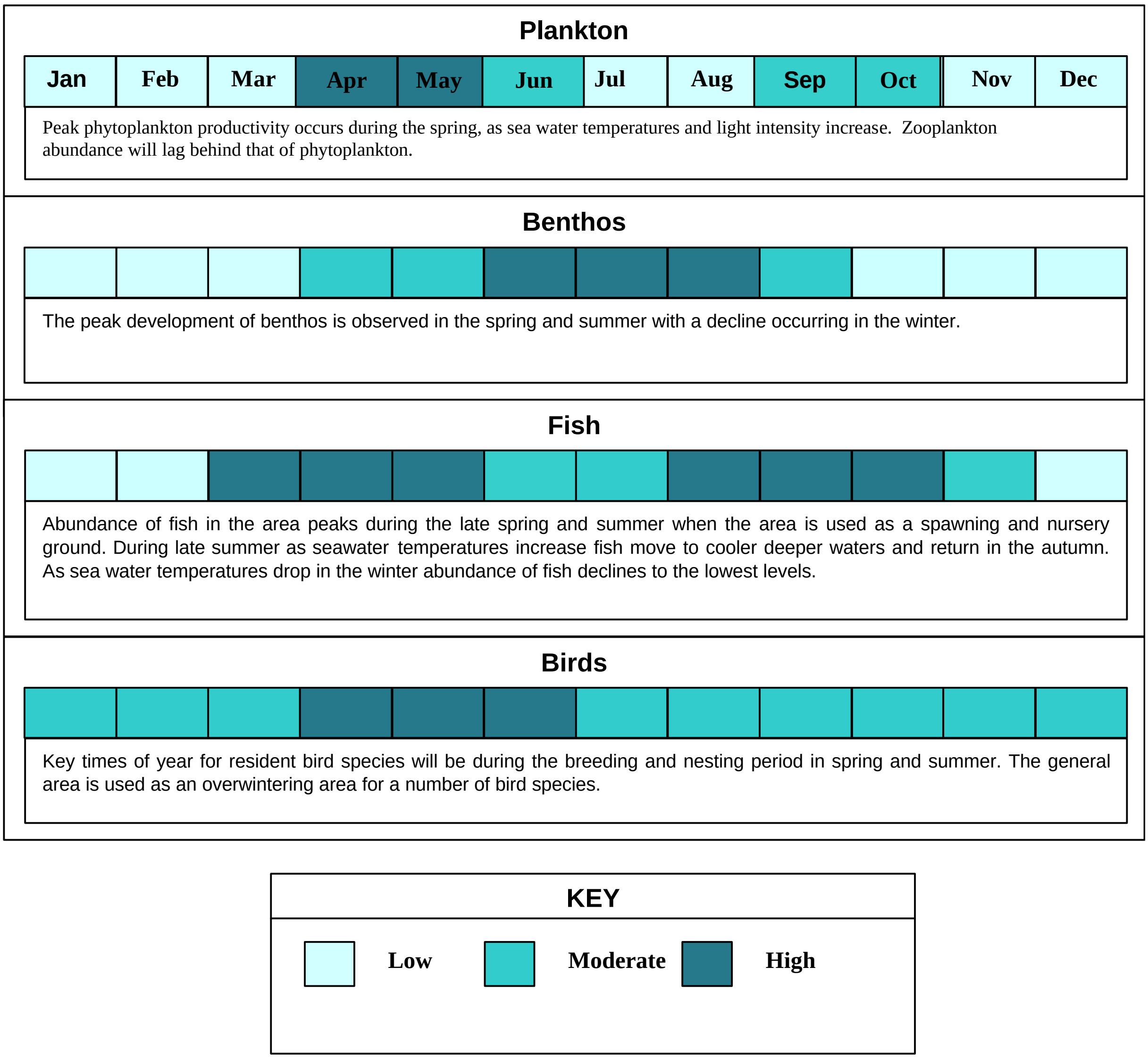
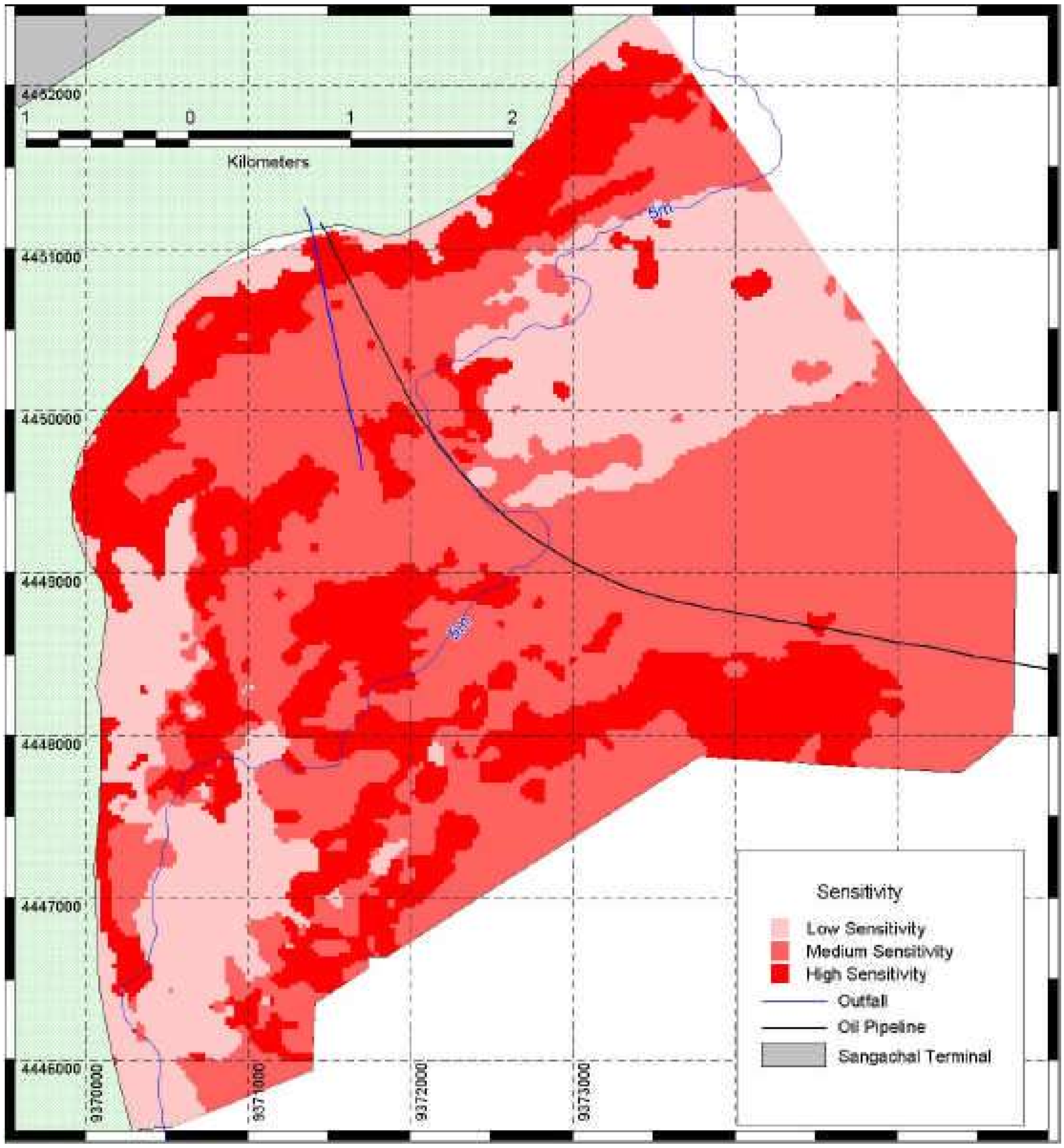


Figure 6.35 illustrates spatial variations in the seabed sensitivity. This has been developed using information on the distribution of seagrass and algae as well as sediment types and their mobility. Those areas which support seagrass and red algae have been considered most sensitive as well as fine 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 are sandy sediments which could support seagrass mats were classified as medium. Areas where seagrass or red algae was not found during the survey, in addition to those areas composed of silty sand, were assigned the lowest sensitivity.

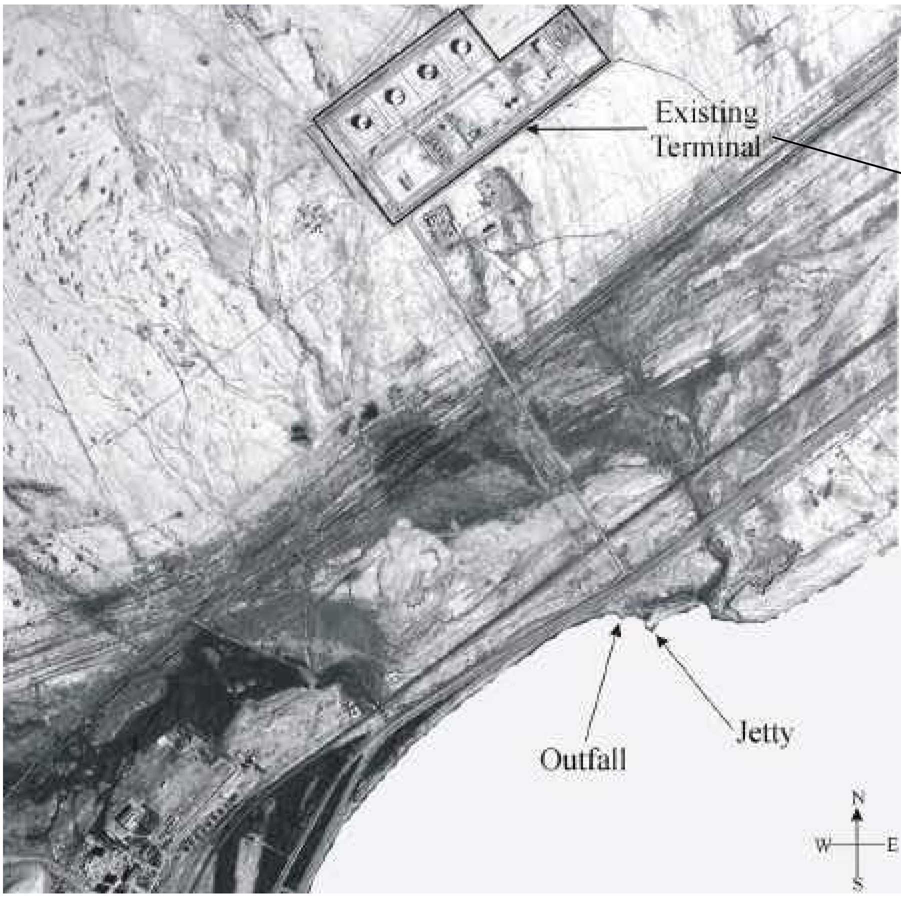
Figure 6.35 Seabed sensitivity

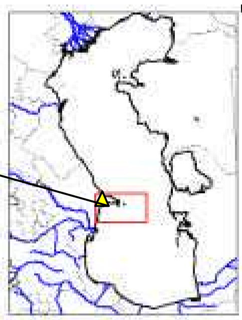


6.4 Coastal and terrestrial environment

This section provides a general description of the environmental conditions in the areas potentially affected by development of the Sangachal terminal and pipelines to it (Figure 6.36).

Figure 6.36 Location of the existing Sangachal terminal





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. 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.

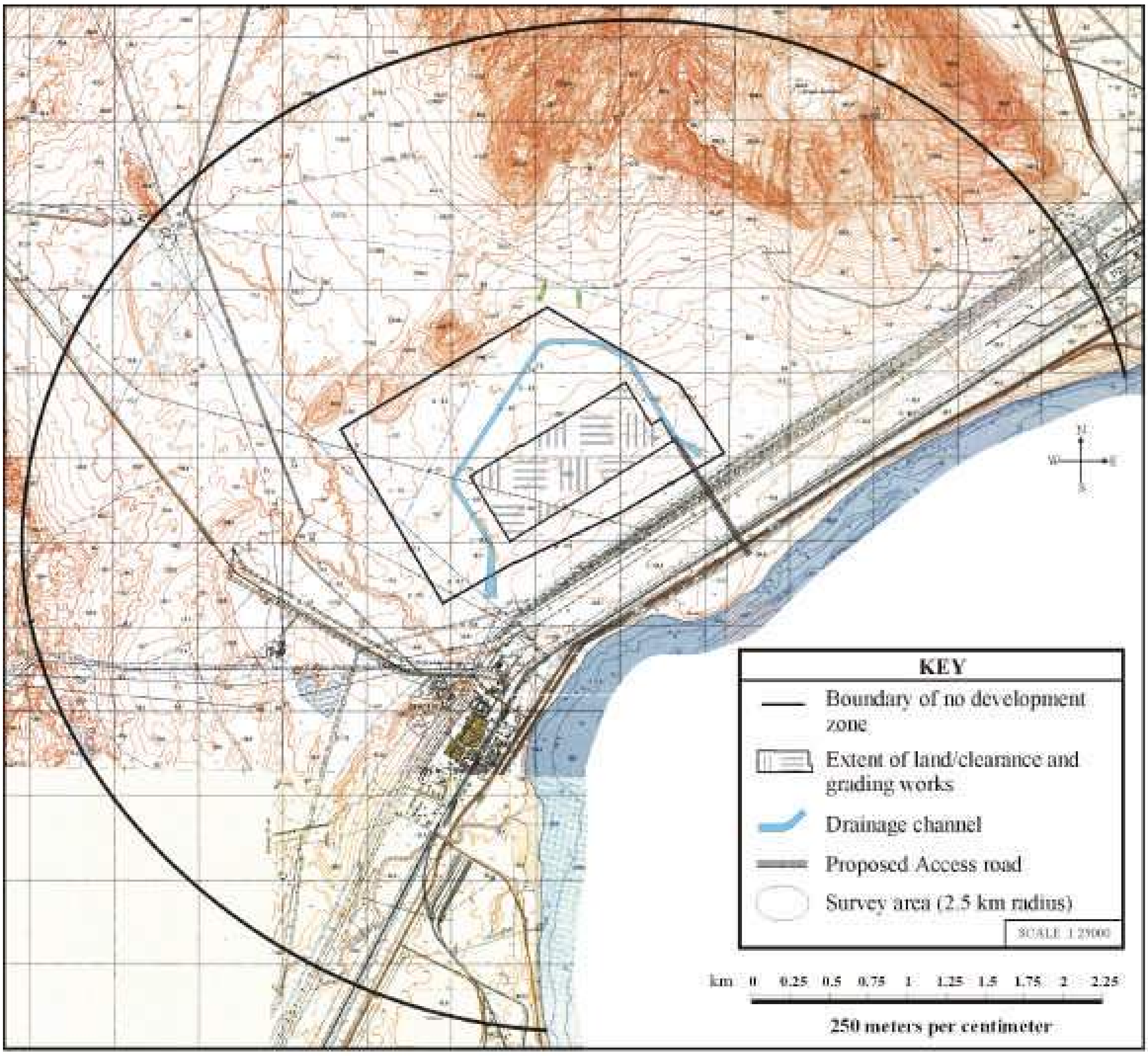
The results of this exercise led to the development and implementation of a field survey programme, in May and June 2001, aimed at gathering the baseline data required to enhance the understanding of the environmental conditions in the region. Local scientists were used during the survey to to access 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 6.37). 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 Phase 1 development. 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 ES.

Figure 6.37 Location and extent of survey area



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:
  - mammals;
  - reptiles and amphibians (collectively referred to as herpetofauna); and
  - avifauna (birds).

6.4.2 Meteorology

It is expected that the meteorology (air temperature, humidity, precipitation and wind regime) for the coastal and terrestrial Sangachal area is similar to that presented for the nearshore environment. Therefore, the reader is 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 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 6.38. 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 by 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 6.39 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 $^{\circ}$ to 9 $^{\circ}$ southwest, as is part of the northern limb dipping to 40^{o} to 45^{o} northwest. The southern limb dips gently 5 $^{\circ}$ to 8 $^{\circ}$ 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 6.38 Surface geology of the South Gobustan region

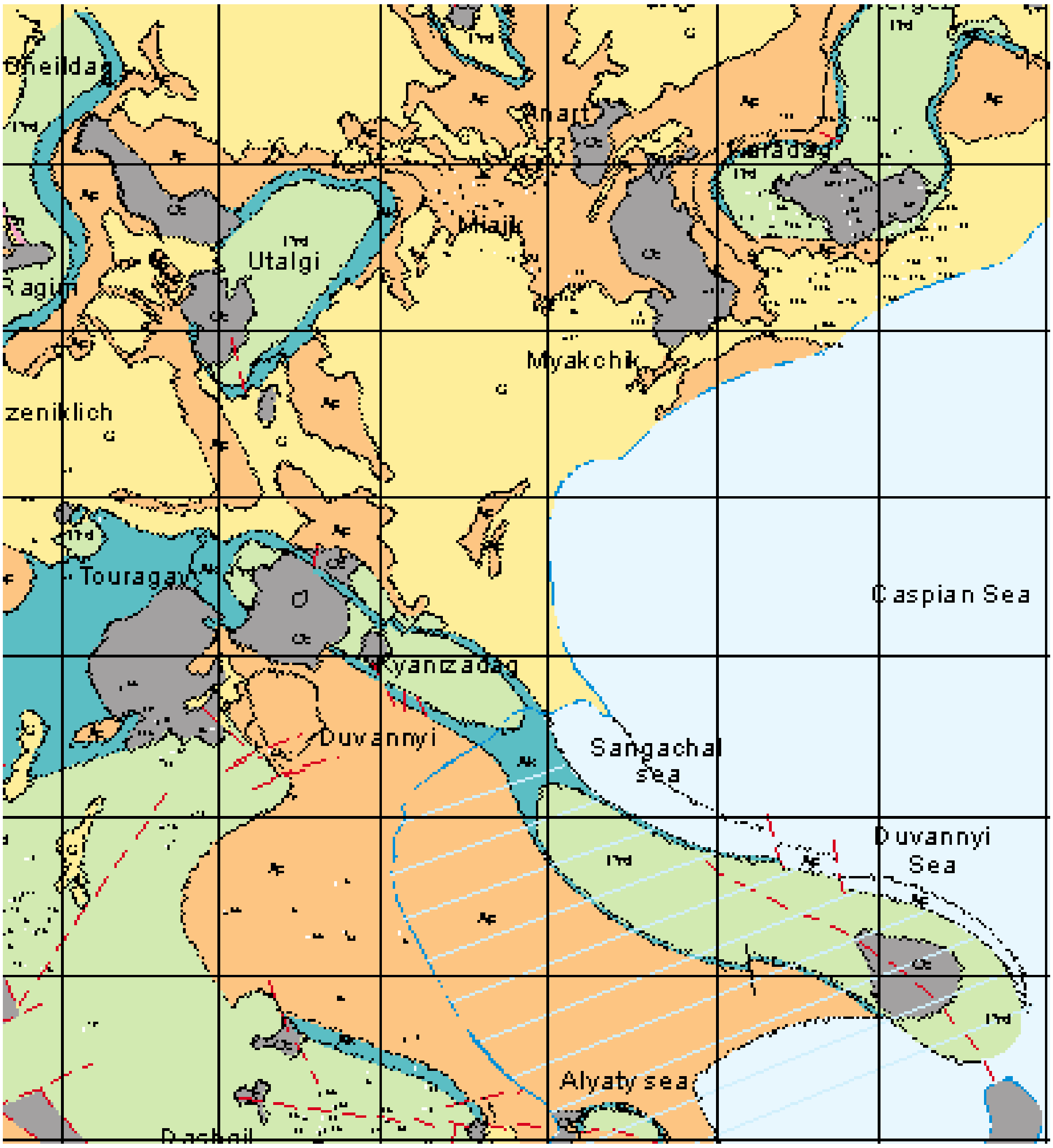
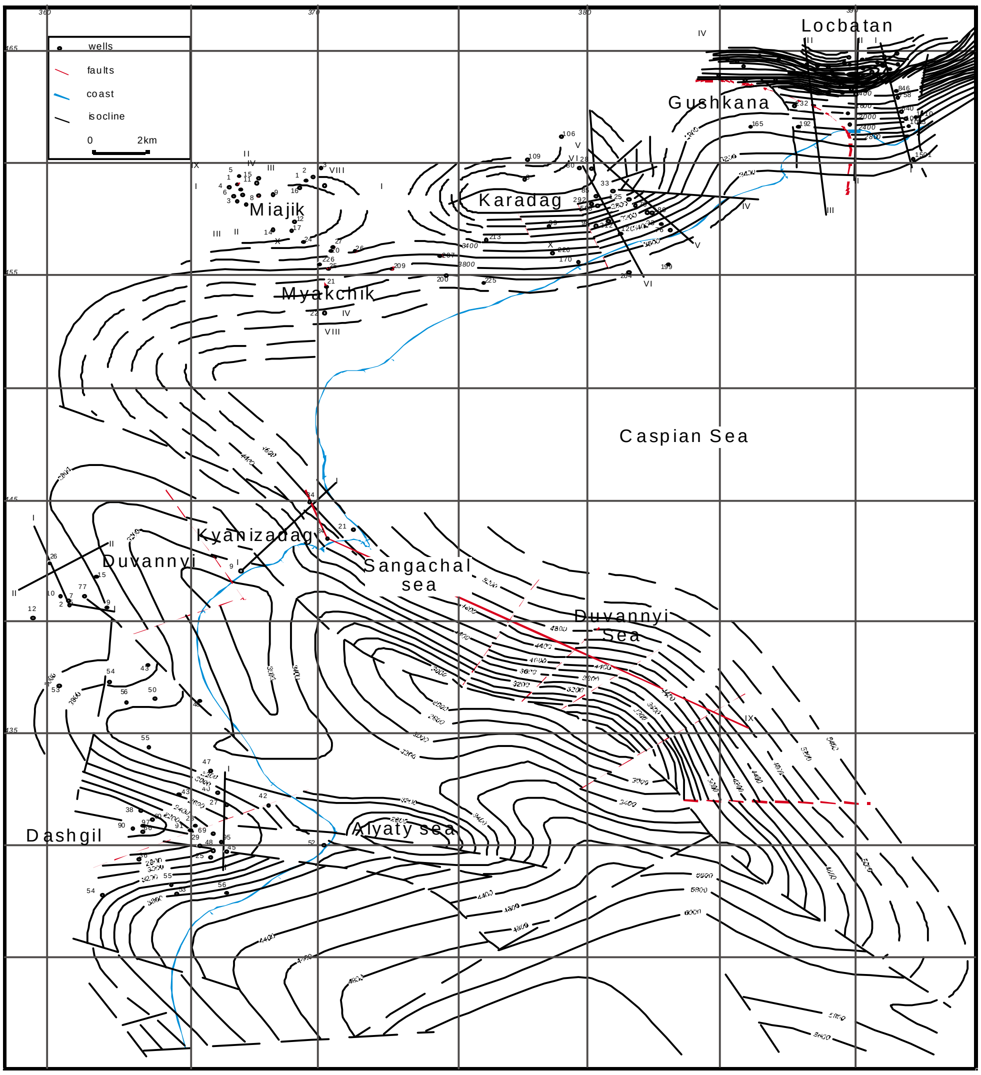


Figure 6.39 Regional geological structures in the South Gobustan region



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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. In the offshore area (Chirag Field) three units are identified: an upper unit of interbedded mudstone anhydrite and thin sandstones, a mudstone dominated middle unit, and a lower unit comprising mudstones with medium to coarse grained sands and rare evaporates. Such a subdivision does not apply in the onshore Miajik–Utalgi area.

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.

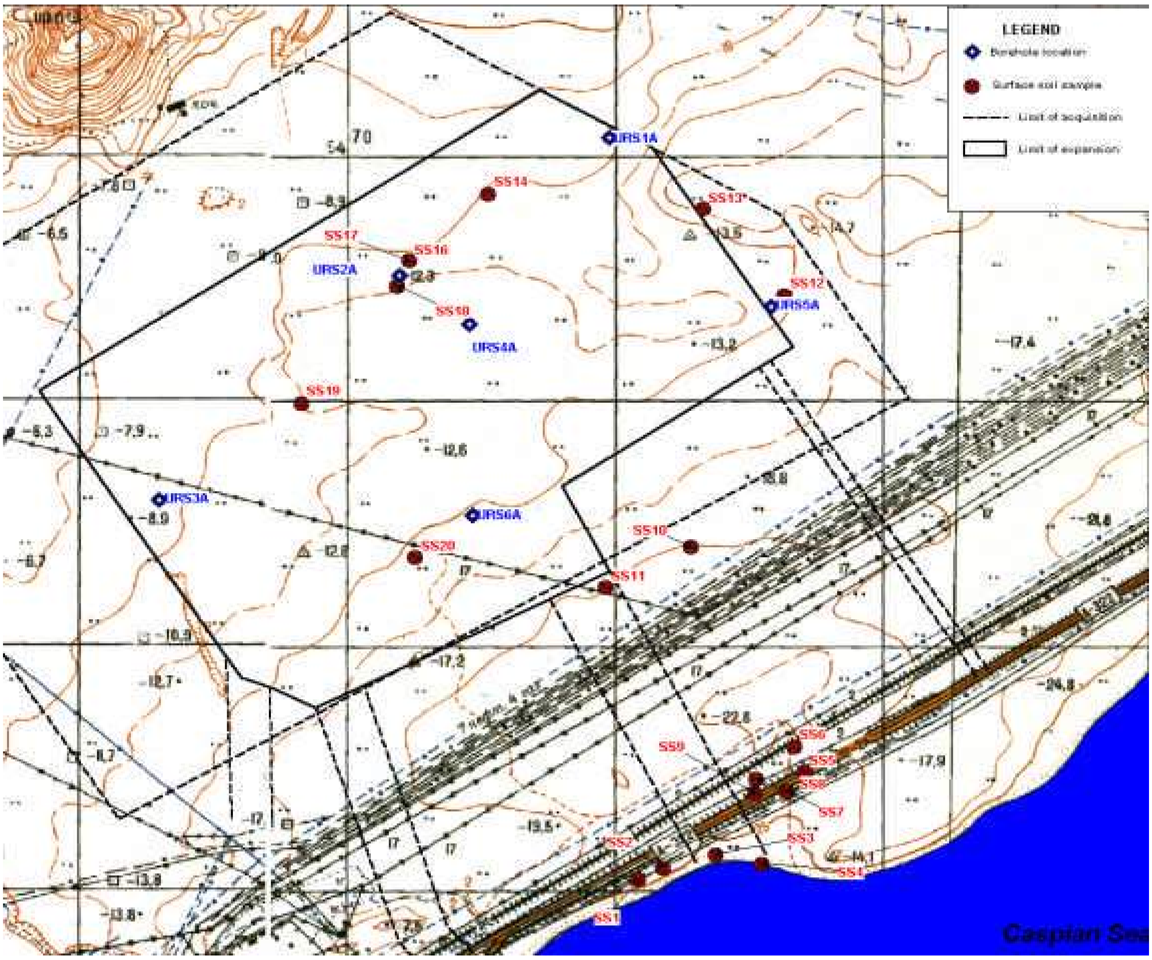
The faults seen in the field are interpreted to have acted as conduits for low temperature mineralisation and will be sealing given the pervasive gypsum cementation which is inferred to be related to the major light lateral fault movement in the Late Pliocene and Quaternary. Mineral rich fluids invaded 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 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 6.40. 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 in BHURS1 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 6.40 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 13mbgl. 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 40-75 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[1]. 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.

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

[1] Barium is constituent of drilling mud and the high concentration may indicate historic contamination.

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 6.19 summarises the results of the 2001 survey as reported in Preliminary Noise Study ACG Full Field Development and Shah Deniz at Sangachal Terminal (Job no. 6694 & C691) Sangachal, Azerbaijan (Kellogg Brown and Root, 2002).

Table 6.19 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 6.19, 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 6.41.

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 6.20.

Table 6.20 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.

6.4.10.1 Southeast sector (SE)

The SE sector was observed to include and support:

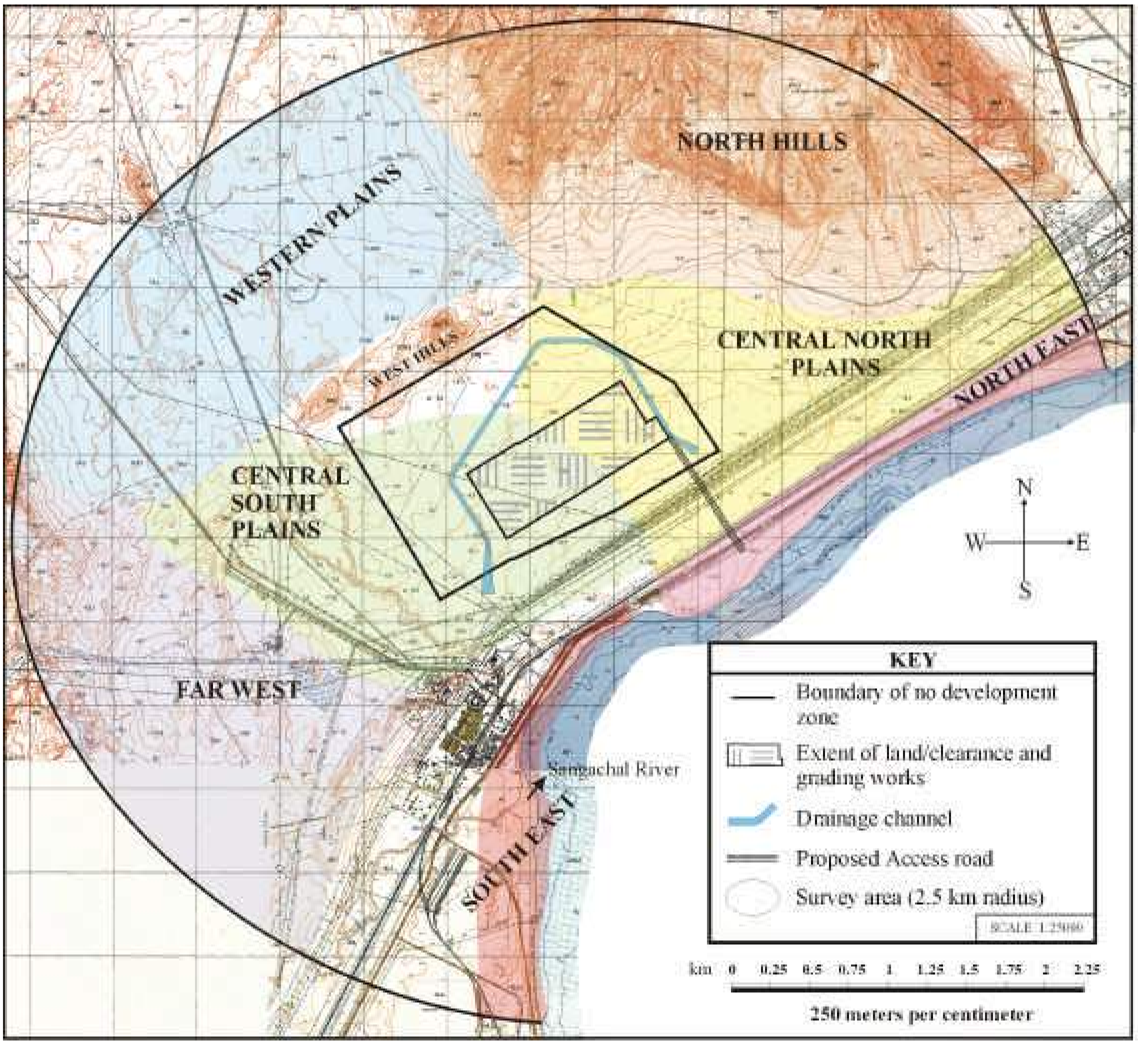
- sandy beaches;
- ephemeral, shallow lagoons (i.e. usually waterlogged from September/October to March);
- a few wet (marshy) slacks with riparian vegetation; and
- an area at the southern-most section supporting a heterogeneous arrangement of coastal and semi-desert elements.

6.4.10.2 Northeastern sector (NE)

The NE sector supports similar coastal biotopes to the SE sector. The following disparities were observed and noted:

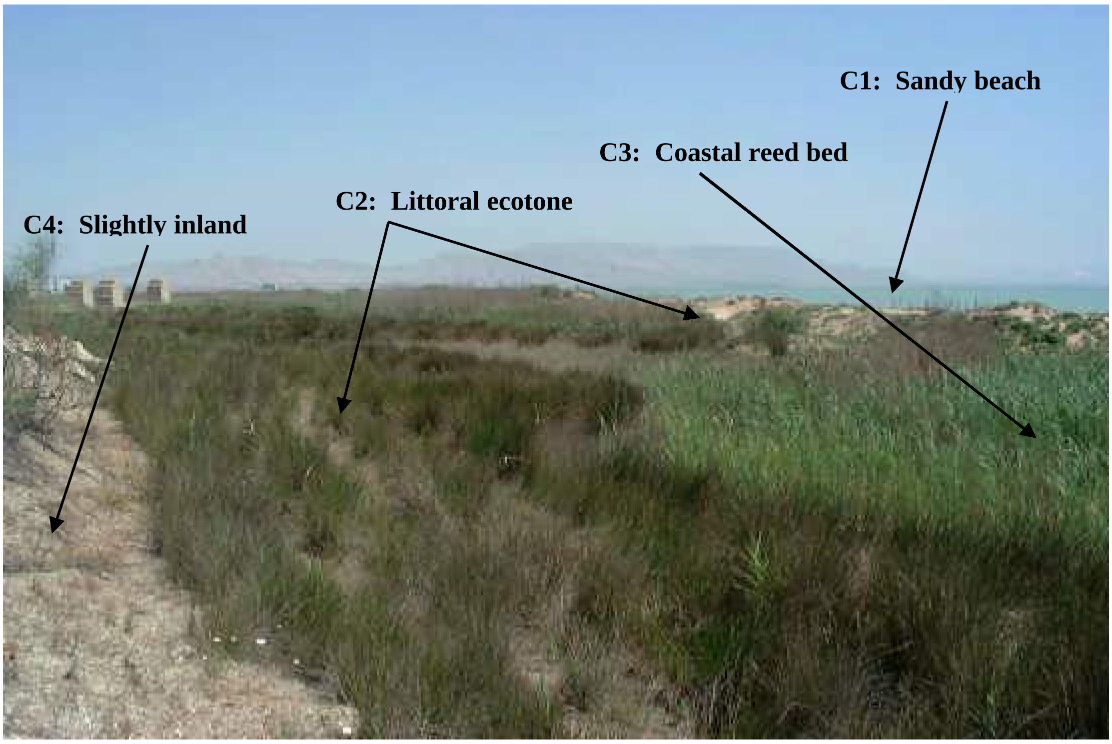
- overall less wetland (both ephemeral and permanent);
- less habitat associated with more inland areas (e.g. semi-desert) due to its proximity to the Baku-Tbilisi highway (set as the easternmost boundary of the SE and NE coastal sectors); and;
- numerous areas of rocky coastline with little to no vegetation.

Figure 6.41 Geographic location and extent of survey sectors (defined primarily on geomorphological characteristics)



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 6.42.

Figure 6.42 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%-60% with scattered *Phragmites australis* (reed) displaying 5%-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 6.21 below.

Table 6.21 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 6.22 below.

Table 6.22 SE section "reedbeds" species and Domin Scale Ranking

Species	Domin Scale Ranking
Phragmites australis	10
Juncus acutus	2

C4: Coastal to near shore zone

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 60-70%. 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 6.23.

Table 6.23 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 6.43 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 6.43 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.

6.4.10.3 Coastal flora recovery rates

The four main coastal botanic communities identified vary in time necessary to recover if they are impacted. Table 6.24 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 6.25 to 6.28 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 6.24 Coastal floral communities natural recovery rates

Community	Soil type	Percentage Recovery to Pre-impact Levels (Years)[2]									
		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 6.25 Sandy beach species recovery times

Species	Recovery Time in Years
Argusa siberica	2

Table 6.26 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 6.27 Reedbed species recovery times

Species	Recovery Time in Years
Phagmites australis	2

Table 6.28 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

[2] 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 6.44. Detailed descriptions of all transects surveyed and detailed taxonomic information concerning sample plots are provided in the Technical Appendices to this ES report.

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 2-3 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 20-25% 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) 30-40% less than expected. In addition, a number of invasive species have taken root thereby slowing and/or impeding natural revegetation.

6.4.11.1 Semi-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.

6.4.11.2 *Salsoletum nodulosae* and *Suaeda dendroides* association

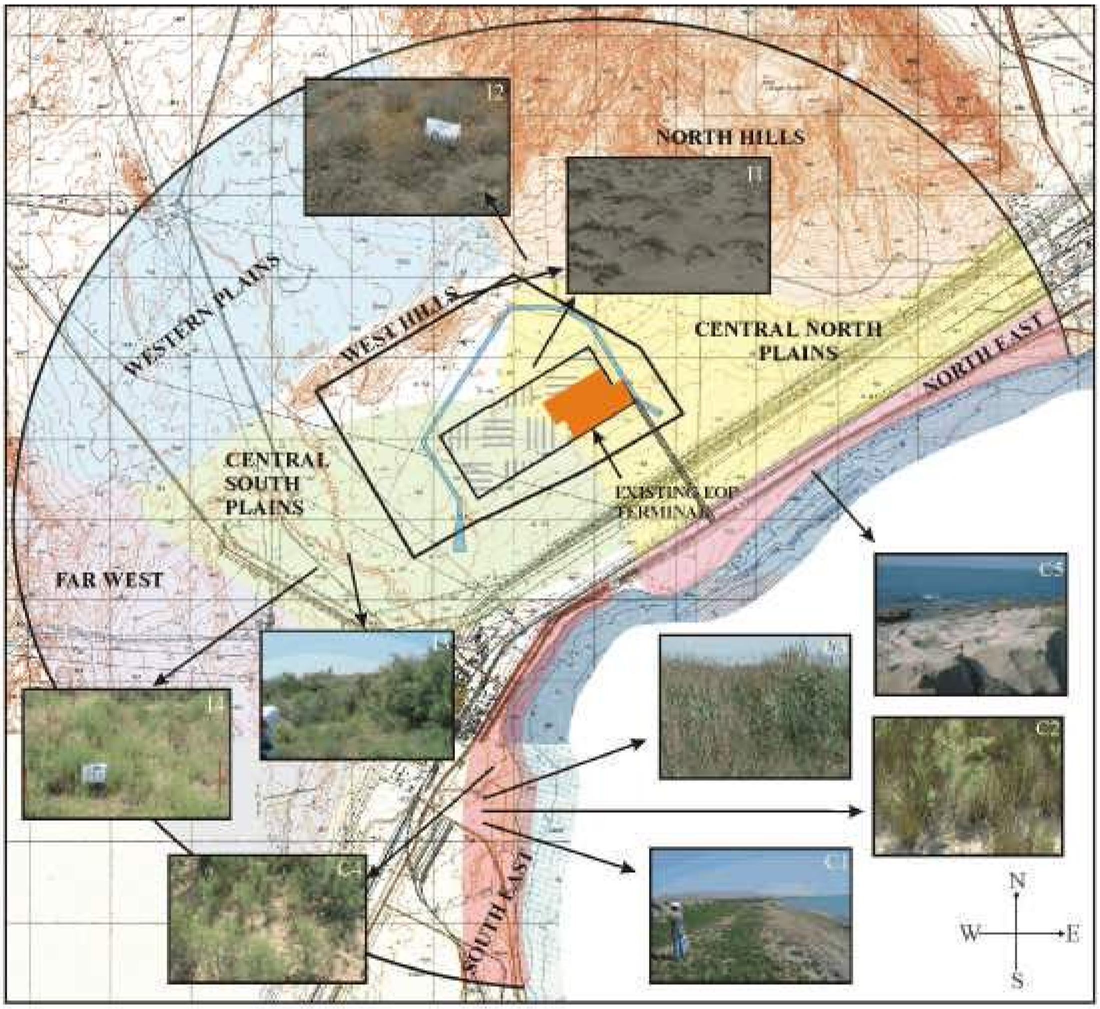
The *Salsoletum nodulosae* and *Suaeda dendroides* association (Figure 6.44, Photo I1) is common for this region and is characteristic of *solonchak* (i.e. soils containing relatively high levels of neutral salts) and slightly saline, clay and pale loam soils. Homogonous groupings of *S. nodulosa* and *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 are shown in Table 6.29.

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 6.29 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	+

Figure 6.44 Photographs of the 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

6.4.11.3 *Artemisietum 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 6.44, Photo I2).

Table 6.30 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.

6.4.11.4 Other floral communities

***Tamarixetum meyeri* thickets**

Tamarix meyeri (tamarisk) thickets (Figure 6.44, 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 6.31.

Table 6.31 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 6.32 (Figure 6.44, Photo I4).

Table 6.32 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

6.4.11.5 Inland flora recovery rates

Identified inland botanic communities vary in the amount of time required to recover following impact. Table 6.33 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 6.34 to 6.37 present a breakdown of each community with recovery time in years for each constitutent species.

Table 6.33 Inland floral communities recovery rates

Community	Soil type	Percentage Recovery to Pre-impact Levels (in years)[3]											
		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

Table 6.34 *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

[3] Natural variation in revegetation time is signified where numbers are repeated across columns.

Table 6.35 *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 6.36 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

Table 6.37 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.

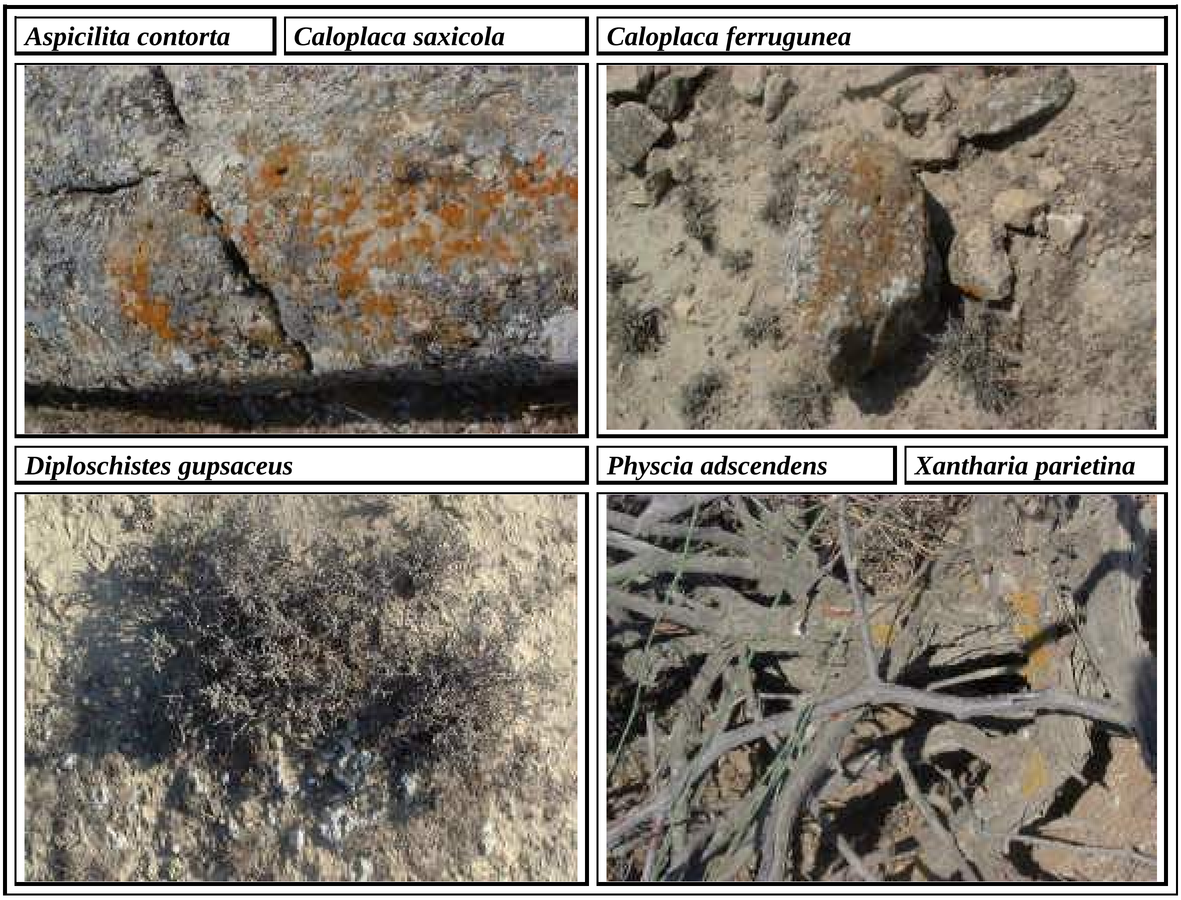
Lichen species encountered during the survey and brief morphological descriptions are provided in Table 6.38 below. Selected photos are presented in Figure 6.45. More detailed information regarding species location, abundance and other characteristics are provided in the Technical Appendices of this ES report.

Table 6.38 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
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 6.45 Selected lichen species



6.4.11.7 Azeri Red Book / IUCN Red List species encountered

Species identified during the survey activities and listed in Table 6.39 fall into one of the following categories:

- included in the 1989 Red Data Book of the Azerbaijan Republic[4]; 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 6.43) 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).

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

[4] The Red Data Book is currently in the process of being revised; some species included will be removed and others added.

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.

Table 6.39 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[5]
Calligonum bacuensis	Slightly inland (coastal/semi-desert)	Plant	Azerbaijan	Y	Y	Indeterminate
Iris acutiloba	Semi-desert	Seeds	Azerbaijan	Y	Y	Endangered[6]

1. whole plant, seeds, etc.
2. Azerbaijan Red Book.
3. 1997 International Union for the Conservation of Nature Red List of Threatened Plants.

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 6.40. 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 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.

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[5] 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.

[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.

6.4.12.1 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[7] 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 6.46) 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 6.46 shows the traps used and the area of investigation for the night work.

[7] 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 6.46 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 6.47) 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 2 of the 25 live traps were sprung, both with House mice.

Figure 6.47 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 2 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 6.48) a species listed in the 1989 Red Data Book of the Azerbaijan Republic and in 1994 IUCN Red List of Threatened Animals as "vulnerable"[8], 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).

[8] 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 6.48 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 6.49).

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 6.49 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.

6.4.12.3 North 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 6.50) were observed.

Two bat species, one Horseshoe bat and an Asian Barbastelle bat (Figure 6.51) 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 6.50 Caucasian agama

Figure 6.51 Asian barbastelle bat

Table 6.40 below summarizes the mammal and herpetile species recorded during the May/June 2001 survey activities.

Table 6.40 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

English Name	**Genus / Species**	**Location (sector) Within Survey Area Where Recorded**								**Biotope**	**Evidence**	**Time (D/N)**
		SE	**NE**	**CS**	**CN**	**WP**	**FW**	**WH**	**NH**			
House mouse	*Mus musculus*	X								Riverside	Captured	N
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.

6.4.13.1 Class: *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*												

Notes (*): 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 prefers 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.

6.4.13.2 Class 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 - 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 6.41 below lists the Azeri Red Book / IUCN Red List mammal and herpetofauna species observed during the 2001 survey activities.

Table 6.41 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[1]
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

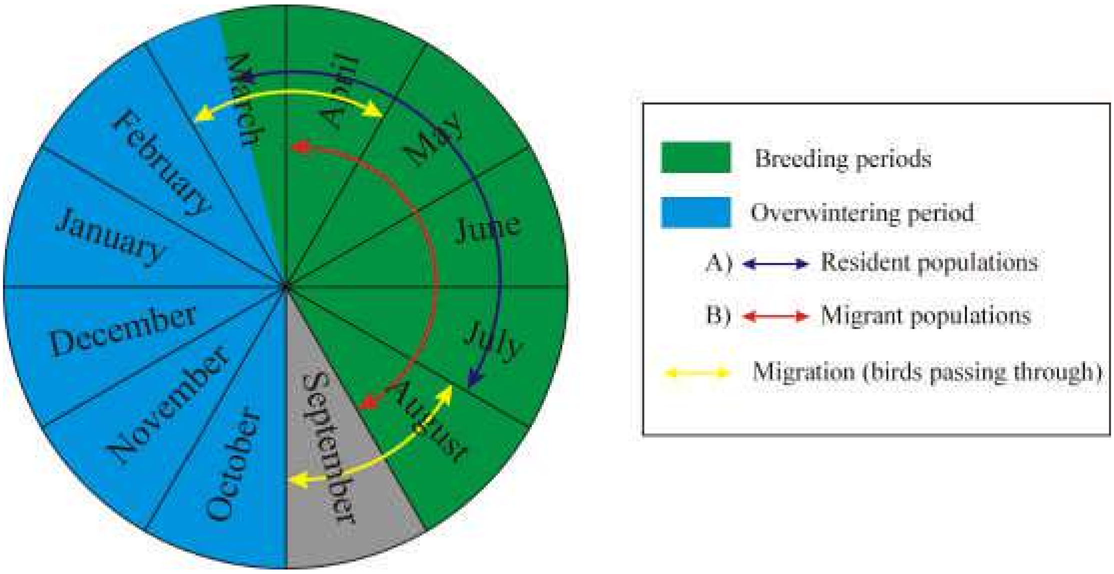
6.4.15.1 Introduction

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 much of the survey area 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 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 6.52 illustrates key periods for birds which either visit or reside in the survey area.

[1] 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 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 ES report 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 ES report.

6.4.15.2 Breeding 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 6.42 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 6.42 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 widely present 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 6.43 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 6.43 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
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

Species (Common English Name)	Genus species	North Hill	South Central Plain	North Central Plain	West Hills	Western Plains
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 6.44.

Table 6.44 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*	-	-	-	-	1	-

Common Name	Genus / Species	Sector					
		SE	NE	CS	CN	WH	WP
	percnopterus						
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 6.45 below lists the Azeri Red Book / IUCN Red List bird species observed during the 2001 survey activities

Table 6.45 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 a matrix was compiled of all the project activities and socio-economic receptors. The receptors were based on the information contained in the following socio-economic baseline and the stakeholder consultation process.

7.2 Methodology for compiling the socio-economic baseline

The approach undertaken during the socio-economic baseline data collection is outlined in summary below. The work comprised a number of main elements:

- collection and interpretation of all 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 and accessed and these are referenced by footnote where appropriate in this chapter. Each document was reviewed to ensure that the data was relevant and up-to-date.

In addition, individuals from two non-governmental organisations were 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.

7.2.2 Field visits[1]

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:

- 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, Azer Fishery State Concern;
- representative, Fisheries Institute;
- railway barrier operator;
- security guard at 15th century historical restaurant (Caravansari); and
- employee, ‘Firuza’ stone mine.

[1] 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.

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. 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 the 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.

Information has also been drawn from a sociological survey of Umid, Primorsk and Sangachal undertaken by the Azerbaijan-Holland Friendship Society, on behalf of BP, for the purposes of the BP social investment strategy. Additional information on the café/garage owner and the stone mine was drawn from interviews undertaken by BP during the ESIA process with the manager of the café/garage in Sangachal and the Director of the Firuza stone mine.

7.3 Geopolitics

With a total land area of 86,600 sq. km, Azerbaijan is the largest of the three Transcaucasian 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 north-west, 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. The majority of the country is dominated by lowlands around two rivers; the Kura flows from the north-west 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 2 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 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 dispute 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 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 to 8 million as of January 1st 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. Over 10% of the Azerbaijani population has become internally displaced as a result of the continuing occupation of one-fifth of the territory of Azerbaijan by Armenia. The occupation has left the country today with 900,000 Internally Displaced People (IDP) who are dispersed throughout the country. Just under half of these live in rural areas (URS 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) grant 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).

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 gender inequalities persist.

Women's employment is concentrated in lower-paying sectors of the economy and women are poorly represented at the higher levels of management, even in sectors that employ predominantly women. For example, women account for more than two-thirds of employment in health, education, and cultural work, where remuneration levels are particularly low, and yet they represent only about 35% of the heads of clinics and polyclinics and less than 20% of management in the education system. The average wages paid to women are lower than those paid to men in all sectors and unemployment is likely to be particularly severe among women.

The drop in light industry and food industry production over the last decade has had an adverse impact on women's economic empowerment as they have traditionally relied upon these two industries for employment. Government statistics show that women accounted for about 60% of the registered unemployed throughout the 1990s and the UNFPA puts unemployment for women at six times higher than it is for men (ASSC, 1999, UNFPA 2001, Azerbaijan UNHDR 2000).

From 1993 to 1997 the share of women among postgraduate students declined by one third. The country has, however, achieved almost universal literacy. The number of women in vulnerable groups is increasing, including the proportion of women heading households, in particular among the one million IDPs and refugees. The Government has established an inter-ministerial State Committee for Women's Problems to address gender concerns and formulate gender-sensitive policies and programmes (UNFPA 2001).

At present 12 percent of seats in Azerbaijan's Parliament (the Milli Mejlis) are held by women, 9 percent of ministerial-level positions are filled by women who also comprise 9 percent of regional heads of administration and 11 percent 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
1998	168,419 (~ $36US)*
1999	184,368 (~ $40US)
2000	205,112 (~ $44US)

Source : Azerbaijan Economic Trends Oct-Dec 2000.
* 4620 manats equals $1 – conversion added by authors

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* have 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 in 1998). Pensions are often subject to substantial delays in payment. The pension amount varies according to the recipient's work experience. In addition, 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; and
- Statistics Division ESCAP 2000
- Azerbaijan UN HDR 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 (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 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 of which oil accounted for AZM 1.384 trillion. Meanwhile, total state revenue for 2000 was AZM 4.137 trillion of which oil accounted for AZM 1.511 trillion (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 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. However this was 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 (URS, 20000a).

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 that is 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. This will allow a reduction in gas imports and fuel oil consumption 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. 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 (percent)

	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 Azerbaijan 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 which are centred around the Apsheron Peninsula and Baku. The activities of these ports is summarised in Table 7.5 below.

Table 7.5 Commercial Seaports in Azerbaijan (ERT, 1998)

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

The Caspian Shipping Fleet is operated by the Caspian Shipping Company (CSC), Volgotanker River Shipping Company, and other smaller companies. The CSC is an Azerbaijani state-owned company comprising 33 cargo tankers. In addition, the CSC operates 23 dry bulk chips, 2 'roll on roll off' ships and 8 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 comprise up to 10 vessels of 6,000 DWT and 6 small tankers with 3,000 DWT.

7.4.4.3 Fishing

Information in this section has been gathered from the following sources:

- Caspian Environment Programme - various reports.
- A report provided by the Caspian Fish Company.
- A report provided by the Azerbaijan Fisheries Institute.

Fishing on the Caspian has represented a relatively major contribution to GDP at approximately 1%. The Caspian is an important fishing area, with commercial catches of sturgeon, sprat, carp, darters, gobs, herring, salmon and mullet. However, Caspian fish stocks have 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 considered however, 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 lead to increased illegal and over-fishing. 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[2].

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

[2] Caspian Environmental Programme

State Fisheries Concern, based on information from fishing areas. However, this information covers only data obtained in the Azeraijani 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 (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	1.9
1996	6,636	1.3
1997	5,302	1.0
% change 1990-1997	(86.6)	(86.6)
Notes : exchange rate used of 4,620 manat = $1		

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 Azeribaijan 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	

This sharp reduction in sturgeon catch is believed to be connected with 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 of poaching following the break up of the Soviet system. This has been enabled by the collapse of control and monitoring of the sea, weakening of law-enforcing bodies and the loss of the government monopoly over sturgeon caviar. 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, with Azerbaijan's parliament, the 1125 member Milli Mejli, approving the Convention on International Trade of Endangered Species (CITES) on 23 June 1998. This came into force on 21 February 1999[3]. Since the break up of the Soviet Union, sturgeon poachers have illegally transported caviar to countries such as Turkey and 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 in May and this lasts through until mid July. The second round of breeding is between September to 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 fishpumps and cone-shaped nets, and are invariably caught during the night. Sprat is fished all year round, however the best fish can be caught between September through to April, with fishing activity slowing down in 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 2 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 is confined to the western and southern coasts and never moves offshore to depths in excess of 40-50 metres. However it does travel long distances along the coastline. The salmon are attracted to the coast between November through to February, this being the best fishing season for them.

Carp are concentrated in the Northern Caspian. These fish are caught between 40-60km from the shore by boats using lights to attract the fish. There used to be some 500 vessels involved in this type of fishing but numbers have dropped to approximately 100 vessels. Whilst wild carp is fished all year round, the best months are May-April and October-December. Mullet is concentrated mainly in the Southern Caspian, with fishing in the Kur Dashy in 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.

[3] 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

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; and
- Statistics Division ESCAP 2000.
- Azerbaijan UNHDR 2000

Azerbaijan's access to external markets has continually been disrupted by regional political turmoil. For instance, by January 2000 finished products valued at 587.1 billion manats has 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. Previous restrictions on trade have virtually all been removed and the authorities plan to reduce the general import tariff rate of 15% to 10%. In addition, Azerbaijan has applied to join the 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 $929 million. Its import growth rate was -4.1% or some $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 $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).

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. Barriers to trade such as duties and strict licensing restrictions have been eased. While these efforts 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 $342 million in 1996 rising to $1 billion in 1997 and $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 of nearly 100% for 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). The state 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. About 80% of rural land titles are believed to 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 estimate is presently available for status of land reform. The main part of state land was transferred to regional administrations and since then, land has been allocated to the population. This rate of progress of this process has recently been increased and approximately 60% to 70% of land has been allocated (ERM, in press).

7.4.9 Infrastructure

Most of Azerbaijan's infrastructure, built during the Soviet period, is in poor condition. There has been inadequate public investment and maintenance of infrastructure since independence. The power generation and distribution system is deteriorating, and gas, water, electricity, and oil product shortages are common in the capital of 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 use more oil domestically. In April 2001, in an effort to boost foreign investment in the energy sector, Azerbaijan established the Fuel and Energy Ministry 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 Arax rivers that provide most of Azerbaijan’s fresh water are 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 pipe distribution system. The degraded and poorly managed irrigation system is responsible for agricultural water losses of about 50% and in 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[4] [5]. 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 their 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 population. 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, n order of magnitude, include:

- 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, diptheria, and malaria and there has been an increase in the incidence of rabies, brucellosis, anthrax, tuberculosis 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.

[4] Ref: 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.

[5] 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 with only seven cases registered between 1987 and 1992 but 164 HIV cases 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 is need of fundamental improvements and needs 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).

Around 20% of families, according to World Bank experts, can be classified as severely vulnerable. Over 500,000 are unemployed. The lowest average salaries are found in the agricultural, wood industry and educational sectors. The cost of the minimum consumer basket[6] in Baku currently exceeds by 3-4 times the average Azerbaijani salary. 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 some 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 systems. 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 may be evidence of a 'brain drain' taking place within Azerbaijan however more research would be needed to confirm whether this is the case.

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 which are 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.

[6] 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.

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)

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 are published in Baku. The majority of newspapers, magazines and journals 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.

Azerbaijan's telephone system is a combination of old Soviet era technology used by Azerbaijani citizens, 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). Their lines are not laid but 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 south-eastern 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 was not freely available, and collection and recording methods 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.[7]

In addition, some data has 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.

[7] 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 issues (for instance URS were unable to speak with the café/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

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.

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 indicates slightly more females in the district than males. The age profile of the population in Garadag District for 2001 is outlined in Table 7.9. In addition to these settlements there are also a further three small villages, namely Umid, Shikhlar and Kotel. Figures for the overall population were obtained for Umid. As far as can be ascertained however, no population figures exist for Shikhlar or Kotel and no age or gender distribution details exist for any of the three villages.

Table 7.8 Population figures Garadag District (2001)

Settlement	Male		Female		Total
	Number	%	Number	%	
Lokbatan	14,118	48	15,164	52	29,282
Shail (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
Ukranian	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
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.[8]

Table 7.11 Income levels Garadag District (1996-2001)

Year	Average Monthly Salary ($US)	Population Income (US$M)
1996	40	1.8
1997	50	2.1
1998	59	2.6
1999	72	3.1
2000	84	3.5
2001	75	3.5
% change 1996-2001	87.5	94.4

Note: Exchange rate AZM4620 = US$1.00.
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 (URS 2000a). There is very little arable farming due to the

[8] It should be noted that the AHFS survey of the residents of Sangachal, Primorsk and Umid found that approxiemately 35% of those surveyed receive no income at all. Only around 24% receive an income of between 200.000 and 500.000 manats ($43-108).

poor climatic and soil conditions (AIOC, 2000a). Some small market gardens are evident around settlements but no intensive farming activities are present (AIOC, 2000a).

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

The fishing industry is relatively limited in Garadag District with fishing activities concentrated around Elet, Sangachal and Lokbatan. Fishing activities are recreational and subsistence, rather than for commercial purposes. No information is available as to the numbers employed in the fishing sector in the District (Garadag Executive Power; 23/7/01).

Table 7.13 details the available labour force in Garadag District between 1996 and 2001. As illustrated there has been a continuing increase in the available labour force in the District in the last 6 years amounting to almost 28% between 1996 and 2001. This equates to almost 5% per annum. 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 tally 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 (million US$) Garadag District (2001)

Year	Total GDP	Of which: Oil and associated industries GDP[1]	Of which: Construction Industry GDP[1]
1997	160	82	48
1998	162	83	49
1999	169	86	51
2000	159	81	47
2001[2]	82	42	25
% change 1997-2000	(49)	(49)	(48)

1. Approximate.
2. First 6 months.

Source : Garadag Executive Power Office

In the Garadag District Azerbalyk, the State Fisheries Concern, have a hatchery at Primorsk. The hatchery was built in 1976 and they breed salmon and white sturgeon fry. Before the fall of the Soviet Union, the fish farm was used to raise fish brought from lake Mengichevir with the goal of releasing them into the Caspian. The farm is also involved in salmon and white sturgeon fishing along the coastline up to the town of Alyat, with most of the fishing done 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 7 and 10 tonnes of sanders being produced annually. However in recent years the level of sanders has drastically reduced and there are now none. Whilst offshore developments have been blamed for this loss, the role of uncontrolled fishing and the use of banned fishing equipment, such as keep nets and self fishing tackles, is also recognised as having contributed to the decline. The majority of the fishing grounds are based in and around the coast areas of Neftcala.

It is estimated that approximately 70 people are employed in the fishing industry in the area between Baku and Gobustan, the majority of whom are employed at the fish farm in Primorsk. In 1997 the region caught some 380 kg of fish, however this is not consistent with the 2 tonnes of fish claimed to be caught in that same year by the national office of Azerbalyk. In 1995 the fish catch for the same area was 780 kg (i.e a 50% decrease over 2 years). The trend of drastically reduced fish catches over the past five years has extended across all species. For example, between the 96/97 fishing season and the 97/98 season, two separate species of fish fell from 76 to 5 specimens and 49 to 0 specimens respectively.

7.5.5 Infrastructure

The Baku-Alyaty highway routed along the Sangachal Bay coastline passes to the south of the terminal location. This section of road is a main highway in Azerbaijan. It is part of the main transportation route north from Baku to Boyuk and to Kesik at the Georgian border (a total of 510 km) and south from Baku to Astara (a total length of 313 km) to the Iranian border. Both routes cover 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 to 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[9] 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)	Aspheron Water Company
Water Pipeline	SOCAR Amirov O&GPD

[9] 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 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 2 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. The Garadag Cement Plant also contributes to respiratory problems suffered by local residents. Figures show that up until August 2001 between 700-750 people had been injured in the workplace.

7.5.7 Education

There are 22 secondary schools and 4 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[10]. 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 detailed in Table 7.16. The IDP in the District are primarily located in Lokbatan, Shail, 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 IDP from Fizuli, Agdam, Zengilan, Gubadli, Kelbejer, Jebrayil, Lachin districts and Shusa, Khojavend, Khojali city and villages of the Nagarno Karabakh region. They have been arriving since 1992 (Garadag Executive Power; 23/7/01).

[10] 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.

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 ACG Phase 1 Project onshore facilities, has been compiled from a number of sources as described below (and as outlined in the methodology section at the beginning of this chapter). A number of meetings and sites visits were undertaken with relevant stakeholders and those resident in the area.[11] During these visits, both quantitative and qualitative data was collected using questionnaires.[12] 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.

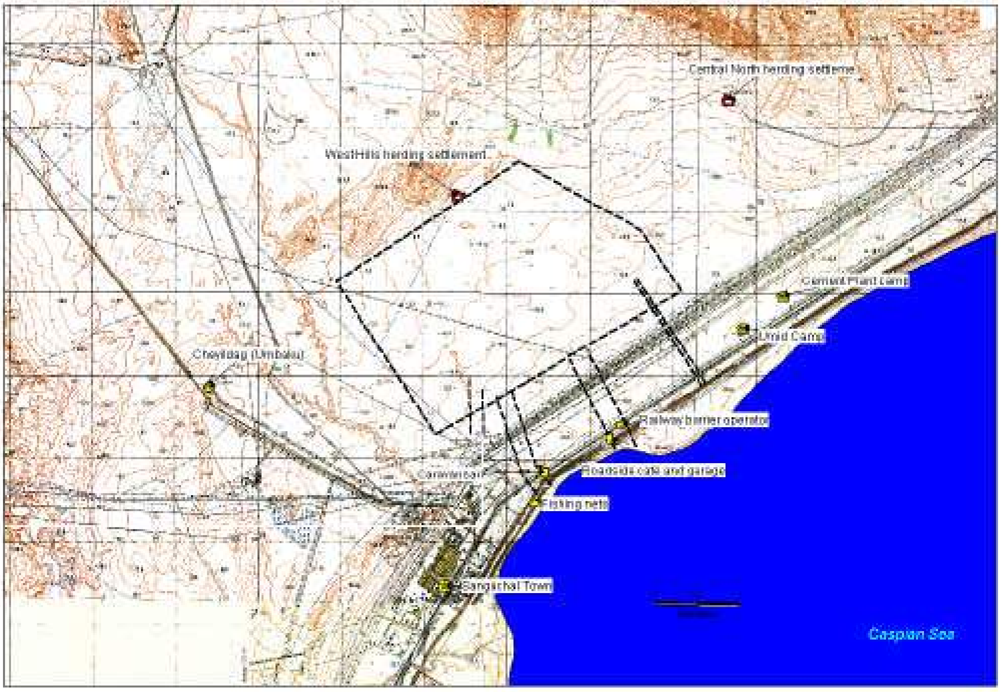
The information sourced illustrated the following socio-economic receptors[13] within the local area[14] around the proposed ACG Phase 1 Project onshore developments:

- 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);
- 'Firuza' stone mine;

Each of these is discussed below and illustrated in Figure 7.2. 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. However, the information in the following section has been separated out 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 on Umid Camp is in some instances, specific to the IDP population and is not inclusive of the cement camp workers. This is indicated in the text where necessary.

[11] Details of individuals interviewed, sites visited are presented in Section 7.2.
[12] The questionnaires covered a range of socio-economic issues. The questionnaires are contained in the Technical Appendix to this document.
[13] 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
14 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

Figure 7.2 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. Individuals who provided information requested however, 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 Town has been increasing every year for the past 5 years by between 4 and 5% per annum.

Some 97% of the residents are Muslim with the remaining 3% Christian. In a community survey residents identified themselves as the following nationalities:

- Azeri Turk (95.2%);
- Russion and Slav (2.9%); and
- other 1%[15].

Approximately 62.5% of the population is male and 37.5% female (AHFS, 2001).

[15] 1% of respondents gave no answer to this question.

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 is US$75 or AZM346,500 (US$1 = AZM4,620). 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.

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)	%
No reply	1.9
0	35.6
<100, 000	11.5
<200, 000	23.1
<500, 000	26.9
<1, 000, 000	1
>1, 000, 000	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;
- 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).

Although figures were provided for overall population within Sangachal and those employed, no figure was available giving the available labour force for Sangachal. 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[16]. 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[17].

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 ACG Phase 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 is illustrated in Table 7.21.

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

[16] See the National section of this chapter for a discussion on social security conditions within Azerbaijan.
[17] See the National section of this chapter for a discussion on gender distribution.

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)[18]. 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"[19] 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 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).

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 town. The issue of health was discussed as part of the AHFS survey undertaken in Sangachal and Table 7.22 details the results. As illustrated over 50% of the population assess their health as poor. No official figures were however, available to support

[18] 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..
[19] Shelter to temporarily house local residents.

this assertion. In addition, the information from the 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 are 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 7.3. 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 6 and 17 attend school. This year there are some 724 children at Sangachal school and 63 teachers.

Last year approximately 10 children went onto university education, with half of them being young women. The numbers who go on to such higher education varies from year to year (Garadag Executive Power; 5/7/01) and has attendant difficulties. Some universities charge an attendance fee and as public transport to Baku is not reliable (i.e. the service is irregular and seats can be limited) it can make regular attendance at university difficult.

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[20].

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 7.3 Sangachal School

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. They 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 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 3 or 4 (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

[20] See the Section 7.4.11.

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[21] 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).

Figure 7.4 Sangachal Town

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.

[21] 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

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.

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 7.5 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. Previously the cement camp was under the administration of Primorsk. Recently it, along with the IDP camp, was granted the status of a town in its own right. This confers a more formal status and feeling of permanency on the settlement. All the residents of Umid Camp are Muslim and a mosque, illustrated in Figure 7.6, has recently been built at the camp (Head of Garadag Executive Power Representation, Umid Settlement; 05/07/01).

Figure 7.6 Umid Camp mosque

7.6.3.2 Income

Table 7.25 below provides an estimate of the income levels within IDP Umid Camp. 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)	%
No reply	0
0	36.7
<100,000	33.3
<200,000	23.3
<500,000	6.7
<1,000,000	0
>1,000,000	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 7.26 below.

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.

For those that are employed, Table 7.27 below details 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. However the total population is 1000 and approximately 70 employed from this total equates to 7%. Although the two tables are from different sources the figures roughly tally and can be taken to be 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 and this is 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 this specifically affects employment opportunities where the men have been injured. 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 by over 330% in 2 years (Head of Garadag Executive Power Representation, Umid Settlement; 05/07/01). There are now 130 households. However 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 however, 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 site.

Figure 7.7 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 7.8). 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. 8 Umid Camp waste disposal

Sewage waste is transported via a simple open drainage ditch as illustrated in Figure 7.9.

Figure 7.9 Umid Camp sewage system

7.6.3.5 Health

According to the Garadag Executive Power, Umid Camp has not experienced any 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 only 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. Doctors visit the camp at vaccination time. Whilst the medical facilities are free, 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 7.10). It is attended by approximately 120 children which represents all the children of school age in the Camp (Head of Garadag Executive Power Representation, Umid Settlement; 05/07/01). Repairs and maintenance were undertaken at the school by the Ministry of Education 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 7.10 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 $US5 per month per person. There is some international assistance given to IDP. This is however, ad hoc and inconsistent.[22]

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[23]. 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 ACG Phase 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 and one of the herder supervisors in October 2001

[22] information sourced from Garadag Executive Power
[23] Although a similar process exists in Sangachal town the groups of elders are different for Sangachal and for Umid Camp.

- 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

Some of the information collected to date is conflicting.

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 7.11 and 7.12, is used by herders during both the winter and summer seasons[24] 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 5-6 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 4-5 people, remains at the settlement for security reasons.

Figure 7.11 Herding settlement - Central North

[24] 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.

7.6.4.2 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 7.13).

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 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.[25]

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 8 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.

Figure 7.12 Herding settlement - Central North

[25] 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 7.13 Herding settlement – West Hills external photo

Figure 7.14 Herding settlement – West Hills internal photo

7.6.4.3 Economic activity and income[26]

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.

[26] 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 5-10 horses, up to 50 donkeys and between 8-15 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 $60-65 per month per herder from this, although other figures of around $1000-$2000 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.

7.6.4.4 Land ownership

Grazing areas are distributed by the Grazing Office which 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 1636 hectares of which 1500 ha is suitable for grazing and 256ha 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[27] with signs of malnutrition in the younger children. However, no accurate health data has 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[28].

[27] Assessment based on general observations when on site visit to Central North herder settlement on 24/04/01.
[28] 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 hour shift and then 3 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 main and only source of income. The hut at the barrier provides shelter with basic facilities[29].

7.6.6 Historical restaurant (Caravansari)

Near Sangachal town sits a 15th century historical restaurant that was a "caravanserai" (i.e. acamel resting place) (Figure 7.15). 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[30].

Figure 7.15 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 7 years and has mains electricity, although the supply is unreliable and was not working during the data

[29] 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.
[30] This information was sourced from an interview with the security guard at the historical restaurant which took place during the data collection process.

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.[31]

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 7.16). The Fish Hatchery Plant supports the salmon population numbers in the Caspian Sea that require constant stock supplementation.

Figure 7.16 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.[32]

There are some 3 or 4 fishermen employed to work these nets and cages. There is a temporary building near the shore where the fishermen can shelter (Figure 7.17). 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.[33]

[31] This information was sourced from an interview with the person who runs the café/garage which took place as part of the ESIA process and was undertaken by BP.
[32] Information provided by BP and gathered as part of the Resettlement Action Plan process, 2002
[33] Information provided by BP and gathered as part of the Resettlement Action Plan process, 2002

Figure 7.17 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 (i.e. US$5)[34]. 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 7.18).

34 Based on an exchange rate of AZM4620 = US$1.

Figure 7.18 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 8 and 9 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 1-2 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.[35]

[35] 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.

7.6.10 Cultural heritage

Individuals from the Azerbaijan Academy of Sciences, Institute of Archeology and URS Dames & Moore 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 GPS. The team stopped when an item of interest was observed. Photos were taken along with GPS coordinates for features identified. Visual dating was performed by the Institute members while smaller items (pottery shards, etc.) were collected and taken to the Institute of Archeology 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
- 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 II 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.

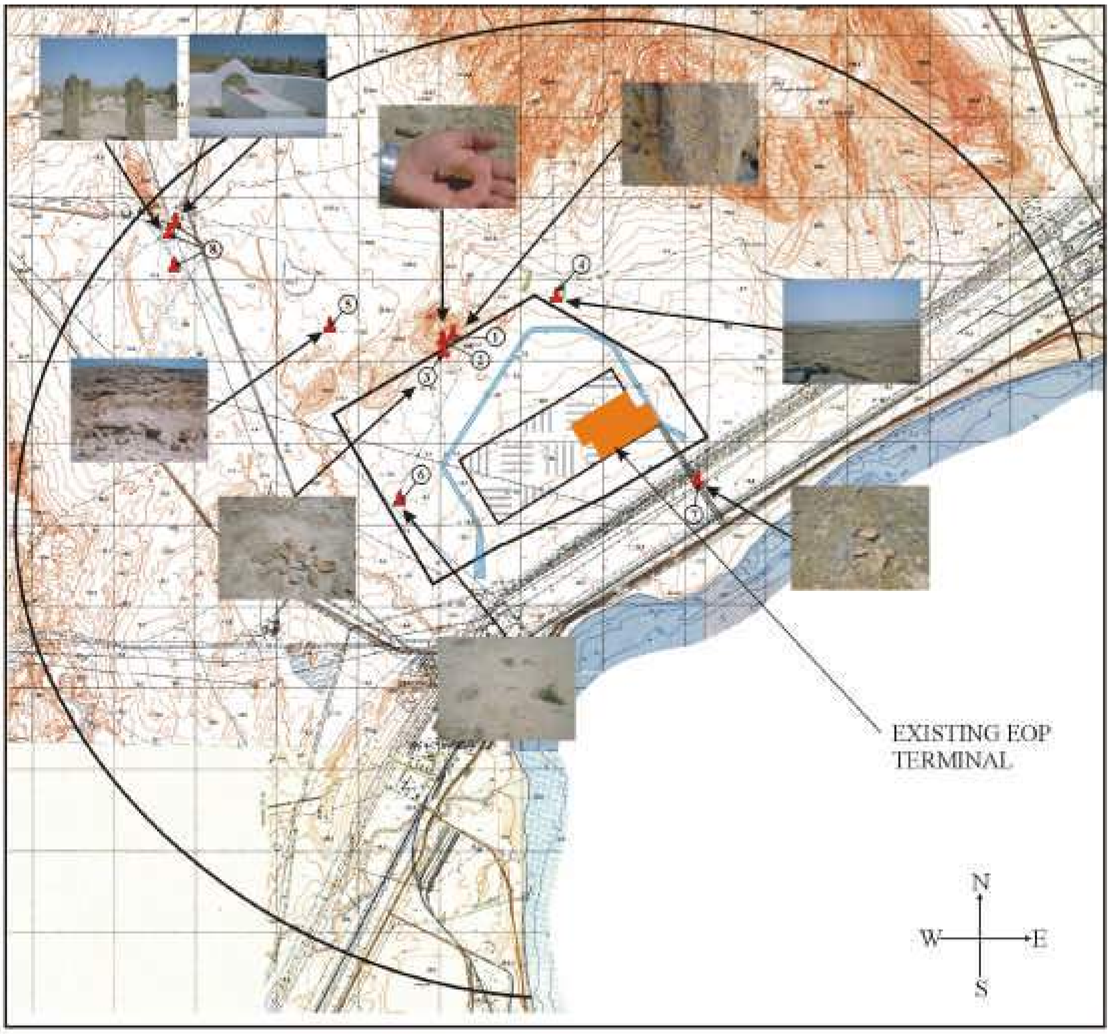
From the apparent level of pre-conception[36], artistry, and likeness to the carving found in Gobustan as mentioned above, it is estimated that these images might have been carved in the same period (i.e. II Century B.C.). The rest of the features discovered on and around the West Hills have been dated 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.

[36] '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 7.19 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 7.20 Cave with stone carvings at West Hills

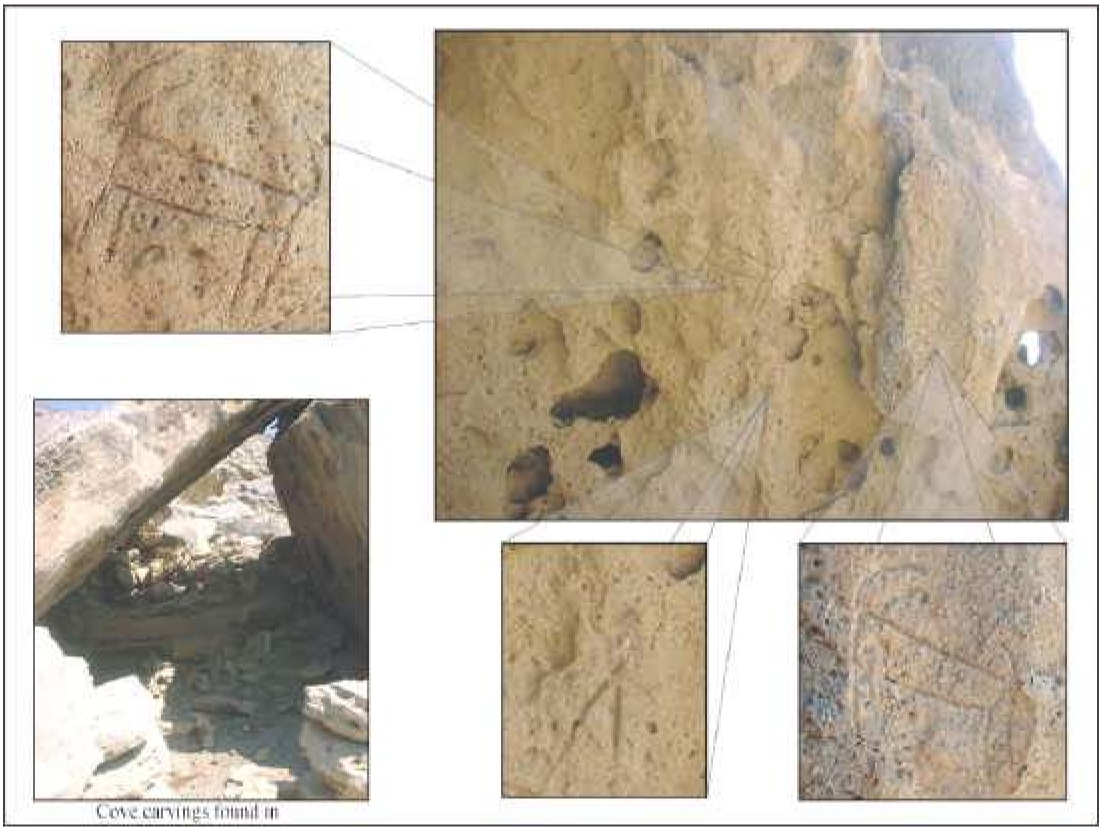


Table 7.28 Items of Interest to Cultural Heritage Identified

Name	Map Reference Number	Artifact(s)	Cultural Identity	Site area[37]
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

[37] 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	Artifact(s)	Cultural Identity	Site area[37]
Settlement#6	6	earthenware debris	Medieval	Few hectares
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 the AIOC conducts its business and communication with the project stakeholders is an essential component of any environmental and socio-economic assessment process (Figure 3.1). AIOC is committed to active and ongoing communication with all organisations and individuals with an interest in the proposed ACG Phase 1 development. The consultation and disclosure programme for ACG Phase 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 ACG Phase 1 ESIA, including the Early Civil Engineering Work Programme (ECEWP). The process was designed to meet the requirements of the Azerbaijan government (including the requirements of the PSA), international requirements, and those of international finance institutions (IFI). Additional and important environmental and social drivers of the AIOC consultation process are:

- understanding the environmental and socio-economic impacts of the ACG Phase 1 project including the 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; and
- engaging proactively with national and international NGOs.

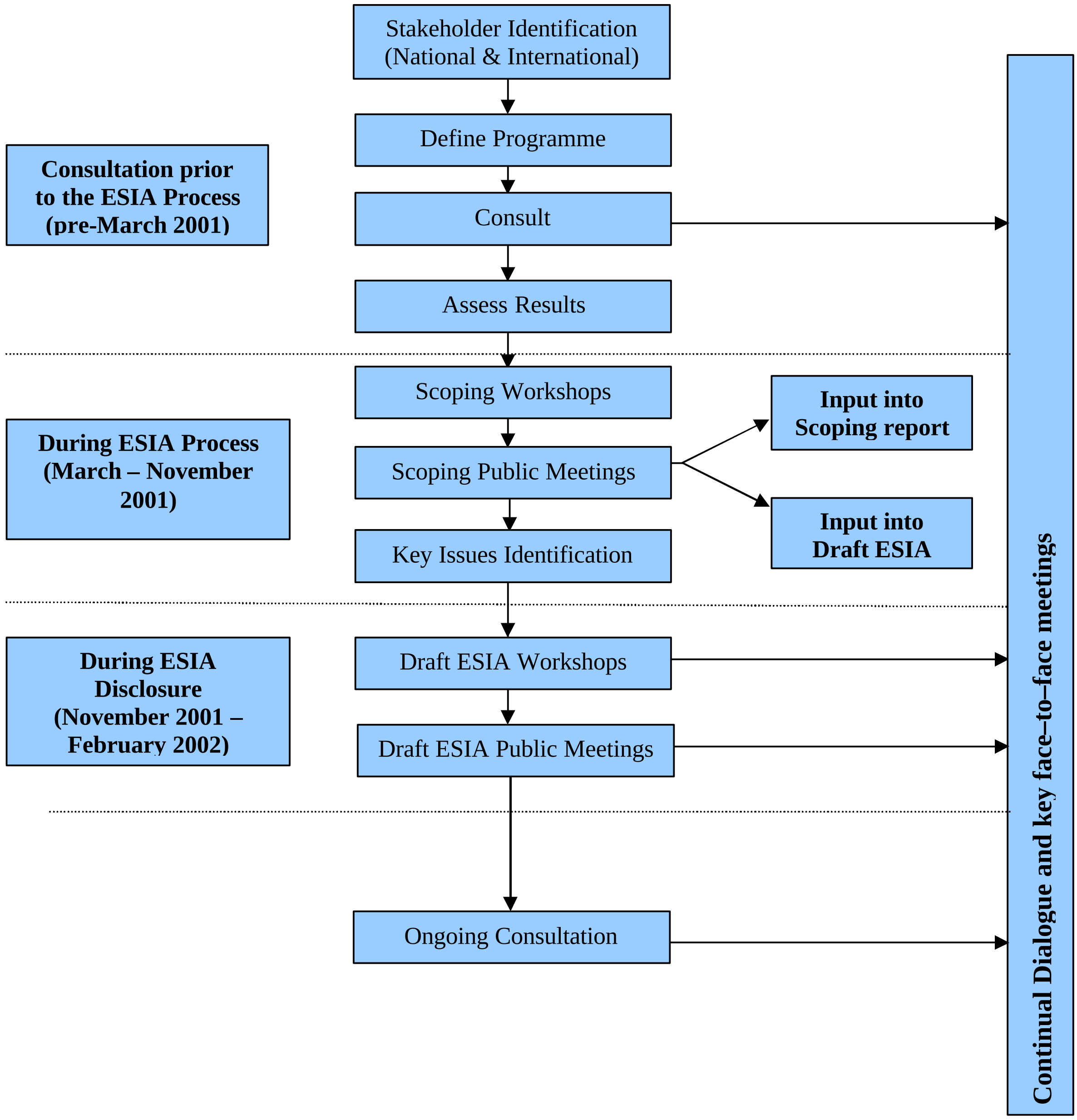
Figure 8.1 illustrates the ACG Phase 1 consultation and disclosure process. The phases of the consultation process are:

- 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 ACG Phase 1 process; and
- consultation relating to Shah Deniz Stage 1.

Figure 8.1 ACG Phase 1 consultation and disclosure programme



These processes will result in three separate but related (and at times overlapping) ESIA documents. The phases of the consultation process in relation to each of these is illustrated in Table 8.1. The ECEWP is preparatory work for both the ACG Phase 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 primarily 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 AIOC 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 ESIAs; and
- listen and respond stakeholder concerns.

The public consultation and disclosure process has been recorded in a formal Public Consultation and Disclosure Plan (PCDP), which will be made publicly available in the following places:

- on the BP Project Web Site in English with directions for accessing multi language CDs if required;
- in paper form in the same locations as for the final ESIA document (public libraries in Baku, ISAR office etc)

The PCDP will contain:

- a brief summary of the ACG Phase 1 project;
- a summary of the main international and national laws, guidance documents and IFI requirements relating to public consultation and disclosure processes;
- the roles and responsibilities of the main parties involved;
- the methodology used to identify and consult with the stakeholders;
- a list of the stakeholders consulted;
- a review and analysis of previous AIOC/BP consultation processes;
- the locations and dates of the meetings and workshops;
- an outline of ongoing consultation and community relations;
- reporting arrangements, including a grievance procedure;
- appendices detailing the stakeholders and summarising the advertising methods and meeting materials used for the various meetings and workshops.

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.

AIOC/BP have been working in a public participatory manner in Azerbaijan for a number of years and over this time have 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 AIOC/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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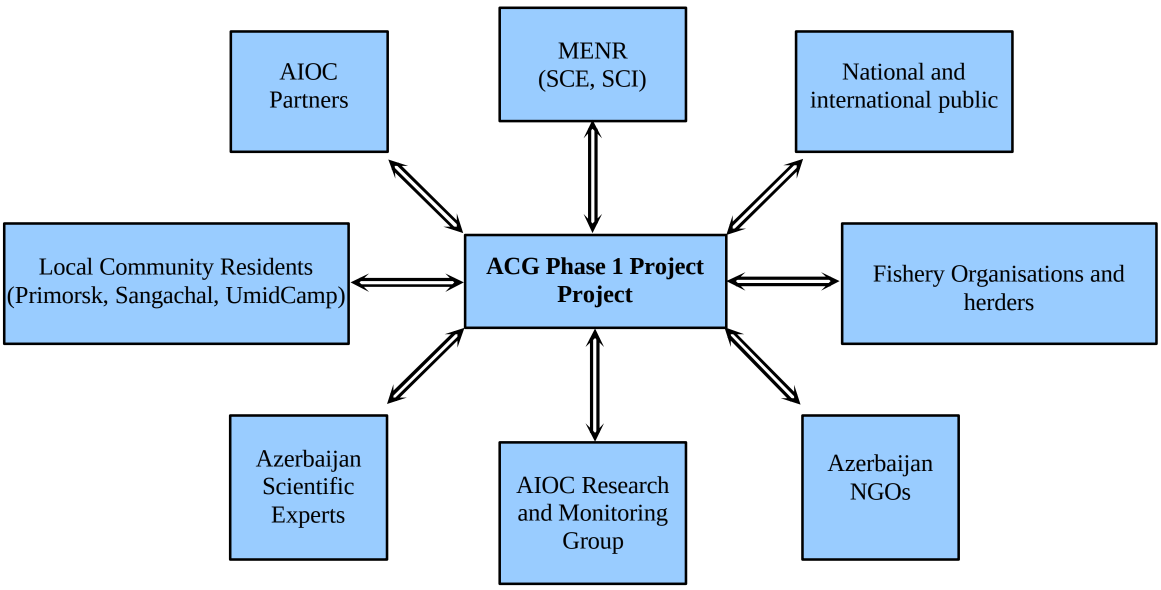
The organisations and groups consulted are shown in Figure 8.2. Details regarding the individual stakeholders will be presented in the full PCDP.

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;
- 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 ACG Phase 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. The majority of these minutes are available on request from the BP office in Baku. In addition Table 8.2 below records the key issues raised during the scoping workshops and meetings and draft disclosure meetings for the ACG Phase 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 for AIOC to understanding 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 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

The 'Environmental and Socio-Economic Overview' together with an Executive Summary, was published in 2000. It describes the entire Full Field Development (FFD) of the ACG project and outlines the associated environmental and socio-economic aspects. It was prepared to:

- provide interested parties with information about the development;
- discuss the more significant environmental and socio-economic aspects of the development;
- present the environmental standards for Phase 1 of FFD;
- set out the way forward, including the programme of detailed environmental impact assessments and monitoring programmes; and
- provide a mechanism for ongoing consultation with stakeholders.

The document was circulated to a wide audience including:

- State Committee of Ecology
- State Caspian Inspectorate
- AIOC Environmental Sub-Committee and Research and Monitoring Group
- SOCAR HSE Department
- SOCAR HSE-Foreign Investments Division
- Public Libraries
- NGO groups via ISAR
- Caspian Environmental Programme
- IFC and EBRD
- Executive Committee and Schools in the Sangachal area
- Cabinet of Ministers, HSE Sector
- Azerbaijan Parliament, Energy, Ecology and natural resources commission
- Institutes of the Azerbaijan Academy of Sciences

The document enabled concerns to be identified and raised, by NGOs, scientists and governmental agencies, at an early stage in the design process when there was most opportunity to influence outcomes. It was also formally submitted to the State Committee for Ecology on November 30th for their review and was subsequently approved as an appropriate basis for progressing the development.

A series of preliminary consultation meetings were held with the principle aim of giving attendees an early summary of the proposed developments and the proposed ESIA strategy for the ACG Phase 1 project. The key activities included meetings with the following regulatory bodies and organisations:

- MENR (formally Azerbaijan State Committee for Ecology) -Chairman and Department of Expertise;
- Cabinet of Ministers (HSE Sector);
- State Caspian Inspectorate (part of former Azerbaijan State Committee for Ecology);
- Academy of Sciences;
- AIOC Research and Monitoring Group, and
- State Oil Company of the Azerbaijan Republic (SOCAR).

In addition a workshop was held in June 2000 with the Azerbaijan environmental NGOs to present an overall picture of BP activities within Azerbaijan along with BP experience and activities with respect to the management of environmental and social issues associated with their development projects.

Regular meetings have been held with the AIOC Research and Monitoring Group throughout the life of the project and these have proved to be of assistance in identifying possible impacts and understanding the local conditions and culture more thoroughly.

8.4 ESIA scoping consultation

A number of consultation meetings were held during the ACG Phase 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: ACG Phase 1 ESIA scoping workshop with Azerbaijan scientists so that AIOC 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: ACG Phase 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:

- **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, 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 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 ACG Phase 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 AIOC Research and Monitoring Group.

Table 8.2 below identifies all of the key issues raised during the scoping consultation process for the full ACG Phase 1 and Shah Deniz Stage 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 during the ACG Early Oil Project (EOP) construction when there was little 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 project on their grazing lands and their options for compensation. The consultation process will also be described and documented in the final RAP document.

Consultation has also been undertaken to understand the impacts of the ACG Phase 1 project 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 fullRAP. An Executive Summary of this document will be publicly available in the following places (with directions for accessing the full document):

- on the BP Project Web Site in English with directions for accessing multi language CDs if required;

8.6 ESIA draft disclosure consultation

As outlined in Section 8.2, two sets of ESIA documents have been produced for the ACG Phase 1 Project. The first was the Early Civil Engineering Work Programme (ECEWP) ESIA which was completed in December 2001 and included the ECEWP for the ACG Phase 1 and Shah Deniz Phase 1 proposed developments. The second is this document, the final version of the full ESIA for the ACG Phase 1 Project (which includes the ECEWP).

8.6.1 ECEWP draft ESIA

The ECEWP draft ESIA document has been disclosed and made freely available to the public in Azerbaijan for comment. The disclosure period has finished and 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, and have also been incorporated into the Table 8.2 in this document.

8.6.2 ACG Phase 1 Project draft ESIA

The draft ACG Phase 1 Project ESIA document was disclosed and made available to the public for comment for a period of 60 days from late November 2001. Copies of the document were freely available and were distributed widely for easy access by interested and affected stakeholders.

A similar series of workshops and public meetings as that held during the ECEWP draft disclosure period, were conducted in order to present the findings of the ACG Phase 1 ESIA process and all comments were recorded. Issues and comments raised have been incorporated into the final ACG Phase 1 ESIA document where appropriate.

8.7 Forward consultation plan

Consultation throughout the construction and operation phases of the project will be ongoing. AIOC has appointed a Community Liaison Officer who has primary responsibility for liaison with relevant stakeholders throughout the construction phase of ACG Phase 1 (Chapter 14).

The project is fully committed to a continued dialogue with stakeholders, continuing into and during the operations phase of the project. Some of the issues raised during consultation will be worked through as the project moves through detailed design, construction and installation and operation. The continuation of the Community Liaison Officer role during the operations phase is under consideration by the ACG Poject Management Team and will be decided at a future date.

Table 8.2 Key issues raised during ACG Phase 1 ESIA consultation process

Issue	Concern	Issues Raised By:				During:		Section Addressed
		Regulator	Academics/ Scientists	NGOs	Individuals	Scoping	Disclosure	
Triggering of seismic events	Fear that increased operations will increase the number of seismic events, in particular drilling activity, cuttings re-injection, deep well disposal of produced water.	•	•	•		✓		Section 6.4.5 Section 10.6.2.2 Section 10.6.3.1
Seismic/tectonic activity	Ability of the facilities to withstand seismic event (earthquake or mud volcano activity).		•	•		✓		Section 10.6.3
Oil spills	Potential oiling of marine life and impact on the environment from an offshore spill. Potential for oil spills during storage at the terminal. Measures to eliminate the consequences of oil spills. Reliability of oil spill control equipment. Oil spill contingency planning. Oil spill modelling. Wildlife response.		•	•		✓	✓	Section 10.6.1 Section 13.4.2 Section 14.2.2 Technical Appendix 7
Pipeline	Ensure pipeline integrity, particularly at the landfall. Operational life of pipelines. Disposal of hydrotest waters.	•		•		✓	✓	Section 5.6.2 Section 5.6.4 Section 10.4.2.2 Section 10.6.3
Discharge of produced water to the sea	Volumes to be discharged. Produced water discharge specification. Produced water monitoring.	•	•	•		✓		Section 5.5.1.2 Section 5.5.6 Section 10.3.2.5

Issue	Concern	Issues Raised By:				During:		Section Addressed
		Regulator	**Academics/ Scientists**	**NGOs**	**Individuals**	**Scoping**	**Disclosure**	
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.		•	•		✓	✓	Section 5.7.4.5 Section 10.4.6.2 Section 10.6.2.2
Discharge of cuttings and water based muds to the sea.	Concern over the environmental impact to the Caspian Sea environment. Impact on benthos and rate of recovery. Cuttings dispersion modelling.	•	•	•	•	✓	✓	Section 5.2.4 Section 5.3.1 Section 5.5.6 Section 10.3.2.3 Section 10.3.3.3 Technical Appendix 4
Cuttings re-injection	Over pressurising of the sub-surface geology. Integrity of the well. Containment of injected wastes in the event of an earthquake.			•		✓	✓	Section 5.3.1.1 Section 10.3.4 Section 10.6.2.1
Cooling water discharge	Use of antifoulants.	•					✓	Section 5.5.1.5 Section 10.3.2.4 Technical Appendix 4

Issue	Concern	Issues Raised By:				During:		Section Addressed
		Regulator	Academics/ Scientists	NGOs	Individuals	Scoping	Disclosure	
Chemical use offshore	Can a Caspian specific protocol for selection of chemicals be used? Drilling mud components. Cement components. Heavy metal contamination.			•	•	✓	✓	Section 5.2.4 Section 5.2.5 Section 5.3.1 Section 5.5.1.1 Section 6.2.6.3 Section 6.2.8.2 Section 6.2.9.2 Section 6.3.4.7 Section 6.4.7 Section 10.3.2.3 Section 10.3.2.4 Section 10.3.2.5 Section 10.3.2.6
Well testing	Number of wells to be tested and amount of fluids to be flared.	•					✓	Section 5.2.7 Section 10.3.1.2 Section 10.3.2.7
Sewage	Discharge of sewage offshore and its impact on the sea. Sewage water treatment at the terminal. Suitability of sewage waters for irrigation purposes.	•		•		✓	✓	Section 5.2.11.3 Section 5.2.15.2 Section 5.4.3.8Section 5.5.4.10 Section 5.6.4.1 Section 5.7.2.2 Section 5.7.3.4 Section 5.7.4.9 Section 10.3.2.2
Impacts on water quality	Impacts from construction and operations on sea water quality.	•	•			✓	✓	Section 10.3.2
Air quality	Terminal operations impact on air quality. Impacts on air quality in the event of an emergency.		•	•		✓	✓	Section 10.4.1 Technical Appendix 3

Issue	Concern	Issues Raised By:				During:		Section Addressed
		Regulator	Academics/ Scientists	NGOs	Individuals	Scoping	Disclosure	
Flaring	Potential to flare associated gas and its contribution to the 'greenhouse effect'. Impact on birds offshore and onshore.		•	•	•	✓	✓	Section 5.5.1.4 Section 5.5.6 Section 5.7.4.9 Section 5.7.5 Section 10.3.1 Section 10.4.1 Section 13.4.1 Section 14..2.1.6
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.		•	•		✓	✓	Section 5.7.5.3 Section 10.3.1.4 Section 10.3.2.1 Section 10.4.9 Section 11.4.4.3 Section 11.4.4.4
Terminal land take	Concern over the area of terminal expansion. Compensation for habitat loss.		•				✓	Section 5.7.1 Section 5.7.2 Section 10.4.9 Section 11.4.2 Section 14.2.1 Section 15.4
Terminal drainage channel	Effects of water flow from the channel outlets and on the environment. Potential for water to stagnate in the channel resulting in odour.		•				✓	Section 5.7.2 Section 10.4.5.2 Section 10.4.9 Section 14.2.1.5
Geology	Assessment of the geological status at the terminal site.				•		✓	Section 6.4.4
Biodiversity	Potential reduction in biodiversity as a result of the project implementation.		•			✓		Section 10.4.8 Section 10.4.9 Section 14.2.1.4

Issue	Concern	Issues Raised By:				During:		Section Addressed
		Regulator	Academics/ Scientists	NGOs	Individuals	Scoping	Disclosure	
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. Invertebrate survey. Requests to monitor the impacts (including soils). To include local scientists/NGOs. Publish results.		•	•		✓	✓	Section 6.4 Section 10.4.8 Section 10.4.9 Section 14.4 Technical Appendix 11
Fauna at the terminal construction site	Concern over animals living within the soils.				•		✓	Section 6.4.9 Section 10.4.9 Section 14.2.1.4
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.		•	•	•	✓	✓	Section 10.3.2 Section 10.3.3 Section 14.4
Surface waters	Monitoring of surface waters around the terminal.		•				✓	Section 14.4
Interference with fishing activities	When and how will the activities be organised?				•	✓	✓	Section 10.3.3.4 Section 11.4.2.2 Section 11.4.3
Seal mortality and extinction	Impact of oil production (and seismic survey) on the seal death rate.		•			✓	✓	Section 6.2.7.8
Gas production	Why can the gas from the developments not be provided to the Azerbaijan national grid, rather than sold overseas (or injected offshore)?		•	•		✓		Section 5.5.1.4
Landscape and visual impact	Effects on the landscape from the terminal and wind dynamics.		•		•	✓	✓	Section 10.4.7

Issue	Concern	Issues Raised By:				During:		Section Addressed
		Regulator	Academics/ Scientists	NGOs	Individuals	Scoping	Disclosure	
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.		•			✓		Section 7.6.10 Section 11.4.8 Section 15.11
Waste Management	Groundwater contamination from waste landfill. Lack of waste management infrastructure in Azerbaijan. Concern about radioactive wastes and radioactive hazards. Cuttings treatment and disposal onshore.		•	•		✓	✓	Section 5.10 Section 10.5 Section 14.3.2
Cumulative impacts.	Cumulative impacts from other activities should be included in the ESIA.			•		✓		Chapter 12
Health and Safety on the platform	Distance on the platform between the living quarters and the drilling/production ops and safety to personnel.		•	•		✓		Section 5.4.1 Section 5.5.2
Traffic	Overloading of the existing transport infrastructure.			•			✓	Section 5.8 Section 11.4.4 Section 11.4.7 Section 15.9
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.	•		•	•	✓	✓	Section 5.7.4.9
Benefits to Azerbaijan	How will the population benefit? Will a refining industry be developed in Azerbaijan for the produced oil and gas?		•	•		✓		Executive Summary Section 4.2 Chapter 16
Access to Information	Ensure easy access to information with respect to the activities and to monitoring of the activities.		•	•	•	✓	✓	Chapter 8

Issue	Concern	Issues Raised By:				During:		Section Addressed
		Regulator	Academics/ Scientists	NGOs	Individuals	Scoping	Disclosure	
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.		•			✓	✓	Section 11.4.2 Section 15.4
Sustainable development	More attention to be paid to Social aspects.		•			✓		Section 15.1.1 Section 15.10
Fishing	Disruption and possible pollution.		•	•	•	✓	✓	Section 10.3.2 Section 11.4.3.2 Section 15.4
Compensation	Will AIOC compensate fishermen for losses incurred due to the project, similar to the situation in the North Sea and other regions?			•	•	✓	✓	Section 11.4.2 Section 15.4
Decommissioning	Programmes to address decommissioning at the end of field life. Loss of jobs.			•			✓	Section 5.9 Section 10.7
ESIA methodology	Methods and criteria used in the impact assessment.			•				Chapter 3. Section 10.1. Section 11.1.
Azeri translation of the ESIA	Request to submit the ESIA in English, Russian and Azeri languages.			•		✓		N/A

Issue	Concern	Issues Raised By:				During:		Section Addressed
		Regulator	Academics/ Scientists	NGOs	Individuals	Scoping	Disclosure	
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.				•	✓	✓	Section 5.4.3 Section 5.5.3 Section 5.7.2 Section 5.7.3.3 Section 5.7.4.7 Section 11.4.9 Section 11.5 Section 15.1.1 Section 15.6
Terminal construction camp.	The number of workers at the camp.				•		✓	Section 5.7.3.2 Section 11.4.4.1 Section 15.6.2
Training	Concern over the skills base required to get a job. There is a need to train local people in Azerbaijan.				•	✓	✓	Section 11.4.9 Section 15.6
Social investment	Investment in the Sangachal area required. What social investment plans does AIOC have?				•	✓	✓	Section 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 for 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 Section 2);
- the environmental baseline (see Section 6);
- the socio-economic baseline (see Section 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 focussed 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 every community and/or stakeholder concern.

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	Air quality in and around the proposed project offshore development sites.
	Global atmosphere and gases with a Global Warming Potential (GWP)
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	Air quality in and around the proposed project onshore development sites.
	Global atmosphere and gases with a Global Warming Potential (GWP)
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 population (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.
Community Infrastructure	The buildings and infrastructure (e.g. schools, hospitals, community halls) provided by government for use by the local community.

Environmental Receptor	Comment
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 aspect.

The completed environmental and socio-economic aspect matrices are presented at Tables 9.2 –9.5.

Following the completion of the environmental 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 Section 3. The results of the impact assessment process are presented in Sections 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 / Cutural 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	SPS yard upgrade											●		●		●													●	●				●	●	●		●	
	SPS yard facilities/services/utilities operations											●																	●						●			●	
	SPS yard power generation																																						
	Fabrication and construction operations (jackets; drilling template)											●																	●	●				●	●	●		●	
	PDQ and C&WP topsides assembly and/or construction											●																	●	●				●	●	●		●	

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 / Cutural 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																												●	●		●	●		●	●		●	
	Testing and commissioning of integrated deck											●																	●									●	
	Demobilisation																												●	●			●						
Installation and Commissioning	Tow out and launch of jackets, drilling template (including vessel operations)	●	●	●								●														●	●			●								●	
	Piling of jackets and drilling template	●	●	●			●			●	●															●	●			●								●	
	Tow topsides to offshore location and floatover; PDQ, C&WP (including vessel 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 / Cutural 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
	Install bridge link (DPQ to C&PW) (including vessel operations)	●	●																							●	●			●								●	
	Modifications to Chirag topsides and installation of riser (including vessel operations)	●	●																							●	●			●								●	
	Commissioning																																						
Drilling	Mobilisation of the Dada Gorgud for pre-template and template wells (including vessel operations)	●	●	●																						●	●			●								●	
	Dada Gorgud utilities operation (sewage, drainage fire water, potable water)	●	●																											●								●	

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 / Cutural 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
Dada Gorgud power generation	●																												●								●	
Dada Gorgud drilling of pre-template well and template wells - 36" and 26" sections; discharge drilling fluids (WBM) and cuttings	●	●	●		●	●	●	●																					●								●	
Dada Gorgud drilling of pre-template well and template wells lower hole sections	●	●	●	●	●																								●								●	
Dada Gorgud cooling water discharge	●	●	●		●	●	●		●																													
Dada Gorgud cuttings re-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 / Cutural 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
	Well testing fluid disposal (to flare)	●	●	●						●	●																			●								●	
	Platform driving of 30" conductor and drilling of 26" section; discharge drilling fluids (WBM) and cuttings	●	●	●	●	●	●	●	●																					●								●	
	Platform drilling of lower hole sections	●	●		▪	▪						▪				▪														●								●	
	Cement pump / cementing	●	●	●					●																					●								●	
Production	Presence of platform facilities offshore	●	●	●		●	●	●	●	●	●															●	●			●						●		●	
	C&WP gas compression	●																																					

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 / Cutural 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
PDQ and C&WP utilities operation (sewage, drainage, fire water, potable water)	●	●			●	●																																
PDQ and C&WP power generation	●																																					
PDQ and C&WP cooling water discharge	●	●	●		●	●	●		●																													
Produced water generation treatment and disposal overboard (as required)	●	●			●	●	●																															
Routine flaring	●								●	●																												
Planned non-routine flaring	●																																					

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 / Cutural 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	●	●																																				
	Corrosion protection		●	●										●																									
	Helicopter operations	●									●	●										●							●	●								●	
	Vessel supply and backload (including waste transfer)	●	●									●														●	●			●					●			●	
Potential Accidental Events	Vessel collision (resulting in a spill)	●	●	●		●	●	●		●	●	●	●									●	●			●	●		●								●		●
	Loss of facilities during transfer to offshore location		●	●					●																	●	●							●		●			●

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 / Cutural 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	●	●	●																																			
Blow-out at well-head during drilling operations; pipeline rupture	●	●	●		●	●	●	●	●	●	●	●							●		●	●			●	●		●		●	●	●	●		●	●		●
Loss of NWBM over board		●	●		●	●		●																														
Chemical spill		●			●	●																																
Extinguishing flare/flare failure	●																																					
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 / Cutural 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)	●	●	●		●	●	●	●	●	●																									●			●
Loss of integrity of cuttings disposal well			●	●																															●			
Earthquake/other tectonic event resulting in loss of offshore facilities	●	●	●		●	●	●	●	●	●																									●			

Table 9.3 Environmental and socio-economic aspects – subsea pipelines

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
Pipe laydown area in Azerbaijan	Yard facilities/services/utilities operations										
	Transportation to / from yard										
Installation onshore (landfall to Sangachal)	Onshore works preparation										
	Pipeline trench construction										
	Pipe-laying onshore										
	Pipeline crossings of existing onshore services										
Installation Coastal/ Nearshore	Site works preparation for beach pull (onshore)	●									●
	Construction of landfall	●	●								●

ACTIVITY		Coastal / Terrestrial – Physical: Atmosphere	Coastline	Soil	Groundwater / Aquifers	Surface Water	Hydrological Systems	Subsurface Geology	Landscape / Topography	Coastal / Terrestrial – Biological: Coastal Habitat / Flora	Terrestrial Habitat / Flora	Terrestrial / Coastal Birds	Reptiles / Amphibians	Mammals
Pipe laydown area in Azerbaijan	Yard facilities/services/utilities operations	●												
	Transportation to / from yard	●												
Installation onshore (landfall to Sangachal)	Onshore works preparation	●		●		●	●		●	●	●	●	●	●
	Pipeline trench construction	●	●	●	●	●	●		●	●	●	●	●	●
	Pipe-laying onshore	●		●						●	●	●	●	●
	Pipeline crossings of existing onshore services	●												
Installation Coastal/ Nearshore	Site works preparation for beach pull (onshore)	●	●							●	●	●	●	●
	Construction of landfall	●	●							●	●	●	●	●

ACTIVITY		Socio-Economic: 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	Other: Government Revenue	Transboundary	International Procurement	Liability / Reputation
Pipe laydown area in Azerbaijan	Yard facilities/services/utilities operations					●	●					●			●	
	Transportation to / from yard					●										
Installation onshore (landfall to Sangachal)	Onshore works preparation	●			●	●	●			●		●			●	
	Pipeline trench construction	●			●	●	●			●		●			●	
	Pipe-laying onshore				●	●	●			●		●			●	
	Pipeline crossings of existing onshore services				●	●	●	●		●		●			●	
Installation Coastal/ Nearshore	Site works preparation for beach pull (onshore)	●	●		●	●	●					●			●	
	Construction of landfall	●	●		●	●	●					●			●	

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
	Construction of finger pier(s)	●	●	●			●	●	●		●	●	●												●	●		●	●	●					●			●	
	Construction of nearshore trench	●	●	●		●	●	●	●		●	●														●				●					●			●	
	Pipe-laying in the nearshore (including vessel operations)	●	●	●			●	●	●		●	●														●	●		●	●					●			●	
Installation Offshore	Preparation for pipeline crossings (and mud channel crossings) - install stabilisation mattresses	●	●	●				●	●																	●	●			●					●			●	
	Pipe-laying (including vessel operations; anchor drag)	●	●	●				●	●																	●	●			●					●			●	
	Rectification of freespans	●	●	●				●	●																	●	●			●					●			●	
	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	Oils and Gas Infrastructure	National Industrial Base	Government Revenue	Transboundary	International Procurement	Liability / Reputation
	Material and equipment supply (including vessel operations)	●	●	●								●														●	●			●					●			●	
Hook-up and Commissioning	Tie in of pipelines to PDQ, C&WP, Chirag	●	●	●																						●	●											●	
	Diving operations (DSV on site)	●	●	●																						●	●			●					●			●	
Operations and Maintenance	Pipelines operation (presence)						●			●																				●					●	●		●	
	ROV check (including vessel operations)	●	●									●														●	●			●					●			●	
	Corrosion protection		●																											●									
Potential Accidental Events	Vessel collision (resulting in a spill)	●	●	●		●	●	●		●	●	●	●									●	●			●	●		●								●		●
	Hydrate formation in pipelines	●																																					
	Oil pipeline leak (>100 but <1,000 tonnes)		●			●	●						●							●		●																	●

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
Gas pipeline leak	●	●	·	·	●	●	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	●	·	·	●
Loss of entire 30" oil line inventory	●	●	●	·	●	●	●	●	●	●	●	●	·	·	●	·	·	·	●	·	●	·	·	·	●	●	·	·	·	·	·	·	·	·	●	·	·	●

Table 9.4 Environmental and socio-economic aspects – onshore

		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
RECEPTORS / **ACTIVITY**		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 Commissionin	Land acquisition and tenure																											●	●		●	●							
	Ground clearance and grading											●		●		●	●		●		●	●	●	●	●			●	●	●	●		●		●				
	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											●		●		●	●		●		●	●	●	●				●	●	●			●		●			●	
	Mobilisation of workforce																												●	●		●	●		●			●	

RECEPTORS		Marine										Coastal / Terrestrial													Socio-Economic											Other			
		Physical				Biological						Physical								Biological																			
ACTIVITY		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
	Construction site facilities/services/utilities/operations		●									●																	●	●	●				●			●	
	Terminal construction (including underground, foundations, buildings)											●		●	●	●	●	●	●		●	●	●	●				●	●	●			●					●	
	Demobilisation																												●	●			●						
	Commissioning											●																		●								●	
Operations and Maintenance	Process facilities (physical presence)											●										●	●	●						●					●	●		●	
	Oil storage											●																											
	Produced water storage											●																											
	Gas compression and refrigeration											●																											
	H2S treatment (if required)											●									●	●							●										

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
	Chemical injection											●																											
	Utilities operation (sewage, drainage fire water, potable water)		●									●										●	●	●															
	Power generation											●									●																		
	Routine flaring (pilot light)											●									●	●							●										
	Non-routine flaring											●										●																	
	Fire system tests											●																											
Waste	Produced water (and hydrotest water) disposal via re-injection onshore at Lokbatan											●			●			●											●	●					●			●	
Waste	Produced water (and hydrotest water) disposal at Garadag Cement Plant											●																	●	●			●		●			●	

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
Potential Accidental Events	Extinguishing of flare/flare failure											●																	●										●
	Loss of integrity of water disposal well														●			●											●					●					●
	Fire / explosion											●		●							●	●	●	●					●		●			●					●
	Loss of oil storage inventory											●		●	●	●					●	●	●	●					●							●			●
	Earthquake after tectonic event 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

Section 3.6 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 were 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 Section 3.6, 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 ACG Phase 1 Project, little data pertaining to the Caspian and broader Azeri 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.

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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;
- Table 10.7: Environmental impact significance – transportation; and
- Table 10.8: Environmental impact significance – decommissioning.

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 summarised above and in detail in Chapter 3. Socio-economic impacts are addressed in Chapter 11.

Table 10.4 Environmental impact significance – offshore

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Comments
		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	SPS yard upgrade											5		5		5									Emissions; noise; surface runoff
	SPS yard facilities/services/ utilities operations											5													Emissions; noise
	SPS yard power generation											5													Emissions; noise
	Fabrication and construction operations (jackets; drilling template)											5													Emissions; noise
	PDQ and C&WP topsides assembly and/or construction											5													Emissions; noise
	Mobilisation of workforce																								No environmental impact
	Testing and commissioning of integrated deck											5													Emissions; noise

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Comments
		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	
	Demobilisation																								No environmental impact
Installation and Commissioning	Tow out and launch of jackets, drilling template (including vessel operations)	5	5	5								5													Emissions; discharges; noise
	Piling of jackets and drilling template	5	5	5			5			5	5														Emissions; noise; physical disturbance
	Tow topsides to offshore location and floatover; PDQ, C&WP (including vessel operations)	5	5	5								5													Emissions; discharges; noise
	Install bridge link (DPQ to C&PW) (including vessel operations)	5	5																						Emissions; discharges; noise
	Modifications to Chirag topsides and installation of riser (including vessel operations)	5	5																						Emissions; discharges
	Commissioning	5	5																						Emissions; discharges
Drilling	Mobilisation of the Dada Gorgud for pre-template and template wells (including vessel operations)	5	5	5																					Emissions; discharges; noise & physical disturbances

RECEPTORS / ACTIVITY	Marine										Coastal / Terrestrial													Comments
	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	
Dada Gorgud utilities operation (sewage, drainage fire water, potable water)	5	5																						Emissions; discharges; noise
Dada Gorgud power generation	5																							Emissions; noise
Dada Gorgud drilling of pre-template well and template wells - 36" and 26" sections; discharge drilling fluids (WBM) and cuttings	5	5	5		5	5	5	10																Emissions; oil fall out
Dada Gorgud drilling of pre-template well and template wells lower hole sections	5	5	5	5	5																			Physical disturbance; noise
Dada Gorgud cooling water discharge	5	5	5		5	5	5		5															Emissions; thermal and chemical plume
Dada Gorgud cuttings re-injection	5			5																				Emissions; disposal of cuttings into subsurface fractures
Well testing fluid disposal (to flare)	5	5	5						5	5														Emissions; oil fall out

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Comments
		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	
	Platform driving of 30" conductor and drilling of 26" section; discharge drilling fluids (WBM) and cuttings	5	5	5	5	5	5	5	10																Emissions; cuttings and drilling fluids; noise; stakeholder concern
	Platform drilling of lower hole sections	5	5		5																				Physical disturbance; noise
	Cement pump / cementing	5	5	5					5																Emissions; physical disturbance
Production	Presence of platform facilities offshore	5	5	5		5	5	5	5	5	5														Emissions; noise; heat
	C&WP gas, drives gas compression	10																							Physical disturbance
	PDQ and C&WP utilities operation (sewage, drainage, fire water, potable water)	5	5			5	5																		Emissions; discharges; noise
	PDQ and C&WP power generation	10																							Emissions
	PDQ and C&WP cooling water discharge	5	5	5		5	5	5		5															Discharge; temperature; antifoulant

RECEPTORS / ACTIVITY	Marine										Coastal / Terrestrial															Comments
	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			
PDQ cuttings re-injection	5			5																						Disposal of cuttings into subsurface fractures
Produced water generation treatment and disposal overboard (as required)	5	5			5	5	5																			Discharges; contaminant plume; stakeholder concern
Routine flaring	5								5	5																Emissions; stakeholder concern
Planned non-routine flaring	10																									Greenhouse gas emissions
Fire system tests	5	5																								Discharges
Corrosion protection		5	5										5													Emissions
Helicopter operations	5									5	5										5					Emissions; noise
Vessel supply and backload (including waste transfer)	5	5									5															Emissions; discharges; physical disturbance

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Comments
		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	
Potential Accidental Events	Introduction of exotic marine organisms			5		6	6	6	6																Alteration to existing marine biological community structure
	Vessel collision (resulting in a spill)	6	6	6		6	6	6		6	6	6	6									6	6		Fuel spill; contamination; physical disturbance
	Loss of facilities during transfer to offshore location		2	2					2																Contamination; physical disturbance
	Encounter shallow gas during drilling	4	4	4																					Emissions; discharges
	Blow-out at well-head during drilling operations; pipeline rupture	6	10	10		10	10	10	10	10	10	6	10							10		10	6		Oil spill; contamination; physical impacts
	Loss of NWBM over board		4	4		4	4		4																Chemical contamination
	Chemical spill		4			4	4																		Chemical contamination
	Extinguishing flare/flare failure	3																							Emissions

RECEPTORS / ACTIVITY	Marine										Coastal / Terrestrial														Comments
	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	
Loss of fuel inventory (diesel spill) or spill during fuel transfer	6	6			6	6				6														Fuel spill; contamination
Loss of containment (fire, explosion)	8	8	8		8	8	8	8	8	8														Fuel and chemical spills; emissions
Loss of integrity of cuttings disposal well			4	4																				Loss of produced water into subsurface aquifers; possible seismic event
Earthquake/other tectonic event resulting in loss of offshore facilities	5	5	5		5	5	5	5	5	5														Fuel chemical spill; emissions

Table 10.5 Environmental impact significance – subsea pipelines

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Comments
		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 laydown area in Azerbaijan	Yard facilities/services/utilities operations											5													Emissions; noise
	Transportation to / from yard											5													Emissions
Installation onshore (landfall to Sangachal)	Onshore works preparation											5		5		5	5		5	5	5	5	5	5	Emissions; noise; surface runoff; loss of habitat
	Pipeline trench construction											5	5	5	5	5	5		5	10	10	5	10	5	Emissions; noise; physical disturbance; loss of habitat
	Pipelaying onshore											5		5						5	5	5	5	5	Emissions; noise; physical disturbance
	Pipeline crossings of existing onshore services											5													Emissions; noise; physical disturbance
Installation Coastal/ Nearshore	Site works preparation for beach pull (onshore)	5									5	5	5							5	5	5	5	5	Emissions; noise; physical disturbance
	Construction of landfall	5	5								5	5	5							5	5	5	5	5	Emissions; noise; physical disturbance; loss of habitat
	Construction of finger pier(s)	5	5	5			5	10	10		5	5	10												Emissions; noise; physical disturbance; loss of habitat
	Construction of nearshore trench	5	5	10		5	5	10	10		5	5													Emissions; noise; physical disturbance; loss of habitat

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Comments
		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	
	Pipelaying in the nearshore (including vessel operations)	5	5	5			5	5	5		5	5													Emissions; noise; discharges; loss of habitat
Installation Offshore	Preparation for pipeline crossings (and mud channel crossings) - install stabilisation mattresses	5	5	5				5	5																Emissions; noise; physical disturbance
	Pipe-laying (including vessel operations; anchor drag)	5	5	5				5	5																Emissions; noise; physical disturbance
	Rectification of freespans	5	5	5				5	5																Emissions; noise; physical disturbance
	Helicopter operations	5									5	5										5			Emissions; noise
	Material and equipment supply (including vessel operations)	5	5	5								5													Emissions; discharges; physical disturbance
Hook-up and Commissioning	Tie in of pipelines to PDQ, C&WP, Chirag	5	5	5																					Emissions; physical disturbance
	Diving operations (DSV on site)	5	5	5																					Emissions; physical disturbance
Operations and Maintenance	Pipelines operation (presence)						5			5															Emissions
	ROV check (including vessel operations)	5	5									5													Emissions; noise; physical disturbance
	Corrosion protection		5																						Emissions

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Comments
		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	
Potential Accidental Events	Vessel collision (resulting in a spill)	6	6	6		6	6	6		6	6	6	6									6	6		Fuel spill; contamination; physical disturbances
	Hydrate formation in pipelines	2																							Oil spill; emissions
	Oil pipeline leak (>100 but <1,000 tonnes)		4			4	4						6							6		6			Oil spill; Emissions; stakeholder concern
	Gas pipeline leak	4	4			4	4																		Emissions; stakeholder concerns
	Loss of entire 30" oil line inventory	4	4	4		6	6	4	4	6	8	4	4			4				8		8			Oil spill; emissions; stakeholder concern

Table 10.6 Environmental impact significance – onshore terminal

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Comments
		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																								No environmental impact
	Ground clearance and grading											5		10		5	5		5		10	15	15	5	Emissions; surface runoff; physical disturbance
	Modification of existing services											5													Stakeholder concern; discharges
	Excavation of drainage channel; construction of bund wall and security dyke											5		10	5	10	10		5		10	5	5	5	Physical disturbance; emissions
	Construction of fencing and perimeter lighting											5							5						Physical disturbance
	Construction of access road and railway crossing											5		5		5	5		5		10	5	5	5	Physical disturbance; stakeholder concern
	Mobilisation of workforce																								No environmental impact
	Construction site facilities/services/utilities/operations		5									5													Physical disturbance; surface water runoff
	Power generation											5													Emissions; noise
	Terminal construction (including underground, foundations, buildings)											5		5	5	5	5	5	5		5	5	5	5	Physical disturbance

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Comments
		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	
	Demobilisation																								No environmental impact
	Commissioning											5													Emissions; noise
Operations and Maintenance	Process facilities (physical presence)											5										5	5	5	Emissions; noise; visual
	Oil storage											5													Emissions
	Produced water storage											5													Emissions; discharges
	Gas compression and refrigeration											5													Emissions
	H2S treatment (if required)											5									5	5			Emissions;
	Chemical injection											5													Emissions
	Utilities operation (sewage, drainage fire water, potable water)		5									5										5	5	5	Emissions; discharges; noise
	Power generation											10									5				Emissions; noise
	Routine flaring (pilot light)											5									5	5			Emissions; noise; visual
	Planned non-routine flaring											10										5			Emissions; discharges; stakeholder concern

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Comments
		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	
	Fire system tests											5													Emissions; discharges
Waste	Produced water (and hydrotest water) disposal via re-injection onshore at Lokbatan											5			5			5							Emissions; physical disturbance
	Produced water (and hydrotest water) disposal at Garadag Cement Plant											5													Emissions
Potential Accidental Events	Extinguishing of flare/flare failure											6													Emissions
	Loss of integrity of water disposal well														4			4							Emissions; physical disturbance; discharges
	Fire / explosion											3		3							3	3	3	3	Emissions
	Loss of oil storage inventory											4		6	6	6					6	6	4	8	Oil spill; contaminated surface runoff
	Earthquake after tectonic event resulting in loss of inventory											6		4	4	4					6	6	6	6	Fuel chemical spill; emissions

Table 10.7 Environmental impact significance – transportation

RECEPTORS / ACTIVITY		Marine										Coastal / Terrestrial													Comments
		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													Emissions; discharges; noise
	Rail Transport											5													Emissions; noise
	Road Freight											5													Emissions; noise
Accidental Events	Introduction of exotic marine organisms		5		5	5	5	5	5																Emissions; noise

10.2.2 Summary of impact assessment results

The ACG Phase 1 project has been assessed as having the potential to cause 35 impacts of "high" significance. 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" or "Critical" Significance Impacts	Environmental Receptors	Contributing Activities
Offshore	15	2	5
Subsea Pipelines	9	7	3
Terminal	11	7	5
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 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

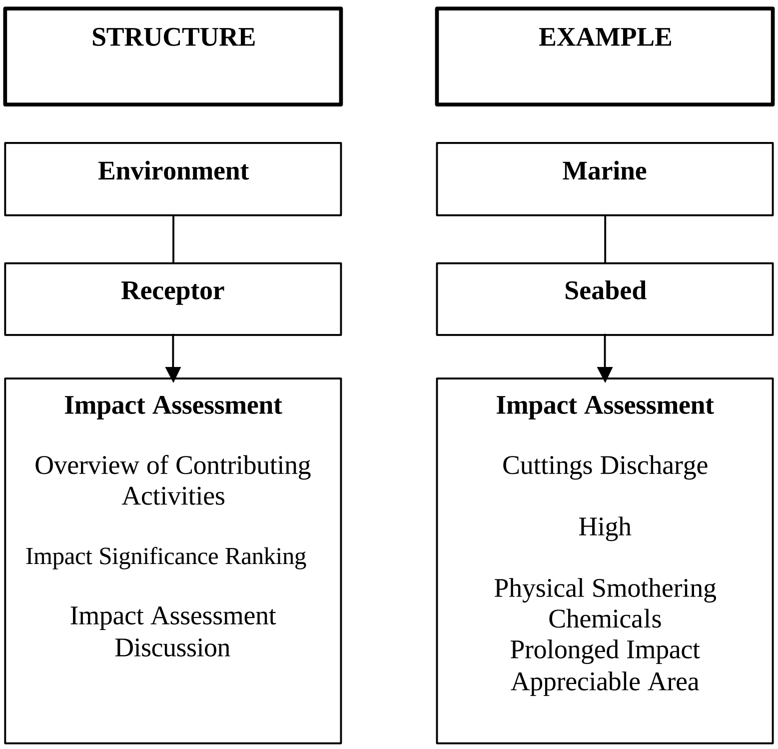


Figure 10.2 illustates the structure of this Chapter.

Figure 10.2 Structure of environmental impact assessment chapter

Impacts on offshore environmental receptors (Section 10.3)

- Impacts to offshore atmosphere (Section 10.3.1)
- Impacts on seawater and seawater biology (Section 10.3.2)
- Impacts on seabed and benthos (Section 10.3.3)
- Impacts on offshore subsurface geology (Section 10.3.4)

Impacts on onshore environmental receptors (Section 10.4)

- Impacts to onshore atmosphere (Section 10.4.1)
- Impacts on the (physical) coastline (Section 10.4.2)
- Impacts on soils (Section 10.4.3)
- Impacts on groundwater and aquifers (Section 10.4.4)
- Impacts on hydrological systems and flows (Section 10.4.5)
- Impacts on subsurface geology (Section 10.4.6)
- Impacts on topography and landscape (Section 10.4.7)
- Impacts on coastal habitat, flora and fauna (Section 10.4.7)
- Impacts on terrestrial habitat, flora and fauna (Section 10.4.7)

Continued on next page

Figure 10.2 Structure of environmental impact assessment chapter (continued)

Impacts associated with waste management (Section 10.5)

- ACG waste management criteria (Section 10.5.1)
- Approach to waste management (Section 10.5.2)
- Implications of waste management strategy (Section 10.5.3)
- Summary (Section 10.5.4)

Impacts from accidental events (Section 10.6)

- Oil and chemical spills (Section 10.6.1)
- Loss of control of re-injection wells (Section 10.6.2)
- Seismic events (Section 10.6.3)
- Introduced species (Section 10.6.4)

Impacts associated with decommissioning (Section 10.7)

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 routine and planned non-routine Phase 1 project activities. The offshore environment includes the nearshore zone in which subsea pipeline 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 offshore subsurface geology.

All potential impacts are discussed whether significant or otherwise to ensure that all Phase 1 offshore activities have been appropriately assessed. Greater emphasis has been given to the activities that have been assessed to potentially result in more significant impacts.

10.3.1 Impacts on offshore atmosphere

There are a number of sources of emissions to the offshore atmosphere resulting from Phase 1 project activities. Contributing activities include:

- transportation of project components from overseas;
- the template well drilling programme;
- installation of the project pipelines offshore;
- installation of the offshore facilities; and
- platform operations.

The project activities are described in the Project Description (Chapter 5) along with the estimated emission quantities from these activities.

Atmospheric emissions from these activities comprise carbon dioxide (CO_2), methane (CH_4), oxides of nitrogen (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO) and volatile organic compounds (VOCs).

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 the so-called "greenhouse gases" (primarily CO_2 and CH_4) in excessive quantities, contribute 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.

The environmental fate and effect of other gaseous species that would be generated by Phase 1 activities are presented in Table 10.9.

Table 10.9 Environmental impacts of atmospheric releases

Emission	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 which 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 the sunlit atmosphere. NO is a relatively innocuous species, but is of interest as a pre-cursor of NO_2
Sulphur dioxide (SO_2)	SO_2 is a toxic gas, and is known to contribute to acid deposition (wet and dry) which may impact both freshwater and terrestrial ecosystems. 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.

10.3.1.1 Transportation and installation activities

Emissions to the atmosphere from the pipeline and offshore facilities installation activities and transportation of materials into Azerbaijan principally originate from vessel engine and power generation exhaust emissions resulting from the combustion of diesel fuel.

Impact Significance

As detailed in the Project Description (Chapter 5), estimated quantities measured for these activities were found to be relatively low. Notably, the emission sources are mobile and the duration of emissions is relatively short. It is considered that these emissions would be readily dispersed over a wide geographic area and hence, the impact significance associated with emission source activities 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

10.3.1.2 Template well drilling program

Atmospheric emissions from vessel exhausts would also occur during the transfer of the Dada Gorgud drilling rig and during the drilling programme as well as from associated vessel support and supply activities. Additional activities that would result in emissions to the atmosphere would include:

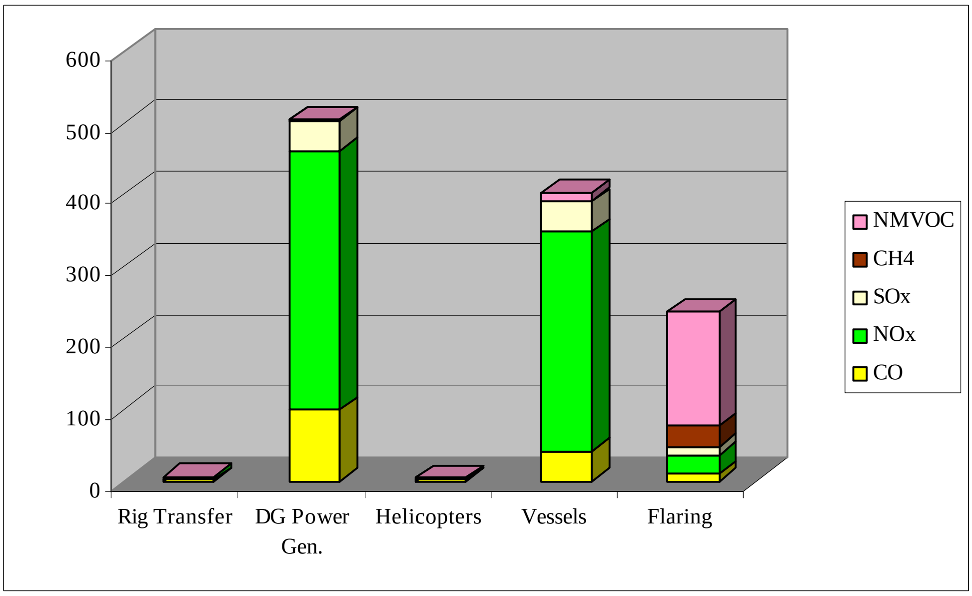
- helicopter exhaust emissions during the transport of personnel;
- power generation combustion emissions from supply and standby vessels;
- power generation combustion emissions from the drilling rig; and

- flaring of hydrocarbons generated during the well test programme.

Fugitive emissions to the atmosphere from the rig facilities such as fuel storage tanks, bulk materials transfer operations and surface mud pits would also be expected but are considered to be negligible.

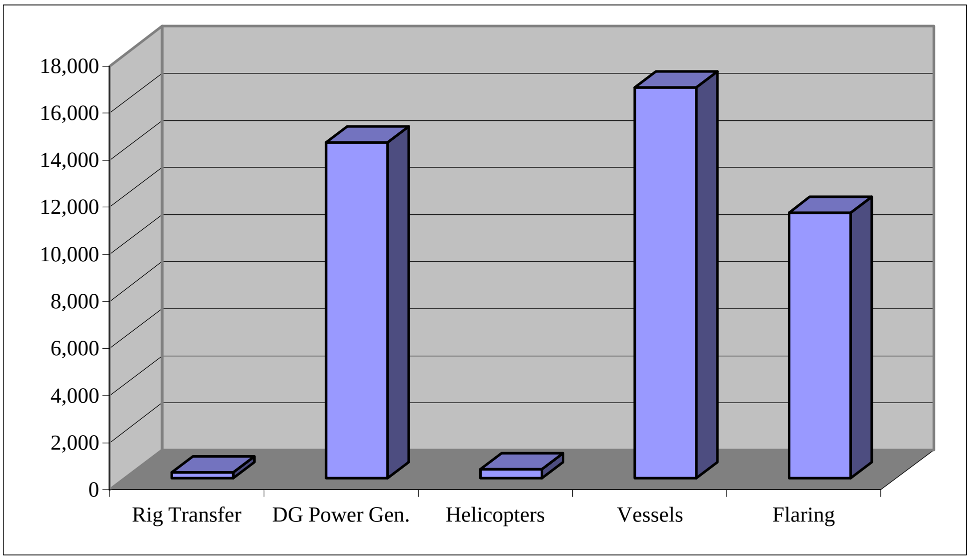
The levels of each gaseous species emitted from each of the activities over the whole period of the template well drilling programme are shown in Figure 10.3a and 10.3b. Figures are based on a maximum time-frame of 64 days for each well for a total of 9 wells (average of the anticipated 8 to 10 wells that would be drilled during the programme).

Figure 10.3a Sources and contribution of estimated atmospheric emissions by species (excluding CO_2) during the template well drilling programme (tonnes)



NMVOC-non-methane volatile organic compounds

Figure 10.3b Estimated CO_2 emissions during the template well drilling programme (tonnes)



Power generation turbine exhaust emissions and exhaust emissions from the support and supply vessels would be the main sources of atmospheric emissions from the template well drilling programme. Vessel emissions would result from a support vessel on standby alongside the rig for the duration of the drilling programme and inputs would also occur as a result of supply vessels travelling between the shore and the rig.

Drilling rig power generation emissions would remain relatively constant throughout the drilling periods and would result through the use of diesel generators.

The hydrocarbons burned following the three planned well tests would also result in a high proportion contribution of atmospheric emissions. Three separate flaring events are planned. Each event would be short-lived with up to 10,000 barrels of oil being flared over a period of 36 hours following each test.

Impact significance

Apart from the drilling rig and vessel personnel, there would be no sensitive human receptors in the vicinity of the drilling location that could be potentially adversely affected by atmospheric emissions. Wind and natural atmospheric circulation would rapidly disperse the emissions. Highest concentrations of emissions at and near to the rig would be expected during hydrocarbon flaring events after well testing and minor localised reductions in air quality could be expected. Due to the very short-lived nature of these flaring activities and the anticipated rapid and comprehensive dispersion of emissions, adverse effects on the health of the rig and vessel personnel in the area are not anticipated. Marine fauna are not expected to be at risk from the atmospheric emissions generated. It is expected that sea level concentrations at the drilling site would be below international guideline levels for each emission species.

Overall, given that atmospheric emissions would be readily dispersed, the significance of impacts on the offshore atmosphere resulting from the release of emissions during these activities 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

The considerable distance of the offshore operations from the shore would mean that no deterioration in onshore air quality would result.

10.3.1.3 Platform operations

Platform operations would include drilling and production from the PDQ and, approximately one year later, gas compression and water treatment from the C&WP. The principal sources of emissions to the atmosphere would include:

- platform power generation turbines;
- gas driven gas compressors;
- flaring;
- support and supply vessels, helicopters;
- other diesel engines (emergency, generator, platform cranes etc); and
- fugitive emissions.

The estimated emission quantities by species from each of the activities over the whole period of the PSA are shown in Figure 10.4a and 10.4b.

Figure 10.4a Estimated total emission quantities by species (excluding CO_2) from routine and planned non-routine operations at the the PDQ and C&WP (tonnes)

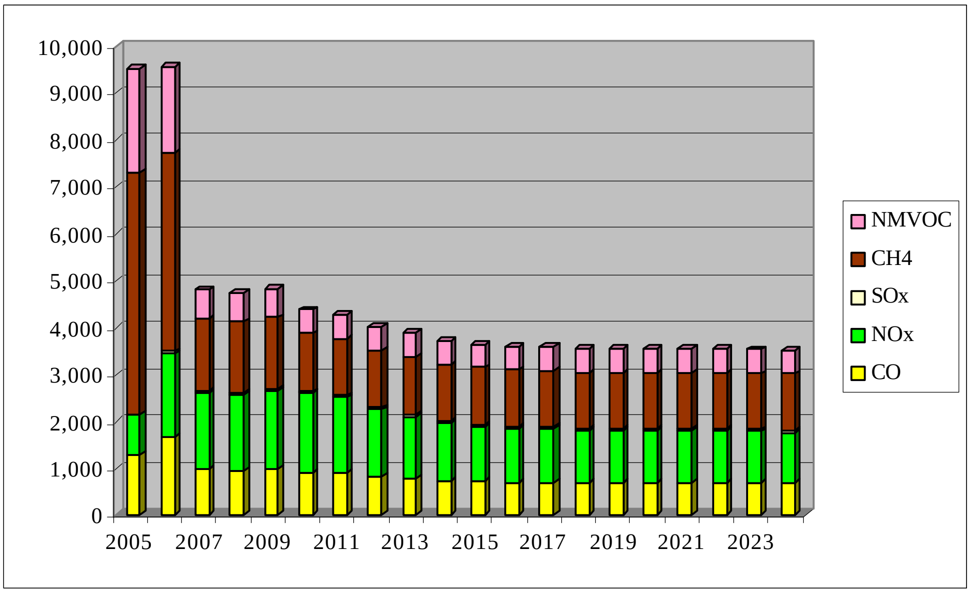
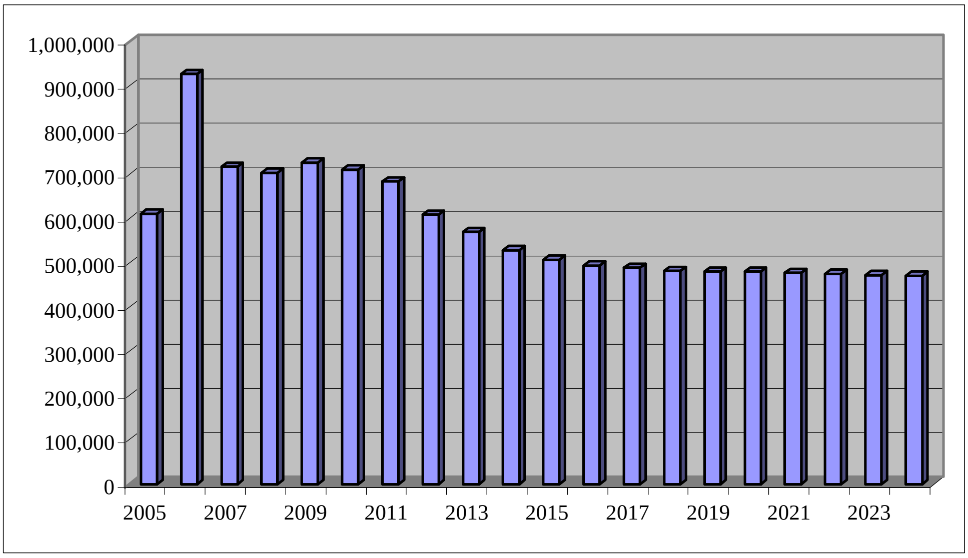


Figure 10.4b Estimated total CO_2 emission quantities from routine and planned non-routine operations at the PDQ and C&WP (tonnes)



Principle contributors to the total emissions from platform operations are the two power generation gas turbines onboard the PDQ and the single gas turbine generator on the C&WP that supply all of the platforms' power requirements. Peak electrical load would be through drilling operations during approximately the first 10 years of operations. Beyond this time, power requirements would be less and would remain fairly constant. Fuel gas, which has a high fuel efficiency in comparison to diesel, would be the principal fuel used for power generation. Fuel gas produces less emissions per unit of energy produced in comparison to other fuels such as diesel. The gas turbines would have dual fuel capability; that is, diesel could be used as a back-up fuel in the event of the loss of gas. An emergency back-up stand-alone diesel generator would also be provided on the PDQ topsides.

Other main contributors to atmospheric emissions would be the two gas turbine driven gas injection compressors onboard the C&WP. These compressors would be used for compression of gas for re-injection down-hole for reservoir maintenance purposes and for gas lift required to promote production flow of the oil. Compressors for produced water re-injection would also be a contributor.

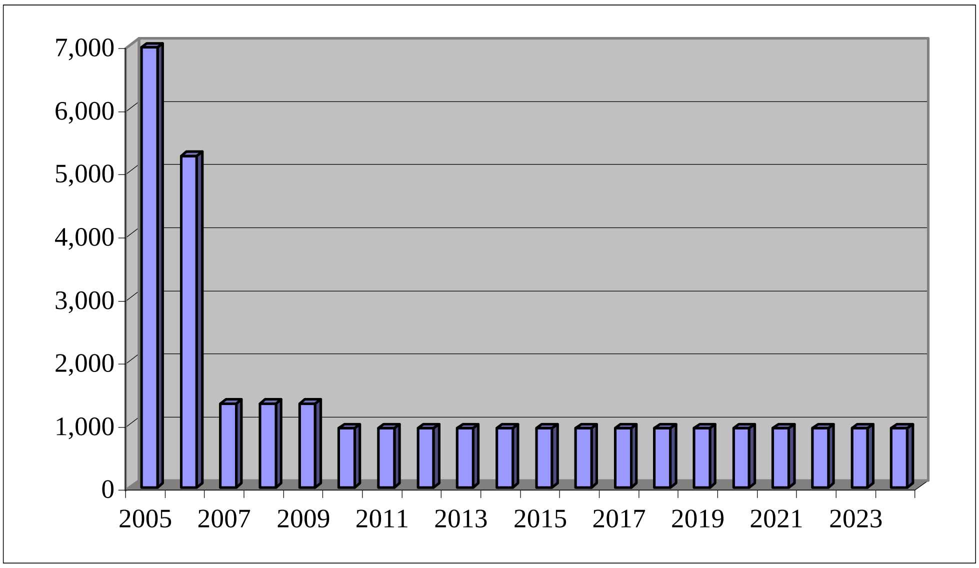
There would be no routine flaring offshore for production purposes. Associated gas would be used as fuel gas onboard the platforms and for gas injection purposes for reservoir pressure maintenance. The remainder will be sent to shore for fuel gas for the terminal facilities and export to SOCAR.

Routine flaring emissions would result from the conventional lit pilot on the flare and purge gas made-up of internal seal and valve hydrocarbon leaks. The total amount of routinely flared gas would amount to 1 MMscfd from the PDQ rising to 2 MMscfd when the C&WP is installed approximately one year later. Emissions from routinely flared gas would relatively low in comparison to emissions from the power generation and gas compression packages.

In the early years of offshore operations, non-routine flaring would result during times of plant unavailability and during commissioning and start-up problems both offshore and/or onshore. Plant availability figures based on previous experience of similar operations in other parts of the world have been estimated as 70% in year 1 and 82% in year 2 (following the C&WP installation). Flaring quantities, although significant, would be expected to be short-lived with the majority of flaring of gas expected to occur in the early days of each year following the installation of the facilities. The plant design availability target for offshore and onshore facilities is set at 95%, hence flaring quantities would reduce with 95% availability expected to be achieved by year 3 and maintained thereafter. Emissions shown in Figures 10.4a and 10.4b above include these anticipated non-routine flaring events which represent a significant contribution to the overall emissions from the platform operations.

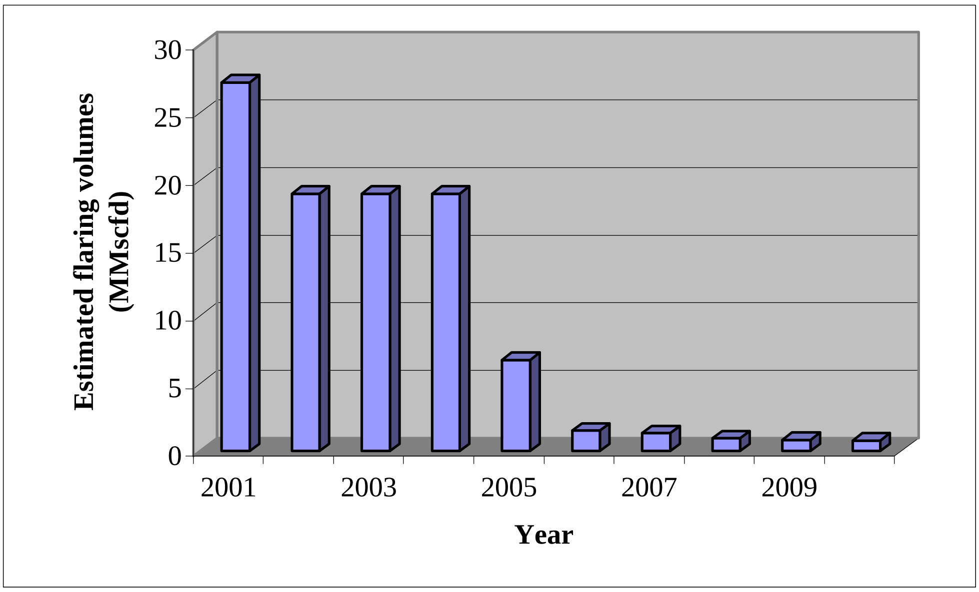
Estimated non-routine flaring volumes anticipated from the Phase 1 facilities offshore are shown in Figure 10.5.

Figure 10.5 Estimated non-routine flaring volumes from the PDQ and C&WP (MMscfd)



Once the C&WP is operational in 2006, gas produced at the Chirag-1 platform would be transferred to the C&WP and co-mingled with Phase 1 gas for use as fuel gas, re-injection or transfer to shore. At present, associated gas from Chirag-1 is transferred to SOCAR's Oil Rocks facility for use as fuel gas. At times when this gas cannot be received however, the gas is flared at Chirag. Linking the Chirag-1 platform to the C&WP would eliminate an ongoing need for continuous flaring at Chirag. Anticipated flaring volumes at Chirag-1 are illustrated in Figure 10.6 showing the reduction in flaring to around 1 MMscfd (primarily purge and pilot gas) by 2006.

Figure 10.6 Anticipated flare gas volumes at Chirag-1 (2001-2010)



Fugitive losses to the atmosphere of volatile hydrocarbons from process equipment connections represent a relatively minor source of emissions from the offshore facilities and would be largely controlled by minimisation through appropriate specifications for storage tank seals, valves and flanges and seals during detailed engineering.

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 Phase 1 project. As with the template well drilling programme, emissions from supply vessels and helicopters, although adding to the overall emission totals for the project, would be transient in nature and would be readily dispersed. Combustion emissions from the support vessel are relatively low in comparison to the full offshore Phase 1 operations.

Impact significance

As noted above, no sensitive receptors at the offshore location would be at risk from the emissions due to predicted rapid and thorough dispersion in the offshore environment. No deterioration in the local air quality would be expected. The power generation emission stacks and the flare boom are of sufficient height and are appropriately positioned to ensure that emissions are released at sufficient distances from the platform working areas so that no health effects on the personnel working offshore would be incurred.

Interim air dispersion modelling of CO, NO_x and SO_2 from the offshore facilities has been carried out using worst-case emissions (i.e. during normal operations and non-routine flaring) to establish whether offshore emissions would impact on onshore sensitive receptors. The results, as presented in the Technical Appendix (Appendix 3), show only a slight increase in ambient levels at each of the onshore receptors studied, with no breach of international air quality standards.

With the exception of $CO_{2,}$ atmospheric emissions from the Phase 1 offshore operations although appreciable, would be readily dispersed and hence, are considered to be of "low" significance in terms of impacts on the offshore and onshore atmospheres and onshore sensitive (human) receptors as follows:

Likelihood of occurrence = 5 - certain to occur Consequence = 1 - impact largely not discernible on a local scale Significance = 5 – low

CO_2 has a long residence time in the atmosphere and, being an acknowledged greenhouse gas, has potential global consequences. The CO_2 contribution from the offshore Phase 1 facilities is considered to be appreciable and hence, significant in terms of global greenhouse emissions as follows:

Likelihood of occurrence = 5 - certain to occur Consequence = 2 – concern over greenhouse gas contribution Significance = 10 – high

CO2 emissions from the Phase 1 project are further discussed in the Transboundary Impacts chapter (Chapter 13).

10.3.1.4 Airborne Noise

Airborne noise would be generated during all phases of the project from:

- vessel activity;
- installation of the jackets and pipelines;
- floatover and positioning of the PDQ and C&WP topsides;
- mobilisation of the Dada Gorgud;
- drilling and production;
- flaring; and
- helicopter operations.

Engine noise would be comparable in level to other vessel activities in the area and would be continuous in places (for example the drilling location) and intermittent along transportation routes.

Impact significance

Offshore airborne noise may disturb birds (shorebirds and seabirds) and the Caspian Seal with resultant behavioural changes such as avoidance. This impact could be expected to be more significant near the shoreline where increased vessel activity would be closer to larger numbers of birds than occur offshore. Avoidance behaviour in these individuals may cause certain species to leave their feeding, nesting or breeding areas if the disturbance is prolonged or repeated.

Where surface noise is continuous (e.g. offshore installations), it is likely that birds and seals would become accustomed to the sound and would return to the area if avoidance was the initial response. There is anecdotal evidence of this from sightings of the Caspian Seal around the Chirag-1 platform. Similar evidence suggest that birds are also generally unperturbed by offshore installation and operation activities. In the North Sea for example, personnel have formed ornithological clubs onboard offshore drilling and production platforms that regularly record bird sightings and distributions around these installations.

Noise impacts on animals resulting from 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 those activities that would generate noise (e.g. drilling) and those would result in discharges to the water column (e.g. drilled cuttings and cooling water discharge).

10.3.2.1 Underwater noise

A number of Phase 1 activities would result in the generation of underwater noise. These principally include:

- sea-going vessel transportation of materials, equipment and plant into country;
- offshore installation operations in relation to:
  - the Dada Gorgud drilling rig;
  - the PDQ and C&WP jackets and topsides
- offshore drilling and production operations;
- installation and operation of subsea intrafield pipeline; and
- pipeline operations.

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 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; that is, for individuals to move away from the noise source. 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 km) from the source. As with birds and marine mammals, the typical response is to move away from the source. 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 (based upon data reported in McCauley, 1994)

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

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.

Impact significance

Overall, the impact assessment found that noise impacts from the Phase 1 project activities on seawater biology are considered to be of "low" significance as discussed below.

Table 10.11 Sound sources from various maritime activities (Evans and Nice, 1996)

	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

Notes:
1 Beaufort Sea, Canada, early 1980's.
2 St George's Channel, Irish Sea, 1993.
* Actual measurements.
† Extrapolated.

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 Phase 1 development would increase, it is expected that if animals initially displayed avoidance behaviour, they would eventually return to the affected area once they become accustomed to the increased noise levels or once the noise source had moved or ceased. The highest level of activity would be 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. The activities at the offshore location are relatively short-lived and for the pipeline installation transitory as the vessels move along the pipeline route. Individuals would be expected to return once these relatively short-lived activities have been completed.

Overall, impacts resulting from noise emissions from vessel activities 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

Facility and pipelines installation

The most significant noise source during offshore facility installation would be the piling of the PDQ and C&WP jackets into place. A total of 12 piles would be used to secure each jacket. The pile driver normally operates at up to 40 "blows" per minute and at its source, can produce noise emissions up to 206 dB (BP, 2001).

It is difficult to predict what the actual noise levels would be at a distance from the source as environmental conditions at the time of installation operations would play a significant role in determining the behaviour of the noise waves through the water column and hence their effect on biological receptors. Typically however, it would be expected to be between 105 and 165 dB at a distance of 100 m. Overall impacts resulting from these noise emissions would last for between seven and 10 days for each jacket installation programme and are hence considered to be short-lived. It is expected that marine animals would move away from the area during this time, returning once the piling activities were complete.

Noise emissions associated with the installation of the subsea and interfield 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 "low" 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 as follows:

Likelihood = 5 - certain to occur
Consequence = 1 - impact largely not discernable on a local scale
Significance = 5 - low

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).

Template drilling from the Dada Gorgud would create relatively lower noise levels than many large ships (Richardson *et al*, 1989) but levels (Table 10.15) would be likely to result in avoidance behaviour by fish.

Underwater noise levels generated by drilling from the PDQ (after template drilling) would be similar to that emitted by the Dada Gorgud. Once commenced, PDQ production operations at the PDQ would, for a period of years, be concurrent with drilling activities on the facility. Underwater noise levels generated by combined platform PDQ drilling and production is anticipated to be similar to drilling alone as noise resulting from production activities (e.g. power generation; gas compressor operation) would primarily be generated on the platform topside and not underwater. It is considered that the long-term presence of the ACG Phase 1 production facilities would be unlikely to result in fish permanently avoiding the area and therefore, impacts associated with noise emissions on this receptor are 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 operations noise. Evidence of similar behaviour by marine mammals is available for other offshore oil production operations, 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. Such emissions may travel through the water column and disturb marine organisms and in particular fish. As the noise levels would be small and as they would dissipate relatively rapidly, the significance of this potential impact is considered to be “negligible” as follows:

Likelihood = 5 - certain to occur
Consequence = 0 - impact absorbed by local natural environment
Significance = 0 - negligible

10.3.2.2 Aqueous discharges to sea

The discharges to the sea arising from Phase 1 activities are shown in Table 10.12.

Table 10.12 Phase 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, jackets, topsides, pipelines)	Sewage, bilge waters
Supply and support vessels	Sewage, bilge waters
Drilling	Sewage, bilge waters, drainage, food waste, WBM cuttings, WBMs, cooling water
Production	Sewage, bilge waters, drainage, food waste, cooling water

Impact significance

Overall, the impact assessment found that noise impacts from the Phase 1 project activities on seawater biology are considered to be of "low" significance as discussed below.

Overall, the impact assessment on seawater quality and seawater biology resulting from the discharge of sewage, bilge water, drainage and food waste are considered to be of "low" significance as discussed below.

Sewage discharges

It is estimated that approximately 19,500 m^3 per year of sewage water would be generated at and discharged from the Phase 1 offshore facilities. Details on the sources, types and individual amounts of aqueous discharges offshore are presented in the Project Description (Chapter 5).

Discharge of sewage effluent can result in localised organic enrichment in the vicinity of the discharge point that in turn, can result in potential oxygen depletion in the discharge plume resulting in some minor disturbance to the marine ecosystem close to the point of discharge.

Sewage discharges from the Dada Gorgud and the PDQ would be from a US Coast Guard Marine Sanitation Device (MSD) or certified equivalent. Residual chlorine content in discharges would be of less than 2.0 mg/l. All vessels used for installation and commissioning and for supply and support would be required to comply with MARPOL which stipulates no discharges of sewage waters in nearshore waters and treatment of sewage waters in a marine sanitation unit prior to discharge offshore.

It is expected that the anaerobic digestion of the effluent carried out on the offshore facility marine sanitation units would rapidly reduce the Biochemical Oxygen Demand (BOD) at and near to the sewage discharge point to levels that are insignificant. Water currents would also assist the dilution and dispersion of discharged material and would 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 as follows:

Likelihood = 5 - certain to occur Consequence = 1 - impact largely not discernable on a local scale Significance = 5 - low

While not explicitly part of the base case for sewage treatment, maceration of solids would also assist in ensuring that there are no visible solids as well as assist dispersion in the surrounding waters.

Food wastes

Food waste would be generated on board all operational vessels and offshore facilities. Such wastes would be macerated and discharged directly to the water column. Large-scale discharges of organic material can result in increased biological productivity in the vicinity of the discharge point with a resultant reduction in dissolved oxygen in the receiving waters. Given the limited number of personnel that would be onboard offshore installations (i.e. maximum 300) 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 as follows:

Likelihood = 5 - certain to occur
Consequence = 0 - impact absorbed by local natural environment
Significance = 0 - negligible

Bilge, ballast and drainage water

Bilge and drainage waters have the potential to 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. Drainage water discharges would therefore contain very low levels of oil and would be readily dispersed after discharge. Impacts on marine water quality and marine organisms 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

Ballast waters from transportation vessels and the Dada Gorgud 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 10.6.

10.3.2.3 Discharge of drilled cuttings, drilling fluids and WBM

As discussed in the Project Description (Chapter 5) the Phase 1 drilling programme would consist of the development of up to 48 wells as follows:

- the drilling of eight to 10 pre-template and template wells from the Dada Gorgud prior to the installation of the PDQ; and
- the drilling of up to a further 39 platform wells from the PDQ.

The cuttings generated during surface hole drilling of each Phase 1 well will be released directly to the seabed. The cuttings generated during top-hole (26") drilling will be returned to the offshore drilling facility with the circulating drilling mud, where they will be separated from the mud for disposal. A Best Practicable Environmental Option (BPEO) study was completed to determine the most viable and appropriate disposal method for drilled cuttings from the surface hole and 26" hole sections. 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 top-hole drilled cuttings and drilling fluids/WBM is discharge to the marine environment. The key factors leading to this conclusion were:

- the drilling muds to be used for the 26" hole sections will either be water-based mud 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 between 250 m and 350 m of the discharge point;
- the energy consumption and therefore atmospheric emissions, would be least for discharge overboard;
- ship-to-shore requires considerably morehandling of cuttings and mud, with attendant safety risks;
- the high rate of cuttings generation during 26" hole drilling could compromise the integrity of the re-injection facilities;
- additional dedicated re-injection wells would be necessary to re-inject the high volumes generated from then multiple wells; and
- the economic case for discharge overboard is more robust than that for cuttings re-injection and ship-to-shore.

The base case option for the disposal of drilled cuttings and muds from the surface and 26" hole sections from each well was therefore to discharge to the marine environment as follows:

- Dada Gorgud template well drilling programme:
  - 36" surface hole section drilled with seawater and viscous (bentonite gel) sweeps directly to the seafloor;
  - 26" top-hole section drilled with a WBM system to the water column via a caisson at –11 m below the sea surface following separation of the WBM from the drilled cuttings;
- Platform wells (PDQ):
  - 30" conductor (driven) and drilled out with seawater and viscous (bentonite gel) sweeps directly to seafloor; and
  - 26" top-hole section drilled with seawater and viscous (bentonite gel) sweeps to the water column via a caisson at –97 m below the sea surface.

It should be noted that all cuttings generated from lower hole sections drilled with non-water based mud systems (NWBM) will be re-injected offshore into dedicated cuttings re-injection wells, in the event that the re-injection facilities are unavailable offshore, the cuttings will be contained and shipped-to-shore for treatment and disposal. No cuttings from hole sections drilled with NWBM will be discharged to sea.

The total volume of cuttings and mud to be discharged would be 815 m^3 per well, based on a 36" diameter surface-hole and 26" top-hole. For 48 wells, the total volume of cuttings would therefore, be 39,120 m^3. The surface-hole design diameter for the platform wells was amended to 30" as described above, so total actual volumes discharged will be slightly lower.

Cuttings from the 26" top-hole sections would be returned to the surface with the circulating drilling mud/fluid and would be separated out in solids control treatment packages on the Dada Gorgud (template wells) and the PDQ (platform wells). A proportion of residual drilling mud is however, likely to remain attached to the discharged cuttings prior to cuttings discharge.

The formulation of the WBM to be used for the template wells is one which has been and is widely used and that has been subject to thorough environmental testing. Table 10.13 identifies the WBM components, their characteristics and environmental fate. The bentonite gel would most likely consist of bentonite, caustic soda, soda ash and guar gum as a contingency chemical.

Table 10.13 Chemistry and fate of WBM components

Chemical	Composition	Environmental Fate	OCNS Category[1]	Comment
Barite	Barium sulphate ore	Deposit on seabed	E	Inert and dense material. Primary seabed effect would be due to physical smothering. No significant impact would be expected associated with the levels of heavy metals.
Bentonite	Clay ore	Eventual deposit, but suspended in water column for some time	E	Inert material that may cause limited physical effects (e.g. light attenuation; clogging) in main part of plume but would rapidly disperse to background turbidity levels.
Caustic soda	Sodium hydroxide	Dissolve in water column	D	Inorganic material that dissolves readily and components are of negligible toxicity.
Guar Gum	Non-ionic polymer	Dissolve in water column	E	Simple, degradable natural polymer of very low toxicity
Soda ash	Sodium carbonate	Dissolve in water column	E	Simple, degradable and very low toxicity.

OCNS: Offshore Chemical Notification Scheme - a system used in the North Sea, UK 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 overall impacts of the discharge of drilled cuttings, drilling fluids and WBM on seawater and seawater biology were found to be of "low" significance as discussed below. The main physical impacts on seawater from the discharge of cuttings, drilling fluids and WBM are associated with a localised increase in water turbidity in the vicinity of the discharge point and minor changes in local water quality. Turbidity in the water column may increase the reflection and scattering of light thus reducing light penetration and subsequently biological activity. In addition, organic material in the discharge may contain an associated high oxygen demand. Significant changes in seawater quality may also have flow-on effects on marine biology. Impacts from cuttings release from the Dada Gorgud would be likely to have a greater impact than releases from the PDQ as the former would be in the primary production zone (i.e. at –11 m) whereas releases from the PDQ would be at –97 m.

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. Zooplankton is unlikely to be physically affected by increased turbidity as a result of cuttings discharge from either the Dada Gorgud or PDQ (except possibly in a very small zone surrounding the immediate point of discharge) as plume would be expected to disperse quite rapidly to levels well below 30 g/l TSS.

Fish could potentially be affected in the vicinity of the plume by the large quantities of fine-grained sediments such as those at the Azeri Field well site (Chapter 6). 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. Other species would be expected to exhibit avoidance behaviour in response to increases in turbidity.

The Caspian Seal populations 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.

Impacts on seawater quality and seawater biology resulting from the discharge of drilled cuttings, drilling fluids and WBM 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

Impacts of the deposition of the drilled cuttings and muds on the seabed are discussed below in Section 10.3.3.3.

10.3.2.4 Cooling water uptake and discharge

Cooling water requirements for the Phase 1 development would result in three sources of cooling water discharges to the sea as follows:

- from the Dada Gorgud during the template drilling programme:
  - cooling water uptake at –10 m and a rate of 600 m^3/hr
  - discharge temperature approximately 15^{O}C above ambient; and
  - cooling system not be treated with antifouling agents.
- from the PDQ during platform drilling:
  - cooling water uptake at –101 m at rate of 1,700 m3/hr;
  - discharge at –67 m at a temperature of approximately 15^{O}C above ambient;
  - cooling system treated with antifouling agents;
- from the C&WP during production:
  - cooling water uptake at –101 m at rate of 4,200 m3/hr;
  - discharge at –67 m at a temperature of approximately 15^{O}C above ambient; and
  - cooling system treated with antifouling agents.

Seawater passed to the cooling medium on the PDQ and C&WP would be dosed with a copper-chlorine "antifouling" solution to inhibit the build-up of organic growth within the system. The dosing concentrations would be 5 ppb (parts per billion) copper and 50 ppb chlorine (on each platform) and dosing would occur for one minute in every five of cooling system operation (i.e. 20% of the time). Discharged cooling water would on average therefore, have copper and chlorine concentrations of 1 ppb and 5 ppb respectively. Dosing with chlorine by electrochlorination of sodium hypochlorite solution has also been considered.

Impact significance

The potential environmental effects of cooling water uptake and discharge would be sterilisation of a portion of the volume of the plume due to:

- entrainment of phytoplankton/zooplankton and (juvenile) fish;
- the temperature differential between discharged and receiving waters; and
- antifouling chemical additives in the discharged cooling water.

The overall impacts of the uptake and discharge of cooling waters on seawater and seawater biology were found to be of “low” significance as discussed below.

Entrainment

- Phytoplankton and zooplankton

Recent surveys around the appraisal wells GCA5, GCA6 drilled in the ACG Contract Area and around the Chirag sites (ERT, 2000) suggest plankton biomass value of 250 mg/m^3 is typical of the waters in the area. This roughly translates to a biomass production rate of 30 to 100 mg/m^3/day; that is, on average 70 mg/m^3/day.

The Dada Gorgud would draw seawater for cooling from -10 m below the sea surface. Phytoplankton and zooplankton found at this depth would be entrained in the uptake stream with a consequent mortality due to the rapid increase in ambient temperatures and highly disturbed water flow. Using the biomass value of 250 mg/m^3 and a seawater uptake rate of 600 m^3/hr (i.e. 14,400 m^3/day), approximately 3.6 kg/day of biomass would be lost (assuming total mortality of entrained organisms).

The cooling water intakes on the PDQ and C&WP platforms are planned to be at a depth of -101 m, which is well below the productive surface layers of the water column where phytoplankton abundance is greater. Zooplankton are however, present at these depths. Assuming the same standing biomass value of 250 mg/m^3 (likely to be an over estimate) and a combined PDQ and C&WP seawater uptake of 5,900m^3/hr (i.e. 141,600m^3/dy) a loss of approximately 35.4 kg/day of biomass could be expected (assuming total mortality of entrained organisms).

Using biomass production rate of 70 mg/m^3/day, the amount of biomass lost due to entrainment on the PDQ and C&WP (the worst-case scenario) would be replenished by a seawater volume of approximately four times the cooling water volume. Another basis for comparison is to estimate the daily biomass production of surface waters (taken to be upper most 30 m of the water column) around the platforms. At a radius of 500 m the productive volume is be 23,550,000 m^3. The estimated biomass production rate for this volume of water would be approximately 1,500 kg/day, well in excess of that predicted to be lost as a result of seawater uptake on the Dada Gorgud and the combined PDQ and the C&WP installations.

It is concluded that local production of plankton is more than sufficient to compensate for the estimated losses resulting from seawater uptake and therefore, the significance of the loss of plankton due to entrainment is considered “negligible” as follows:

Likelihood = 5 - certain to occur Consequence = 0 – impact absorbed by local natural environment Significance = 0 - negligible

- Larvae and juvenile fish

As discussed in the Environmental Description (Chapter 6), the Middle Caspian is a fish spawning area. The ACG Contract Area includes spawning grounds for anchovy and Big-eyed kilka[1]. Spawning occurs below the sea surface and embryo rise to the surface where they hatch.

The volumes of cooling water that would be used during the template drilling programme (Dada Gorgud) in comparison to the whole of the Middle Caspian would be very small. 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 significance of this impact is considered "negligible" as follows:

Likelihood = 5 - certain to occur Consequence = 0 – impact absorbed by local natural environment Significance = 0 - negligible

It is unknown what the potential distribution of larvae and juvenile fish may be in deeper waters in the Contract Area. Given the greater seawater uptake on the PDQ and C&WP (in comparison to the Dada Gorgud), it is considered that there would be a greater potential for losses as a result of entrainment. Again based on the amounts of seawater uptake in comparison to the whole of the Middle Caspian however, the significance of potential losses is considered to be "negligible" as follows:

Likelihood = 5 - certain to occur Consequence = 0 – impact absorbed by local natural environment Significance = 0 - negligible

- Adult fish

Kilka are one of the more abundant fish species in the Middle Caspian in deeper waters but total numbers would still be likely to be more significant at the shallower depths. It is considered that the majority of adult fish would avoid seawater intakes but young adults or smaller individual Anchovy and Kilka could be entrained if velocity gradients at the intakes are sufficiently high. The significance of the total number of individuals that that could be lost due to entrainment is however considered to be "negligible" as follows:

Likelihood = 5 - certain to occur Consequence = 0 – impact absorbed by local natural environment Significance = 0 - negligible

Thermal plume discharge

The primary concern associated with the discharge of heated water is the potential for direct effects on the physiology of individuals within the area of the discharge plume. Broadly, metabolic rates increase by a factor of two for each 10°C increase in temperature. From an ecological point of view this has two important implications as follows:

- metabolically-dependent processes such as growth and development will be higher at higher temperatures (subject of course to remaining within tolerable limits); and
- a higher proportion of assimilated organic carbon will be expended in respiration at higher temperatures.

[1] "Kilka" is a term that collectively refers to several species of herring.

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 World Bank guideline[2] set for cooling water discharges states that a temperature increase of no more than 3°C above ambient seawater temperatures is permitted 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. To minimise effects of the thermal plume discharge and to meet this standard, discharge caisson depths have been selected to maximise cooling of the thermal plume upon discharge.

Thermal plume dispersion modelling was conducted to establish whether or not the base case design meets the required standard. Discharge plumes were modelled for cooling water discharges from the PDQ and C&WP platforms at flow rates of 1,700 m^3/hr and 4,200 m^3/hr respectively. The cumulative discharge of both platforms operating simultaneously (i.e. 5,900 m^3/hr) was also modelled. While in reality each platform would have a caisson (separated by between 50 to 100 m), because of the model resolution, a single discharge point for both platforms was used.

Modelling showed for all seasonal scenarios that the thermal plume was well within 3°C above ambient seawater temperature within 100 m from the discharge point in all directions. In fact, all simulations showed a temperature rise of only between 0.5 - 1.0°C above ambient conditions within 100 m of the point of discharge in all directions. The thermal impacts of these cooling water discharges on seawater and seawater biology were 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

A full technical report on the thermal plume dispersion modelling is presented in the Technical Appendix (Appendix 4).

Chemical plume discharge

Cooling water on the Dada Gorgud would not be treated with antifouling chemicals.

Two options were under consideration for antifouling treatment of the cooling water on the PDQ and C&WP facilities. These were:

- **BFCC** ä [3]**:** pulsed dosing with a copper-chlorine solution with concentrations of 5 ppb copper and 50 ppb chlorine; and
- **electro-chlorination:** dosing with a chlorine only solution at a concentration of 2,000 ppb.

The chemical plume arising from both antifouling treatment systems were also modelled using the same hydrodynamic model as used for the thermal plume modelling. All discharge scenarios were modelled (i.e. PDQ, C&WP and combined PDQ and C&WP). The results from all simulations are presented in the Technical Appendix (Appendix 4).

[2] World Bank Operational Policy 4.01: Environmental Assessment (1999).
3 The BFCC™ copper-chlorine system is a proprietary system produced by Baker-Hughes in the UK.

The copper-chlorine system is dosed at 5 ppb copper and 50 ppb chlorine at the seawater intake point for one minute in every five minutes (i.e. 20% of the time). Assuming total mixing in the cooling system, the 'end-of-pipe' discharge concentrations would be 1 ppb copper and 10 ppb chlorine from the PDQ and C&WP platforms. The 'end-of-pipe' discharge concentration of chlorine from the electrochlorination system would be 2,000 ppb from each platform.

Discharged chemical plumes would be continually subject to dispersion and dilution. Some time after initial release, an equilibrium or "steady state" is reached between the discharge plume and dispersion and dilution. The model indicates that steady state conditions would be established approximately seven days after initial discharge.

The results of modelling of the combined PDQ and C&WP discharge and the steady state antifouling chemical concentrations are shown in Table 10.14. This represents a worst-case discharge scenario of 5,900m^3/hr of 2 ppb copper and 20 ppb chlorine for the BFCC™ system and 4,000 ppb chlorine for the electrochlorination system. In the steady state, the model predicted that maximum chemical concentrations would be found at water depths of between –11 m and –22m in the winter months and between –37 m and –49m in the summer for both systems.

Table 10.14 Steady state antifoulant chemical concentrations (ppb) in the dispersion plume for the combined PDQ and C&WP cooling water discharges

Season/Period	BFCC System		Electro-chlorination System
	Copper (Cu)	Chlorine (Cl)	Chlorine (Cl)
Winter:			
01 Jan – 15 Jan	0.006	0.06	11.2
15 Jan – 31 Jan	0.003	0.04	7.2
Summer:			
13 Jul – 28 Jul	0.006	0.05	10.0
02 Aug – 17 Aug	0.005	0.05	9.6

As can be seen from Table 10.14, the electrochlorination system results in higher concentrations of chlorine in the water column in comparison to the BFCC system. Modelling indicated however, that the dispersion pattern never carried any constituent chemical to the surface of the water column rather it showed a vertical spread around the release site. All dispersion scenarios are presented graphically in the Technical Appendix (Appendix 4). In steady state, the maximum concentration portion of the plume would cover a diameter of up to between 2 and 5 km.

The actual caisson depth was chosen as the average plume depth as established from thermal dispersion modelling. This is a very conservative estimate that assumes that chemicals released with the cooling water are completely dissolved and travel with the plume and only begin to disperse after the plume has stopped its vertical ascent. All of the results are therefore, 'worst-case' scenarios in terms of plume chemical concentrations.

As shown in Table 10.14, the maximum predicted steady state concentrations of copper and chlorine in the dispersion plume for the BFCC™ system are 0.006 ppb (parts per billion or μg/l) and 0.06 ppb respectively. In fact these concentrations would not be measurable and have been presented as predicted model outputs only. In addition the model output concentrations occur during worst-case (summer maximum and winter maximum) conditions. The predicted concentration of copper in the dispersion plume for the BFCC™ system (i.e. 0.006 ppb) is in the order of three orders of magnitude below the Maximum Allowable

Concentration (MAC) limit for Azerbaijan (i.e. 5 ppb). Concentrations outside of this 'maximum concentration plume' rapidly decline within hundreds of meters.

For electrochlorination the maximum predicted steady state concentration of chlorine determined was 11.2 ppb (winter maximum conditions) and as noted above the height and depth of the plume are the same as for the BFCC™ system.

A decision to adopt the BFCC™ system both for the PDQ and C&WP was made.

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 would form copper compounds and precipitate out around the platforms. If this occurs, concerns could be raised on the potential increase in copper concentration in the seabed sediments and its bio-availability.

There is no data available for the acute toxicity levels of copper for Caspian Sea 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. Nevertheless slight accumulations of copper as well as cadmium, mercury and lead were 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 however, copper and some of its compounds are 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 modelled maximum concentration of copper that would result from combined cooling water discharge from the PDQ and C&WP is 0.006 ppb. This is a very low concentration and hence, the significance of impact on seawater and seawater biology is 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 PDQ and C&WP 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. The dosing concentrations (i.e. 2,000 ppb) associated with the electrochlorination system are similar to those used to disinfect sewage (i.e. 2,000 – 5,000 ppb residual chlorine) and it is considered that at these concentrations, acute lethal effects on marine organisms would occur.

There is no Caspian-specific criterion for chlorine concentrations in marine waters but it is considered that a dilution factor of 10 to 100 times would mitigate acute lethal effects. The dispersion plume modelling predicts that the worst-case (i.e. winter maximum) steady state plume concentrations of chlorine would be a maximum of 11.2 ppb and 0.06 ppb for the electrochlorination and BFCC™ systems, respectively. The lateral extent of the highest concentration part of the plumes would be approximately 500 m and 250 m, respectively.

While both antifouling systems are predicted to result in adequate dilution of the plume (i.e. to avoid acute toxic effects on marine organisms), the BFCC™ system results in a significantly lower steady state chlorine concentration and the plume is laterally less extensive than that of the electrochlorination system. For these reasons, the BFCC™ system is considered to be environmentally, a better option.

Overall, the low concentrations of antifouling chemicals present in the cooling water discharges offshore and the rapid dilution of these chemicals predicted by the modelling study conducted, indicates 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

10.3.2.5 Produced water discharge

As discussed in Chapter 5 (Section 5.5.1.2) the Phase 1 project would initially not separate produced water from hydrocarbon product offshore and hence, all water would be sent to shore with the oil stream for separation and disposal. It is proposed that when water production rates increase, a produced water treatment package would be retrofitted to the PDQ.

The base case design for the Phase 1 development includes no overboard discharge of produced water under normal operating conditions. All generated produced water would be co-mingled with treated seawater and re-injected for reservoir pressure maintenance. There remains the possibility however, that if the water injection facilities are taken off-line for maintenance or if they fail, then treated produced water would need to be disposed of to sea.

Produced water consists of formation water from the reservoir as well as other components as a result of contact with the produced hydrocarbons and the offshore production process. The composition of produced water varies between wells and the mixture of chemicals is always complex. Typically, produced water contains dispersed and dissolved hydrocarbons, trace metals, dissolved inorganic salts and organic components such as fatty acids. In addition, some proportion of the process chemicals used in the production process such as corrosion inhibitor, scale inhibitor, demulsifier and methanol may also remain in the water phase.

The biodegradation potential of the compounds present in produced waters varies. A study carried out for Statoil (Varskog, 1999) measured standard biodegradation rates for produced water compound groups. These are presented in Table 10.15 below.

Table 10.15 Produced water

Compound Group	Biodegradation Rate (½ Life in Days)
BTEX	0.5
Naphthalenes	1.5
2-3 ring PAH	17
4^+ ring PAH	350
Alkyl phenols (C0-C3)	1.2
Alkyl phenols (C4+)	10
Aliphatic hydrocarbons	60
Metals	No degradation
Organic acids	Organic acids are highly water soluble and degrade rapidly
Production chemicals	Product specific

Source: Johnsen et al., 2000.
Note: BTEX = benzene, toluene, ethylene, xylene; PAH = poly-aromatic hydrocarbons.

Table 10.15 shows that the most recalcitrant components in the produced water discharges are associated with any oil present, the heavier poly-aromatic hydrocarbons (PAH) and to a lesser extent the aliphatic hydrocarbons.

The produced water treatment package on the PDQ has been designed to comply with the IFC Environmental, Health and Safety Guidelines: Oil and Gas Development (Offshore) (IFC, 2000). These Guidelines require oil-in-water concentrations to be a daily maximum of 42 mg/l and a monthly average of 29 mg/l. The PSA requirements are less stringent at 72 mg/l on a daily basis and 48 mg/l as a monthly average.

Figure 10.7 and 10.8 presents the predicted volumes of produced water and quantity of oil-in-water respectively that would be discharged to the water column over the life of the Phase 1 project assuming the produced water re-injection facilities are unavailable for 5% of the time and a monthly average oil-in-water content of 29 mg/l.

Figure 10.7 Predicted volume of produced water discharged to sea assuming injection facilities are unavailable 5% of the time (bpd)

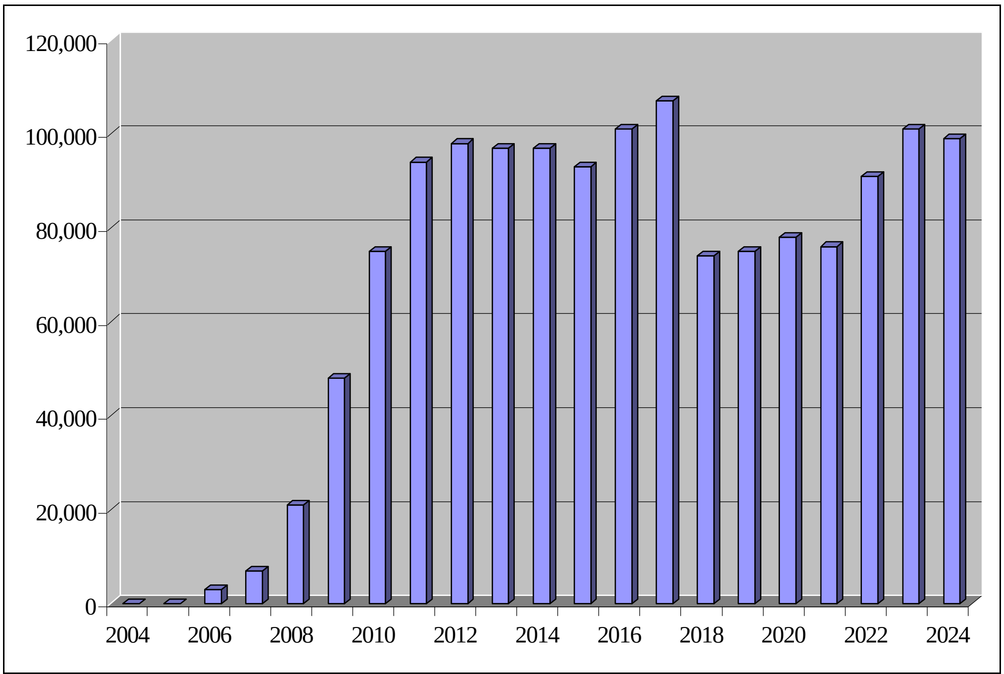
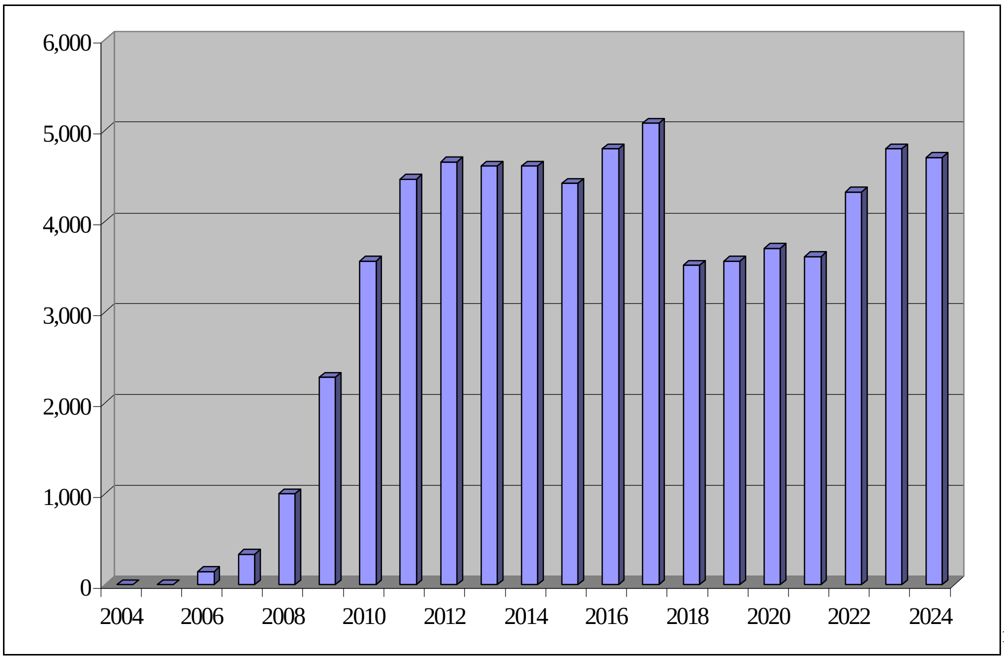


Figure 10.8 Predicted oil in produced water quantity discharged to sea assuming injection facilities are unavailable for 5% of the time (tonnes per annum)



Assuming a monthly average oil-in-water concentration of 29 mg/l (ppm)

Impact significance

Impacts on seawater and seawater biology associated with the discharge of produced water in the event of unavailability of offshore re-injection facilities is considered to be of "low" significance as discussed below. Discharge of produced water to the sea is common practice in international oil and gas operations offshore and is considered Best Available Control Technology (BACT) for this waste stream in the absence of re-injection facilities.

Literature values for total oil toxicity vary widely and do not provide a reliable context for quantitative impact evaluation. Data from an unpublished study in the UK suggests however, that a tentative environmental quality standard (EQS) for total oil of 12 µg/l, based on experimental no-effect concentrations of approximately 1.5 to 2.0 mg/l total oil. The Azerbaijan EQS for total oil is 50 µg/l (or 0.05ppm). It is estimated that the maximum concentrations likely to occur after initial dilution of the produced water discharges would not cause biological harm in the water column. The low concentrations of oil in the discharge would be expected to disperse rapidly. The aromatic compounds would only be present in trace levels and they are known to have low aqueous solubility and are normally adsorbed to particulate material. The bio-availability of these compounds is low when they are bound to solid particles.

Concentrations of metals in produced water are very low and are almost always close to the background levels found in seawater. As was discussed above in regards to copper in cooling water discharges, metals tend to interact with components present in seawater to form insoluble inorganic compounds that settle onto the seabed. Although not specific to produced water discharges, studies have shown that these metal compounds are virtually non bio-available to marine organisms (Neff *et al*., 1989a, 1989b).

The amount of production chemicals that may remain in the produced water discharge is very much dependant on the solubility coefficient between water and oil of each chemical.

Chemicals that are partially water-soluble would remain in the water stream. Others hydrophobic chemicals would predominantly remain with the oil stream as it passes out of the offshore production process and on to the onshore terminal.

At the time of writing, the chemical formulations to be used in the offshore Phase 1 production process were unknown. Typically, the amount of chemicals used in a production process is kept to a minimum and hence it is expected that the level of production chemical contaminant remaining in any produced water discharge would be very low. Dissolved chemicals would be rapidly diluted upon discharge. Light components would be volatilised and surface-active ingredients would preferentially adsorb to the sides of any solid particulate matter in the effluent.

Studies of produced water discharges have shown that any effects on marine fauna are limited to the immediate vicinity of the discharge point and that dilution of the effluent reduces the concentration of the components present to negligible levels within tens of metres of the discharge point (Somerville *et al*., 1987). A study in the North Sea (Davies *et al*., 1987) found slightly depressed zooplankton populations in the vicinity of a continuous produced water discharge although no direct effects were evident on phytoplankton or on the larvae of the native cod and herring. Planktonic species would however be the most vulnerable to the discharge as they would come into direct contact with the plume. Any reduction to primary production rates of plankton in the vicinity of the produced water discharges would nevertheless be expected to be insignificant in terms of the overall populations in the area as discussed in relation to cooling water discharges above.

As discharges would occur only as a contingency in the event of any down-time on the water injection facilities and treatment prior to discharge would be to standards that exceed the requirements of the PSA resulting in only very low concentrations of oil in the discharge stream, the effects on marine organisms in the mixing zone are expected to be insignificant. Overall, impacts associated with produced water discharges are considered to be of "low" significance as follows:

Likelihood = 5 - certain to occur (event of no injection facility)
Consequence = 1 - impact largely not discernable on a local scale
Significance = 5 - low

The operator will seek to review new technology for oil-in-water treatment as it becomes available so as to further reduce oil component discharges to the sea when produced water discharges are necessary.

10.3.2.6 Corrosion protection of jackets and pipelines

The Phase 1 pipelines and offshore jackets 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.

The specification for the subsea pipeline active anodes states that they must be made of an aluminium-zinc-indium type alloy proven for long-term continuous service in seawater, saline mud or alternating seawater and saline mud environments. The required chemical composition is presented below. No specific information is available in regards to the jacket anodes but it is assumed that they would be of a similar make-up to the pipelines.

Chemical composition of subsea jacket and pipeline active anodes

- 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

Impacts on seawater and seawater biology associated with the slow decay of active anodes are considered to be of "low" significance as discussed below.

According to the UK Offshore Operators Association (UKOOA), 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 active anodes on the pipeline. It is considered therefore, that the ACG Phase 1 pipeline and jacket anodes similarly would 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. Impacts 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

10.3.2.7 Drill stem tests (oil-on-water)

In total, three drill stem tests (DSTs) are planned during the template well drilling programme for the ACG Phase 1 project. The Dada Gorgud drilling rig is unable to contain the hydrocarbons following testing and consequently the hydrocarbons would be sent to the burner boom for disposal by flaring.

Inefficient combustion of hydrocarbon products could result in the release of unburnt or partially burnt hydrocarbons to the water column potentially resulting in the formation of a small slick of oil on the sea surface. Oil on the sea surface may result in the fouling of seabirds and/or marine mammals and the introduction of a small of hydrocarbon product to the water column.

Impact significance

Flaring of hydrocarbon products is a very rapid process with each test flaring expected to last for approximately 32 hours. Hydrocarbons would be burnt in a four-headed "Green Dragon Burner" that is a proven high efficiency burner. Additionally, during burning, specialist engineers would ensure that the mixture of hydrocarbons to air is kept to an optimum to reduce the potential for hydrocarbon fallout. Given these factors and the relatively small amount of hydrocarbons that would potentially be introduced to the sea surface, impacts on seawater and seawater biology associated with oil droplet fallout from the burner boom 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 Impacts on seabed and benthos

A number of Phase 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 resulting in alteration to local seabed topography and destruction of benthos;
- WBM and seawater fluid drilled cuttings deposition resulting in smothering of benthos and interference with marine organism physiological processes; and
- physical presence the offshore structures resulting in the creation of an artificial reef environment on and around the platform jackets and subsea pipelines.

These impacts and the contributing activities are discussed in the following sections.

10.3.3.1 Offshore installation activities

Phase 1 installation activities offshore that would result in a degree of physical disturbance to the seabed and associated seabed biology include:

- positioning and anchoring of the Dada Gorgud for pre-template and template drilling;
- installation of the drilling template;
- installation of the PDQ and C&WP jackets; and
- installation of the subsea and interfield pipelines.

Impact significance

Impacts on the seabed and seabed biology associated with physical disturbance resulting from offshore installation activities is considered to be of "low" significance as discussed below.

Positioning and anchoring of the Dada Gorgud and installation of drilling template

Localised disturbance of the seabed during placement of anchors and mooring chains for the Dada Gorgud would result from the use of vessel anchors, anchor chains the preparation of areas of seabed for the drilling template. The total area affected would be small at approximately 1 ha and mortality of benthic fauna would be restricted to this area. Impacts are therefore, considered to be "low" 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 the later installation of the PDQ and C&WP jacket structures.

Installation of the PDQ and C&WP jackets

The installation of the offshore jackets and jacket piling would result in physical disturbance to the seabed. The PDQ jacket footprint would cover an area of approximately 5,000 m^2. Assuming that the C&WP jacket would be of a similar size, then the total seafloor area covered by these installations would be in the order of 10,000 m^2 (i.e. 1 ha). It is estimated that vessel anchoring and other installation activities would disturb an additional 1 ha of seabed. In total therefore, it is estimated that the jackets installation activities would affect the seabed over an area of approximately 2 ha.

The physical disturbance would result in the destruction of sessile or non-moving benthic organisms, including those living on (epifauna) and within (infauna) the sediment. The total area that would be impacted by the PDQ and C&WP represents only approximately 0.005% of the total ACG Contract Area. The amount of biota that would be lost is considered to be insignificant in the context of that present in the the Contract Area and is low in terms of the portion of the Caspian Sea that falls under Azerbaijan's jurisdiction. Overall, the impacts associated with installation of the PDQ and C&WP jackets is considered to be "low" as follows:

Likelihood = 5 - certain to occur Consequence = 1 - impact largely not discernable on a local scale Significance = 5 - low

Installation of subsea pipelines and interfield pipelines offshore

The pipelay vessel 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 concrete mattresses 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 30" oil subsea pipeline is taken as being the section between the offshore platforms and the 8 m water depth contour (i.e. the shallowest depth in which the pipeline lay-barge would operate). The section from the 8 m water depth contour and the shoreline is taken as the nearshore pipeline and is discussed below. The offshore section of the pipeline amounts to a length of approximately 185 km. An additional, three interfield lines each of approximately 10 km in length are proposed between the existing Chirag-1 platform and Phase 1 offshore facilities. Assuming that pipeline installation activities would disturb the seabed over a 50 m wide corridor along the pipeline routes (a conservative estimate), then the total area that would be disturbed as a result of subsea and interfiled pipeline installation and associated activities would be approximately 1,100 ha. Benthic communities in this area would be directly impacted most likely resulting in their loss.

The impact from the installation of the pipelines 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 the area of installation activities. The relative impact of this depends on the fraction of local or regional communities of a particular type that are affected by the activity.

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. bird 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.

For much of the proposed route, the pipelines would be situated in shallow water between the 10 and 20 m depth contours as illustrated in Figure 6.1. Recent survey work (ERT, unpublished data) has shown that sediments along the pipeline corridor are inhabited by communities that are largely dominated by introduced species (Chapter 6). Only in deeper water further offshore do native species dominate the ecology. Native communities are characterised by endemic amphipods, cumacea and gastropods all of which are resilient to physical disturbance but are of greater ecological importance than the alien species that dominate the nearshore environment. Sediments along the offshore section of the pipeline route in this area of the Caspian Sea are more variable in composition than the nearshore sediments but are less subject to frequent natural disturbance. After seabed disturbance and subsequent loss of benthos, restoration of natural community structure gradually takes place.

The offshore portion of the pipeline 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 would be otherwise unlikely to occur and become established. This implies that in the offshore environment through which the pipeline passes, a slight change in structure of marine faunal community may be incurred.

While the total area that would be impacted as a result of pipeline installation is appreciable, the fact that the installations operations would be relatively short-term and that the disturbed areas would be free to rehabilitate without further 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

10.3.3.2 Pipeline installation activities in the nearshore

The installation of the 30" pipelines along the existing Chirag-1 pipeline corridor in Sangachal Bay would, as illustrated in Figure 6.32, cross seagrass and red algae beds and , pass through habitats of medium and high sensitivity (Figure 6.24). Installation activities would result in direct physical disturbance of the seabed and loss of rocky outcrop and seagrass habitats. A number of activities would contribute to the impacts and these include:

- trenching of the pipeline out to the 5 m depth contour including:
  - mechanical excavation from 0 to 2 m depth;
  - "jetting" from 2 to 5 m depth;
- construction of finger-pier to allow access for an excavator to excavate the nearshore trench for the 30" pipeline; and
- laying of the pipeline in the trench.

Impact significance

Impacts on the seabed and seabed biology in Sangachal Bay resulting from pipeline installation activities in the nearshore is considered to be of "high" significance as discussed below.
This significance ranking is driven by:

- the fact that nearshore benthic (seagrass) habitats present in Sangachal Bay are important in terms of:

  - their ecological function; and
  - their role in maintaining stability of seabed sediments; and
- their long restoration times (i.e. several years).

Loss of seagrass habitat can also 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.

Seagrass habitat in Sangachal Bay

In Sangachal Bay, *Zostera* species of seagrass form continuous mats that extend marginally by growth of stolons. *Ruppia maritima* does not have a dense rhizome base but nonetheless, also contributes to seabed sediment stability. The stabilising effect of seagrass is an important characteristic in the Bay (Chapter 6). The habitat is also important in terms of the biodiversity it supports and the ecological role it plays as a spawning and nursery area for a range of marine organisms including commercially important fish species. A summary table of the functions and values of seagrass habitat *per se*, is presented in Table 10.16.

Table 10.16 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 foodwebs. **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

Excavation of the pipeline trench would result in the direct loss of seabed habitat over an area of approximately 0.5 ha. Deposition of excavated material adjacent to the trench is estimated to impact an area of at least the same size and possibly as up to twice as large. Trench construction activities are therefore, estimated to directly impact 1.5 ha of benthic habitat.

In order to mechanically excavate the trench, it is proposed to construct a finger-pier from the shoreline out to the 2 m water depth contour. While alternative civil engineering enabling techniques are under consideration, a rock groyne finger-pier along which the excavator could move is the most likely option. It is estimated that the base of pier would be 10 m wide and its total length between 250 m and 300 m. The total area of seabed that would be directly impacted by this structure would therefore, be up to 0.3 ha. This would be in addition to that area affected by trenching and spoil deposition.

Approximately 450 ha (i.e. 12% of Sangachal Bay) are covered by sensitive habitat (seagrass). Direct loss of between 1.5 and 2 ha of nearshore habitat would result from construction of the finger pier, trenching, deposition of excavated material, pipeline installation and vessel operation. It is estimated that 20% to 25% of this would be high sensitivity (seagrass) habitat. The remainder would be moderate sensitivity habitat (primarily loose sediment) (Figure 6.34).

Benthic habitat 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 at potentially considerable distance from the immediate construction area.

Current speeds ranging between 0 cm/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 south-west (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 changes in sediment grain size distribution measured 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) concluded that there is a complex nearshore hydrodynamic circulation pattern and a dynamic sediment regime in the Sangachal Bay nearshore environment. As illustrated in Figure 6.27, a northward moving sediment plume suggests the presence of currents strong enough to mobilise the Bay's benthic sediments. The figure also shows an eddy in the southern part of the Bay. It is considered that this may potentially be associated with a shear zone caused by a nearshore current in the southern direction interacting with the northward flowing sediment plume.

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%). Deposition of sediment on sensitive habitat removed from the construction site may mean however, that considerably more area could be impacted. While marine flora and fauna are probably to some degree, accustomed to turbid waters in the Bay and hence could be expected to be able to sustain short term, low to medium level disturbance, deposition of significant amounts of sediment 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 the long restoration times (i.e. years) for seagrass habitat, impacts resulting from pipeline construction and 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 it is planned to remove the finger-piers following pipeline installation and the area to be returned to its original status. The removal process would result in further disturbance and a re-suspension of sediments thereby potentially impacting again on nearby seagrass beds. Additionally, impacts on benthic habitats in Sangachal Bay would also occur as a result of pipeline installation for ACG Phases 2 and 3 and for the proposed Shah Deniz development. This potential cumulative impact is discussed in the Cumulative Impacts chapter (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 (see Environmental Mitigation and Monitoring; Chapter 14).

10.3.3.3 Discharge of drilled cuttings, drilling fluids and WBM

As previously described, the cuttings generated during surface hole drilling of each Phase 1 well will be released directly to the seabed and from the top-hole (26") section will be returned to the offshore drilling facility with the circulating drilling mud, where they will be separated from the mud for discharge to sea.

Surface-hole sections would be drilled using seawater as a lubricant with occasional slugs of bentonite gel used to clean out the cuttings from the hole. The displaced cuttings released from the well hole to the seabed, would produce a mound of cuttings material close to the drilling site. The 26" hole sections will be drilled with WBM during the template well drilling programme (Section 5.2) and with a seawater based system during the platform drilling programme (Section 5.3). Following separation on the drilling facilities they will be discharged to sea via subsurface caissons at water depths of - 11m from the Dada Gorgud drilling rig (template wells) and -97 m from the PDQ (platform wells).

The dispersion behaviour and the likely deposition pattern on the seafloor of drill cuttings and mud discharged from the offshore installations are 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;
- the type of drilling mud used;
- dispersion and agglomeration characteristics of the mud and cuttings;
- position, orientation and diameter of the discharge caisson;
- depth of water below the discharge; and
- the relative proportion of soluble and insoluble components.

In order to assess the dispersion and deposition of the proposed cuttings discharges marine dispersion modelling for the Phase 1 wells has been carried out using MUDMAP, a computer-based model developed by Applied Science Associates (ASA), to predict the near and far field transport, dispersion and bottom deposition of drill muds and cuttings.

Drilled cuttings dispersion modelling

The full text and results of the modelling simulations are included in the Technical Appendix (Appendix 4). It should be noted however that since the completion of the cuttings discharge modelling study, the cuttings discharge configuration on both the Dada Gorgud and PDQ platform have changed to that described in Section 5.2 and 5.3. At the time of the modelling study the Dada Gorgud discharge caisson outlet was placed at a water depth of -8.3 m rather than -11 m and the depth of the PDQ discharge caisson was at a water depth of –60 m. rather than -97 m.In addition, there are 48 well slots on the PDQ, the impact assessment has been based on nine template wells to be drilled, leaving a further 39 slots for platform drilling. At the time of the modelling, 34 wells was the base case with five spare drilling slots remaining.

The modelling results reflect the cuttings and mud discharge conditions and discharge depths as summarised in Table 10.17.

The amendments to discharge depths and proposed drilling programme have been taken into account in the assessment of the environmental impacts of cuttings discharge.

Table 10.17 Cutting and mud release conditions

Hole Section (inches)	Volume of Cuttings (m^3)	Release Depth (m)	Caisson Diameter (m)	Production Time (hr)	Lubricant
36	538.57	Seafloor	N/A	5	Sea Water
26	276.22	60	0.80	17.5	WBM
26	276.22	8.3	0.36	17.5	WBM

One of the chief variables is the particle size range of the cuttings (De Margerie, 1989) and this is determined in turn by the combination of drilling equipment and mud type used as well as the physical properties of the geological formation being drilled. A typical particle size distribution for WBM-contaminated cuttings was developed for cuttings dispersion modelling based on grain size data recorded from ACG field exploration wells. This along with data for settling velocities and times is presented in Table 10.18.

Table 10.18 Cutting and mud release grain size distribution

Nominal Grain Size (microns)	Specific Gravity	Percentage of Total Mass	Fall Velocity (m/hr)
12,500	2.5	85	2,582.50
9,625	2.5	1.25	2,266.13
6,750	2.5	1.25	1,897.74
3,875	2.5	1.25	1,437.87
1,000	2.5	1.25	730.44
74	3.0	10	11.39

In order to bound the cuttings dispersion trajectory and eventual bottom thickness contours, the simulations were conducted during average and maximum flow events during the summer (June through August) and winter (December through February). Table 10.19 presents a complete listing of all release simulations, parameter variations and pertinent results. The nomenclature used in the table is season-maximum/average-surface-hole section; for example, WM36 = winter maximum, 36" surface-hole section discharge.

Table 10.19 Pertinent results of cuttings dispersion modelling

Scenario	Hole Section (inches)	Release Depth (m)	Season (M= Max) (A = Avg)	Start Time	Time to Complete Release Settling (hr)	Maximum Travel Distance (km)
WM36	36	Seafloor	Winter (M)	21 January at 1600 hrs	5.5	N/A
WA36	36	Seafloor	Winter (A)	09 January at 1200 hrs	5.5	N/A
WM26_A	26	-60	Winter (M)	21 January at 1600 hrs	40	4.3
WA26_A	26	-60	Winter (A)	09 January at 1200 hrs	40	1.3
WM26_B	26	-8.3	Winter (M)	21 January	45	4.5

Scenario	Hole Section (inches)	Release Depth (m)	Season (M= Max) (A = Avg)	Start Time	Time to Complete Release Settling (hr)	Maximum Travel Distance (km)
				at 1600 hrs		
WA26_B	26	-8.3	Winter (A)	09 January at 1200 hrs	45	1.5
SM36	36	Seafloor	Summer (M)	05 August at 1600 hrs	5.5	N/A
SA36	36	Seafloor	Summer (A)	22 July at 0000 hrs	5.5	N/A
SM26_A	26	-60	Summer (M)	05 August at 1600 hrs	40	2.6
SA26_A	26	-60	Summer (A)	22 July at 0000 hrs	40	1.0
SM26_B	26	-8.3	Summer (M)	05 August at 1600 hrs	45	3.0
SM26_B	26	-8.3	Summer (A)	22 July at 0000 hrs	45	1.2

The simulations conducted for releases to the seafloor from the 36" surface-hole section indicated that all of the material would be deposited within tens of metres of the well location.

There is a direct correlation between the distance of the release above the bottom and the complete time for the discharge settling. The model showed that cuttings discharged at the seafloor settled after 5.5 hours of the start of the release with only a 5 hour total drilling time, whereas cuttings released above the seabed took 45 hours to settle from the Dada Gorgud and 40 hours to settle from the PDQ, with a total drilling time of 17.5 hours. There is also a correlation between the seasonal conditions relative to the maximum travel distance and as expected, during the maximum seasonal conditions, the smaller materials within the mud cutting mixture are advected further and create a larger deposition footprint.

Details and graphical outputs from the modelling are presented in the Technical Appendix. Overall, the modelling shows that the cuttings particles discharged from one well are spread very thinly over a wide area and that no appreciable cuttings accumulations would be expected.

While the single well release scenarios are useful in determining the total particle settling time and the deposition pattern of single wells, the deposition from one well from the Dada Gorgud were summed to represent the releases from the proposed nine template wells. Similarly, results from one well from PDQ were summed to represent releases from an additional 34 wells.

Figure 10.9 presents the deposition pattern for the simulation of drilled cuttings discharges from nine template wells during the maximum winter conditions. The deposition pattern for this scenario is elongated to the south-southeast due to current carrying the lighter particles downstream. The region of highest deposition occurs very near to the drill location with maximum deposition thickness on the order of 3 m while the elongated deposition region has deposition thickness ranging from 10 to 500 μm.

Figure 10.10 presents the deposition pattern for the simulation of cuttings discharges from nine template wells during the maximum summer conditions. The deposition pattern for this scenario is offset to the southeast with two distinctly separate regions. The region of highest deposition occurs very near to the drill location with maximum deposition thickness on the order of 5.6 m while a second broader deposition region with thicknesses on the order of 10 to

1,000 µm develops to the southeast. The development can be attributed to the smaller particles being carried downstream by the current before settling occurs.

Figure 10.9 Deposition patterns for the simulation of 9 template wells during the maximum winter conditions

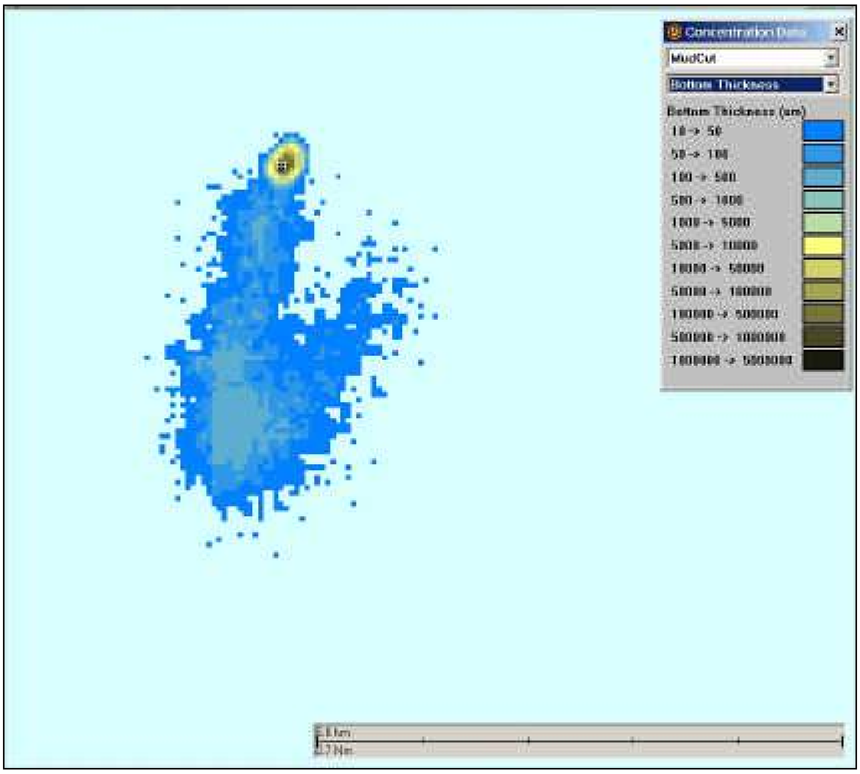


Figure 10.10 Deposition pattern for the simulation of nine template wells during the maximum summer conditions

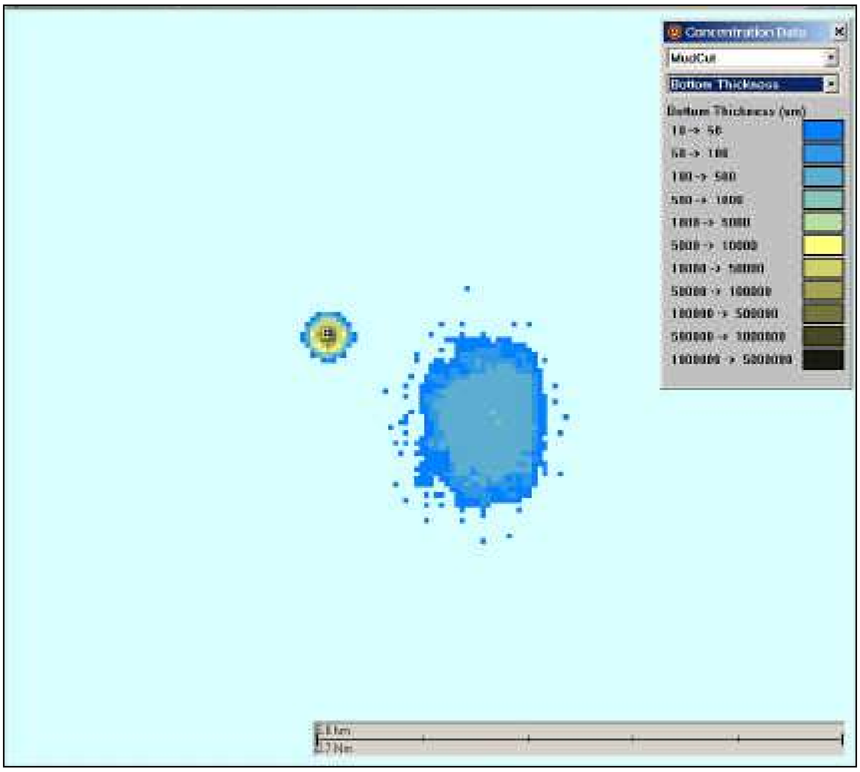


Figure 10.11 presents the deposition pattern for the simulation of cuttings discharges from 34 platform wells during the maximum winter conditions. The deposition pattern for this scenario is elongated to the south-southeast due to the current carrying the lighter particles downstream. The region of highest deposition occurs very near the drill location with maximum deposition thickness on the order of 1.15 m while the elongated deposition region has deposition thickness ranging from 10 to 1,000 µm.

Figure 10.12 presents the deposition pattern for the simulation of cuttings discharges from 34 platform wells during the maximum summer conditions. . The deposition pattern for this scenario is offset to the southeast with two distinctly separate regions. The region of highest deposition occurs very near the drill location with maximum deposition thickness on the order of 2 m while a second broader deposition region with thicknesses on the order of 10 to 2,000 µm develops to the southeast. The development can be attributed to the smaller particles being carried downstream by the current before settling occurs.

Figure 10.11 Deposition pattern for the simulation of 34 platform wells during the maximum winter conditions

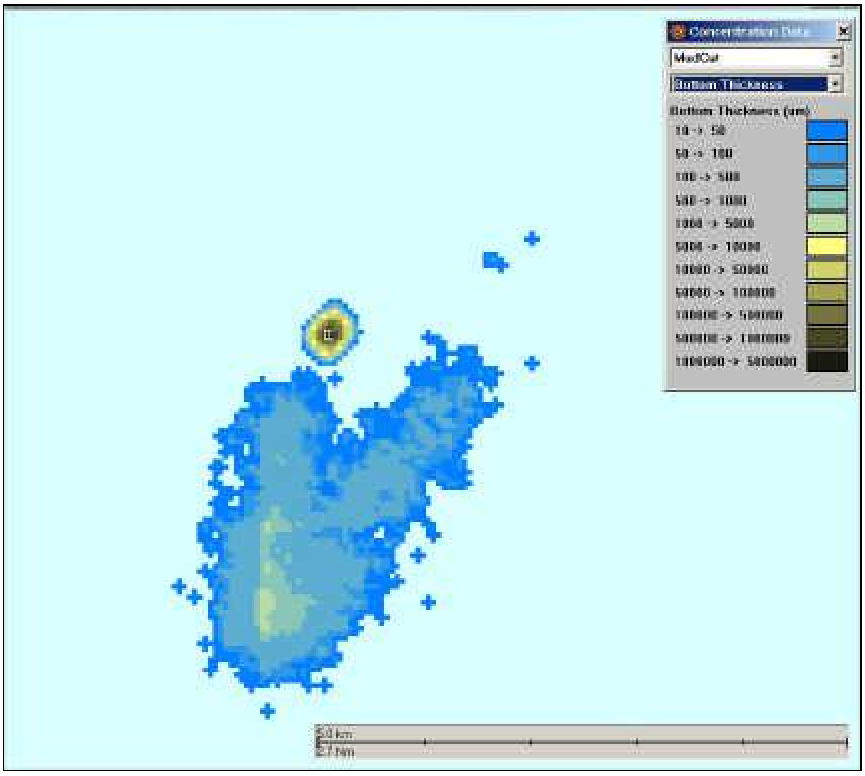
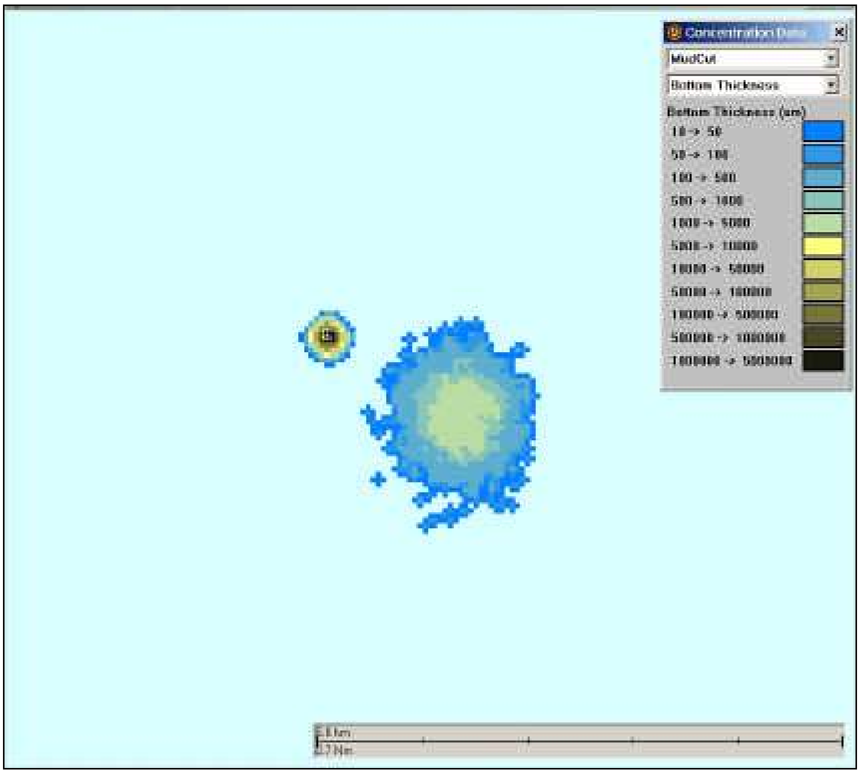


Figure 10.12 Deposition pattern for the simulation of 34 wells during maximum summer conditions



Impact significance

Concerns have been raised about the proposal to discharge top and surface-hole 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.

Following separation of the cuttings from the re-circulating drilling fluids, a proportion of residual mud/fluid will remain attached to these cuttings upon discharge. In addition, spent WBM and seawater based fluids will also be discharged to the sea. The composition of the WBM and seawater based fluids to be used are discussed in Section 10.3.2.3. 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 metals, salts and suspended sediments into the receiving environment.

The impacts on the seabed and seabed biology resulting from the discharge of top and surface-hole cuttings and drilling fluid/WBM are considered to be of “high” significance as discussed below.

To enable an assessment of the impacts that may be incurred as a result of discharges of cuttings from the Phase 1 drilling programme, the site of the proposed offshore development has been surveyed (Chapter 6). The sediments in the area are poorly sorted with a wide range of particle sizes and are predominantly medium to coarse sand with 10% to 26% silt clay content.

The faunal composition at the field drilling location consists of large numbers of surface and direct deposit feeding Annelida (*Hypania invalida* and *Psammoryctes deserticola*) typical of the high silt/clay content. The coarser component of the sediments particularly at the surface, provide a substratum on which surface dwelling suspension feeders such as *Mytilaster lineatus* may attach and proliferate. These species would be particularly vulnerable to excessive sedimentation and cannot be expected to survive the deposition of discharged cuttings and spent muds. More mobile species such as shrimps and many of the amphipod species may however, be able to avoid inundation but would be excluded from the area while active discharge is taking place.

There are two mechanisms of impact 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.

The direct effects on seabed animals from the cuttings deposition on the seabed include in-filling 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 form 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 associated with the barite;
- low levels of trace metals associated with the barite; and
- occasional, small areas of low level organic enrichment

The constituent chemicals in the drilling fluid/WBM all constituent chemicals fall within the lowest hazard categories of the OCNS classification scheme (Groups D and E) and none exhibit any intrinsic toxicity. In addition as, the chemical components of the drilling fluids/WBM are readily soluble, they tend to dissolve within the water column as the discharged cuttings fall. The main components reaching 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 proposed for the template well drilling consists of barium sulphate an insoluble, chemically inert mineral powder that can contain measurable concentrations of trace metals. 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 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. 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 drilling fluids. It should also be noted that all barites will be analysed to ensure that cadmium and mercury concentrations are less than 3 mg/l and 1 mg/l, respectively before they can be used in the drilling mud systems.

Organic enrichment effects associated with the discharge of cuttings and drilling fluids/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 the Phase 1 drilling programme. It is not considered that any organic enrichment effects would be associated with the discharge of cuttings and fluids/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.

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. Small crustacea such as cumaceans and amphipods tend to be 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 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.

Cuttings discharges would result in a distinct physical alteration to the seabed habitat in the near vicinity of the drilling location. Habitat and the resident organisms would be lost from the impacted area and would remain absent for the duration of the drilling programme. As there would be no persistent chemical impacts and as natural sediment movement processes would gradually restore the physical structure of the seabed, natural biological processes would eventually lead to the re-colonisation of the impacted area after the cessation of the drilling programme.

The results from the modelling simulations show that the extent of the area impacted by cuttings discharge while perhaps not significant in the context of the whole of the Caspian, is considered to be appreciable on a local scale. It is concluded therefore, that the impacts associated with the discharge of surface and top-hole cuttings from the proposed number of Phase 1 wells would have an impact of "high" significance on the seabed and seabed biology as follows:

Likelihood of occurrence = 5 - certain to occur Consequence = 2 - local scale impact Significance = 10 - high

Benthic surveys will be periodically conducted to monitor the effects of drilled cuttings discharge and potential alternatives to cuttings discharge will be explored (Environmental Mitigation and Monitoring; Chapter 14).

10.3.3.4 Physical presence of marine structures

The physical presence of the offshore drilling and production facilities 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 represent 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

Impact on the seabed and seabed biology associated with the physical presence of the marine structures is considered to be of "low" significance as discussed below.

Hydrodynamics
The hard surfaces of the offshore structures (i.e. subsea facilities, jackets 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 impact assessment found that the physical presence would have a "low" impact on 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

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 concrete mattresses.

Habitat
It is not believed that the physical presence of the proposed offshore facilities 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 colonies may in fact be beneficial for the local fish populations. In this event, 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 to investigate health of fish found around oil platforms in the North Sea compared with "wild" populations studied three populations of fish as follows:

- fish caught around a drilling and production platforms to represent typical production platforms;
- 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.

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 would be attracted by the fish that are expected would congregate around the offshore structures and the Caspian Seal is regularly observed in the waters around the existing Chirag-1 platform.

10.3.4 Impacts on offshore subsurface geology

10.3.4.1 Cuttings re-injection

The base case design for the disposal of all cuttings drilled from well sections using NWBM systems is re-injection down a dedicated offshore cuttings disposal well and into the Subanchi shale formation at depths of between 2,000 and 2,350 m. In addition to cuttings, it is planned that produced sand retrieved from the offshore production equipment would also be injected into the disposal well along with the cuttings. The cuttings re-injection process is described in Chapter 5.

To assess the likely maximum geometry of an induced fracture and the feasibility of undertaking batched injection of cuttings, a preliminary set of numerical simulations have been undertaken. The total volume of cuttings slurry expected from the Phase 1 development for re-injection will be approximately 960,000 bbls. For the purpose of these simulations it was assumed that this total field waste volume would be split equally between two dedicated re-injection wells so that each disposal domain accommodated 480,000 bbls of cuttings slurry.

For the simulations the maximum predicted well head treating pressures were between 2,720 to 4,350 psi for re-injection at a total vertical depth of 2,200 m). The three dimensional simulation, assuming a volume 480,000 bbls of fluid with a similar viscosity as the cuttings slurry, predicted a fracture that has a half-length of 547 m and has a height of 1,208 m and 305 m above and below the injection point. This places the top of the fracture at a total vertical depth below of 992 m. A less powerful but industry standard two-dimensional model predicted a fracture length of about 530 m either side of the well and total upward growth of approximately 990 m. Relatively little downward growth (120 m) occurs from the disposal zone. This places the top of the fracture at about 1,210 m.

Impact significance

Based on the results of the above assessment, the anticipated impacts on sub-surface geology associated with the implementation of the cuttings re-injection (CRI) programme are summarised below:

- the injection process would create a sub vertical fracture that would be confined to the low permeability shales of the Sabunchi Formation;
- the anticipated rate of cuttings production would require the establishment of a continuous injection model that would lead to the establishment of a large single fracture;
- the geometry of the single fracture would be less than the conservative assessments predicted by the simulators described in the previous section; single fracture geometries could range for 800 m to over 1,200 m in height;
- the fracture would generally grow up from the perforations;
- due to the low permeability of the host rock, pressure leak off into the host rock would be very small as a consequence, a temporary suspension of cuttings re-injection for periods of time up to 48 hours would not have a detrimental impact on the injection process;
- repressurisation of the induced fracture is likely to reopen and extend the original fracture; periods of suspension in well excess of 48 hours may lead to areas of the main fracture closing and the re-pressurisation inducing additional fractures at an oblique angle to the main fracture;
- on completion of the cuttings re-injection process, the injection borehole would be shut in for several days to allow the fracture to close onto the injected cuttings; during this process, excess water from the cuttings would be squeezed out of the cuttings and it is likely that the water would gradually leak-off into isolated beds of sandstone where over time the pressure surcharge would gradually dissipate; and
- due to the low permeability of the host rock and the fact that the induced fracture would be confined to the Sabunchi the long-term environmental impacts of the process would be very low.

Overall, the impact assessment process found that impacts on subsurface geology receptor due to the re-injection of cuttings would be “low” 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 Phase 1 project activities. The onshore environment includes, as described in the Environmental 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 Phase 1 offshore activities have been appropriately assessed. Greater emphasis has been given to the activities that have been assessed to potentially result in more significant impacts.

10.4.1 Impacts on the onshore atmosphere

Emissions to the onshore atmosphere resulting from the Phase 1 project would result from the following activities:

- assembly of the offshore facilities at the SPS fabrication yard;
- terminal early civil engineering work programme and construction;terminal operations; and
- pipeline installation operations in the nearshore and onshore between the landfall and terminal.

The fate and effect of gaseous species emitted during these activities have been discussed in Section 10.3.1.1 and the project activities are described in the Project Description (Chapter 5) along with the estimated emission quantities from these activities.

10.4.1.1 Offshore facility assembly and terminal construction activities

The assembly of the offshore facilities will take place at the SPS yard some 14 km to the north of the terminal site where terminal construction operations (including early civil works) would be undertaken. Atmospheric emissions generated during these assembly and construction activities would result from combustion sources from equipment such as diesel generators, cranes and other diesel driven equipment as well as from excavators, trucks and vehicles at both sites. An increase in vehicle traffic carrying equipment, materials and the workforce to and from each site would also result in an increase in combustion emissions to the atmosphere in the area. Additional combustion emissions would be generated from diesel driven equipment and vehicles during the construction of the Phase 1 30” pipeline landfall and onshore pipeline installation activities.

Impact significance

Estimated quantities of emissions to the atmosphere resulting from activities associated with platform assembly at SPS, terminal construction activities at Sangachal and pipeline installation in the nearshore and onshore were found to be low. While they could result in an increase in the ambient air concentrations of emitted species near to the source of the emissions, they 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 emission 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

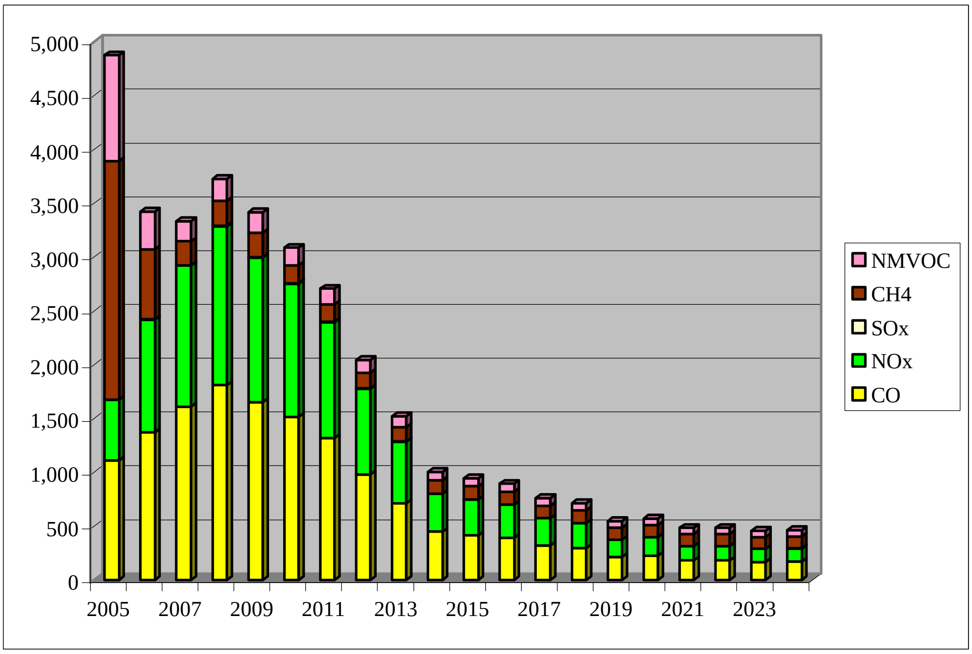
10.4.1.2 Terminal operations

There are a number of sources of emissions to the atmosphere resulting from operations at the oil processing terminal. The principal sources would include:

- power generation turbines;
- process heaters;
- flaring; and
- fugitive emissions.

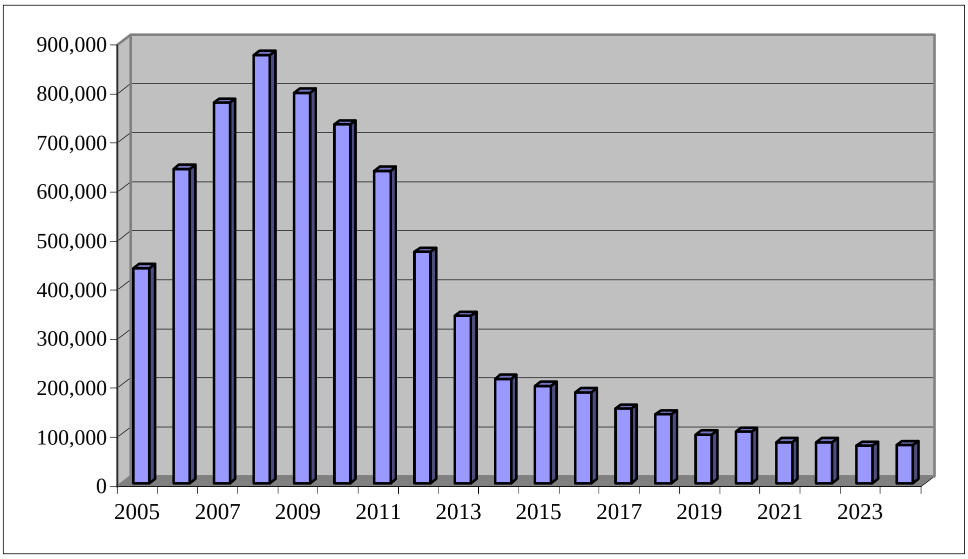
The estimated total emission quantities by species from each of the activities over the life of the project are illustrated in Figure 10.13a and 10.13b.

Figure 10.13a Estimated total emission quantities by species (excluding CO_2) from routine and planned non-routine operations at the terminal (tonnes)



NMVOC: non-methane volatile organic compounds.

Figure 10.13b Estimated total CO_2 emission quantities from routine and planned non-routine operations at the terminal (tonnes)

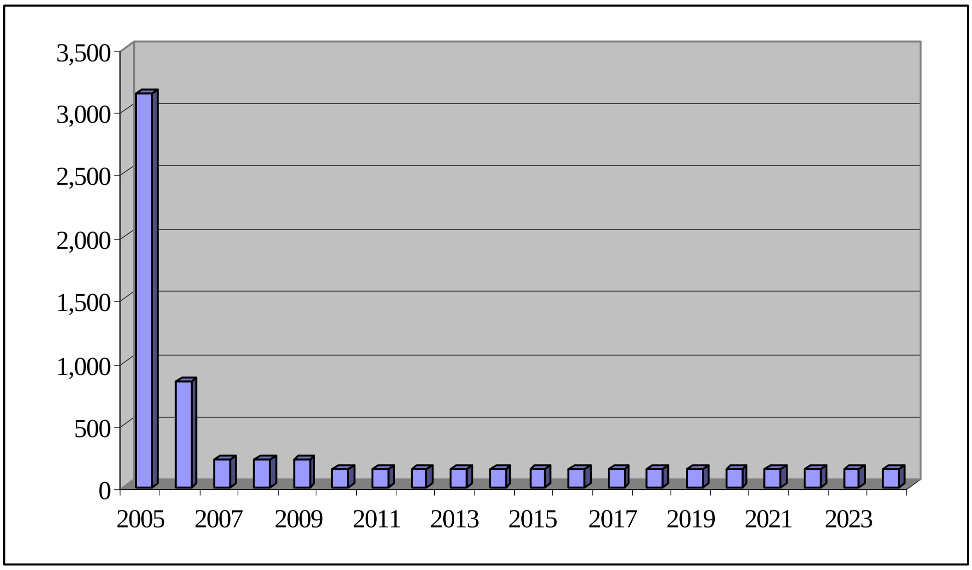


The principle contributors to the total emissions are the power generation gas turbines and the process heaters both of which are fuelled by the fuel gas transferred to the terminal from the offshore installations. Fuel gas requirements are based on the predicted production levels from the development. The gas turbines would have dual fuel capability; that is, diesel could be used as a back-up fuel in the event of the loss of gas. An emergency back-up stand-alone diesel generator would also be provided at the terminal.

Routine flaring at the terminal would be limited to the conventional pilot lights at two flares resulting in a total amount of gas routinely flared at the terminal of only 4 MMscf per year. Routine flaring has been reduced by the decision to install a flare gas recovery system at the terminal that will collect the low volume gas leakage from the process valves and seals for return to the process. Nitrogen, an inert gas, would be used as the terminal flare purge gas.

Periods of flaring would however occur at times of plant unavailability. The plant design availability target for the facilities is 95% but in the early days of commissioning and start up of the terminal and offshore facilities plant availability has been estimated to be 70% in year 1 and 82% in year two following installation of the C&WP offshore. Flaring during these periods would occur at the offshore facilities as far as possible but flaring events at the terminal would also be necessary. Estimated flaring volumes anticipated at the terminal are shown in Figure 10.14.

Figure 10.14 Estimated planned non-routine flaring volumes at the terminal



Non-routine flaring quantities, although significant, would be expected to be short-lived. The majority of flaring of gas would be likely to occur in the early days of each year following the installation of the facilities. Emissions shown in Figures 10.13a and 10.13b above include these anticipated non-routine flaring events. The flaring events represent a significant contribution to the overall emissions from the terminal operations.

Flaring would also occur if at any time SOCAR were unable to receive gas at the terminal boundary. A gas protocol has been signed between AIOC and SOCAR that provides the necessary assurance that the gas deliveries to SOCAR will be properly received and utilised. Under the terms of this agreement SOCAR will have provided appropriate facilities to take the gas available and hence, any inability to receive gas should minimised. Flaring should subsequently, also be limited.

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 oil storage tanks resulting in reduced fugitive emissions at the site.

There have been a number of key design decisions incorporated into the Phase 1 design in order to reduce the emissions from the project. These have been described in Project Description (Chapter 5) and have been summarised in the Mitigation Management and Monitoring chapter (Chapter 14, Section 14.2.1.6).

The power generation emission and flare stack heights would ensure maximum dispersion of the principle emissions from the terminal over a wide area. An initial air dispersion modelling exercise was conducted using ADMS (Atmospheric Dispersion Modelling System) in 2001 to determine whether or not the emissions generated from operations at the terminal would result in impacts on nearby sensitive receptors. At the time of the modelling study, project definition had not been finalised, stack heights used were conservative at 20 m. The results of this modelling and the methods used are included in the Technical Appendix (Appendix 3) and are summarised below.

The modelling study was completed to assess the potential effects during:

- normal operations for combined EOP, ACG Phase 1 and Shah Deniz Stage 1 facilities;
- normal operations including gas turbines;
- for operational upsets of EOP and Phase 1 combined; and
- for operational upset of Shah Deniz facilities on their own.

In addition, emissions from the potential future sulphur treatment facilities at the Phase 1 terminal were included.

It should be noted that modelling conducted in 2001 did not include the predicted operational scenarios of 30% Phase 1 gas injection plant unavailability in year 1 when associated gas will be flared, 18% down-time in year 2 and 5% down-time in year 3 and onwards as this aspect of the project's base case had not been fully defined at the time of modelling. Similarly, modelling was not undertaken for flaring during commissioning of onshore facilities nor of the combined operations of EOP, ACG FFD and Shah Deniz FFD. Nevertheless, the results of the study provide a useful insight into the fate of emissions to the atmosphere during periods of high-level activity. .

The process releases to the atmosphere that have the greatest potential to impact on human health include oxides of nitrogen (NO_x), sulphur dioxide (SO_2), 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 was therefore, conservative and leads to higher predicted concentrations for the scenarios modelled.

SO_2 in the atmosphere can also result in adverse effects on human health. SO_2 emissions would principally result from hydrogen sulphide (H_2S) in the hydrocarbon stream. Although H_2S was detected in small quantities in some earlier appraisal wells drilled in the ACG field, it is not known whether it will occur in Phase 1 fluids and if it does, at what concentration. The results from testing of product from the initial well drilled will define H_2S levels in the hydrocarbon stream and if required, H_2S scrubbing and sulphur recovery systems will be added to the terminal facilities. The modelling has assumed a worst-case emission of SO_2.

CO is toxic to humans at high concentrations. The VOC emitted will be predominantly alkanes (propane, butane etc), although the VOC can also contain a small proportion of suspected carcinogenic compounds.

International standards and guidelines for NO_2, SO_2 and CO are presented in Table 10.20. There are no current standards for VOC emissions.

Table 10.20 International standards and guidelines for air quality

Pollutant	Air Quality Objectives		
	Concentration mgm^{-3}	**Averaging period**	**International Standard or Guideline**
Nitrogen Dioxide	200	1 hour mean (99.8%ile)	WHO[1], EU[2], UK[3]
	40	Annual mean	WHO, EU, UK
Sulphur Dioxide	350	1 hour mean (99.7%ile)	EU, UK
	125	24 hour mean (99.2%ile)	WHO, EU, UK
	50	Annual mean	WHO
Carbon Monoxide	10,000	Rolling 8 hour average	WHO, UK

Notes:

1. WHO – World Health Organisation, 'Guidelines for Air Quality', 2000

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

3. UK - The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Department of the Environment, Transport and the Regions, The Stationary Office, 2000

99.8%ile = standard not to be exceeded more than 18 times per year.
99.9%ile = standard not to be exceeded more than 21 times per year.
99.7%ile = standard not to be exceeded more than 24 times per year.
99.2%ile = standard not to be exceeded more than 3 times per year.

The atmospheric dispersion study modelled the maximum ground level concentrations attributable to the emissions. Modelled ground level concentrations were combined with background concentrations of each species in order to assess cumulative air quality at receptor locations. Results for the terminal operation, during worst-case operational conditions are presented in Tables 10.21 through Table 10.24.

Table 10.21 NO_2 emissions for routine operations and worst-case flaring

Receptor	AQS mgm^{-3}	Background mgm^{-3}	NO_x mgm^{-3}	PEC mgm^{-3}	PEC/AQS %
Maximum hourly average					
Phase 1 terminal	200	6	97[1] (97)[2]	103[1] (103)[2]	51.5[1] (51.5)[2]
Sangachal Town	200	8	44 (45)	52 (53)	26 (26.5)
Nearest Landfall	200	4	3.5 (5.5)	7.5 (9.5)	3.75 (4.8)
Shah Deniz terminal	200	6	135 (NM)	141 (NM)	70.5 (NM)
Zilhoy Island	200	4	2.5 (4.5)	6.5 (8.5)	3.25 (4.3)
Maximum Value	200	6	138 (146)	144 (152)	72 (76)
Annual Average					
Phase 1 terminal	40	3	3 (3)	6 (6)	15 (15)
Sangachal Town	40	4	<1 (<1)	4 (4)	10.5 (10.5)
Nearest Landfall	40	2	<1 (<1)	2 (2)	5.1 (5.1)
Shah Deniz terminal	40	3	3 (NM)	6 (NM)	15 (NM)
Zilhoy island	40	2	<1 (<1)	2 (2)	5.1 (5.1)
Maximum value	40	3	10 (10)	13 (13)	32.5 (32.5)

[1] Flaring from Phase 1 and EOP.
[2] Flaring from Shah Deniz.
AQS: Air Quality Standard.
PEC: Predicted Emission Contribution.
NM: Not modelled.

Table 10.22 SO_2 emissions for routine operations and worst-case flaring[1]

Receptor	AQS mgm^{-3}	Background mgm^{-3}	SO_2 mgm^{-3}	PEC mgm^{-3}	PEC/AQS %
Maximum hourly average					
Terminal	350	30	306	336	96
Sangachal Town	350	12	38	50	14
Nearest Landfall	350	12	3	15	4.3
Shah Deniz site	350	30	205	235	67
Zilhoy Island	350	12	2	14	4
Maximum Value	350	30	1,040	1,070	305
Annual Average					
Terminal	50	15	9	24	48
Sangachal Town	50	6	<1	6	12.6
Nearest Landfall	50	6	<1	6	12
Shah Deniz site	50	15	17	32	64
Zilhoy Island	50	6	<1	6	12
Maximum Value	50	15	42	57	114

[1]All Sources

Table 10.23 CO emissions for routine operation and worst-case flaring[1]

Receptor	AQS mgm^{-3}	Background mgm^{-3}	CO mgm^{-3}	PEC/AQS %
Rolling 8 hour average				
Terminal	10,000	N/A	395	3.95
Sangachal Town	10,000	N/A	214	2.14
Nearest Landfall	10,000	N/A	46	0.5
Shah Deniz site	10,000	N/A	296	3
Zilhoy island	10,000	N/A	35	0.35
Maximum Value	10,000	N/A	1170	11.7

[1]All Sources

Table 10.24 VOC emissions for routine operation and worst-case flaring[1]

Receptor	AQS mgm^{-3}	Background mgm^{-3}	VOC mgm^{-3}	PEC/AQS %
Annual Average				
Terminal	N/A	N/A	42	-
Sangachal Town	N/A	N/A	2	-
Nearest Landfall	N/A	N/A	<1	-
Shah Deniz site	N/A	N/A	17	-
Zilhoy island	N/A	N/A	0.4	-
Maximum Value	N/A	N/A	1170	-

[1]All Sources

The results of the 2001 dispersion modelling show that the emissions would be well dispersed and predicted hourly and annual average concentrations of each species modelled are all well within internationally recognised air quality standards. Short-term assessment criteria and predicted maximum values (15 minute mean) for SO_2 are however, exceeded at locations approximately 250 m from the source of emissions (i.e. terminal site). There are no specific sensitive receptors within this distance from the terminal. It should be noted that SO_2 levels are based on a worst-case assumption and further modelling of this species will be carried out once the H_2S content of the reservoir fluids has been defined (i.e. following the template well drilling programme).

Outside the terminal boundary hourly average concentrations of NO_2 and SO_2, under worst-case operating conditions, range from 3.25% and 26% of the AQS. The predicted level of NO_2 were:

- 44 μgm^{-3} at Sangachal town during flaring periods at the Phase 1 and EOP terminal; and
- 45 μgm^{-3} at Sangachal town during periods of flaring at the Shah Deniz terminal being 26% of the AQS.

Concentrations of CO and VOCs were predicted to be negligible.

Further air dispersion modelling was conducted in January 2002 using revised ACG project data as the project became better defined and more accurate meteorological information was used. 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 flare stack height used was 35 m. The values obtained for NO_x at nearby receptors are provided in Table 10.25 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 Phase 1 and EOP terminal operations.
2006 – year 2 of Phase 1, EOP and year 1 of Shah Deniz Gas Export Stage 1 terminal operations.
2007 – year 3 of Phase 1, EOP, year 1 of Phase 2 and Shah Deniz Gas Export Stage 1 terminal operations.
2010 – Phase 1 peak production, EOP, Phase 2 and Shah Deniz Gas Export Stage 1 terminal operations.

Table 10.25 NO_x concentrations at receptors nearby the terminal location (mgm^{-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 Works	23	44	40	35	29
Cement Camp	51	73	75	50	48
Maximum Concentration	96	-	135	124	106

The model 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

Estimated quantities of atmospheric emissions from terminal operation are considerable, especially during flaring. As such, there could be an increase in the ambient air concentrations of emitted species near to the source of the emissions. Based on the results of the atmospheric dispersion modelling studies carried out however, 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. The impact significance associated with the emissions of potentially polluting species were 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

Onshore terminal operations would also result in considerable amounts of CO_2 being released to the atmosphere and these would be in addition to the Phase 1 offshore emissions of this substance. The CO_2 contribution from these operations is considered to be appreciable and a significant contribution to global greenhouse gases and hence considered to be of "high" significance as follows:

Likelihood of occurrence = 5 - certain to occur Consequence = 2 – concern over greenhouse gas contribution Significance = 10 – high

CO2 emissions from the Phase 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 construction.

Airborne dust can be associated with a human health impact if generated in sufficient amount. The UK Health and Safety Executive (HSE) has developed new technical guidance in the Methods for Determining Hazardous Substances (MDHS). This guidance gives Time Weighted Average (TWA) Maximum Exposure Limits (MEL) for hazardous substances. The TWA for dusts (respirable) is 4mg/m^3 and for dusts (total inhalable) is 10 mg/m^3.

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 Impacts significance ranking = 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 do 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 risk as any 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 30” oil pipeline; and
- construction of the pipeline landfall (i.e. pipeline shoreline crossing).

10.4.2.1 Construction of the finger-pier

As noted in Section 10.3.3.2, the finger-pier required for nearshore pipeline installation works would be approximately 10 m wide at its base and up to 300 m long. It would most likely be a rock groyne structure. The project’s base case is for the pier 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. As discussed in the Environment Description (Chapter 6) sediment accretion is apparent on the north-eastern side of the EOP jetty and to a lesser extent, on the north-eastern side the EOP terminal sewage outfall pipeline. Erosion is apparent on the south-western 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 Phase 1 30” pipeline was considered to be of “high” significance as discussed below. Impacts would be two-fold as follows:

- direct alteration of the physical coastline at the point the finger-pier was constructed; and
- indirect alteration of the coastline near and potentially removed from the finger-pier location due to changed hydrodynamic conditions.

Construction of a finger-pier for installation of the Phase 1 30” subsea pipeline 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 could be expected however, that the beach profile in the immediate vicinity of the works would be changed and that coastal dune structures could also be impacted. Assuming an appropriate level of control of the movement of construction equipment, the area of impact should be limited. It is considered that there would be an opportunity to restore the coastline following removal of the finger-pier structure.

It is a well documented fact that jetty structures in the coastal environment can change local hydrodynamic conditions and sediment transport regimes and hence coastline configuration. Resultant effects can include deposition and erosion of the coastline close to and in areas removed from the facility. The significance of any change that was incurred in the medium to long-term is difficult to predict but is primarily dependent on the magnitude of the change in hydrodynamic conditions and largely dependent on how long the structure was in place.

As discussed in Section 10.3.3.2 above, the hydrodynamic regime in Sangachal Bay is considered to be 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 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 to be constructed as part of Phase 1 subsea pipeline installation activities would be a much larger structure than that built for the EOP pipeline. Given the distance that it would extend into the Bay (i.e. up to 300 m) it can confidently be expected to change local hydrodynamic conditions. Exactly what the results of this change would be, in terms of effects on the physical coastline, is difficult to predict without quantitative sediment dynamics modelling. Certainly however, coastal erosion would constitute a negative impact especially if it occurred in sensitive areas where coastal wetlands (i.e. wadis and marshes) occur or where anthropogenic structures (e.g. roads) are to close the shoreline and hence at risk and as such is considered as being of high significance as follows:

Likelihood of activities occurring = 5 - certain to occur Consequence = 2- local scale impact Impacts significance ranking = 10 - high

Given that the finger-pier is to 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 facility was in place may however require human intervention in the form of pro-active coastline rehabilitation.

10.4.2.2 Construction of pipeline landfall

The pipeline would be trenched within the coastal zone and earthworks associated with this activity would result in some impacts to the area.

Impact significance

Impacts on the physical coastline associated with construction of the pipeline landfall 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 Impacts significance ranking = 5 - low

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 spatial extent of the physical coastline that would be impacted by construction of the pipeline landfall would be quite small and the activity would be short-term with no permanent above ground structures being installed. Construction of the finger-pier, as discussed above, would be likely to result in more significant impacts on the physical coastline.

10.4.3 Impacts on soils

Soils would be directly impacted as a result of the following project activities:

- installation of the onshore section of the 30” pipeline from the landfall to the terminal;
- terminal early civil engineering work programme and construction; and
- SPS yard upgrade activities.

10.4.3.1 Pipeline installation onshore

The proposed onshore pipeline corridor land-take area is approximately 200 m wide for FFD. The pipeline would be trenched to a depth of 1 m from top of pipe (TOP) and would be expected to 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 pipeline landfall to the terminal site is approximately 1.7 km. The area impacted would therefore, be approximately 4 ha.

It should be noted that all the top-soils removed during the excavation of the onshore pipeline trench would be stock piled and would be replaced once the pipeline has been installed.

Impact significance

The installation activities associated with the installation of the 30” pipeline would result in direct disturbance of soil. Impacts would include destruction of the soil profile within the trench footprint and soil compaction is the immediate vicinity as a result of vehicle and plant operations. Such impacts could potentially affect the soil permeability and hence the ability of the area to absorb surface run-off. Conversely, disturbed soil can be more susceptible to erosion.

As the total area that would be affected by the activities would be limited and as 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 Impacts significance ranking = 5 - low

10.4.3.2 Terminal construction

The main impacts on soils resulting from the terminal construction programme would occur during the early civil engineering works programme which would prepare the site for the terminal construction phase. It should also be noted that the early civil engineering works programme would prepare the terminal site for the Phase 1 terminal expansion, the Shah Deniz gas processing terminal and BTC pumping station. Areas that would ultimately be developed for the ACG and Shah Deniz projects would also be utilised during the early civil engineering works programme for materials and equipment lay-down and storage.

The early civil engineering work programme (Project Description; Chapter 5) would include the excavation of top and subsurface soil as part of the construction of the drainage channel and the removal of top- and sub-soil in the area of the Phase 1 terminal, the Shah Deniz gas terminal and the BTC pump station. 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 would be constructed. Although removed soils would be stockpiled for later use in bund wall construction and land levelling and/or site rehabilitation works, it would be permanently lost from its point of origin.

Impact significance

Early civil engineering work would result 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 (Phase 1, Shah Deniz 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 would therefore result in direct impacts on soil over an area in excess of 170 ha. It should be noted that soil in areas additional to this would be indirectly impacted as a result of vehicle movements and soil stockpiling. Most of the area to be levelled 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 due to the fact that habitat in the impacted area would also be lost as follows:

Likelihood of activities occurring = 5 - certain to occur Consequence = 2- local scale impact Impacts significance ranking = 10 - high

Impacts on terrestrial habitats are discussed in Section 10.4.9 below. 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.

10.4.3.3 SPS yard upgrade

Prior to the construction of the offshore facilities the selected fabrication yard (i.e. SPS) would require a number of upgrades some of which would include ground levelling and laying of aggregates. The scope of facility upgrade works is yet to be finalised but would be limited to the existing yard area.

Impact significance

As works at the SPS yard would be primarily in regards to refurbishing and upgrading existing facilities, the impact significance of SPS yard upgrade 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 Impacts significance ranking = 5 - low

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 30” pipeline from the landfall to the terminal;
- terminal construction; and
- upgrade activities at the SPS yard.

10.4.4.1 Onshore pipeline installation

Onshore pipeline installation would include the excavation of a trench from the shoreline 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 trench for the onshore section of the 30” pipeline would only be to a depth of approximately 2 m, it is not anticipated 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 Impacts significance ranking = 5 - low

10.4.4.2 Terminal construction

Terminal construction activities that would potentially interfere with subsurface hydrogeological conditions would include construction of the 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 pipework. In this instance, the potential exists for perched groundwater to be intercepted.

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 Impacts significance ranking = 5 - low

10.4.4.3 SPS yard upgrade

SPS yard upgrade works would primarily include refurbishment of existing facilities. In the event that new facilities are constructed, there would be a potential to intercept groundwater resources.

Impact significance

Given the nature of proposed yard upgrade activities and the limited area over which they would occur, impacts on groundwater resources are also 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 Impacts significance ranking = 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 section of the 30" pipeline from the landfall to the terminal; and
- terminal construction activities and operations (including the early civil engineering work programme).

10.4.5.1 Installation of the onshore section of the 30" pipeline

Installation of the onshore section of the 30" pipeline would result in disturbances to hydrological systems and to the flow regime within these systems although as the pipeline trench would be back-filled following pipeline installation, the effects are likely to only be short-term. In the longer term, the physical presence of the pipeline underground is not considered to represent a major 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 30" pipeline would be localised 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 Impacts significance ranking = 5 - low

10.4.5.2 Terminal construction activities and operations (including the early civil engineering work programme)

The terminal flood protection drainage channel and bund wall to be constructed around the terminal (Section 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 change the layout of the existing hydrological system. Surface 'hardening' within the terminal footprint would also contribute to the a changed hydrological regime as surface run-off from the terminal site 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 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 detailed 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 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 Impacts significance ranking = 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 area that would be covered by these features is not know 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 be permanently sterilised (i.e. not be available for exploitation by other users) as a result of development of a terminal facility on the site therefore, does not constitute an impact. 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
Impacts significance ranking = 5 - low

10.4.6.2 Produced water re-injection

The base case for the Phase 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. Produced water is not expected to be generated until later in ACG field development but when produced, would be separated from the hydrocarbon stream at the terminal. Once separated, it would be transported, most likely by pipeline, to Lokbatan for disposal by injection. Predicted rates for produced water generation are presented in the Project Description (Chapter 5). At peak Phase 1 oil production, the produced water generated at the terminal from the oil stabilisation process is anticipated to be approximately 19,000 bwpd with a cumulative disposal for the life of the project of up to 61 million barrels.

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.

Impact significance

Under current estimates produced water injection onshore would not be required until 2007 and additional work will be undertaken to identify the exact location of the preferred injection sites within the south-eastern 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 south-eastern 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 south-east limb of the Lokhbatan 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 Impacts significance ranking = 5 – low

10.4.7 Impacts on topography and landscape

10.4.7.1 Construction of terminal

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 to Astara coastal road 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 north-east 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.

Proposed Phase 1 terminal expansion

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 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 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 (5) 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 10.15 and summarised in Table 10.26.

Figure 10.15 Location of viewpoints

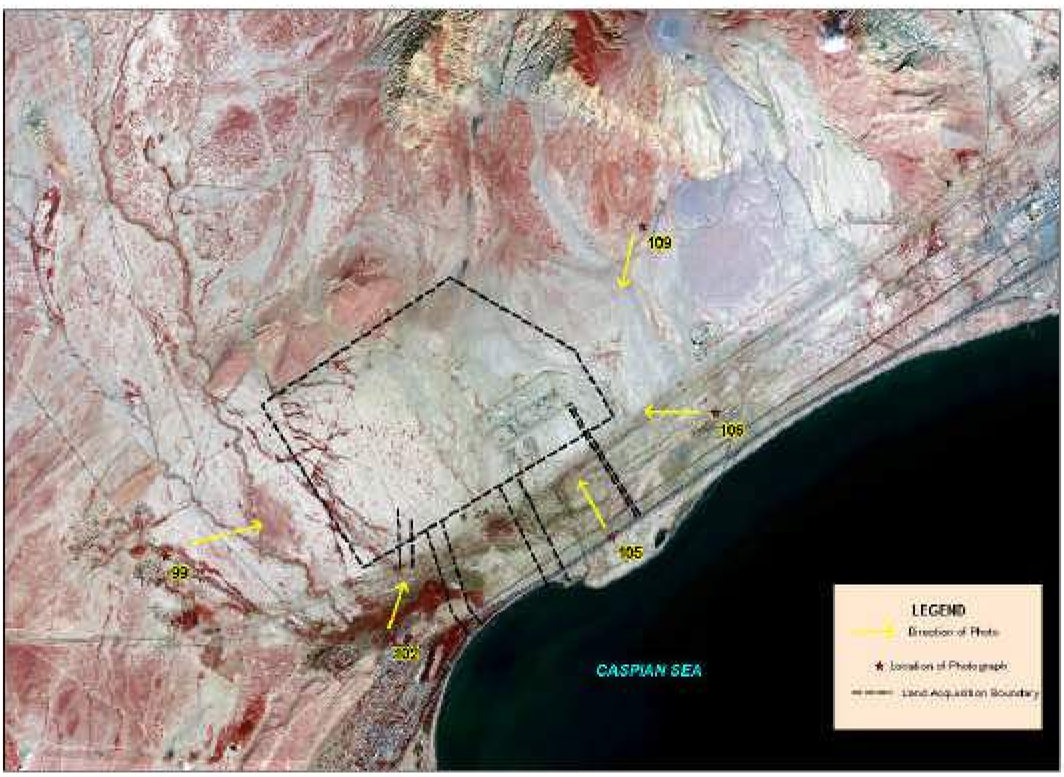


Table 10.26 Viewpoint summary

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. Powerlines 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. Powerlines and poles visually prominent in mid-distance
105	1.5	View from coastal road with background of hills. Slightly lower elevation than terminal site. Powerlines and poles in mid-distance
106	2	View from Umid IDP Camp area on westrn side of coastal road with powerlines 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 downslope 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 (5) view points 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 (5) 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 10.16 illustrates the view from viewpoint 99 pre- and post FFD terminal development.

Figure 10.16 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 north-easterly direction. The visual simulation from this viewpoint illustrates that:

- the additional 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 10.17 illustrates the view from viewpoint 102 pre- and post-FFD terminal development.

Figure 10.17 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 powerlines and support structures are visually prominent elements in the landscape.

View Point 105

Figure 10.18 illustrates the view from viewpoint 105 pre- and post FFD terminal development.

Figure 10.18 View from viewpoint 102 pre- and post-FFD terminal development

Pre-FFD Development

Post-FFD Development

From this viewpoint, the visual simulation illustrates that:

- existing view from the coastal road towards the site includes visually prominent powerlines 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 10.19 illustrates the view from viewpoint 106 pre- and post FFD terminal development.

Figure 10.19 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 powerlines 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

Figure10.20 illustrates the view from viewpoint 109 pre- and post-FFD terminal development.

Figure 10.20 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 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
Impacts significance ranking = 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 pipeline corridor lies within the central south survey sector which has been characterised as inland habitat in the Environmental Description (Chapter 6). Impacts on terrestrial habitat and specific floral and faunal species 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 and technical Appendix 10). 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 Phase 1 constructionand 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 had to be applied.

Individual floral and faunal species may be impacted differently. 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 many 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 Phase 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 in the south-east where it is proposed to construct the pipeline landfall and onshore trench host wetland habitat that is biologically productive and that performs critical ecological functions within the broader ecosystem. Ecotones, boundary or 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 pipeline landfall and the onshore section of the pipeline trench would result in disturbance of approximately 2 ha of coastal habitat including coastal wetlands. In addition, the corridor would traverse the coastal-inland habitat ecotone. As this coastal habitat is important in the local ecosystem, its loss is considered to be of "high " significance. 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, pipeline landfall and trench 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. 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[1]									
		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 those with larger numbers would recolonise later. 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 (Environmental Description, 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.

1 Natural variation in re-vegetation time is implied where the "Recovery Time in Years" is a range.

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* and *Calligonum bacuensis*. Direct habitat loss may result in a decrease in these species' local population numbers.

The impacts on coastal flora species associated with the pipeline construction activities are considered to be of "high significance due to the direct habitat loss and long recovery times as follows:

Likelihood of activities = 5 - certain to occur
Consequence = 2- local scale impact
Impacts significance ranking = 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 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 pipeline landfall construction and as there is similar coastal habitat nearby that would be accessible to resident bats, the impact of the pipeline landfall construction is 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 "negligible".

Golden Jackals would lose hunting/foraging ground wherever coastal habitat is lost, especially if within their home range2. 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 pipeline landfall and trench construction and associated works. This species would also lose hunting/foraging ground wherever coastal habitat is lost. In addition, Foxes use the coastal area and especially the south-east, 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 pipeline 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 installation works and associated activities. The coastal area, including wetlands and coastal semi-desert (slightly inland) areas, are used for3:

- 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.

2 Families hold hunting territories of 2 to 3 km^2
3 Note that the dates cited are species' averages across months.

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 pipeline construction 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.

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 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

While impacts on some coastal fauna resulting from construction of the pipeline landfall, onshore trench and associated works are considered to be of "negligible" to "low" significance, impacts on a few species are considered to be "high". Overall therefore, impact significance is considered "high" as follows:

Likelihood of activities = 5 - certain to occur
Consequence = 2- local scale impact
Impacts significance ranking = 10 - high

10.4.9 Impacts on terrestrial habitat, flora and fauna

Construction of the terminal and pipeline onshore section would impact on terrestrial habitats, flora and fauna. Construction activities associated with construction of the pipeline onshore section have been identified above. Terminal construction activities (including the civil engineering work programme) 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 oil processing facilities adjacent to the existing EOP terminal.

Impact significance

Terrestrial habitat

In excess of 170 ha of land would be directly impacted as a result of construction of the terminal. It should be noted that this includes the land clearance and levelling required to prepare the site for the construction of the Shah Deniz terminal within the terminal 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 impacts (*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 permanent. They would not however, be lost from the proposed 302 ha "no development zone" in the land acquisition areawhich 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);
- use of "TerraZyme" in compacting the new access road surface, 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 this is hard to quantify.

Minimisation of dust levels in the terminal construction area would be achieved by watering-down earthwork areas during the terminal engineering and construction activities. "TerraZyme" would be used in the water-down mixtures to help bind loose soils on the new access road and other areas that may require it. 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 assumed that minor 'burning' of leaves and stems may occur. This indirect impact would be mitigated by, as far as possible, using the product during lower wind conditions and by spraying the water close to the ground.

Uncontrolled soil erosion can lead to the increased turbidity levels in nearby waterways. Increased turbidity can have a number of resultant effects including reduction of aquatic flora growth rates 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 which 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, 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 below 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. Tables 10.34 through 10.37 present a breakdown of each community with recovery time in years for each constitute species.

Table 10.33 Inland floral communities natural recovery rates

Community	Soil type	Percentage Recovery to Pre-project Level[4]											
		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.

[4] Natural variation in re-vegetation time is implied where the "Recovery Time in Years" is a range.

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
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 Sharp-edged Darling Iris (*Iris acutiloba*) 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. Adverse effect on any red-listed species is considered to be of “high” significance as follows:

Likelihood of activities occurring = 5 - certain to occur
Consequence = 2- local scale impact
Impacts significance ranking = 10 - 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 (Environmental Description (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 loss of 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 expansion, the impact significance on this species is nonetheless considered to be “low”.

The Long-eared Desert Hedgehog would be directly impacted (mortality) where 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.

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 expansion and pipeline landfall construction. As the area lost is 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 and pipeline landfall construction would be most significant for this carnivorous species, overall, it is considered that impact would be of "low" significance.

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 significantly impacted as a result of terminal construction and associated activities. 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.

Overall, the impacts associated with the terminal engineering and construction activities on terrestrial fauna are considered to be of "high" significance due to the presence of red-listed species as follows:

Likelihood of activities = 5 - certain to occur
Consequence = 2- local scale impact
Impacts significance ranking = 10 - 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 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.
Impacts significance ranking = 5 - low.

Specific potential interactions are discussed below.

Noise

Vehicle, machinery and aircraft (e.g. helicopter) 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 neighboring 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.

Helicopter operations could also result in collision of helicopters with flying birds. Birds would be at greatest risk during dusk and dawn when they are moving (airborne) to roost and to go on daily foraging expeditions, respectively. Seasonally, the impacts would be greatest during migration periods (i.e. March to April and September to August) and the over-wintering period (October to mid-March). As helicopter operations would primarily be during daylight hours and as the total number of flights per day associated with construction activities and/or facility operations would not be large, collisions with birds is considered an unlikely event and therefore, this impact is considered to be of "low" significance.

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 buildup 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.

It should be emphasized that while emissions from construction and operation activities have been shown to be considerable, 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 mortality of a 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 the project area 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 behavioral effects on animal species with the most serious being those that decrease the chance for survival and reproductive success.

Behavioral effects that might decrease chances of surviving and reproducing include retreat from favorable 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 fetal re-absorbtion;
- 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.

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10.5 Impacts associated with waste management

A waste stream inventory for the ACG Phase 1 project has been compiled by Total Waste Management International (TWMI, 2001). A summary of this, as presented in the Project Description (Chapter 5; Section 5.10), identifies wastes for the range of activities to be conducted both offshore and onshore, for the lifetime of the project. Ultimate responsibility for correct waste disposal lies firmly with BP and in this role it will ensure:

- that project contractor(s) have adequate training and follow stipulated waste management procedures for minimising, handling and storing waste;
- that waste disposal contractor(s) use facilities for treatment and disposal of waste that meet acceptable standards; and
- that both these functions be performed using a combination of training, agreed procedures and audits and that will form part of a BP Caspian Sea operations Environmental Management System.

10.5.1 Approach to onshore waste management

BP policy requires that the disposal of all wastes must be justified by demonstrating that recovery, reuse or recycling is not reasonably practicable. The ACG PSA states:

> *"Trash shall not be discharged offshore. Trash shall be transported to an appropriate land-based disposal facility."*

Correct disposal or recycling of waste requires suitable and adequate facilities for proper segregation, storage and handling of all waste streams at the point of generation. To address and plan for the management of Phase 1 wastes that will be shipped-to-shore for recycling or disposal, AIOC have developed a draft Integrated Waste Management Plan (IWMP) the key aims of which is to:

- identify and where possible quantify the various waste streams resulting from the Phase 1 project (among others);
- assess the present arrangements for waste management;
- make recommendation for the appropriate disposal of Phase 1 wastes where current arrangements are insufficient and/or inappropriate.

The draft IWMP recommends the development 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 recommends 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.;
  - steam cleaners for pipe threads;
  - a neutralising plant for acids and alkalis;
  - steam cleaners for thread protectors 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;
  - bioremediation area for the treatment of drill cuttings;

- a landfill to be developed for the disposal of hazardous and non-hazardous incinerator residues plus hazardous wastes that cannot be incinerated.

AIOC will continue to assess waste disposal initiatives during the Detailed Design stage of the Phase 1 project.

10.5.2 Environmental implications of onshore waste management

Detailed waste management procedures will be put in place for the Phase 1 project including:

- waste storage, transfer and handling protocols;
- the requirement for consignment notes giving an accurate description of the waste; and
- inspection and auditing.

Additionally, all personnel employed at the project facilities will receive formal waste management awareness training, particularly regarding the correct waste segregation, storage and labelling procedures and potential recycling of waste.

These waste management procedures and associated training programmes will be consolidated in a final IWMP that itself will be identified in and linked to the Phase 1 Environmental Management System (EMS).

10.5.2.1 Waste transfer station

Wastes generated offshore, once segregated will be shipped-to-shore for disposal. Figure 10.23 illustrates disposal method for offshore generated wastes.

A waste transfer station is to be developed to receive various waste streams and it is likely that this facility will be developed at the existing SPS yard. An environmental impact assessment is currently underway for the proposed waste transfer facility. This document will address environmental impacts associated with the development. The transfer station would be designed and developed to meet relevant international standards for such facilities.

Figure 10.21 Disposal methods for solid and liquid wastes

Waste	Disposal method
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 to sea – 36"/30" to seabed and 26" sections from sub-sea surface caisson
	Cuttings re-injection (when available) – lower hole sections
	Containerise and ship-to-shore – lower hole sections when cuttings re-injection not available
Produced water	Treatment offshore and re-injection for reservoir pressure maintenance
	Treatment onshore and injection onshore at Lokbatan
Produced sand	Treatment (hydroclones) – re-injection offshore
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 fluids from surface and top-hole sections; and
- offshore re-injection of drilling cuttings and NWBM from lower hole sections.

The lower-hole cuttings from Phase 1 wells will need to be shipped-to-shore for disposal until offshore re-injection facilities are available[1]. Alternative disposal routes are also required as a contingency in the event that re-injection facilities become unavailable during the drilling programme (e.g. failure of re-injection well). The environmental impacts of cuttings re-injection have been discussed in Section 10.3.4.1.

To identify alternative onshore cuttings disposal routes, treatment trials are being initiated by AIOC/BP as discussed in the Project Description (Chapter 5; Section 5.10.1.5). The results of these cuttings treatment trials will influence the decision on what facilities, if any, would be developed onshore for management and disposal of drilled cuttings. The environmental impacts associated with alternative onshore disposal options will be assessed once a decision on which alternative treatment method will be pursued is made.

10.5.2.3 Hazardous and non-hazardous wastes

High temperature incineration

The option of high temperature incineration would be dependent on such a facility being available. Two options have been cited to date namely a use of an existing high temperature (i.e. 2,000^{o}C) kiln at the Garadag Cement Plant or a stand-alone incinerator that would be a new-build. At the time of writing, high temperature incineration as a waste disposal route was still under discussion. An assessment of the environmental impacts associated with high temperature incineration would be completed if this option were to be pursued. The key environmental issues would be associated with emissions to atmosphere and potential to impact on human health and other sensitive receptors in the vicinity of the facility.

Landfilling

A series of lined landfill cells are likely to be required to receive Phase 1 wastes. Such wastes would include disposal of incinerated residues, some hazardous solid wastes and potentially cuttings.

Existing data suggests that it may not be possible to find an area within the existing non-hazardous Serenja landfill. If this is the case an alternative site location will be required. 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 Sumgait although other sites, as yet undefined may be suitable.

There is considerable advantage to AIOC in the use of the Sumgait 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:

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[1] At the time of writing, it was expected that the first, second or perhaps third well would be developed as cuttings re-injection well.

- 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.

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10.6 Impacts resulting from non-routine (accidental) events

Whilst AIOC 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 ACG Phase 1 project, there is a risk of an oil or chemical spill from the offshore facilities impacting the coastline of Azerbaijan and neighboring countries. Such unplanned non-routine releases may be caused as a result of human operational error or by natural phenomena (e.g. seismic events). This Chapter addresses the potential impact of an accidental event occurring and considers the following events:

- oil spills;
- unplanned release of wastes;
- loss of control of re-injection wells (produced water and/or cuttings);
- dropped objects and impact damage to existing live subsea structures (eg pipelines)

10.6.1 Oil spills

The risk of oil spills is a key concern to AIOC as well to the public and was raised as a concern by stakeholders (Chapter 8). AIOC 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 oil spill contingency equipment, thereby removing and/or reducing the likelihood and consequences of an accidental release of oil into the Caspian environment. It is AIOC'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 and this approach has resulted in there being a very low probability of an oil spill from occurring and resulting in significant environmental impact.

10.6.1.1 Risk assessment

Even with the incorporation of comprehensive oil spill prevention measures, the residual risk of an oil spill cannot be eliminated and the formulation of detailed oil spill contingency response plans appropriate to local environmental sensitivities remains integral to AIOC's operation. To assist in this planning, a comprehensive oil spill risk assessment has been conducted for the Phase 1 development in order to identify potential sources and probability of oil spill during the ACG Phase 1 development.

The oil spill risk assessment used data on the frequency and consequence of a spill as derived from a number of sources. These include:

- Historical spill data from oil production operations in 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 these data to the Caspian environment is considered appropriate, as the operations will be run to standards similar to these fields. However it should be recognised that these data have been interpolated from a different geographical region.
- Discussions and workshops held in June and July 2001, involving members of the ACG Phase I design team and environmental specialists from URS when expert option and experience was employed and a consensus achieved concerning frequency and consequence. This process allowed experience gained on the EOP to be imported to the ACG Phase 1 project.

The determination of the most likely spill frequency associated with each project activity for ACG Phase 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 ACG Phase 1 to determine the most likely spill frequency associated with the project. When discussing the frequency of possible oil spills the following terminology was employed:

- 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; and
- extremely remote, spill every 1001-10,000 year.

The results of the risk assessment are provided in detail in the ACG Oil Spill Risk Assessment report (URS, 2001) and so are only provided in summary in this report. Figure 10.22a shows the distribution of oil spills by project activity, with figures 10.23 to 10.24 illustrating the statistically expected number and probability of different sizes of spill from the ACG Project. These results were used to determine the appropriate spill scenarios for input into the Oil Spill Modelling (Section 10.6.1.3).

Figure 10.22 Likelihood of spill by size and source from the ACG Phase 1 project by project activity (2001 through 2024)

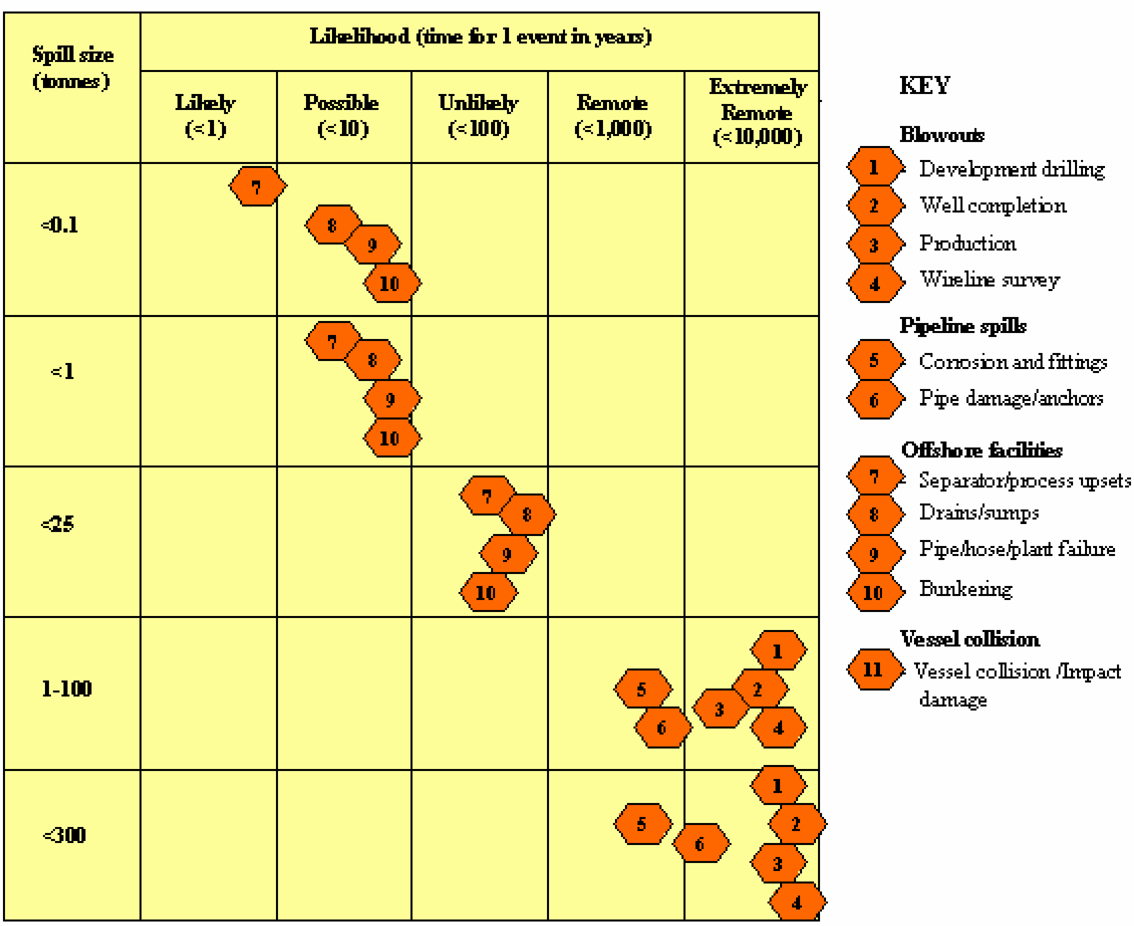
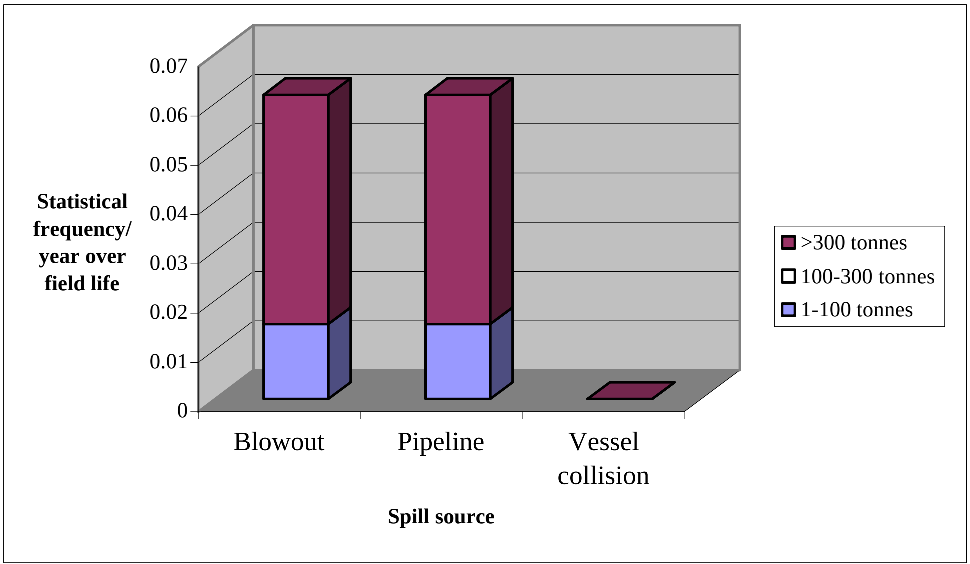
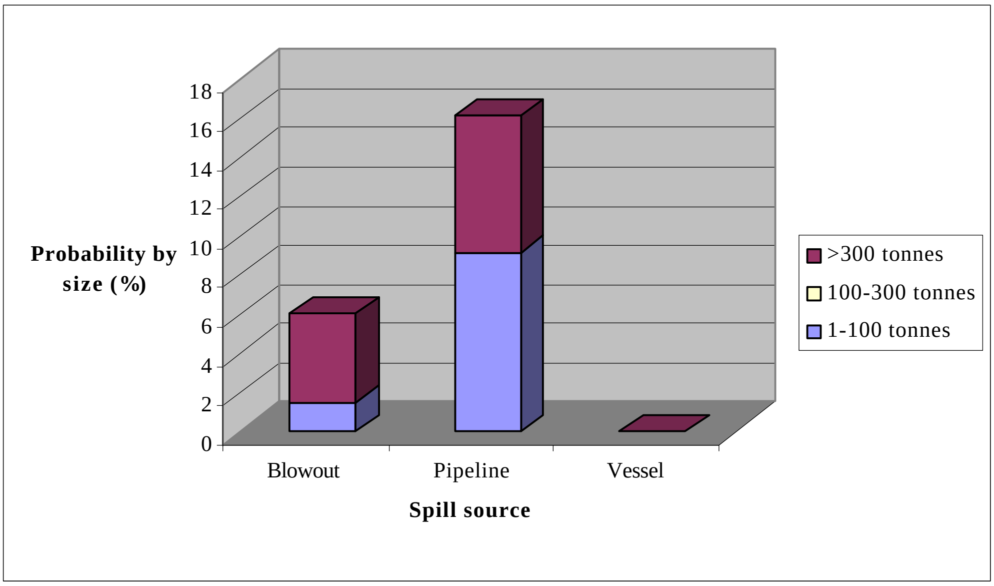


Figure 10.23a Statistically expected number of spills by size - Phase 1 lifetime (2001 through 2024)[1]



[1] Data for small operational spills from offshore leaks are shown in Figure 10.24c.
[2] Spills recorded are either brought under control within the spill size of 100 tonnes or exceed >300 tonnes. No spills fall within the 100-300 tonne range.

Figure 10.23b Probability of one or more spills by size (%) - Phase 1 lifetime (2001 through 2024)



[1] Data for small installation spills shown in Figure 10.24d

Figure 10.24a Statistically expected number and sources of installation spills from by size -Phase 1 lifetime (2001 through 2024)

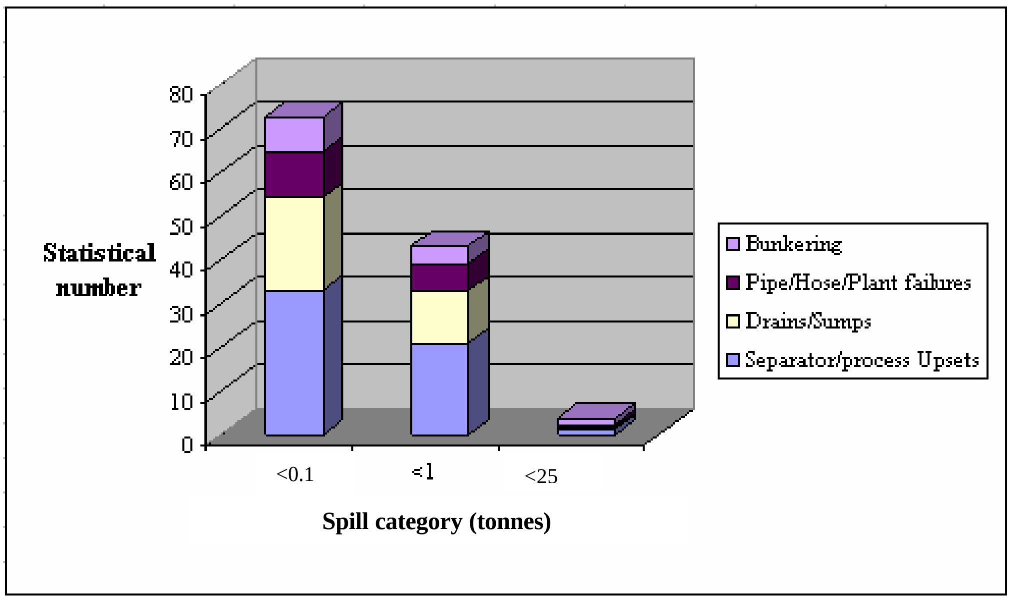
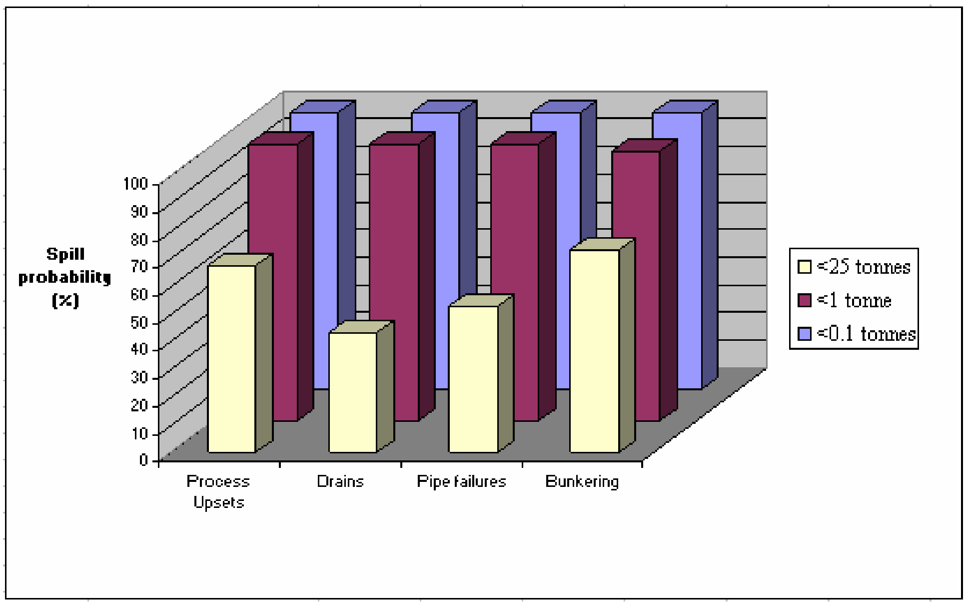


Figure 10.24b Probability and source of small installation spills by size (%) - Phase 1 lifetime (2001 through 2024)



10.6.1.2 Oil weathering and characterisation of Azeri crude

To investigate the behaviour of oil released from the Phase 1 drilling location at sea, oil spill weathering and modelling studies were conducted. The results of these are provided below.

Crude oils spilt on the sea surface undergo evaporation and emulsification processes that change the physical properties of the oil (Section 10.6.1.5). These changes are important as they determine the long-term persistence of the oil and the choice of spill response techniques. Some oils 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. 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 form.

The behaviour of the oil is important in determining a response strategy that it is essential for oil contingency plans to 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 once on the water requires not only information on the physical properties of the crude in a fresh state but also on such properties in a weathered and emulsified state. To be able to understand changes in the physical properties of the oil that would occur in the event of a surface spill, it is necessary to conduct laboratory-weathering studies. Such studies provide "constants" that are specific to the crude oil under investigation. Once oil constants have been determined, spill trajectory modelling (i.e. prediction of the fate of the oil once on the water's surface) can be completed.

For this impact assessment, samples of Azeri crude were subject to laboratory tests in order to determine an OSIS[1] constant to be added to the OSIS database of crude oils. The Azeri Crude oil was analysed for viscosity, emulsification and evaporation to determine the following:

- evaporation, emulsification and changes in viscosity after a spill;
- modelling constants (for OSIS); and
- oil properties modelling with OSIS.

The crude exhibited unusual weathering behaviour in so far as it is a light oil yet forms viscous emulsions at low temperatures. Laboratory tests on the evaporation of the Azeri Crude suggest that it will rapidly lose approximately 20% by volume to the atmosphere by evaporation within the first few hours on the sea surface. After one to two days, approximately 32% by volume will be lost. This loss in volume will however, be counterbalanced by the increase in volume as a result of the formation of a water-in-oil emulsion. The oil is expected to form a stable emulsion at a maximum water content of 82%, significantly increasing the volume of the residual oil and its viscosity.

The viscosity of the crude was observed to be significantly higher with lower temperature, with laboratory conditions of 6^{O}C and 27^{O}C. This difference becomes more apparent as the Azeri crude evaporates. When the oil has weathered for a few hours (i.e. after 20% evaporative loss), the viscosity increases. This difference is further emphasised after 1 to 2 days weathering (i.e. after 32% evaporative loss) where the viscosity increases further to form a stable emulsion that is considerably more viscous at a lower temperatures. For example, at 6^{O}C, the emulsion viscosity is much higher than was observed at 27^{O}C. The high viscosity of the Crude, particularly at low temperatures, suggests that a spill may persist for 10 days at high wind speeds and several weeks at low wind speeds.

10.6.1.3 Oil spill trajectory modelling

Although the probability of an oil spill occurring is unlikely, it is necessary to model the fate and behaviour of oil released to the environment for the reasons discussed previously. Potential sources of oil and fuel spills to the marine environment from the ACG Phase 1 project include the following:

- vessel release from:
  - operator error;
  - collision incident and loss of containment;
  - failure in storage facilities;

[1] OSIS = Oil Spill Information System a computer based industry standard oil spill trajectory modelling application. OSIS Version 3 was used throughout the ESIA.

  - 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;
  - dropped object over a live pipeline and loss of integrity.
- 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 oil-in-water treatment system.

In consideration of the above and to assess the behaviour of an oil spill at sea, oil spill trajectory modelling was conducted using the OSIS oil spill model. The following scenarios were modelled:

- catastrophic blowout at platform location with surface release of crude oil;
- catastrophic failure of main export pipelines to shore with subsea release of oil including;
  - nearshore (~1.25km);
  - offshore;
- small leak in pipeline with subsea release of oil including:
  - near shore (~1.25 km);
  - offshore;
- loss of inventory of storage tank with release to sea surface of diesel;
- small process equipment leak/spillage.

Modelling was conducted using the following types of model runs:

- Stochastic modelling, where actual statistical wind speed/direction frequency data is 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 is used to obtain 'worst case' shoreline impacts without any oil weathering processes applied and produces the shortest time to shoreline contact under these meteorological conditions.

- Single trajectory modelling is used to predict the weathered state of the oil for each of the stochastic modelling results. The model uses the fastest wind-driven travel speed for oil on the sea to predict the shortest beaching time, termed the 'worst-case scenario'. This represents the shortest allowable response time before the oil reaches a shoreline under 'worst case' conditions. The trajectory model also provides an understanding of the changes in the nature and state of the oil 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 PDQ

A well blow-out can occur when the pressure of the formation exceeds the pressure maintained during drilling, resulting in the complete loss of well control and the uncontrolled flow of oil from the wellbore. This is mitigated against during drilling by two independent barriers; the weighted mud system and in the event that this is temporarily lost, the blow-out preventor. Sudden changes in conditions in the well, such as striking localised high pressure zones may cause a rapid high pressure kick which has the potential to cause both prevention barriers to fail.

Whilst the probability of a blow-out is extremely unlikely, the consequences represent the worst-case oil spill scenario with oil flowing from the largest well. This scenario would apply equally to template well drilling and platform drilling. the 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 drill a relief well.

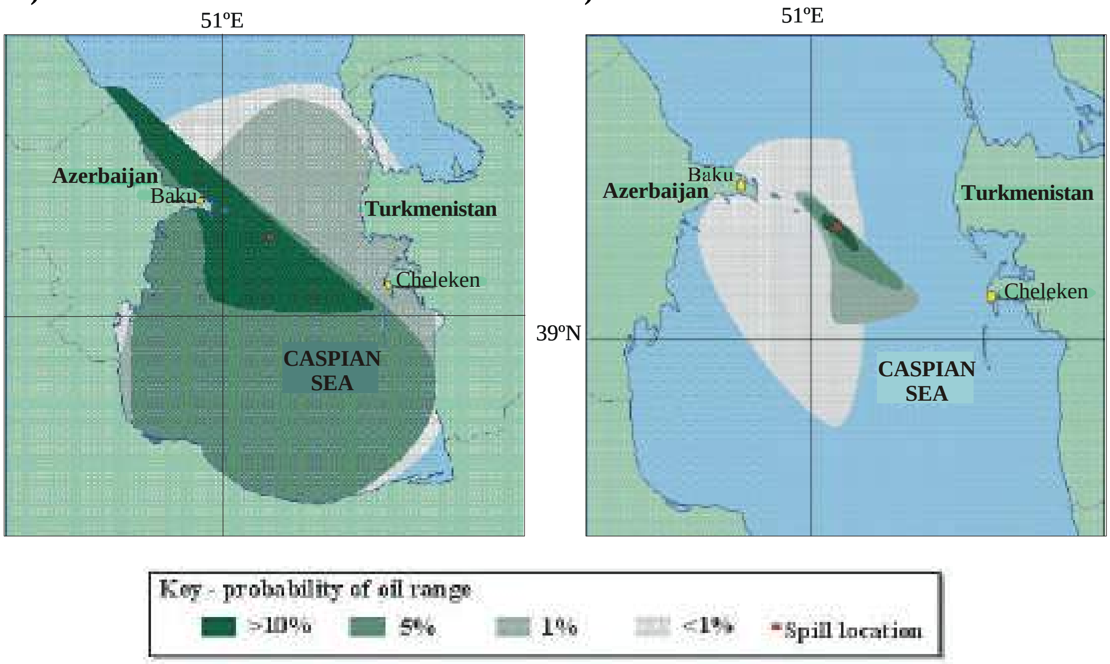
For the Phase 1 project, the blow-out scenario assumed an open hole flow-rate of 30,000 bpd and a minimum of 30 days to mobilise a drilling rig and drill a relief well. Since there are a limited number of drilling rigs available in the Caspian, it has to be assumed that if another drilling rig is required, it will likely be working elsewhere and thus allowance for the drilling rig to cease operations at another location and to transit to the ACG location would take 7 and 5 days respectively. Thus the total time for the worst-case blowout scenario is 42 days. Based on this timeframe, the total amount of oil reaching the sea by this scenario equates to:

- 30,000 bpd = 4,769 m^3/day; and
- for 42 days = 200,324 m^3

Stochastic modelling conducted for this scenario in both winter and summer conditions is shown in Figure 10.25.

Figure 10.25 Stochastic modelling of an accidental release of oil resulting from a well blow out

a) Winter **b) Summer**

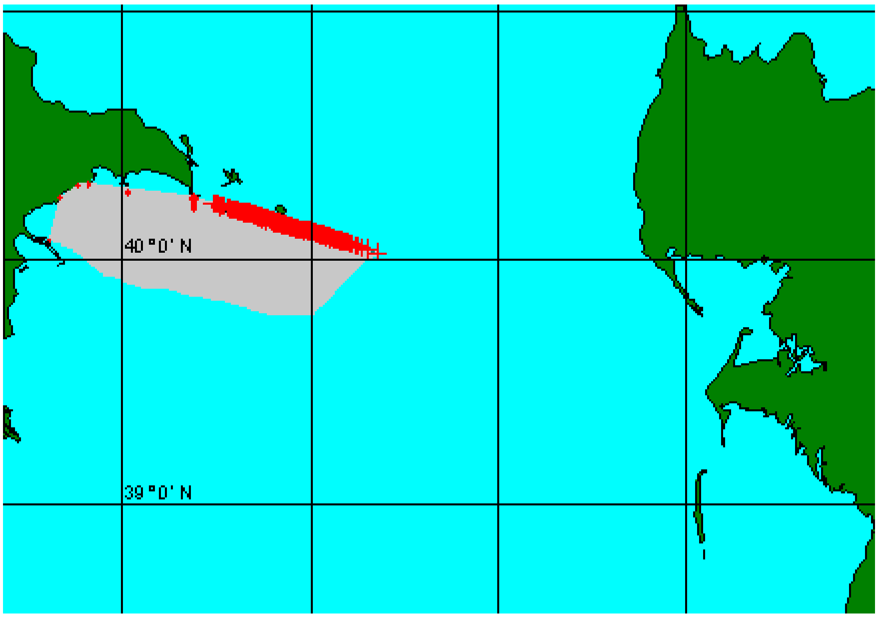


The movement of the oil under the modelled scenario shows a much different distribution under winter conditions than in summer because of seasonal differences in meterological conditions (air temperature, wind direction and speed) and their affect on the physical properties of the oil and on surface currents. With the absence of tidal forces in the Caspian, currents are largely wind driven and during winter when wind and sea conditions are stronger, the oil is physically broken up and as a result does not travel as far (Section 10.6.1.5). Despite these seasonal differences in the extent of oil distribution, in both model runs oil was transported predominantly to the northwest, south and south east of the field into the Southern Central Caspian Sea area, with the heaviest area of oiling also occurring in these directions.

Under summer conditions there is a high probability (>10%) of oil beaching along the coastline north of Baku with oil also reaching the west coast of the Caspian Sea from the Apsheron Peninsula north towards Makhachkala. There is a 5% chance of oil beaching around the coast of the southern Caspian. There is a 1% probability of oil reaching the Cheleken Peninsula in the east.

Trajectory modelling was used to determine the shortest time available before oil beached along these coastlines from a blow out scenario (Figure 10.26)

Figure 10.26 Trajectory model for an accidental release of oil from a well blow out



The trajectory model shows that under the blow out scenario simulated, with a constant 20 kn onshore wind, the oil would first reach land modelling results show that 77,821 m^3 of crude would impact the Apsheron Peninsula after 49 hours. This is considered an adequate time to mobilise a marine and shoreline response (Chapter 14). The oil spill response strategy is further described in Chapter 14.

Potential spills from the 30" oil export pipeline

Pipeline spill risks are reduced by a combination of planning and design (operational standards and practices, sensors to detect pressure changes from lost inventory). However, there is the potential for a number of pipeline spills to occur from Phase I. These can be classified into minor, moderate and major leaks, with the size of the spill depending upon the rate of oil leak from the pipeline and the time taken for detection. Using industry accepted definitions for pipeline spill sizes, the leaks may be defined as follows:

- Minor leak. Low release rates (<0.1 m^3/hr) and usually from small holes (<0.5 mm). Generally the result of pipeline corrosion, poor fitting flanges, damaged or poor fitting seals or vents. 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. A 'significant' leak, which is not detectable by an online leak detection system (i.e. loss of <10% of the pipeline flowrate) but is detectable on the sea surface (requiring a release of 0.23 m^3/hr). Moderate leaks are usually 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 an online leak detection system (leak loss of >10% loss of total flow rate) and the product of a significant impact and physical damage sufficient to cause a pipeline rupture (eg from vessel grounding or dropped anchors).

In consideration of the pipeline leak types discussed, major and minor pipeline spill scenarios were modelled.

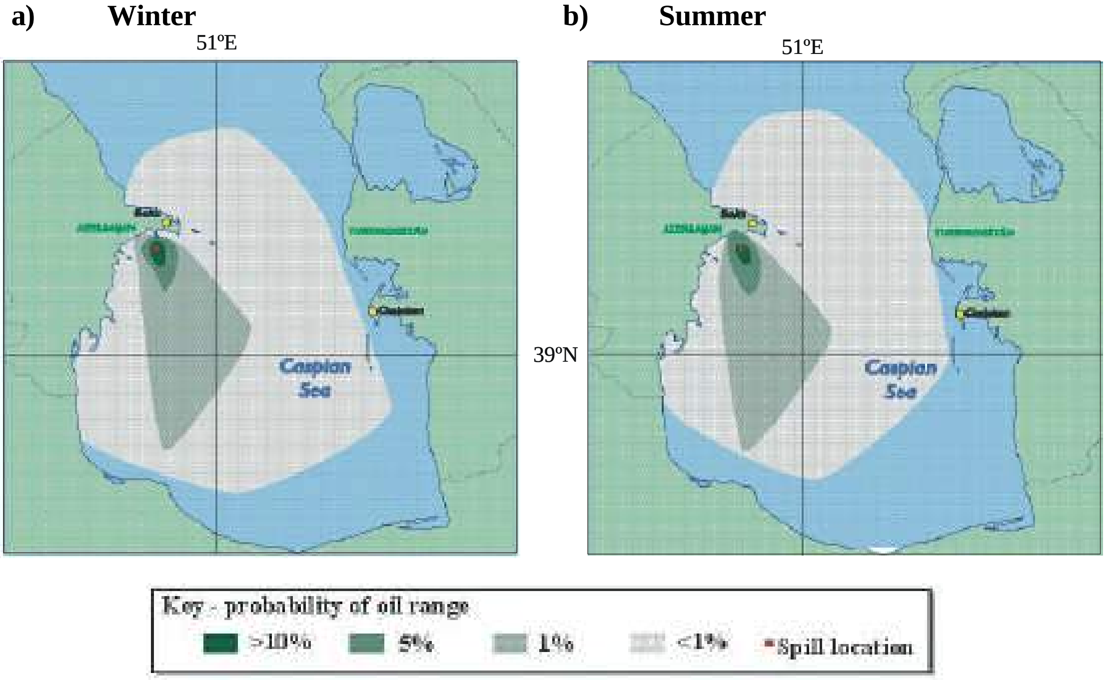
Catastrophic failure of a pipeline

It is considered that, although there is potential for a pipeline leak to go undetected, given the ability of the platform and the terminal to detect pressure drops in the pipeline, it is considered unlikely that a major catastrophic failure of the main export pipeline would take more than an hour to detect and for shut-in of production to be implemented. The worst case for a pipeline failure is therefore, based on the inventory of the pipeline and one hours production.

The volume of the pipeline is 85,746 m^3. The production rate is 5.2 x 105 bpd or 3,451 m^3/hr. Assuming one hour for shut-in of production, then the total potential spill would be 89,197 m^3. Stochastic modelling was conducted for the release of this inventory over 26 hours in winter and summer conditions with scenarios run as two separate events assuming a nearshore (UTM 9371500E, 4449800N) and offshore (UTM 4433190N, 9530085E) releases (Figure 10.27).

Figure 10.27 Stochastic modelling of a major pipeline leak (catastrophic failure) in the nearshore zone

a) Winter **b) Summer**

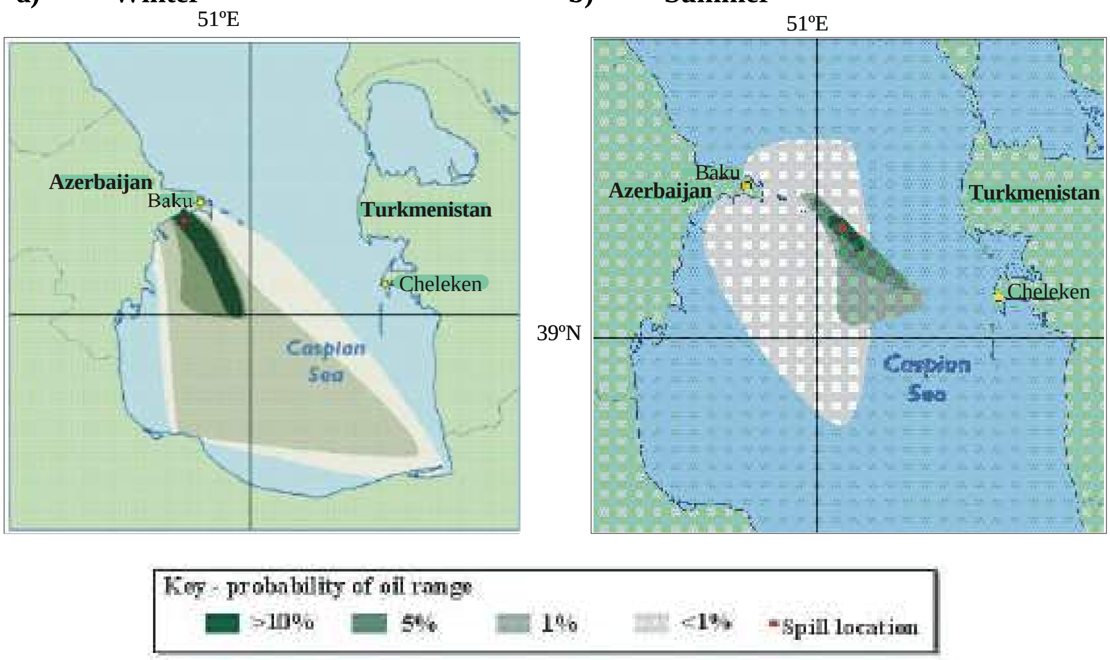


The results for the nearshore release show that despite seasonal meterological and oceanographic conditions, there is a consistent pattern of oil movement in winter and summer conditions with the oil being transported predominantly to the south of the field into the Southern Caspian Sea area. Heaviest oiling is in the area directly to the south and south east of the release location. Even under these extreme conditions, there is a <1% probability of oil reaching the Apsheron Peninsula in the West, the Cheleken Peninsula in the east and the Khazar Island in the Southwest.

For the assessment of an offshore release of the above scenario, the results show a different pattern of behaviour for the winter and summer runs (Figure 10.28).

Figure 10.28 Stochastic modelling of a major pipeline leak (catastrophic failure) in the offshore zone

a) Winter **b) Summer**

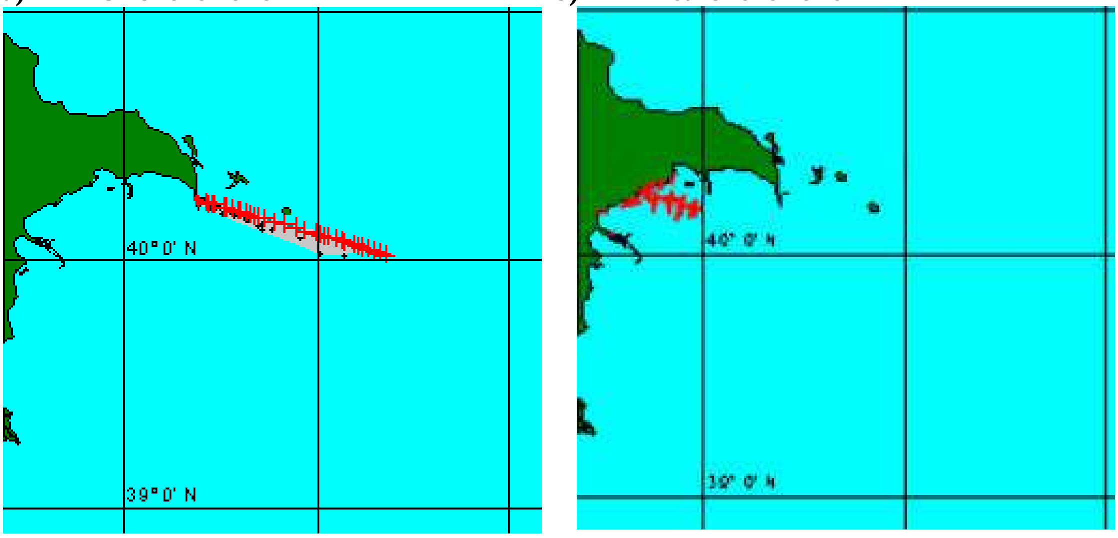


It can be seen from Figure 10.28 that during the winter run, oil is transported predominantly to the northwest and southeast of the field into the Central and Southern Caspian Sea areas with the heaviest area of oiling directly to the southeast and northwest of the release location. In the summer run scenario, the oil was transported predominantly to the southeast of the field into the Southern Caspian Sea area with the heaviest area of oiling directly to the south and south east of the release location. In both winter and summer scenarios, there was a <1% probability of oil beaching.

Single trajectory modelling was conducted for the above catastrophic pipeline failure scenarios to determine the shortest time for oil to reach the shoreline under these scenarios. The results of the simulations are shown in Figure 10.29

Figure 10.29 Trajectory modelling of an oil spill from a catastrophic pipeline failure

a) Offshore zone **b) Nearshore zone**



Modelling of the pipeline spill at the nearshore location shows that on release of the oil there is an increase in volume due to emulsification, before steadily decreasing in volume as the oil disperses and evaporates. At the end of the simulation, 20,470 m^3 of the oil evaporated, 9,974 m^3 dispersed and 29,4481 m^3 of the original volume has beached at the point of nearest landfall after 19 hrs.

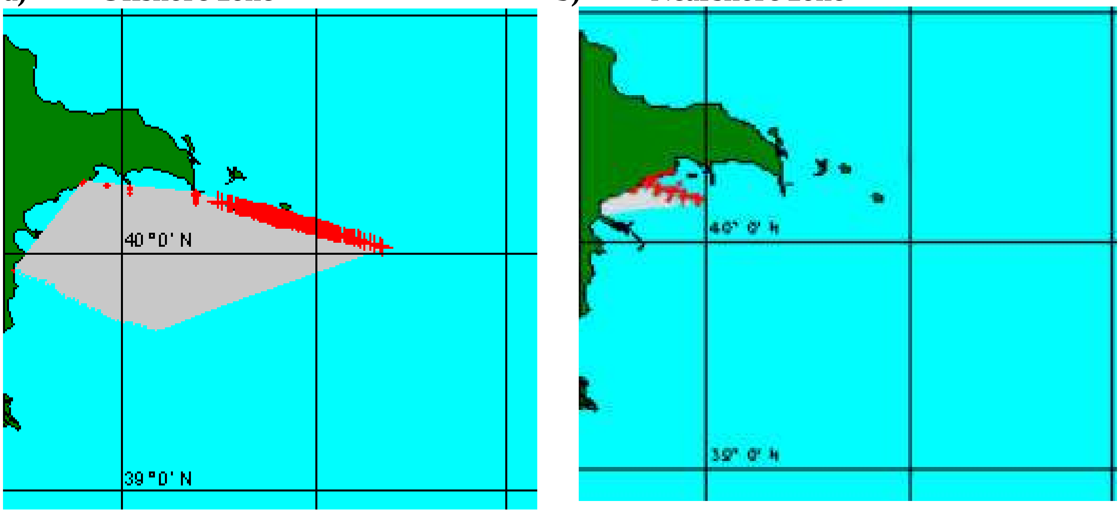
Modelling at the 30" pipeline offshore location using trajectory simulations shows that the oil undergoes an increase in volume due to emulsification before steadily decreasing in volume as the oil disperses and evaporates. At the end of the simulation, 23,458 m^3 of the oil evaporated, 13,409 m^3 dispersed and 264,288 m^3 of the original volume beached at the point of nearest landfall after 38 hours.

Minor pipeline leak

There is potential for delayed detection of smaller leaks with consequent delayed shut-in of production. A more credible undetected pipeline leak is approximately 1 m^3/hr over a period of 30 days. This is based on the assumption that a small leak from the 30" pipeline low-pressure separator could go undetected for some considerable time since the oil would be dispersed and broken down. The worst-case small pipeline leak would therefore, result in an amount 720 m^3 of oil being lost to the water column. The main concern is for these spills to reach sensitive shorelines and as a result trajectory modelling, rather than stochastic modelling is conducted to determine the shortest travel time to shore. Trajectory modelling was conducted for the release of this inventory scenarios run as two separate events, an offshore and a nearshore release (Figure 10.30)

Figure 10.30 Trajectory modelling of an oil spill from a small pipeline leak

a) Offshore zone **b) Nearshore zone**



As can be seen from Figure 10.30, both models mirrored the increase in volume due to emulsification that was observed during the large-scale release as well as the following reduction of the oil volume as the spill dispersed and evaporated.

Offshore it was observed from the model that 321 m^3 evaporated, 358 m^3 dispersed and 197 m^3 beached at the point of nearest landfall after 48 hours.

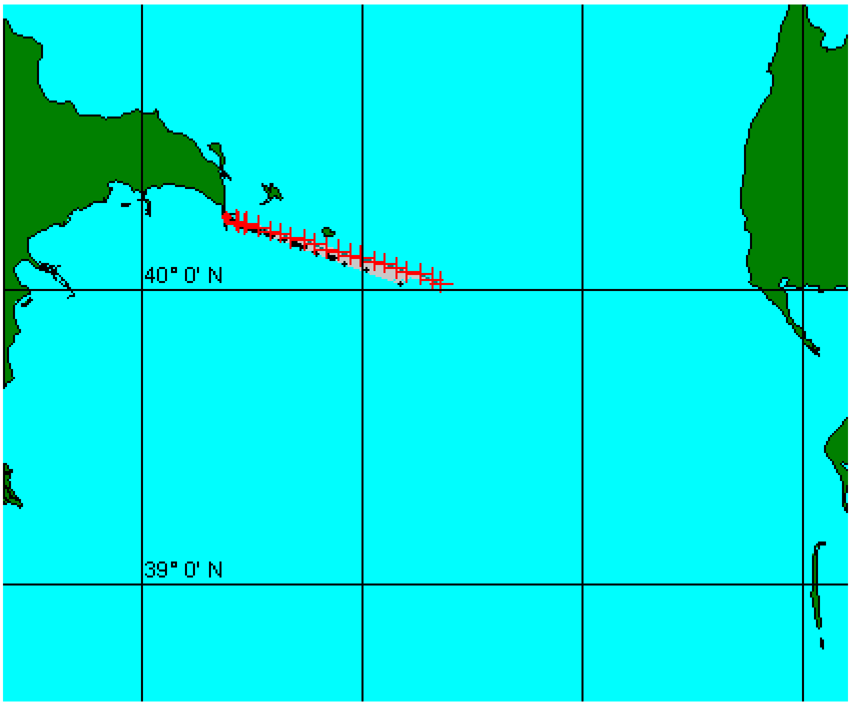
For the nearshore scenario, of the total 720 m^3 volume released, 317 m^3 evaporated, 361 m^3 dispersed and 205 m^3 beached at the point of nearest landfall after 26 hours. The difference between the volume released and total volume of the evaporated, dispersed and beached volumes are attributable to the commingling of oil and water as the oil emulsifies, causing an increase in volume.

Process equipment leak/spillage

Failure of an offshore separator or other process equipment (e.g. rupture or failure of a valve or pipework) could lead to a loss of 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 shutdown promptly if not immediately. Furthermore, the drain system should contain most of any process area spill. The most likely scenario would therefore, be a leak of the contents of the one largest of the separators on the platform. In this case the worst-case spill would amount to 140 m^3 assuming no containment of the spilled oil.

In common with small pipeline spills, the small scale spills from loss of inventory were modelled using trajectory simulations to identify areas that may be at risk from the spilled oil. The trajectory model showed that the oil experienced the same changes in volume through emulsification and later evaporation but remained persistent to enable beaching after 37 hours. Of the total oil inventory, 51 m^3 evaporated, 25 m^3 dispersed and 315 m^3 beached (Figure 10.31).

Figure 10.31 Trajectory modelling of an instantaneous release of oil from the LP Separator



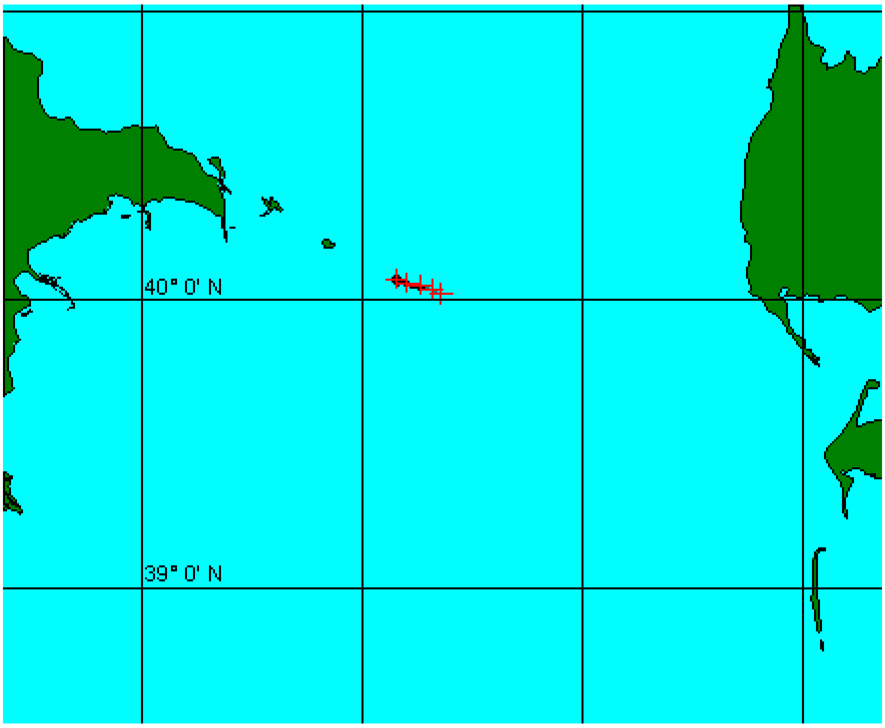
Loss of inventory of fuel/oil storage

In comparison to the risk of spills from blowouts or pipeline rupture, a more common types of spill from 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 offshore diesel storage spillage scenario is the overfilling of the diesel storage tank by the supply boat or filling a diesel storage tank which has the drain valve left open. The maximum diesel storage capacity of the PDQ is 100 m^3 per storage tank. Offshore spills from vessels servicing the platforms are also possible. For the purposes of modelling and for risk assessment, it has been assumed that the support vessels carry approximately the same volume of diesel.

As with the loss of oil from the low-pressure separator, it was not considered necessary to use stochastic modelling for this release. The results of the trajectory model showed that upon release, the diesel quickly evaporated (39.54 m^3) and dispersed (60.46 m^3) to the point that after 8 hours the surface slick at sea became insignificant. This is illustrated in Figure 10.32.

Figure 10.32 Trajectory modelling of an instantaneous release of diesel (instantaneous release from loss of diesel storage tank) in worst-case



In summary, the modelling shows that a large spill of Azeri Crude from the ACG PDQ and nearshore and offshore pipeline locations have a low to extremely low probability of oil impacting the shoreline around the Caspian. The shortest beaching times for large crude releases from the platform, pipeline nearshore and pipeline offshore locations are 49 hours, 19 hours and 38 hours respectively. This allows sufficient time to mobilise marine and shoreline response resources.

10.6.1.4 Effectiveness of dispersants

The spill trajectory modelling shows that under certain conditions, there is a potential for oil to impact the coastlines of Azerbaijan, Turkmenistan and Islamic Republic of Iran. Transboundary impacts from the accidental release of oil are discussed in Chapter 13 Transboundary Impacts.

Dispersants have been developed and used to combat oil spills that have the potential to impact sensitive coastlines and an early study of the suitability of dispersant use in these cases is provided in the technical appendices. 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 the spill. It should be noted however, that whilst it is recognised that dispersant use is not the principal response option in Caspian waters, dispersants are stockpiled in case of safety incidents.

For the purposes of this impact assessment, one dispersant type (i.e. Finasol OSR51) that is available in Azerbaijan was tested to assess whether this dispersant was effective against spills of Azeri crude oil at various stages in the weathering and emulsification process. The results indicate that the dispersant tested would be effective on a spill of fresh Azeri Crude oil at 6°C and 27°C. Once the oil becomes weathered and emulsified however, Finasol OSR51 was not effective.

Using the OSIS model to analyse the time window for dispersability provides further information on the time available for dispersant application under different conditions. The analysis indicates that at low temperatures, when Azeri Crude is most viscous, the fresh crude is only likely to be 'dispersible' with Finasol OSR51 for less than one hour in all wind conditions. At low temperatures and high wind speeds, the crude will rapidly weather and emulsify to a state at which it is not dispersible with this product. At lower wind speeds (e.g. 2 to 5 m/s), this process of weathering and emulsification is far slower and there may be an extended time window of a few days (compared to higher winds) when Azeri Crude may be possibly be dispersible. At higher temperatures, time window analysis indicates that Finasol OSR51 is likely to be effective for less than one hour at high wind speeds (i.e. 10 to 20 m/s) although this increases to 9 to 55 hours at low wind speeds (i.e. 2 to 5 m/s).

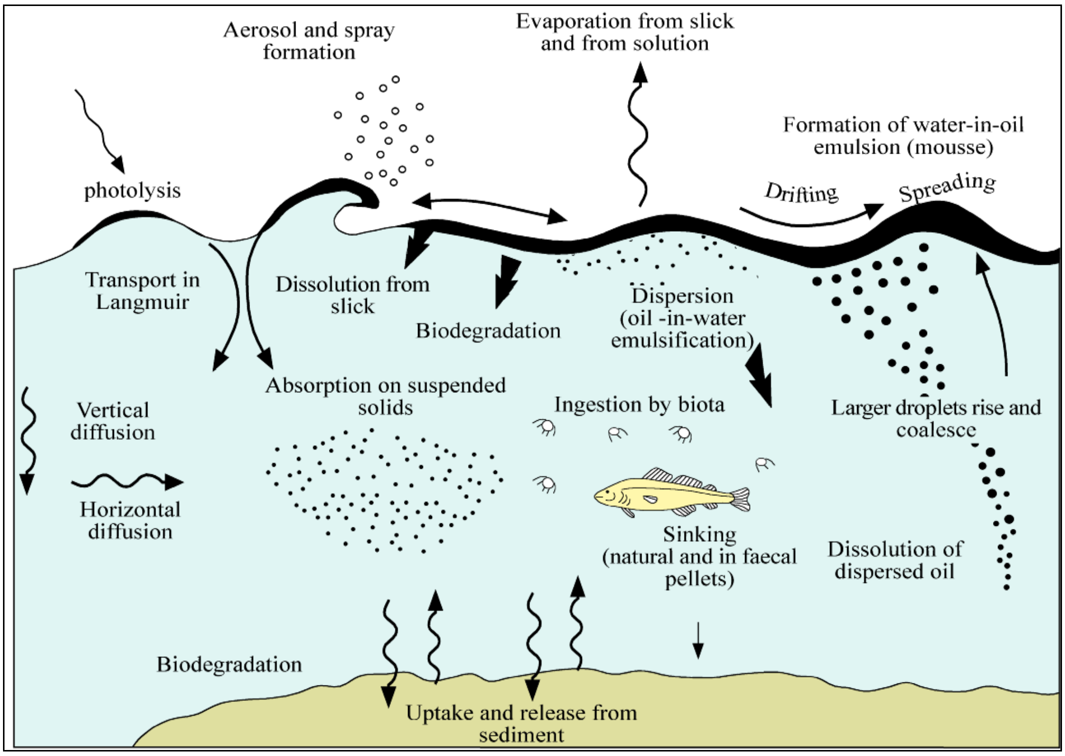
In summary, the laboratory studies indicate that a spill of Azeri Crude will form stable viscous emulsions that may persist for a number of days at sea. It was found that treatment of the crude with dispersant tested is only likely to be effective in the very early stages of a spill and would not be effective in cold conditions. It should be noted however, that whilst the effectiveness of Finasol OSR51 has been shown to be limited, there are many other dispersants on the market that may be more effective in an oil spill response for spilled Azeri Crude. If dispersant use is considered as part of the contingency plan, additional dispersants will be tested to assess their effectiveness in combating Azeri crude spills.

10.6.1.5 Impact of an oil spill from ACG Phase 1

Behaviour of oil in the marine environment

After an oil spill, complex processes in the marine environment start breaking down the oil from the first seconds of the oil's contact with seawater. The behaviour of the oil and the rate of change in its physical condition from the interaction between the oil and the marine environment depends on the properties and composition of the oil itself, parameters of the actual oil spill, and environmental conditions. The main characteristics of oil transformations and the close interaction of physical, chemical, and biological mechanisms of dispersion and degradation of oil components contribute to the transformation of the oil spill into more common and safer substances. The main processes acting on the oil spill are discussed below and illustrated in Figure 10.33.

Figure 10.33 Fate and behaviour of spilled oil in the marine environment (from Brown, et al. 1992)



Physical transport

The distribution of oil spilled on the sea surface occurs under the influence of gravitational forces, with degree of movement largely controlled by oil viscosity, the surface tension of the water, meteorological and hydrological factors and the direction of movement of the oil depending mainly on the power and direction of wind, waves, and currents. As the oil travels across the surface of the water, the slick gets thinner. During the first several days after the spill as the oil continues to spread, a considerable part of the oil transforms into a gaseous phase as volatile components are lost to the atmosphere. Further losses occur as the slick rapidly loses water-soluble hydrocarbons into the water column, with wind and wave action producing active turbulence which speeds up the dispersion of the slick and its fragments. As these volatile components are lost, the oil becomes more viscous, slowing down the spreading of the slick.

Oxidation and destruction

Chemical transformations of oil on the water surface and in the water column start within a couple of days of the oil entering the marine environment. Oxidation of the oil by photochemical (photooxidation and photolysis) reactions from the ultraviolet waves of the sun aid the decomposition of the most complex molecules of the oil; although the products of oxidation can have increased water solubility and increased toxicity. These processes increase the oil's viscosity and promote the formation of stable oil aggregates.

Dissolution

Most oil components are water-soluble to a certain degree, especially low-molecular-weight aliphatic and aromatic hydrocarbons. Polar compounds formed as a result of oxidation of some oil fractions in the marine environment also dissolve in seawater. Compared with evaporation, dissolution takes more time. Hydrodynamic and physicochemical conditions in the surface waters strongly affect the rate of the process.

Emulsification
Oil emulsification in the marine environment depends, first of all, on oil composition and the turbulent regime of the water mass. The most stable emulsions such as water-in-oil contain from 30% to 80% water. They usually appear after strong storms in the zones of spills of heavy oils and can persist in the marine environment for several months in the form of peculiar "chocolate mousses". Stability of these emulsions usually increases with decreasing temperature. Conversely, oil-in-water droplets are much less stable because surface-tension forces quickly decrease the dispersion of oil. This process can be slowed with the help of emulsifiers - surface-active substances that help to stabilise oil emulsions and promote dispersing oil to form microscopic (invisible) droplets. This accelerates the decomposition of oil products in the water column.

Aggregation
Oil aggregates in the form of petroleum lumps, tar balls, or pelagic tar derive from oil after the evaporation and dissolution of its relatively light fractions, emulsification of oil residuals, and chemical and microbial transformation. Oil aggregates look like light grey, brown, or black sticky lumps. They have an uneven shape and vary from 1 mm to 10 cm in size (sometimes reaching up to 50 cm) and can persist from a month to a year in an enclosed water body and up to several years in the open ocean before slowly degrading in the water column, on the shore (if they are washed there by currents), or on the sea bottom (if they lose their floating ability).

Sedimentation
As the oil mixes in the water column, a proportion is adsorbed on suspended material and deposited to the bottom. This effect is greater in coastal shallow waters where particulates are abundant and water is subjected to intense mixing. In deeper areas remote from the shore, sedimentation of oil (except for the heavy fractions) is an extremely slow process. When the suspended oil reaches the sea bottom, the decomposition rate of the oil buried on the bottom abruptly drops as oxidation processes slow down, especially under anaerobic conditions in the bottom environment. The heavy oil fractions accumulated inside the sediments can be preserved for many months and even years.

Microbial degradation
The fate of most petroleum substances in the marine environment is ultimately defined by their transformation and degradation due to microbial activity, with species of bacteria and fungi able to use oil components to sustain their growth and metabolism. The degree and rates of hydrocarbon biodegradation depends upon the type of oil, the physical state of the oil, including the degree of its dispersion and environmental factors (temperature, concentration of nutrients and oxygen, and, species composition and abundance of oil-degrading micro-organisms). These complex and interconnected factors influencing biodegradation and the variability of oil composition make interpreting and comparing available data about the rates and scale of oil biodegradation in the marine environment extremely difficult.

As a result of the processes discussed, an oil spill from ACG Phase 1 will rapidly lose its original properties as it disintegrates into hydrocarbon fractions. As the original and intermediate compounds disappear, and carbon dioxide and water form the marine environment will recover and the ecosystem become re-established, assuming toxic effects have not exceed the limits of the environment to the point where recovery is not possible.

Impact of an oil spill from the ACG Phase 1 project

Spilled oil poses serious threats to fresh water and marine environments. It affects surface resources and a wide range of subsurface organisms that are linked through a complex food chain that includes human food resources. Harm to the physical environment will often lead to harm for one or more species in a food chain, which may lead to damage for other species further up the chain. In this way, an oil spill can harm the environment in several ways, including physical damages that directly impact wildlife and their habitats (such as coating birds or mammals with a layer of oil), and damages resulting from the toxicity of the oil itself, which if ingested can poison exposed organisms.

The severity of an oil spill's impact depends on a variety of factors, including the physical properties of the oil and the natural actions of the receiving waters on the oil (discussed above). In addition, the degree of impact is influenced by complex interrelations between plant and animal species and their physical environment. Where an organism spends most of its time, for example in open water, near coastal areas, or on the shoreline, will determine the effects an oil spill is likely to have on that organism. Thus the environmental vulnerability to an oil spill is a factor of both the environmental sensitivity and the likelihood of an oil spill reaching that environmental sensitivity.

Modelling has shown that an oil spill from ACG Phase 1 will affect both offshore and coastal areas; therefore the vulnerabilities of these environments need to be considered separately as different parameters will apply.

Offshore vulnerability
In the offshore environment, the likelihood of impact of an oil spill will be determined by the direction of travel of the slick and whether environmental sensitivities are present in its path. In open water, marine organisms such as fish and seals have the ability to swim away from a spill by going deeper in the water or further out to sea, reducing the likelihood that they will be harmed by even a major spill. Evidence from previous major oil spills elsewhere in the world however, suggest that in the open water, these many organisms have the ability to detect oil, even at low concentrations. As a result, most spills in open water have a limited effect on fish and seal populations.

Organisms with a reduced ability to evade an area of an oil spill, such as plankton, may be expected to experience greater impacts, including direct mortality during the early stages of a spill incident from toxicity of hydrocarbon components. However, these organisms are generally subject to high levels of natural variability. In the open sea, rapid dilution of naturally dispersed oil and its soluble components, as well as the high natural mortality and patchy irregular distribution of the eggs and larvae, reduces the possibility of significant effects from an oil spill on plankton.

The greatest environmental sensitivity offshore at the Azeri drilling location is the potential presence of seabird populations. The magnitude of any impact will depend on the species and number of birds present, the amount of time the birds spend on the sea surface, the percentage of the population present, their vulnerability to oil spill and their rates of potential recovery from oil pollution.

Weathering studies of the Azeri crude has shown that the oil is persistent oil, and in the absence of any offshore response, has the potential to persist on the sea surface for a number of days. However, the rapid evaporation of volatile components of the spilled crude, will rapidly reduce the toxicity of the oil within a few hours of the spill. Residual effects on offshore organisms, such as seabird populations will be associated with the physical impact of the oil.

Coastal environments
The likelihood of any oil spill having an impact on the coastal environment is directly related to the volume of the oil released and the volume of emulsified oil beaching. Oil spill modelling for all release simulations, shows a greatest potential (5%) for oil to impact the coastline during a blowout scenario in summer conditions, with oil beaching after 72 hours.

However, although the probability of oil reaching the coastline of the Aspheron Peninsula from a nearshore and offshore pipeline rupture is lower (<1%), the time taken for oil to reach the coastline during such an event is shorter, with oil breaching during the simulations after 19 hours (Section 10.6.3.2). Coastal environmental sensitivities to oil spill at these times of the year include migrating, breeding and overwintering bird populations, including shore birds, waders and diver species, seagrass habitat, sub-littoral and coastal habitats. As a result, environmental sensitivities to oil spill are high all year round.

The most sensitive shoreline areas identified are the coastal wetlands, the most extensive of which are to be found in the Kyzyl-Agach region towards the south of Sangachal Bay (Figure 13.2). These areas are highly productive ecosystems hosting large concentrations of birds and the shallow waters also act as feeding grounds for many fish species. In addition, the shallow waters and seagrass habitat identified along the Sangachal Bay and Aspheron Peninsula make the area a biologically productive region which is also of importance for fish and bird species, including resident, migrating, nesting and breeding species at various times of the year. As the toxic volatile components of an oil spill rapidly evaporate on entering the marine environment, the most likely impact of any oil spill will be one of physical smothering and coating by oil. However, oil dispersed in the water column would have a detrimental impact on the seagrass and its associated communities, through and toxic effects.

In addition to potential Impacts on flora and fauna in Sangachal Bay and Aspheron Peninsula, there is the potential for oil to reach the coastline of neighboring countries (Section 13). The coastlines of Iran and Turkmenistan are of known importance for their coastal wetlands and include a number of sites of designated sites of national and international importance, particularly for their bird populations. Most birds inhabiting this region are waterfowl or shore birds, with sensitive times of the year including spring, summer and autumn (encompassing migration, nesting, fledging and moulting periods) which can be classified as a time of high sensitivity for birds in this area. Important bird areas along the southern Caspian coast are identified and discussed further in Chapter 13.

Impacts on the nearshore feeding area for fish and birds may be increased through adverse impacts on the benthos. Benthic organisms may be impacted as a result of a oil sinking onto the seabed due to the direct toxicity of the oil. Shoreline benthos may also be physically smothered by the oil in the case of stranding. Impacts are likely to be greatest in the immediate area of the spill and these effects will be greater for oil such as Azeri crude, which is more persistent due to its higher viscosity.

In shoreline and shallow water environments where there is a reduced potential for evasion, oil spills may impact seal populations through inhalation, ingestion and smothering/clogging of feathers/fur, all of which increase stress and reduce insulation. Seal pups are considered more vulnerable to oil pollution than adults because of their lack of mobility and dependence on fur for thermal insulation. The breeding/pupping season is the period of highest vulnerability to oil pollution for the Caspian seal, although as the seals breed and pup predominantly in the north Caspian, the majority of the Caspian seal population is not found in the ACG Phase 1 development location during these times of the year. AS a result the impact on the Caspian seal is not considered significant.

As discussed above, significant long term changes to fish populations are not expected to result after an oil spill incident from ACG Phase 1. Fish tainting of fish may occur as a result of a major spill at sea and this has the potential to impact the local community, through lowered values of fish catches and impact on fish caught for subsistence by the local residents.

Impact of cleanup operations

In addition to the direct toxic and smothering effects of spilled oil, ancillary impacts may occur during clean up wherever vessels and helicopters are used to recover oil and conduct surveillance sorties. During such response strategies, clean up operations have the potential to disturb more organisms (eg seals and birds) and impact the coastline more than the original spill. Through these activities clean up operations can threaten different types of marine habitats in different ways:

- Seagrass shorelines and coastal wetlands form important nurseries for fish, birds and other organisms, which are at risk from exposure to the toxic substances within oil as well as smothering. The most sensitive habitats for these areas of aquatic vegetation are coastal areas with shallow depths in the transition zone (the pseudo-littoral zone). The spring growth period from the end of April to the end of June is the most sensitive period for the vegetation and physical disturbance from clean-up operations may result in a greater degree of damage to the environment than from the oil itself.

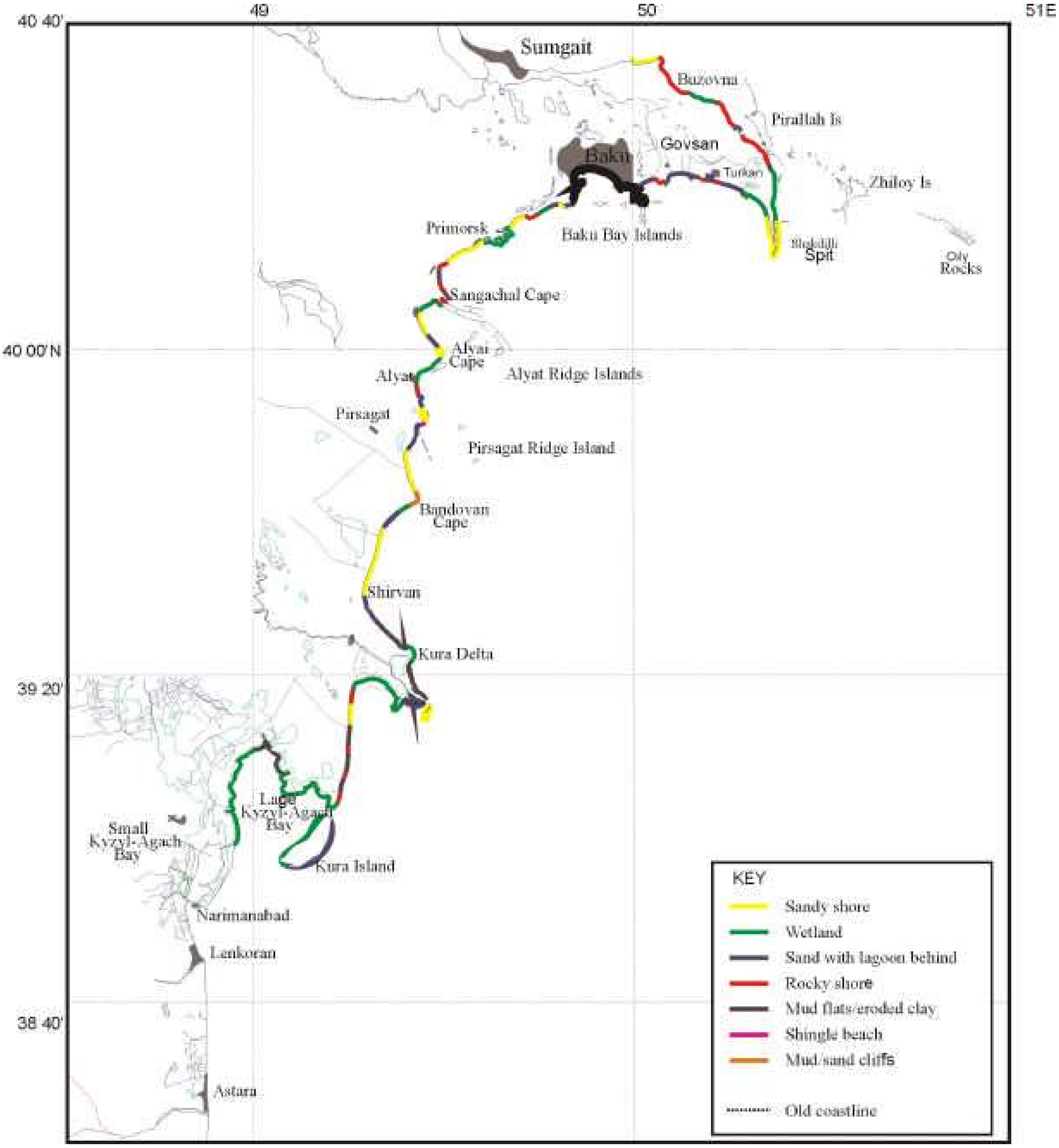
- Exposed sandy, gravel or cobbled beaches are usually cleaned by manual techniques. Although oil can soak into sand and gravel, few organisms live full-time in this habitat, so the risk to animal life or the food chain is lower than in other habitats.

- Sheltered beaches have very little wave action to encourage natural dispersion. If timely cleanup efforts are not begun, oil may remain stranded on these beaches for many years, providing a source for repeated oil introduction and adverse effects.

- Muddy shorelines usually contain rich plant, animal, and bird communities. Deposited oil may seep into the fine-grained sediments, creating potentially harmful effects on the ecology of the area.

- Shoreline sensitivity to oil spill cleanup operations has been the subject of considerable international study and accepted standards exist for the classification of cleanup techniques in different coastal conditions. These are summarised in Figure 10.34 together with the classification of the Caspian shorelines that have the potential to be affected by an oil spill from ACG Phase 1 facilities.

Figure 10.34 Coastal classifications and clean-up strategies for the Azerbaijan coastline (adapted from Gundlach and Hayes, 1989 and AIOC, 2001).



Coastline classification	Clean up strategy and comments
Sandy shore	Where oil does not penetrate into sediment. This facilitates mechanical removal, otherwise oil may persist for several months. Oil penetration may occur depending on water table movements
Wetland	Most productive Caspian environment. Oil may persist for months to years. Physical and chemical clean-up may cause more impacts and disturbance above those caused by the oil. Protection and prevention of contamination is important
Sand with lagoon	Low energy environment. Oil may remain stranded for many years, providing a source for repeated oil introduction and adverse effects
Rocky shore	Reflection keeps the shore offshore. Hard substrate allowing cleaning if necessary
Mud flats/eroded clay	High biological productivity. Deposited oil may seep into the fine-grained sediments, creating potentially harmful effects on the ecology of the area
Shingle beach	Oil may become buried making clean-up difficult. Oil may persist for many months-years. Clean-up should concentrate on high water mark to stop the accumulation of beached oil and formation of solid/heavy oil contamination

Impact significance

In summary, the environmental impacts associated with non-routine (accidental) oil spill events are considered to be of "high" significance as follows:

Likelihood = 2 - unlikely. Consequence = 5 - transboundary and/or national scale impact. Significance = 10 - high.

10.6.2 Loss of control of re-injection wells

10.6.2.1 Cuttings re-injection offshore

There are a number of potential non-routine (accidental) events that may result in environmental impacts. These events are:

- "screen out" of cuttings within the injection well;
- loss of injected cuttings behind the casing of the injector well;
- loss of cuttings to surface via adjacent fault;
- potential to pressurise local sands; and
- intersection of an adjacent well;
- inducement of a seismic event.

Impact significance

The environmental impacts of non-routine (accidental) events associated with cuttings re-injection are considered to be of "low" significance as follows:

Likelihood = 2 - unlikely. Consequence = 2 - local scale impact. Significance = 4 - low.

"Screen out" of cuttings within the injection well

"Screen out" of cuttings is a term used in the industry when a fluid that is loaded with solids has insufficient energy to carry its solids and as a consequence, very quickly loses or deposits the entrained solids in an uncontrolled way. This process can occur either into an induced fracture in a CRI well or directly into the well prior to solids actually entering the induced fracture. If this condition were to occur within the CRI well, the injection process would be terminated, as the solids will completely block the fracture.

It is possible for "screen out" of cuttings to occur, although the probability of occurrence would be expected to be very low as the dedicated CRI well would be explicitly designed for this application.

If "screen-out" of the cuttings were to occur, then further injection into the "screened out fracture" would not be possible and cutting injection would only be able to restart once the well has been re-conditioned and a new fracture location has been established by perforating an additional interval within the well. This process can take many days to complete and as a consequence, if production drilling is to continue, cuttings would be shipped to shore for treatment and disposal.

Loss of injected cuttings behind the casing of the injector well

A poorly cemented casing would result in fluid pressure leaking vertically up the back of the casing as it leaves the casing perforations. With a high quality cementing process, the likelihood of this occurring would be highly unlikely. In the event of a vertical leak occurring, then the impact on the injection process can be classed as major and the injection process would be terminated and cuttings would be shipped to shore for treatment and disposal.

Loss of fluid to surface via surface faults

An extensive network of faults is present at the crest of the Azeri structure, particularly in shallower formations. The likelihood of re-injection fractures intersecting open conductive faults or natural fractures has been considered carefully by BP engineers. Due to the depth of the potential site, the risk of slurry actually escaping undetected to the seabed is considered to be highly unlikely.

Whilst the probability of the slurry actually intersecting a fault and escaping to surface is highly unlikely, the possibility of the induced fracture intersecting a fault cannot be discounted. Indeed, taking a worst-case prediction for the size of the induced fracture, the apex of the disposal domain could theoretically be situated only about 110 m lateral distance from the nearest fault.

Preliminary analysis of the structure undertaken by BP suggests that the risk of the induced fracture intersecting a fault is significant. The possibility of the induced fracture intersecting a smaller fault whose displacement is too small to be identified by a seismic section should also be considered as a possible risk.

The severity of the impact would clearly depend on the hydraulic and geotechnical properties of the fault plane. The worst-case scenario is if the fault that is intersected by the induced fracture is open, in a low stress environment and is permeable. The impact of a permeable fault on the integrity of the induced fracture would also be controlled by the angle of intersection.

If the cuttings disposal domain intersected a permeable fault, then the potential impact on the domain could potentially be more dynamic. If the fault was permeable and intersected at a high angle, then fluid leak-off into the fault could reduce the energy at the crack tip and the fracture may begin to screen out. The dynamics of the situation would increase as the angle of intersection increases. If the angle becomes very acute, then an open permeable fault would have a more dramatic impact on the disposal domain.

The scale of the impact would also depend on the amount of energy stored within the induced fracture. In the event of a high energy fracture intersecting a high permeability fault, the induced fracture may change direction and quickly 'off load' its pressure into the fault plane. This would lead to a rapid fall off in pressure at the well bore.

If the pressure was not maintained by increasing the rate of injection then there is a very high chance of the fracture "screening out". The environmental impacts would only become significant if the pressure loss is matched by an increase in injection rate. In this situation, there would be a period of 'uncontrolled' fracture growth where the speed of fracture growth would increase. Operational procedures would however, be in place to control this situation.

In reality if this was to occur, the injection process would be stopped and the well "shut in". It is unlikely that injection process would be continued in the same fracture but after leaving the induced fracture to heal, the re-injection of the fracture would create a new fracture which would be sub-parallel to the Principal Stress Direction.

If the fault intersected by an induced fracture was sealed and exhibited low permeability then its impact on the disposal domain would be much lower and dependant on the relative direction and dip of both the induced fracture and the fault, one of the following scenarios may develop:

1. If the angle of intersection is very high (i.e. greater than 30 to 40 degrees) then there is every possibility that the induced fracture would pass straight through the fault with minimal impact. The risk of an impact increases as the angle of intersection reduces.
2. If the angle was very acute (i.e. less than 10 degrees) then there is the possibility that although the permeability of the fault plane is low, it would represent a plane of weakness and allow the fracture to preferentially migrate along the strike of the fault. If this was to occur, the rate of fracture growth may increase, although this would be observed at the well-head by a fall in injection pressure.

Once the fall in pressure is recorded at the surface, engineers would be warned of the potential for a faster rate of fracture growth to be occurring. Action would depend on the rate of pressure fall-off. The worst-case scenario would be that the well would be temporally shut-in to observe and record the pressure fall-off. A decision under controlled conditions would then be made by experts to ensure that the risk of a worst-case scenario occurring is significantly reduced.

Potential to pressurise local sands

An induced fracture initiated from a re-injection well in the Azeri field will inevitably penetrate a sequence of interbedded sand and shale extending down from the top of the Surakhany formation. These thin interbedded formations are believed to be laterally extensive and appear to be between 10 to 20 m thick. Adopting a conservative approach to the disposal design, if it is assumed that the sand bodies are closed, such as a sand lens, then it is possible to estimate the increase in pore pressure that results if they act as a long-term 'sink' for fluid from the waste cuttings slurry.

BP engineers have scoped out this issue. Assuming a 20 m thick sand extending for 3,000 m around the re-injection location, then the expected increase in pore pressure caused by influx of 360,000 bbls of brine would be around 100 psi. This volume represents one half of the base fluid in a 25% by volume slurry of all cuttings anticipated from the field. A localised pressure increase of this magnitude may cause a problem when drilling new development wells through the Azeri overburden particularly if the drilling engineers were unaware of the potential for its existence.

Intersection of the disposal domain by an adjacent well

It is not possible to control either the orientation or inclination of an induced fracture. The direction of the induced fracture will be controlled by the direction of the principal stresses. The regional variation in the direction of the principal stresses can be quantified by mapping the direction of borehole breakout.

Drilling of production wells in the immediate vicinity of a CRI fracture system would not be permitted. If the risk of an intersection was identified, then the proposed well would be offset to avoid the occurrence.

If an induced fracture intersected a producing well that had been drilled and cased, then the severity of the impact would be related to the quality of the cement around the production casing (at the point of intersection). If the casing was well cemented, it is likely that the induced fracture would pass around the production well with no impact. If however, the casing was poorly cemented, then the fracture could lose liquid into the uncemented annulus that could act as a 'fast pathway' delivering cuttings to a higher level. If this condition was experienced, then the loss of fluid or cuttings at the tip of the fracture would be observed at the well head as a loss of injection pressure. Clearly the greater the vertical pathway, the higher the fall off in pressure.

If the direction of fracture propagation lies between east to west and northwest to southeast, then the proposed track of PO2 is roughly 370 m lateral distance away to the south-west of the planned re-injector. In this situation the well-bore of PO2 should pass directly under the fracture domain and not be intersected. If however, it is assumed that the fracture grows directly towards PO2, then the well-bore could be intersected between around 2,000 – 2,350 m tvdbrt[2].

Apart from PO2, the nearest well to the planned re-injector is Azeri PO7 situated just over 500 m due south at the intended disposal depth of 2,200 m tvdbrt but this is unlikely to be in a preferred direction. Well Azeri PO5 is closest to the injector well along the likely azimuth of fracture propagation. It lies about 730 m due west of the re-injection location at 2200 m tvdbrt that is outside the worst-case fracture radius of the 550 m.

10.6.2.2 Produced water re-injection onshore

The base case option for the disposal of produced waters onshore and hydrotest waters is injection into dedicated disposal wells to be drilled in the Lokbatan field some 22 km north of the terminal at Sangachal. There are a number of potential non-routine (accidental) events that may occur 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;
- 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 Lokhbatan 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 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.

[2] tvdbrt = total vertical depth below rotary table.

Due to the absence of shallow aquifers containing potable drinking water and the high level of existing surface contamination in the Lokbotan 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 1 km 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 Lokbotan 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 unlikley.

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 2000 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 3,000m 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 of cuttings and 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 re-injection of produced water in the onshore environment or cuttings in the offshore environment is considered to be low due to the limited volumes of injection.

10.6.3 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.

10.6.3.1 Offshore facilities, wells and pipelines

The seismic activity in the area of the Phase 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-500 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.

Impact significance

The probability of a seismic event that leads to the total loss of offshore facilities occurring is extremely low given the consideration of these phenomena in the facilities design. The impact significance of seismic events on offshore facilities is therefore, considered to be "low" as follows:

Likelihood = 1 - very unlikely. Consequence = 5 - transboundary and/or national scale impact. Significance = 5 - low.

Wells

All of the Phase 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 jacket 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:

- jacket-seabed interface (where spoolpieces are covered with mattresses);
- seabed-trench transition interface; and
- buried sections (i.e. mudflow crossing; landfall; etc.).

The effect of seismic activity, with a return period of 3000 and 500 years (corresponding to the Seismic Strength Level (SLE) and Ductility Level (DLE) events, respectively) are to be considered in conjunction with the functional load case only.

10.6.3.2 Onshore facilities

The terminal has also been designed to withstand seismic activity. This has been included in the project design safety standards as a 30% increase on the base case Factor Of Safety (FOS) for the terminal expansion. This is considered sufficient to safeguard the terminal facilities against the type and size of seismic events characteristic of the region.

Impact significance

As a result of design standards and interpretation of operational data from EOP, the probability of a seismic event leading to structural damage to onshore facilities is extremely low. The impact significance of seismic events on onshore facilities is therefore, considered to be “low” as follows:

Likelihood = 1 - very unlikely. Consequence = 5 - transboundary and/or national scale impact. Significance = 5 - low.

10.6.4 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 ACG Phase 1 project would be from international waters to the Caspian Sea via the Volga Don 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[3]; and
- as sessile hull fouling organisms.

3 Ballast water is taken up to compensate for low loads and discharged prior to or at the same time as loading takes place.

10.6.4.1 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:

- 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;
  - maintenance of IMO records of ballast;
  - adherence to ship Ballast Water Management Plan; and
  - ballast exchange at sea.

10.6.4.2 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.

10.6.4.3 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 resuspended 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, which 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 ACG Phase 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.

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[1] of the convention for them. Part X relates to rights of access of landlocked state to and from the sea and freedom of transit.

The ACG Phase 1 facilities will be passed to SOCAR in 2024 along with any other ACG FFD facilities that have been developed. AIOC will work with SOCAR to prepare a detailed decommissioning plan for all onshore and offshore facilities. According to the terms of the ACG PSA, AIOC is required to produce a Field Abandonment Plan one year prior to the completion of 70% production of identified reserves. At this time, all partners involved in the project are 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, an ESIA will be prepared.

10.7.2 Approaches to decommissioning

The eventual abandonment of the ACG Phase 1 facilities will probably be conducted by SOCAR as the facilities are likely to have passed into SOCAR ownership by the time the time

[1] X = Roman numeral for 10.

the Field Abandonment Plan is prepared. It is not possible at this time to list all options or to evaluate the options in terms of their environmental (and socio-economic) consequences because the operating environment may be very different in 25 years time.

The Comparative Assessment will have to consider advances that have been made in technology as well as advances in equipment (e.g. heavy lift vessels) that may have occurred over the life of the project. Additionally, it is likely that technological resources that are not presently available 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 Phase 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 Phase 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 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.

Many of the materials used in these facilities have high intrinsic value, for example the steel used in the construction of the jacket has a high re-use value. AIOC will ensure that a recycle and re-use philosophy is followed for all of the decommissioned components 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. Most of the material has been re-used. The level of recycling of Phase 1 facilities that could be achieved would, in part, be dependant on suitable facilities being available in Azerbaijan.

10.7.2.2 Wells

Before removing any of the platform facilities it will be necessary to plug and abandon all of the Phase 1 wells in order to isolate individual productive intervals and prevent any flow of fluids to the surface. The clearing of any obstruction will require the cutting of the sub-sea wellheads and conductor casing below the surface of the seabed.

Cutting operations will typically results in the 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 and top-hole section drilled cuttings be discharged from each of the Phase 1 wells (Section 10.3.3.3). These sections will be drilled with seawater drilling fluids and in some cases water based muds that are chemically inert. Any further dispersion of these cuttings would result in localised increases 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. On the ACG PDQ platform there may be as many as 48 wells to be decommissioned. The production tubulars or injection tubulars as appropriate 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 the offshore installations and at the onshore terminal is typically decommissioned before the installations are. In regards to offshore installations, 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 jacket and shipped-to-shore (as one piece or in pieces).

Process equipment is generally decommissioned by circulating nitrogen through the process train. The gas strips hydrocarbons that may still be present within the system after production operations have ceased. In regards to offshore process equipment, wastes generated by this stripping process are 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 Offshore installations

The platform topsides installation offshore allows for a reverse floatover thus enabling straightforward removal by barge for onward transport to shore. Topsides will be dismantled following decommissioning of the offshore processing facilities. If crane barges with the sufficient carrying capacity are available in the Caspian Sea at the time, the jackets would be lifted and removed as one piece. It is more likely however, that they will be removed in sections for shipment to shore.

Removal of jackets in pieces will required the use of explosives and mechanical cutting devices cut the facility into liftable components. These methods would result in short-term high level noise emissions to the underwater environment resulting in disturbance to any resident marine fauna in the area (see Section 10.3.2.1). As there would be considerable activity in the area prior to the cutting of the jacket it is considered that marine fauna that could leave the area would have done so already. Potential for significant noise impacts or direct mortality to individuals would therefore, be minimal.

10.7.2.5 Subsea pipelines

Neither UNCLOS or the IMO Guidelines contain specific specifications for decommissioning of subsea pipelines. Generally though, decommissioning options include complete removal or abandonment *in-situ*. The decision of which option to adopt in regards to the Phase 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 time. Abandoning the pipelines *in-situ* would require that any areas that may prevent a snagging risk to fishermen or vessels be covered or removed. Total removal would result in impacts as described for pipeline installation, principally disturbance to benthos as well as marine flora in the nearshore zone (Section 10.3.3.2).

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 was 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 resemble 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.

10.7.3 Schedule of abandonment and decommissioning

Table 10.38 presents an approximate schedule for Phase 1 abandonment and decommissioning activities.

Table 10.38 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.

10.8 Summary of Significant Environmental Impacts

In summary the environmental impact assessment found that that the majority of the activities associated with the Phase 1 development would result in only negligible or low impacts on the surrounding environment.

A total of 84 routine and planned non-routine project activities were identified for each of the elements of the proposed Phase 1 project and each activity was assessed against the environmental receptors present in the project development area. Of the 84 activities identified only 13 were considered to have a potential to cause environmental impacts of "high" significance on 12 separate environmental receptors. The assessment found that none of the project activities identified would result in environmental impacts of "critical" significance. The contributing activities that would result in impacts ranked as being of "high" significance along with the receptors that would be affected are summarised in Table 10.39.

Table 10.39 Summary of Phase 1 activities resulting in "high" significance environmental impacts

Project Component	Contributing Activities	Impact	Impacted Receptors
Offshore activities	Template well cuttings discharge.	Physical impacts on benthos.	Benthos
	Platform well cuttings discharge.	Physical impacts on benthos.	Benthos
	C&WP gas driven gas compressors.	Contribution to greenhouse gas emissions.	Atmosphere
	PDQ and C&WP power generation.	Contribution to greenhouse gas emissions.	Atmosphere
	Planned non-routine flaring.	Contribution to greenhouse gas emissions.	Atmosphere
Subsea pipeline activities	Pipeline trench construction nearshore	Loss of flora and associated fauna along pipeline trench. Direct and indirect impacts on flora and fauna.	Seabed Marine habitat/flora Benthos Coastline
	Finger-pier construction	Loss of flora and associated fauna in nearshore. Interference with natural sediment transport mechanisms.	Marine habitat/flora Benthos Coastline
	Pipeline trench construction onshore	Direct and indirect impacts on terrestrial flora and fauna along the pipeline corridor.	Coastal habitat/flora Terrestrial habitat/flora Reptiles/amphibians
Terminal activities	Ground clearance and grading	Permanent loss of habitat. Direct and indirect impacts on flora and fauna.	Soil Terrestrial habitat/flora Terrestrial/coastal birds Reptiles/amphibians
	Excavation of drainage channel	Loss of habitat. Direct and indirect impacts on flora and fauna. Potential alteration to hydrological systems.	Soil Surface water Hydrological systems Terrestrial/coastal birds
	Construction of access road / railway crossing	Loss of habitat. Direct and indirect impacts on flora and fauna.	Terrestrial/coastal birds
	Terminal power generation	Contribution to greenhouse gas emissions.	Atmosphere
	Planned non-routine flaring	Contribution to greenhouse gas emissions.	Atmosphere

The project activities associated with these identified activities have been further considered and additional mitigation measures assessed and evaluated in order to minimise these impacts. These are discussed in Chapter 14 along with the monitoring that will be required to monitor the impacts.

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 ACG Phase 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 impact assessment completed for the ACG Phase 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 ACG Phase 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). • Moderate 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. • Some 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). • Modest 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 14).

Table 11.4 Socio-economic impact assessment - offshore

RECEPTORS / ACTIVITY		Socio-Economic											Other				Comments
		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	SPS yard upgrade					5	+				++	+	+		+		Significant upgrade of oil gas facilities procurement; noise; disturbance to local population; job creation.
	SPS yard facilities/services/utilities operations					5						+			+		Some noise, disturbance to individuals; job creation and procurement of supplies.
	SPS yard power generation																Some noise, disturbance to individuals; job creation and procurement of supplies.
	Fabrication and construction operations (jackets; drilling template)					10	+				+	+	+		+		Some noise, disturbance to individuals; job creation and procurement of supplies.
	PDQ and C&WP topsides assembly and/or construction					5	+				+	+	+		+		Some noise, disturbance to individuals; job creation and procurement of supplies.
	Mobilisation of workforce					15	+		5	5		+	+		+		Significant movement into areas of workers thus increased transport pressure on community infrastructure.
	Testing and commissioning of integrated deck					5									+		Noise; visual disruption to local population; job creation.
	Demobilisation					10	15			5							Significant movement into areas of workers thus increased transport pressure on community infrastructure.
Installation and Commissioning	Tow out and launch of jackets, drilling template (including vessel operations)		5	5			+								+		Disruption to fishing, shipping routes; some employment.
	Piling of jackets and drilling template		5	5			+								+		Disruption to fishing, shipping routes; some employment.

RECEPTORS / ACTIVITY		Socio-Economic											Other				Comments
		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	
	Tow topsides to offshore location and floatover; PDQ, C&WP (including vessel operations)		5	5			+								+		Disruption to fishing, shipping routes; some employment.
	Install bridge link (DPQ to C&PW) (including vessel operations)		5	5			+								+		Disruption to fishing, shipping routes; some employment.
	Modifications to Chirag topsides and installation of riser (including vessel operations)		5	5			+								+		Disruption to fishing, shipping routes; some employment.
	Commissioning																Disruption to fishing, shipping routes; some employment.
Drilling	Mobilisation of the Dada Gorgud for pre-template and template wells (including vessel operations)		5	5			+								+		Some employment but also fishing, shipping disturbances due to other vessel movements and restriction zone.
	Dada Gorgud utilities operation (sewage, drainage fire water, potable water)						+								+		Some employment but also fishing, shipping disturbances due to other vessel movements and restriction zone.
	Dada Gorgud power generation						+								+		Some employment but also fishing, shipping disturbances due to other vessel movements and restriction zone.
	Dada Gorgud drilling of pre-template well and template wells - 36" and 26" sections; discharge drilling fluids (WBM) and cuttings						+								+		Some employment but also fishing, shipping disturbances due to other vessel movements and restriction zone.
	Dada Gorgud drilling of pre-template well and template wells lower hole sections						+								+		Some employment but also fishing, shipping disturbances due to other vessel movements and restriction zone.
	Dada Gorgud cooling water discharge																No socio-economic impact.
	Dada Gorgud cuttings re-injection																No socio-economic impact.

RECEPTORS / ACTIVITY		Socio-Economic											Other				Comments
		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	
	Well testing fluid disposal (to flare)						+								+		Some employment but also fishing, shipping disturbances due to other vessel movements and restriction zone.
	Platform driving of 30" conductor and drilling of 26" section; discharge drilling fluids (WBM) and cuttings						+								+		Some employment but also fishing, shipping disturbances due to other vessel movements and restriction zone.
	Platform drilling of lower hole sections						+								+		Some employment but also fishing, shipping disturbances due to other vessel movements and restriction zone.
	Cement pump / cementing						+								+		Some employment but also fishing, shipping disturbances due to other vessel movements and restriction zone.
Production	Presence of platform facilities offshore		5	5			+						+		+		Some employment but also fishing, shipping disturbances due to other vessel movements and restriction zone.
	C&WP gas compression																No socio-economic impact.
	PDQ and C&WP utilities operation (sewage, drainage, fire water, potable water)																No socio-economic impact.
	PDQ and C&WP power generation																No socio-economic impact.
	PDQ and C&WP cooling water discharge																No socio-economic impact.
	Produced water generation treatment and disposal overboard (as required)																No socio-economic impact.
	Routine flaring																No socio-economic impact.

RECEPTORS / ACTIVITY		Socio-Economic											Other				Comments
		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	
	Planned non-routine flaring																No socio-economic impact.
	Fire system tests																No socio-economic impact.
	Corrosion protection																No socio-economic impact.
	Helicopter operations					5	+								+		Noise disturbance to local population, some employment.
	Vessel supply and backload (including waste transfer)		5	5			+					+			+		Disruption to shipping, fishing due to more vessel movements, provision of supplies.
Potential Accidental Events	Vessel collision (resulting in a spill)		6	6		4								6		6	Restriction on fishing and shipping potential oil spill to effect landuse, population.
	Loss of facilities during transfer to offshore location		2	2							5		2			5	Restriction on fishing and shipping.
	Encounter shallow gas during drilling																No socio-economic impact.
	Blow-out at well-head during drilling operations; pipeline rupture		10	6		6		6	6	6	10		10	10		10	Major impact on all receptors.
	Loss of NWBM over board																No socio-economic impact.
	Chemical spill																No socio-economic impact.

	RECEPTORS / ACTIVITY	Socio-Economic											Other				Comments
		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	
	Extinguishing flare/flare failure																No socio-economic impact.
	Loss of fuel inventory (diesel spill) or spill during fuel transfer																No socio-economic impact.
	Loss of containment (fire, explosion)												10			10	-
	Loss of integrity of cuttings disposal well												10				-
	Earthquake/other tectonic event resulting in loss of offshore facilities												10				-

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				Comments
		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	Yard facilities/services/utilities operations					5	+					+			+		Noise & general disturbance. Some employment and procurement.
	Transportation to / from yard					5											Limited disruption to population.
Installation onshore (landfall to Sangachal)	Onshore works preparation	5			5	5	+			5		+			+		Some inconvenience with transportation network; job creation.
	Pipeline trench construction	5			5	5	+			5		+			+		Some inconvenience with transportation network; job creation.
	Pipe-laying onshore				5	5	+			5		+			+		Some inconvenience with transportation network; job creation.
	Pipeline crossings of existing onshore services				5	5	+	5		10		+			+		Some inconvenience and disruption to individuals, utilities and other infrastructure.
Installation Coastal/ Nearshore	Site works preparation for beach pull (onshore)	5	5		5	5	+					+			+		Some inconvenience to individuals and fishing; job creation.
	Construction of landfall	5	5		5	5	+					+			+		Some inconvenience to individuals and fishing; job creation.
	Construction of finger pier(s)	5	5		5	5	+					+			+		Some inconvenience to individuals and fishing; job creation.
	Construction of nearshore trench		10				+					+			+		Some inconvenience to individuals and fishing; job creation.

RECEPTORS / ACTIVITY		Socio-Economic											Other				Comments
		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-laying in the nearshore (including vessel operations)		5	5		5	+					+			+		Some inconvenience to individuals and fishing; job creation.
Installation Offshore	Preparation for pipeline crossings (and mud channel crossings) - install stabilisation mattresses		5	5			+					+			+		Restrictions to fishing and shipping with vessel movements; job creation.
	Pipe-laying (including vessel operations; anchor drag)		10	10			+					+			+		Restrictions to fishing and shipping with vessel movements; job creation.
	Rectification of freespans		5	5			+					+			+		Restrictions to fishing and shipping with vessel movements; job creation.
	Helicopter operations					5	+								+		Some disturbance with helicopter movements and limited employment.
	Material and equipment supply (including vessel operations)		5	5			+					+			+		Restrictions to fishing and shipping with vessel movements; job creation.
Hook-up and Commissioning	Tie in of pipelines to PDQ, C&WP, Chirag		5	5											+		Restrictions to shipping and fishing; job creation.
	Diving operations (DSV on site)		5	5			+					+			+		Restrictions to shipping and fishing; job creation.
Operations and Maintenance	Pipelines operation (presence)						+					+	+		+		Employment creation and supplier procurement.
	ROV check (including vessel operations)		5	5			+					+			+		Some disruption/inconvenience to fishing and shipping.
	Corrosion protection						+										No socio-economic impact.

RECEPTORS / ACTIVITY		Socio-Economic											Other				Comments
		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	
Potential Accidental Events	Vessel collision (resulting in a spill)		6	6		4								6		6	Restrictions on fishing and shipping, potential to affect land use and local population.
	Hydrate formation in pipelines																No socio-economic impact.
	Oil pipeline leak (>100 but <1,000 tonnes)															6	-
	Gas pipeline leak												10			6	-
	Loss of entire 30" oil line inventory		8	8									10			8	Significant restrictions on fishing and shipping routes.

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				Comments
		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								Potential need to resettle people, some general disruption to livelihoods and community structure.
	Ground clearance and grading	5			10	5	+	5		5		+					Potential to disrupt grazing areas and disrupt population, utilities and transport.
	Modification of existing services				5	5	+			5	++	+			+		Noise disturbance; job creation; upgrading of oil and gas infrastructure; supplier procurement.
	Excavation of drainage channel; construction of bund wall and security dyke				5	5	+					+			+		Noise disturbance to population; job creation; supplier procurement.
	Construction of fencing and perimeter lighting				5	5	+					+					Job creation and disruption to local population.
	Construction of access road and railway crossing				5	10	+			5		+			+		Disruption to transport infrastructure and local population.
	Mobilisation of workforce					15	+		5	5		+			+		Significant impact on local population with large numbers of employees; impact on transport network and community infrastructure.
	Construction site facilities/services/utilities/operations					5	+	5				+			+		Limited disruption.
	Power generation					5											Limited disruption; noise; emissions.

RECEPTORS / ACTIVITY		Socio-Economic											Other				Comments
		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	
	Terminal construction (including underground, foundations, buildings)				5	10	+			5					+		Limited disruption.
	Demobilisation					5	15			5							Significant impact to local community with movement of people out of area.
	Commissioning						+								+		Some disruption to local population; job creation.
Operations and Maintenance	Process facilities (physical presence)						+					+	+		+		Job creation.
	Oil storage																No socio-economic impact.
	Produced water storage																No socio-economic impact.
	Gas compression and refrigeration																-
	H2S treatment (if required)					5											Disruption to local population.
	Chemical injection																No socio-economic impact.
	Utilities operation (sewage, drainage fire water, potable water)																No socio-economic impact.
	Power generation																No socio-economic impact.

RECEPTORS / ACTIVITY		Socio-Economic											Other				Comments
		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	
	Routine flaring (pilot light)					5											Visual intrusion to local population.
	Non-routine flaring																No socio-economic impact.
	Fire system tests																No socio-economic impact.
Waste	Produced water (and hydrotest water) disposal via re-injection onshore at Lokbatan					5	+					+			+		Employment creation and supplier procurement; additional transport movements.
Waste	Produced water (and hydrotest water) disposal at Garadag Cement Plant					5	+			5		+			+		Employment creation and supplier procurement; additional transport movements.
Potential Accidental Events	Extinguishing of flare/flare failure					6										6	-
	Loss of integrity of water disposal well					4					4					4	No socio-economic impact.
	Fire / explosion					3		4			4					4	Some impact on human health/welfare, provision of utilities and oil and gas infrastructure.
	Loss of oil storage inventory					6							6			8	Some impact on individuals, utilities, significant impact on oil and gas infrastructure.
	Earthquake after tectonic event resulting in loss of inventory					6					8		6			6	Significant impact on oil and gas infrastructure.

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				Comments
		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	10		5	+					+			+		Disruption to fishing, shipping routes and local population; procurement and supplies.
	Rail Transport					10	+			10					+		Disruption to rail network; noise and disturbance to local population.
	Road Freight					10	+			10					+		Disruption to road network; noise and inconvenience to local population.
Accidental Events	Introduction of exotic marine organisms																Disruption to local ecosystem and potential reduction of prey species for commercial fish stocks, resultant decline in fish stocks and fish catches.

Note: The direct local positive impacts on oil and gas infrastructure are considered self-evident and therefore, not discussed further.

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11.4 Analysis of socio-economic impact assessment results

11.4.1 Preamble

Socio-economic impacts associated with the ACG Phase 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 three distinct construction activities as outlined in the Project Description (Chapter 5):

- onshore terminal construction (early civil works and main construction work);
- upgrade of the yard to be used for construction/assembly of offshore facilities; and
- offshore construction (onshore assembly of offshore facilities and offshore installation of facilities).

All of this work will be undertaken by BP via contractors and/or third party owner/operators. The scope of the ACG Phase 1 ESIA covers only the onshore terminal construction and the offshore construction. The upgrades of third party offshore construction yards is not formally included in the ESIA scope. However, as both the yard upgrades and the offshore construction itself will be undertaken by the same contractors as part of one construction process BP has included the yard upgrades in the impact assessment process for offshore construction (onshore assembly of offshore components and offshore installation) activities.

11.4.2 Land use

Potential resource use conflicts between ACG Phase 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; and
- nearshore leisure activities.

Table 11.8 presents a breakdown of existing and proposed land-take areas for the ACG Phase 1 Project.

Table 11.8 Existing AIOC property and Land-take areas breakdown

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 would be 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 proposed 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 will entail 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 ACG Phase 1 Project as a whole, that will be completed for the early civils work, 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 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; 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 whether or not these routes will be affected by the onshore terminal construction activities of the ACG Phase 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 childrens' 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 operations and documented in the Resettlement Action Plan (RAP).

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 2003 and 2004. It is estimated that offshore installation of the pipeline will take place over approximately 12 months however the exact time that installation will take through the Sangachal Bay area is as yet unknown. The onshore installation is expected to take approximately 4 months (Chapter 5). 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 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.

[1] The impact of ACG Phase 1 development activities on fishing is covered below in Section 11.4.3

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 ACG Phase 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 jackets
- tow out and floatover of the platform topsides
- 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
- accidental oil spills, 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 = 3- some impact on human health, well-being, livelihoods. Impacts significance ranking = 15 - high.

The transportation methods for the offshore installation of pre-fabricated components and pipe sections for the subsea pipelines are still under evaluation and are not yet finalised. A number of transportation methods and routes are under consideration and these are discussed in the Project Description (Chapter 5). It is likely that a considerable volume of the facility components and pipe sections will be transported by sea and the number of vessels required for this transportation is significant. 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;
- from Europe to the Baltic Sea and into the Caspian through the Baltic Volga canal; and
- from the Middle East across the Persian Gulf to Iran.

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 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 which will double the tanker traffic volume through the Bosphorus (Chapter 7). At this stage of the development of transportation logistics it is unknown how many vessel transfers will be made through the Straits, however there is expected to be a significant volume of vessel traffic which will interfere with other shipping movements in the area.

Some of the loads into the Black Sea will be transferred onto rail wagons or international road trailer for onward transfer and it is also unknown at this stage how many loads will pass onto the Caspian Sea through the Baltic-Don and Volga-Don. There is no historical data on vessel numbers passing through the Baltic-Volga or Don-Volga canals, however the number and frequency of vessel movement anticipated for this project will result in a level of interference with other shipping activities by increasing the load on these waterways. Once into the Caspian the vessels will transfer to Baku using the recognized Astrakhan to Baku transit route. Increased vessel movements due to transportation of Phase 1 components from the Middle East across the Persian Gulf to Iran are not expected to be as significant and will cause less inconvenience to other users of the sea.

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 ACG Phase 1 location a number of vessels will be present on the sea surface 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 pipelay barge will come into water depths of 8 m (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, launch and installation of PDQ jacket	50-60 days	1 jacket barge 3 support tugs (1 on standby)
Tow out PDQ topsides and install	14-21 days	1 jacket barge 3 support tugs (1 on standby)
Pipeline installation (offshore)	180 days	1 laybarge 3 support tugs 1 supply vessel
Tow out, launch and installation of C&WP jacket	50-60 days	1 jacket barge 3 support tugs (1 on standby)
Tow out C&WP topsides and install	14-21 days	1 jacket barge 3 support tugs (1 on standby)
Pipeline tie ins	150 days	1 DSV 2 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 pipelay activities there will be a clearly indicated exclusion zone around the lay barge. 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 this area of the sea will effectively be excluded from other vessels and fishing operations where before they had unhindered right of access. During operation of the pipelines there will be a 1000 m safety zone marked on navigational charts. 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.[2] 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 and illegal fishing have also contributed to the reduction in fish populations in the Caspian[3].

The impact significance ranking for this receptor has been calculated to be:

Likelihood of activities occurring = 5 - certain to occur. Consequence of activities = 2- some impact on human health, well-being, livelihoods Impacts significance ranking = 10 - high

The fishing currently undertaken within Sangachal Bay will be directly affected by the proposed ACG Phase 1 developments, as there will be restrictions on access and use of the 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).

As detailed in Chapter 7, Azerbalyk use nets and cages in the Bay for spawning activities and employ 3-4 fishermen to manage this. As a result of the restrictions on access and use, an agreement has been reached with Azerbalyk to move the nets and the one cage lying within the ACG Phase 1 pipeline corridor. It is understood that the change in location will not affect the productivity of the nets or the livelihood of the fishermen involved. 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. As 30-40% of the catch from the nets and cage was taken by the fishermen in lieu of wages[4], negotiations are ongoing with the 4

[2] For instance, the non-governmental organisation (NGO) consultation meetings undertaken as part of the ACG Phase 1 ESIA process demonstrated that this belief was held by a number of the Azerbaijan environmental NGOs. The minutes of these meetings will be contained in the PCDP Annex to the final version of this ESIA document.

[3] Preliminary Transboundary Diagnostic Analysis May 2000 (Draft) Caspian Environment Programme
[4] See Chapter 7 Socio-economic Baseline

fishermen employed by Azerbalyk to ensure that their livelihoods are not affected by the removal of the nets and the destruction of the cage.[5]

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. 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 with Azerbalyk on an alternative site.

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 40-60km 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 re-routed during 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 sound, or that any emissions are comparable in magnitude to existing sources;
- 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;
- 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;
- noise, dust and ground-borne vibrations.

The activities that may result in these potential impacts include:

- transporting pre-fabricated components and equipment to Azerbaijan;
- upgrading of construction yards in country (SPS and Zikh);
- preparing the laydown area for equipment;

[5] These negotiations will be documented as part of the Resettlement Action Plan which will be publicly available.

- mobilisation of the workforce;
- demobilisation of the workforce;
- early civil engineering work at the terminal site;
- construction of the terminal;
- construction/assembly of the offshore facilities;
- 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 early civil engineering works programme at the onshore terminal site, the upgrade of the SPS yard for offshore construction, the construction of the onshore terminal itself and the assembly onshore of the offshore components.

The early civil engineering works will last approximately 6 months from January 2001. During the programme there will be a small influx of workers to the Sangachal area. As at the time of writing, the tender process for the programme had not been concluded, final details relating to the precise size and source of the workforce were not available. It is understood however, that the total number of employees on-site at any one time will be a maximum of around 230. Of these the proportion of expatriate workers is anticipated to vary over the course of the programme reaching a maximum of 30 to 40 individuals. 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.

Current tender information confirms that on average a minimum of 70% of workers employed on construction activities, for both onshore terminal construction, upgrade works and the assembly of offshore components, will be drawn from Azerbaijan. For the onshore and offshore construction processes it is envisaged at this stage that approximately 40% of workers 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 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. For the upgrade works at the SPS yard, and subsequent assembly of offshore components, it is envisaged that there will be around 400 workers housed in an open camp.

The construction of the terminal will begin in January 2002 and will last for approximately three years. The upgrade of the assembly yard will also commence in January 2002 with assembly of the PDQ jacket commencing in mid 2002. PDQ jacket and topside and C&WP jacket assembly will last for approximately three years.

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 ACG Phase 1 construction activities.

For both offshore and onshore construction activities however, a significant number of workers will be housed in open camps at both the Sangachal terminal site and in or near the SPS yard as outlined above.

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 opportunity to secure 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 14.

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, terminal construction, assembly yard upgrades and onshore assembly of offshore components workforces, along with those migrating to the area in the hope of finding employment. 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- some impact on human health, well-being, livelihoods. Impacts significance ranking = 15 - high

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[6] Umid Camp. As outlined above, at public meetings held as part of the ACG Phase 1 and Shah Deniz Stage 1 ESIA process, local residents identified employment opportunities as one of their main interests. Specifically, concerns were focused on percentages of employment

[6] Internally Displaced Persons.

for local people, skills transfer, and comparability of wages between local and expatriate workers[7].

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, current indications are that for both onshore and offshore construction, it is likely that between 15% and 30% of the workforce will be drawn from outside Azerbaijan. The nationality of expatriate workers is yet to be confirmed.

For both onshore and offshore construction, the effect the ACG Phase 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 14). The onshore terminal construction workforce will also 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 ACG Phase 1 construction workforces 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.

Market distortion

The onshore and offshore construction workforces 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 ACG Phase 1 employment opportunities may be to increase the welfare of some residents at the expense of others. However, given that construction

7 See minutes of public meetings with local residents held during the ESIA process in the first half of 2001.

employment is a time limited activity (for all Phases of the ACG project it is likely to last for around 10 years), employment during the onshore and offshore operational phases 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 ACG Phase 1 tender submissions, it appears however that the main health issues could include:

- communicable diseases;
- sexually transmitted diseases and contraception issues; and
- restriction of land needed for livelihoods leading to a decline in nutritional health.

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- some impact on human health, well-being, livelihoods. Impacts significance ranking = 15 - high

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 which 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 or offshore 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 AIOC/BP as part of a Social Investment Programme as outlined in Socio-economic Mitigation, Monitoring and Management

(Chapter 14), 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[8]. 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 the around 50% of workers for the ACG Phase 1 onshore and offshore construction activities will be either local to the area or transported to and from the site each day. However, for both offshore and onshore construction, workers from other parts of Azerbaijan and expatriate workers will 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, where 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 ACG Phase 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.

In addition, the disruption to local subsistence livelihood fishing activities outlined in Section 11.4.3 above may also negatively impact on the health and nutritional status of members of the local community.

8 Field Report, Joint UN Project to Prevent STDs and HIV/AIDS in Azerbaijan, March 2000.

11.4.4.3 Noise

Perception of noise

The construction and operation of the proposed terminal facilities, adjacent to the existing EOP facilities would increase the existing ambient noise levels around the site. Similarly, the onshore assembly of the offshore facilities would be likely to have an impact on nearby sensitive receptors.

Sound may be defined as any pressure variation that the human ear can detect. Compared to 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 referred to as the "threshold of pain".

The ratio between these two extremes is more than one 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 human 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 ranging 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 the "A-weighting" the results of which are 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 6 dB represents a doubling of the sound pressure, an increase of about 8 to 10 dB is required before sound 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. Typically however, 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 Such noise are usually perceived as the most annoying form of noise.
- **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 100 Hz. 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 distances. Low frequency noise is more annoying than would be expected from the "A-weighted" sound pressure level.

World Bank Guidelines on noise emissions

The World Bank Pollution Prevention and Abatement Handbook (1998) criteria against which estimated noise levels generated by onshore project activities have been assessed states:

> *"Noise abatement measures should achieve either the levels given below or a maximum increase in background levels of 3 decibels (measured on the A scale) (dB_A). Measurements are to be taken at noise receptors located outside the project property boundary."*

The maximum allowable Leq in dB_A from oil and gas production (onshore) are presented in Table 11.10.

Table 11.10 World Bank Pollution Prevention and Abatement Handbook (1998) noise criteria for onshore oil and gas production

Receptor	**Maximum Allowable Leq (hourly) in dB_A**	
	Daytime (07:00-22:00)	**Night-time (22:00 – 07:00)**
Residential, institutional, educational	$55dB_A$	$45dB_A$
Industrial, commercial	$70dB_A$	$70dB_A$

Sensitive receptors

Figure 11.1 presents a satellite image of the location of the EOP and proposed ACG terminal facility (land-take area). Identified sensitive receptors are also shown. The concentric lines on the figure represent increments of 1 km.

Distances to sensitive receptors that may be subject to noise impacts during ECEWP and terminal construction and operation are presented in Table 11.11.

Figure 11.1 Location of existing EOP terminal, boundary of proposed land acquisition area and nearby sensitive receptors

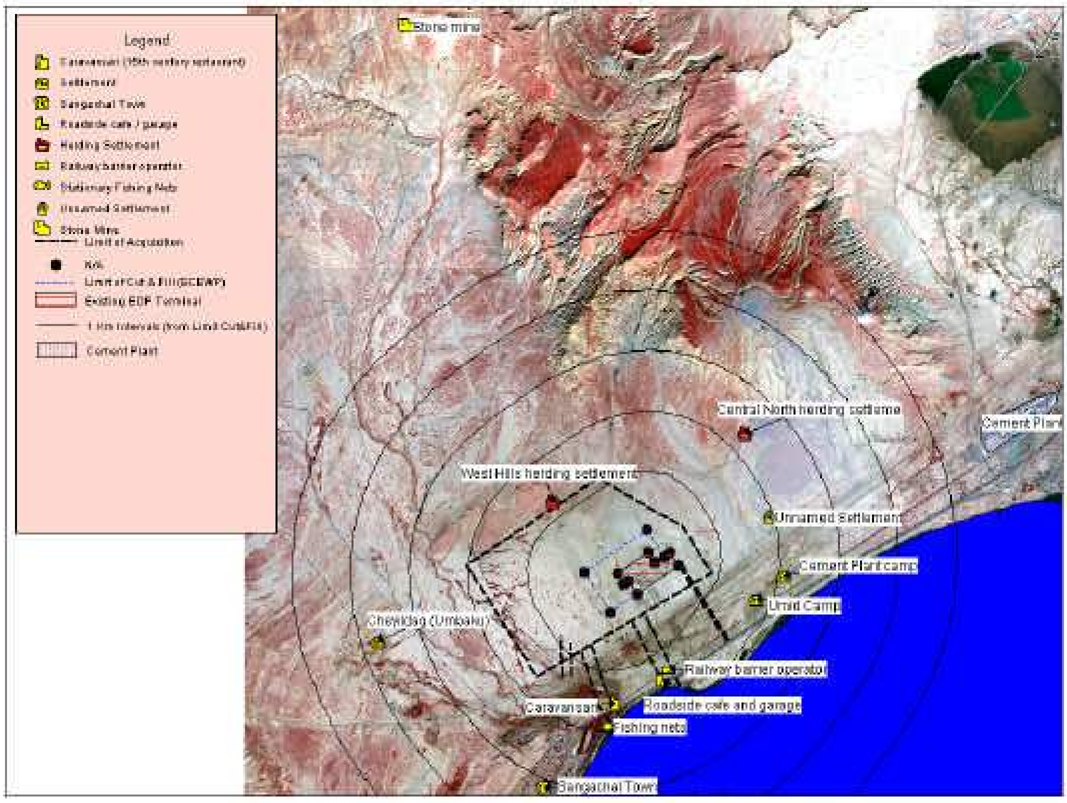

Table 11.11 Approximate distances between receptors and ECEWP / terminal construction and operation activities

Receptor	Receptor Type	Approximate Distance	From
Stone Mine	Industrial	9.4 km	Limit of terminal land-take area
West Hills Settlement	Residential	1.3 km	Limit of terminal land-take area
Central North Settlement	Residential	2.3 km	Limit of terminal land-take area
Unnamed Settlement[9]	Residential	1.9 km	Limit of terminal land-take area
Umid IDP Camp	Residential	650 m 1.6 km	New access road Limit of terminal land-take area
Cement Plant Camp	Residential	1.3 km 2.0 km	New access road Limit of terminal land-take area
Railway Barrier Operator	Industrial	1.35 km	Limit of terminal land-take area
Roadside Café / Garage	Commercial	1.4 km	Limit of terminal land-take area
Caravansari	Commercial	1.5 km	Limit of terminal land-take area
Cheyildag (Umbaku)	Residential	3.7 km	Limit of terminal land-take area
Sangachal town limit	Residential	2.23 km	Limit of terminal land-take area
Cement plant	Industrial	5.3 km 5.76 km	New access road Limit of terminal land-take area

Note: ECEWP and terminal construction and operation activities will take place within the terminal land-take area.

[9] This settlement was identified off newly acquired satellite image and is considered to be an oil well operators' camp.

Existing noise environment

The environmental measurements were measured over four different periods between Friday 23 November and Sunday 25 November 2001 (Acoustic Technologies Ltd, 2001; Technical Report AT 5189/1 Rev 0). Night-time measurements were carried out during late Sunday evening, when traffic noise was likely to be at a minimum. The wind was relatively constant ranging in speed between 2 m/s and 5 m/s, predominantly from the northwest direction (i.e. blowing towards Umid community). The measured levels are summarised in Table 11.12.

Table 11.12 Existing noise levels (ranges) in the vicinity of the EOP terminal as measured in November 2001

Location	Noise Level (dB_A)		
	Leq	L_{10}	L_{90}
Umid	45 to 48	48 to 51	40 to 45
Roadside Café / Garage	54 to 67	59 to 71	45 to 52
Umbaku	42 to 48	43 to 52	38 to 41
Herdsman's Farmstead	40 to 48	42 to 51	33 to 41

Note: A night-time measurement at Herdsman's Farmstead was not possible; levels shown for night time were actually taken in the early morning.

Traffic along the main road was busy and relatively constant throughout the day and did not significantly decrease even at 23:00 hours on Sunday night. The traffic consisted of a large proportion of heavy goods vehicles. Traffic noise had a significant impact at Umid and the restaurant whilst less so at the Umbaki measurement location, which was screened by the two residential towers. Traffic noise was not significant to the north of the terminal (location 4).

A rail track runs parallel to the main road with a train approximately every half hour. None of the measurements were considered to have been impacted by rail noise although it would not be significant compared to the contribution from traffic.

There was very little livestock or wildlife to impact the measurements with occasional dog barking providing a minimal contribution to the overall noise level.

Depending on the wind speed and direction, the flare was sometimes audible at Umid only. The sound had a likeness of a jet in the distance drifting in and out of audibility. With a westerly wind, the flare was barely audible at location 4, which was 950 m from the stack. The remainder of the terminal was inaudible at all the measurement locations.

ECEWP and terminal construction

ECEWP and terminal construction activities will include the following noise generating activities:

- site grading, foundations and underground services installation;
- earthworks;
- access and site roads construction;
- terminal construction; and
- operation of the construction camp.

The exact type and number of plant and equipment that will be used during the ECEWP and terminal construction activities was not known at the time of writing. The plant and equipment that would be expected to operate during the ECEWP and during construction of the proposed terminal facility and the estimated noise emission levels for the equipment are presented in Table 11.13. The majority of heavy equipment movement would be restricted to the terminal land-take area. Some vehicle movement within the land acquisition area 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)	BS 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 emission estimates

Noise estimates have been completed in accordance with BS 5228:1997 and the Standard has been applied to explore the likely propagation of noise from the ECEWP and terminal construction area. The Standard generally requires the input of noise attenuating data (e.g. ground hardness; sound barriers (natural or built); etc.) but as such data was not readily available, the noise emission estimates were calculated without these inputs. These factors would have an effect on noise levels and especially in regards to the propagation of noise beyond 300 m from the source. As such, the results of the assessment of noise emissions are likely to be an over-estimate of what in actuality would occur. In addition, noise emission calculations have assumed a worst-case operational scenario; that is, the assessment assumes the simultaneous operation of all plant equipment which in reality, may not occur.

The results of the noise assessment indicate that there is a potential for minor noise impacts on sensitive residential receptors (i.e. noise level >55 dB during the day-time) that lie approximately 850 m from the proposed ECEWP and terminal construction area. Such receptors include:

- the Umid IDP Camp (650 m from the new access road site);
- the railway barrier operator;
- the roadside café / garage; and
- the caravansari.

It is emphasised that the noise emission estimate assumes simultaneous operation of all plant and equipment and no attenuation of noise as a result of sound barriers (natural or built). In reality, the identified minor exceedences may not occur at all identified receptors. 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.

11.4.4.4 Vibrations

There is no data on existing ground-borne vibrations sources or levels within the area of the ACG Phase 1 Project activities.

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 in 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 would 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 run directly to the terminal facility for a distance of approximately 1.7 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.

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. In re-routing the power line, it is envisaged that the supply will be cut off for a few hours. It is understood that the electricity line is a back-up supply line for the Firuza stone mine some 10 km west of terminal site. The stone mine uses electrical equipment to cut the stone and produces approximately two large lorry loads of stone a day for use in the local building sector. As the line is a back-up it is not envisaged that any disruption will take place to the stone mine operations. If in fact the disconnection, re-routing and reconnection of the line does affect the stone mine operations it is expected that the delay will not be of significant length, being a few hours only. In addition the disconnection and reconnection will be scheduled out of working hours so as not to cause any production loss to the mine.

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. Power will be supplied to the construction camps using diesel generators, hence no impact on local power supplies.

No disruption to local utilities is expected during the operational phase of ACG Phase 1.

While the potential impact to utilities is not considered significant and hence no mitigative action 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 and offshore upgrade and assembly 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 ACG Phase 1 construction phase. Although the tendering processes for both onshore and offshore construction are yet to be finalised, current tender information indicates that a minimum of 70% of workers employed on construction activities, for both onshore terminal construction, upgrade works and the assembly of offshore equipment, 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. For the upgrade works at the SPS yard, and subsequent assembly of offshore components, it is envisaged that approximately 400 workers will be housed in an 'open' camp.

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. Both the onshore and offshore construction camps 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 AIOC/BP as part of a Social Investment Programme as overviewed in Socio-economic Mitigation, Monitoring and Management (Chapter 14).

11.4.7 Transport

There are a number of activities 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;
- upgrade of existing assembly/construction yards in Azerbaijan;
- construction/assembly of offshore facilities;
- demobilisation of workforce;
- civil engineering and construction works for the terminal;
- installation of onshore pipeline sections;
- decommissioning of the terminal, pipelines and offshore works; and
- waste disposal for the terminal, pipelines and offshore elements.

Each activity will increase the number of vehicle movements by either road or rail, creating 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 ACG Phase 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 = 2 - inconvenience experienced in accessing community facilities and utilities for short (hours) period of time.
Impacts significance ranking = 10 - high

Construction phase
Information on the transport systems local to the project area indicate 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 AIOC/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. It is not envisaged however, that this disruption will be lengthy nor sustained and thus disruption is likely to be limited. Until the exact additional traffic load has been calculated for the construction phase of the project however, it is difficult to predict the exact significance of the impact on the current transport situation.

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 both the onshore construction facilities and camp and the offshore upgrade and assembly works. 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 750 camp workers (onshore and offshore construction combined) 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.

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 34 it is not envisaged that the transport needs of these workers will place any extra pressure on the existing public transport system. The maximum number of workers for offshore operations is 300. If private transport is not provided for these employees then they may increase pressure on the system leading to negative impacts for existing users.

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.

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 both onshore and offshore construction activities.

Potential benefits to the local communities may result from upgrading and maintenance of roads and the rail transport system in order to ensure they meet the safety requirements for the project.

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 ACG Phase 1 Project site (Table 11.14). These known features lie outside the proposed land take area and therefore would not be directly impacted as a result of ACG Phase 1. It was noted by the local archaeological experts[10] however, that there is a potential for subsurface artefacts to be located within the ACG Phase 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 ACG Phase 1 terminal expansion and associated facilities (access roads, onshore pipelines) and temporary works including storage yards and office sites, etc. will pose the greatest risks to potential subsurface archaeological features. Negative impacts 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.

Table 11.14 Archaeological features identified during 2001 survey

Map Reference Number	Artefact(s)	Within safety/buffer or near other project construction zones (in metres) (Yes/No)? If no, shortest distance (m) from perimeter fence boundary or nearest project structure.	Approximate Site Area
1*	Remains of fireplace, earthenware debris, figure of goat carved on rocky dwelling interior, pottery made on potter's wheel	NO - 310 meters	Few hectares
2*	Burnt bricks, collapsed building, fireplace - artificial fire grooves found on large rocks	NO - 330 meters	Few hectares
3*	Unglazed earthenware debris, jug and pitcher parts	NO - 220 meters	Few hectares
4	Earthenware debris - one fragment decorated with geometrical figures and spots, stone slab with grooves	NO - 300 meters	Several hectares
6**	Earthenware debris	YES - 8 meters inside safety/buffer zone	Few hectares

10 Experts involved in the archaeological field survey were Nadiv Khasanov and Elmira Abbasova of the Institute of Archaeology and Ethnography, Azerbaijan Academy of Sciences.

Map Reference Number	Artefact(s)	Within safety/buffer or near other project construction zones (in metres) (Yes/No)? If no, shortest distance (m) from perimeter fence boundary or nearest project structure.	Approximate Site Area
7**	Earthenware debris	YES - 90 meters NE of proposed access road	Several hectares

* These locations, all grouped together, are at the foot of or atop the west hills. There is no foreseeable Project activity that would require physical presence on these hills except, perhaps the excavation of soil for use in constructing bunds (this soil can easily be collected from other areas).
** For features indicative of human settlement that have been identified, when located within the project activity zones (land acquisition zone and areas where excavation will take place), it is assumed that some further verification will take place prior to any ground disturbances.

Positive impacts can result from ACG 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 and immediate reporting of potential finds to the appropriate BP representative, especially while undergoing excavation activities, Azerbaijan's cultural history can be augmented.

An Archaeological Management Plan (AMP; Chapter 14) will be developed and implemented for ACG Phase 1. The AMP can be expected to provide a positive impact insofar as it would result in a contribution to the recording and understanding of Azerbaijan's cultural history and the protection of archeological sites and artefacts within the area local to the project.

11.4.9 National Employment/Industrial Base/International Procurement

11.4.9.1 Introduction

This section has been divided between the construction phase of ACG Phase 1 and the operations phase in order to take account of the differences in employment and procurement impacts between the two different phases of the project.

11.4.9.2 Construction of ACG Phase 1

Overview

The primary impacts during construction relate to employment and income generated by ACG Phase 1 and include:

- direct employment associated with the construction programme of ACG Phase 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 of between 500 and 700 workers in the country[11] with sufficient experience in international fabrication practices that are available to support the proposed construction programmes for the Phase 1 development. A strong training and re-training programme will therefore be committed to support the construction phase of ACG Phase 1. Potential candidates for training have however been identified to support a sustainable increase in skilled labour for the fabrication industry.

[11] Caspian Construction Capacity Report Rev06, April 2000, AIOC Full field Development Project

An assessment[12] was undertaken of the advantages and disadvantages of the yards visited and the relevant human resource issues pertaining to each. For reasons of confidentiality, the detailed findings of this report cannot be disclosed, however we have sought to provide a brief overview below. Most of the major issues encountered whilst assessing the suitability of the available labour force 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 would 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 AIOC/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. AIOC/BP are actively encouraging the contractors to locally source goods and materials which meet the necessary specifications. Such requirements are included in the contract between the contractor and AIOC/BP.

In regards to the proposed full ACG 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 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.. 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 into the construction capacity of the Caspian 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

[12] Ibid.

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 Impact

The impact assessment process in relation to employment is summarised in Table 11.15 below. As illustrated, whilst the majority of activities will result in a positive impact on the employment base, during demobilisation the loss of this key employment source will have a significant negative impact on the local employment base. The sourcing of employment during construction, for both onshore and offshore, is to be determined by the selected contractors. The % of local content will form one of the evaluation criteria in the tender selection process for all contractors.

Table 11.15 Impact significance ranking – employment - onshore construction

Activity	Likelihood	Impact	Impact significance ranking
Modification of existing services	5	+	+
Excavation of drainage channel/bunding	5	+	+
Construction of fencing and perimeter lighting	5	+	+
Construction of access road and railway crossing	5	+	+
Mobilisation of workforce	5	+	+
Construction operations	5	+	+
Demobilisation	5	3	15
Hook up	5	+	+

Whilst the contractor has not been selected for the construction of the **terminal** it is possible to estimate that approximately 800 people will be employed during terminal construction.[13] 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. It is likely however, that there will be ongoing construction work associated with Phases 2 and 3 of ACG FFD (Chapter 12).

It should be noted that the Phase 1 Sangachal terminal will have a layout that enables the Shah Deniz gas processing terminal to be placed adjacent to it as appropriate. BP will operate both projects, and there are some inherent synergies that can be obtained 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 Phase 1and those employed may become involved in the development of Phase 2 and also the construction of the Shah Deniz Stage 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.

[13] 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

A key consideration in estimating the economic impact of ACG Phase 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.

At present it is not possible to give full details on the proposed sourcing of the construction workforce for the terminal as the terminal contractor has not yet been selected. However, it is understood 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%. However 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 as it will remain in the country of origin.

The **proposed cost** in relation to the construction of the terminal for ACG Phase 1 is estimated at $350 million[14]. It has been estimated that some 50% of this expenditure will occur within Azerbaijan. These costs include not only the capital costs of the infrastructure, but also the installation costs (i.e. all associated contracts), owners costs and contingency. The costs are defined as +/- 20%.

The contractors for the **offshore works** have been selected and it has been estimated that approximately 4,000 people[15] will be employed for the offshore elements of ACG Phase 1. Employment will gradually build up from January 2002 to September 2002, when it will continue at peak levels until February/March 2004.

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 Phase 1 may become involved in the development of Phase 2 and also the construction of the Shah Deniz Stage 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, and the extent to contractors select local residents as employees.

It is known that the contractors for the offshore construction propose to source between 70 and 80% of the required personnel within Azerbaijan. It is understood that the offshore construction contractor will only source labour from the international market where the national labour force cannot supply the skills required for the programme. The contractors for

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

the upgrade of the SPS yard (a related project) propose to locally source between 60% and 70% of the required workforce.

As discussed above, some training of the workforce will be required. It is proposed that the offshore contractors will be running a training programme for employees; for example 200 personnel will be trained for the drilling programme alone, with training scheduled to start September 2001.

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.

The **proposed cost** in relation to the construction of the offshore elements of ACG Phase 1 is estimated at $1,650 million[16]. It has been estimated that some 44% of this expenditure will occur within Azerbaijan. These costs include not only the capital costs of the infrastructure, but also the installation costs (i.e. all associated contracts), owners costs and contingency. The costs are defined as +/- 20%.

11.4.10 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 suggest 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 say 60% implies a multiplier of 1.67 and leakage of say 40% implies a multiplier of 2.5. Multipliers for leakages 10% to 90% are given in Table 11.16 below.

[16] Source : BP.

Table 11.16 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

EBRD estimates that approximately 70% of expenditure (i.e. procurement and income) will leak from the Azeri 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 ACG Phase 1 is detailed in Table 11.17 below.

Table 11.17 Direct and estimated total (offshore and onshore) impact ($ million)

	Azerbaijan
Direct	888.1
Indirect and Induced	381.9
Total	1,270.0
Source : Consultants estimates	

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.

11.4.10.1 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[17].

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. However, there is 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

[17] ACG FFD Environmental and Socio-economic Overview p72

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 ACG Phase 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.

11.5 Operational phase

11.5.1 Direct impact

During the operational phase of ACG Phase 1 approximately 170 AIOC/BP positions will be created between the onshore and offshore elements and this is illustrated in Table 11.18 below. Due to the nature of the work involved a number of the positions will entail shift work and it will be necessary to employee approximately 300 personnel for the offshore operations to support the 150 positions. The requirements for shift work is not as high onshore, however it still is required in a number of instances. As a result for the 20 positions created onshore some 35 people will be employed.

Table 11.18 Employment during operation

	Number of Positions	Number of Employees
Offshore	150	300
Onshore	15	30
Onshore support	5	5
Total	170	335

Source : BP's ACG Phase 1 Operations Manager

It is envisaged that from day one of operation some 50% of the jobs will be occupied by Azerbaijani nationals. It is hoped that this will increase over time as skills are developed and experienced gained, with 75% of positions being held by Azerbaijani's after 5 years and 95% after 10 years.

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 will also be inviting individuals to register at recruitment centres in early 2002 to ensure that those that are hired can undertake the necessary training in advance of when the project becomes 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 2 and 3 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 give 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 ad other areas before then mobilising to Baku for the hook-up and commissioning of both the Sangachal terminal and offshore platforms.

The operating and maintenance costs for ACG Phase 1 over an operating life of 21 years have been estimated at a total of $1.1 billion[18]. This cost estimate is +/- 10%. The extent to which this expenditure will occur within Azerbaijan is difficult to estimate, however it is estimated that overall some 70% of expenditure may occur within the country.

11.5.2 Indirect and induced impact

As with the construction phase, in estimating the total employment creation impact of ACG Phase 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 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 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 ACG Phase 1 on the Azeri economy is detailed in Table 11.19 below.

Table 11.19 Direct and estimated total impact ($ million)

	Azerbaijan
Direct	770
Indirect and Induced	331.1
Total	1,101.1

Source : Consultants estimates

[18] BP’s ACG Phase 1 Operations Manager

11.5.3 Wider economic impact

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 (ie. 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 14).

11.6 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. However, there are 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 which 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[19] 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

[19] 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).

impacts by providing artificial financial support which 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, 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. However, the realisation of such impacts is 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 also requires attention to the resolution of local economic and socio-economic problems in order to develop a strong and sustainable economy.

11.7 Summary of Significant Socio-economic Impacts

In summary, a number of socio-economic impacts were assessed and ranked as having a “high” significance, however, the impact assessment concluded that many of the activities associated with the Phase 1 development would result in only negligible or low impacts on the surrounding socio-economic environment.

A total of 84 routine and planned non-routine project activities were identified for each of the elements of the proposed Phase 1 project and each activity was assessed against the socio-economic receptors present in the project development area. Of the 84 activities identified, 16 were considered to have a potential to cause impacts of “high” significance on 6 separate socio-economic receptors. One routine activity was assessed as having the potential to result in a socio-economic impact of “critical” significance and this impact (on the local herding population) and this is being addressed through a mitigation process, which aims to determine an acceptable outcome to all parties.

The contributing activities that would result in impacts ranked as being of “high” or “critical” significance along with the receptors affected are summarised in Table 11.20.

Table 11.20 Summary of Phase 1 activities resulting in "high" or "critical" significance socio-economic impacts

Project Component	Contributing Activities	Impacts	Impacted Receptors
Onshore construction of offshore facilities	Fabrication and construction activities	Community tensions surrounding employment issues, health, informal market and market distortion effects on local economy associated with workforce and inward migrating population in search of employment. Impact on direct, indirect and induced employment.	Population in the vicinity Transport
	Mobilisation of workforce		Population in the vicinity
	Demobilisation of workforce		Population in the vicinity National employment base
Subsea pipeline activities	Pipeline crossings of existing onshore services.	Impacts on the transport system and infrastructure including congestion, deterioration, nuisance to other users	Transport.
	Construction of nearshore trench	Nearshore trench construction restricting access to and use of local subsistence fishing areas with possible impact on local livelihoods	Fishing.
	Pipelaying (including vessel operations, anchor drag)	Pipelaying interference with recreational and legal commercial fishing and shipping activities and route to market	Fishing Shipping.
Terminal activities	Land acquisition and tenure	Land take and ground clearance for terminal construction leading to permanent loss of herding community grazing land	Land use
	Ground clearance and grading		Land use
	Modification of existing services	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. Impact on direct, indirect and induced employment	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	Impacts on the local and regional transport system. Disruptions to fishing and shipping activities in the Caspian and sea routes in to the Caspian	Fishing Shipping
	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. This is discussed in Chapter 15.

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.

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12.2 Regional context of the ACG Phase 1 project

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.

12.2.1 Offshore projects

Offshore, the only field currently operated by the Azerbaijan International Oil Operating Company (AIOC) is the ACG Early Oil Project (EOP) with production from the Chirag-1 platform conveyed to the 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 (Figures 12.1 and 12.2).

Figure 12.1 ACG Contract Area

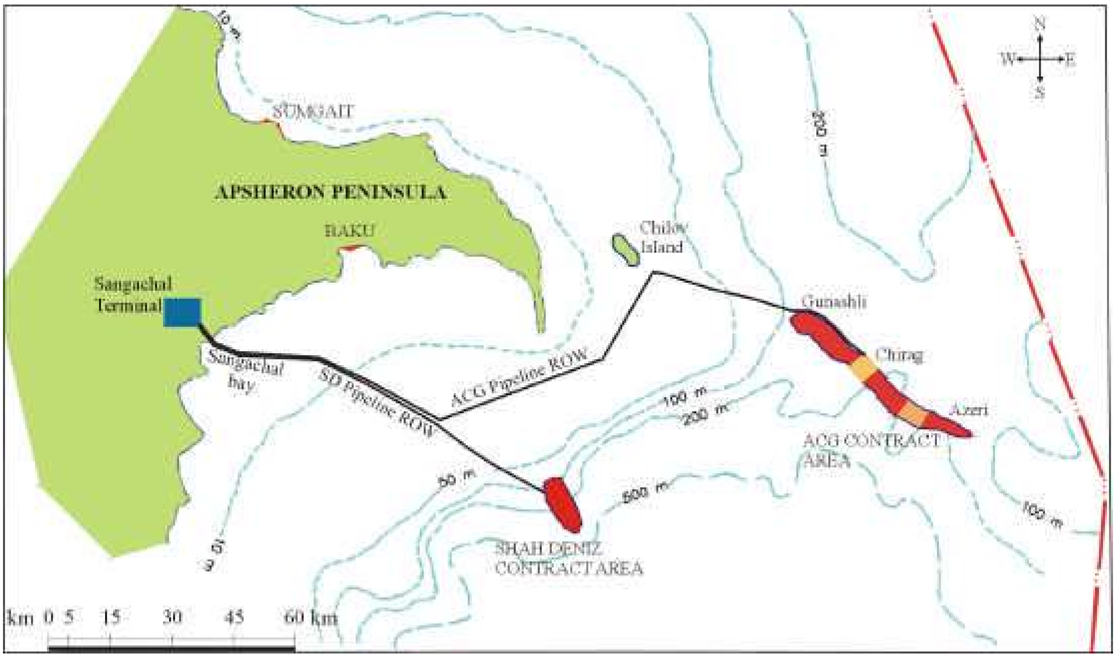
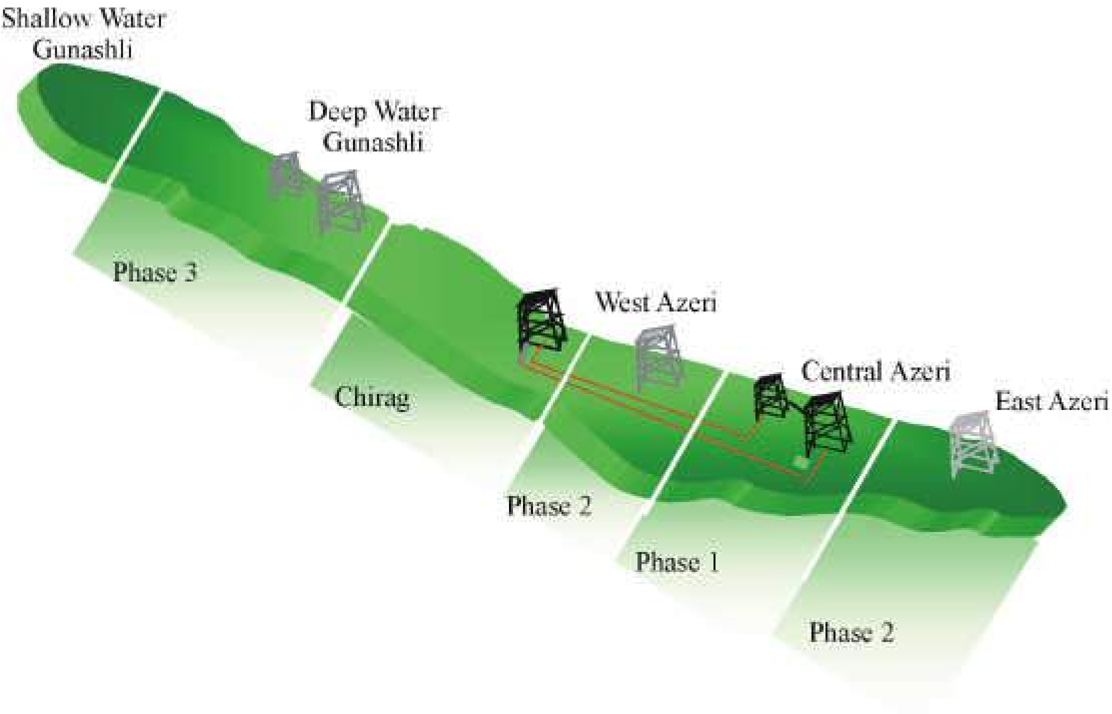


Figure 12.2 ACG Full Field Development



A number of offshore PSAs have been awarded in recent years with those in close proximity to the ACG field including the Oguz field to the northwest and the Apsheron field to the west. No PSA developments in the vicinity of the ACG Contract Area are however, currently taking place. Many of the PSA Contract Areas are in the exploration phase with a few to date, returning negative results. The ACG and Shah Deniz fields (operated by BP) proved exceptions to this when large oil and gas/condensate reserves were discovered and targeted for development. Exploration will continue in many of the PSAs, although this is being hampered somewhat by the limited drilling rigs available in the Caspian region for these programmes. 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 the fields.

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 ACG Phase 1 terminal location is situated at Lokhbatan, approximately 20 km to the northeast of Sangachal.

The EOP terminal currently operates at the site of the proposed ACG and Shah Deniz terminal facilities. The proposed ACG Phase 1 terminal will be constructed as an expansion of the existing EOP terminal and ultimately, the operations at the two facilities will share many of the existing utilities at the site. Current planning places the proposed Shah Deniz gas/condensate processing terminal facility immediately adjacent to the new ACG facilities. The proposed additional land-take at the terminal location will therefore incorporate both the ACG and Shah Deniz 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 to Tblisi to

Ceyhan (BTC) Main Export Pipeline) and a possible gas export pipeline for Shah Deniz gas transfer 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 Lokbatan oilfield operated 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 and 4 km from Sangachal village, the block to the west is some 16-17 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 either AIOC or BP operations in the area.

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12.3 Phase 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 ACG Phase 1 development is the first Phase of the proposed ACG Full Field Development (FFD) and follows on from the EOP (Chapter 1). The terminal facilities and associated pipeline nearshore approach and landfall for the proposed Shah Deniz project will also be developed in the area around Sangachal. It is planned that the Phase 1 offshore facilities will be assembled at the SPS fabrication yard and in order to achieve this, yard upgrades will be necessary. The anticipated timeline for all of these components of the Phase 1 development in the context of these other planned activities in and around the terminal site as well as offshore is shown in Figure 12.3. It is important to note that this schedule is estimated as many aspects of the full programme were only at the detailed planning stage at the time of writing this document.

Figure 12.3 Estimated schedule of regional development activities

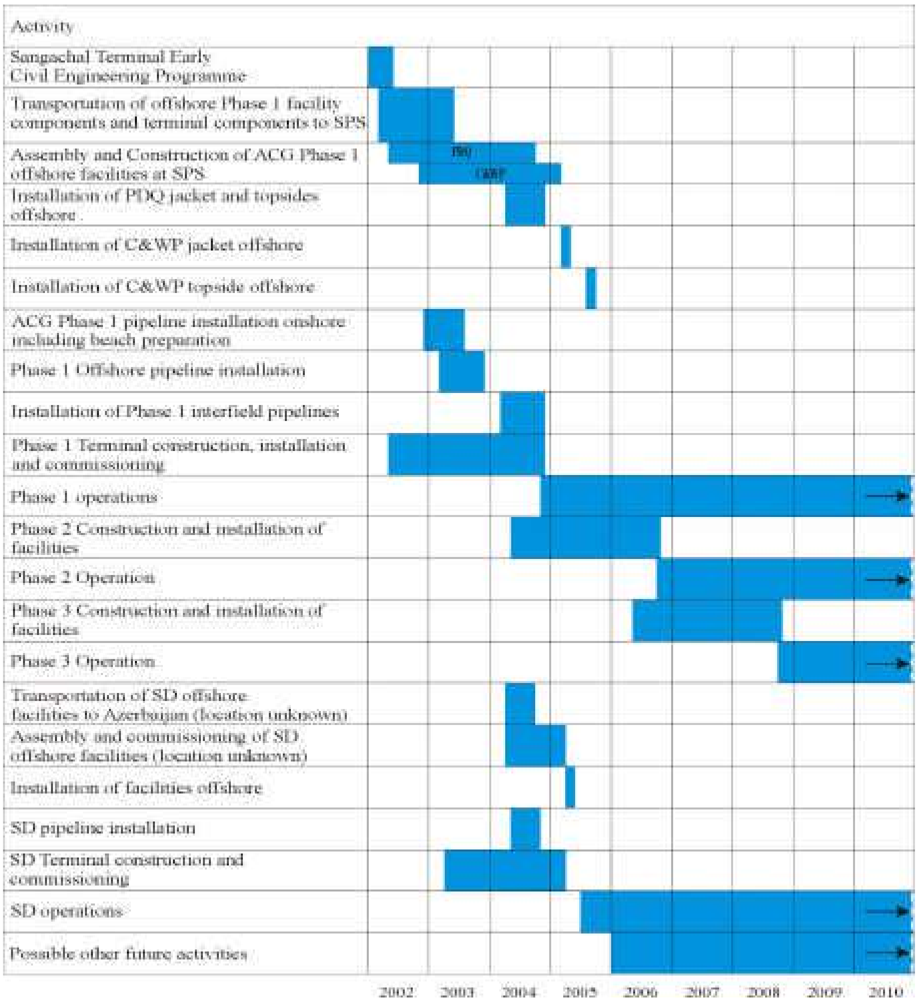


Figure 12.3 shows that the ACG Phase 1 terminal construction activities would occur at the same time as the assembly of the ACG Phase 1 offshore facilities at the SPS yard some 14 km to the north. In addition, ACG Phase 1 pipe-laying activities onshore and nearshore will add to the activity in the area around the terminal.

It is anticipated that ACG Phase 2 construction activities will have begun by the time ACG Phase 1 production has commenced. Phase 3 construction is also likely to have started by the time Phase 2 is operational and producing oil. The layout of the terminal has been planned such that construction for each subsequent phase of the development can be carried out whilst production from a previous Phase continues. At the time of writing this document, the schedule for construction and operational activities associated with the proposed Shah Deniz development was under review and planning. There is however, a possibility that construction of the Shah Deniz terminal facilities will begin whilst the Phase 1 terminal construction programme is ongoing.

The following section examines the aspects of the Phase 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 ACG Phase 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 Phase 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 facilities and the nearest sensitive receptors (i.e. onshore) are sufficiently large that noise will attenuate to insignificant levels and hence no impacts are expected. Workers on the platform 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 Phase 2 and Phase 3 facilities are expected to be similar to those from Phase 1. Given that these facilities would also be well removed from the nearest sensitive receptors, it is considered that no cumulative impacts on sensitive (onshore) receptors would be incurred. Similarly, Shah Deniz facilities would be well removed from the receptors (and ACG offshore facilities) and therefore, would not contribute to any cumulative impact.

Onshore

Normal Operations

As discussed in the Socio-economic Impact Assessment (Chapter 11), preliminary modelling of noise emissions from the Phase 1 terminal facilities 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. The modelling also concluded that the combined noise levels of ACG Phase 1 and Shah Deniz Stage 1 terminal, under normal operating conditions, would be compliant with the World Bank Environmental Guidelines on noise levels for both residential and commercial receptors. Similarly, operation of ACG FFD and Shah Deniz FFD terminals would be compliant within the Guidelines.

Figure 12.4 illustrates the noise emissions for the combined ACG Phase 1 and Shah Deniz Gas Export Stage 1 project. Figure 12.5 illustrates the combined ACG FFD and Shah Deniz FFD operations.

It should be noted that subsequent stagesof the Shah Deniz Gas Export project would be brought on line to maintain the target production rate 900 MMscfd. Commissioning of these latter Stages would not necessarily require any expansion of the terminal beyond that constructed for Stage 1. As such, it assumed that noise emission levels at the terminal for Shah Deniz FFD would be the same as for Stage 1 alone.

Figure 12.4 Noise emission levels for combined ACG Phase 1 and Shah Deniz Stage 1 terminals under normal operating conditions

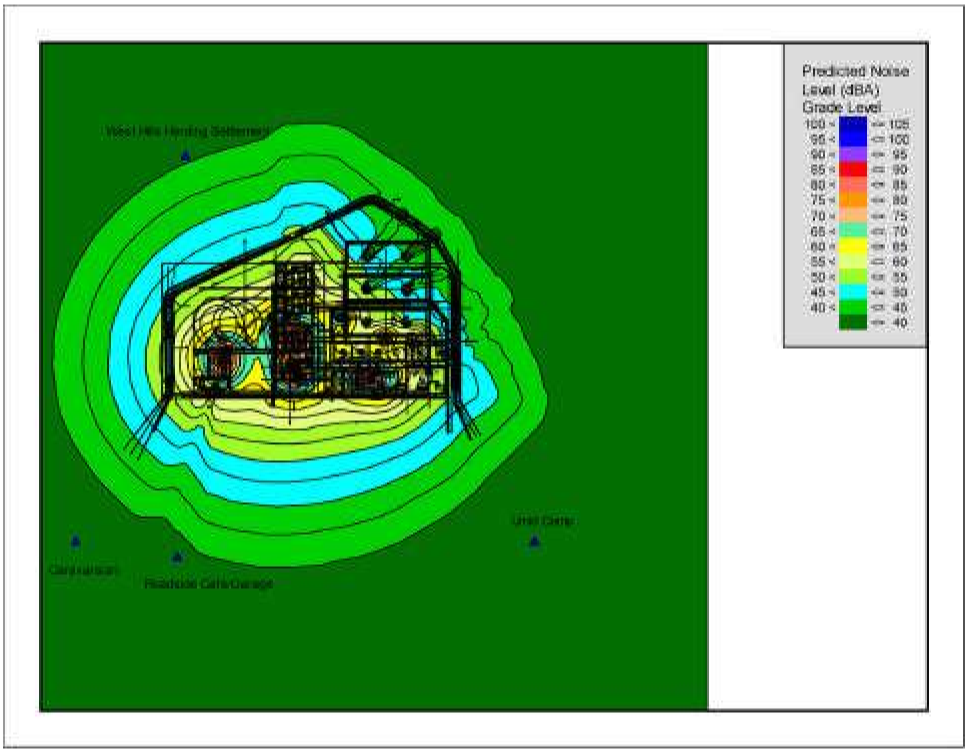
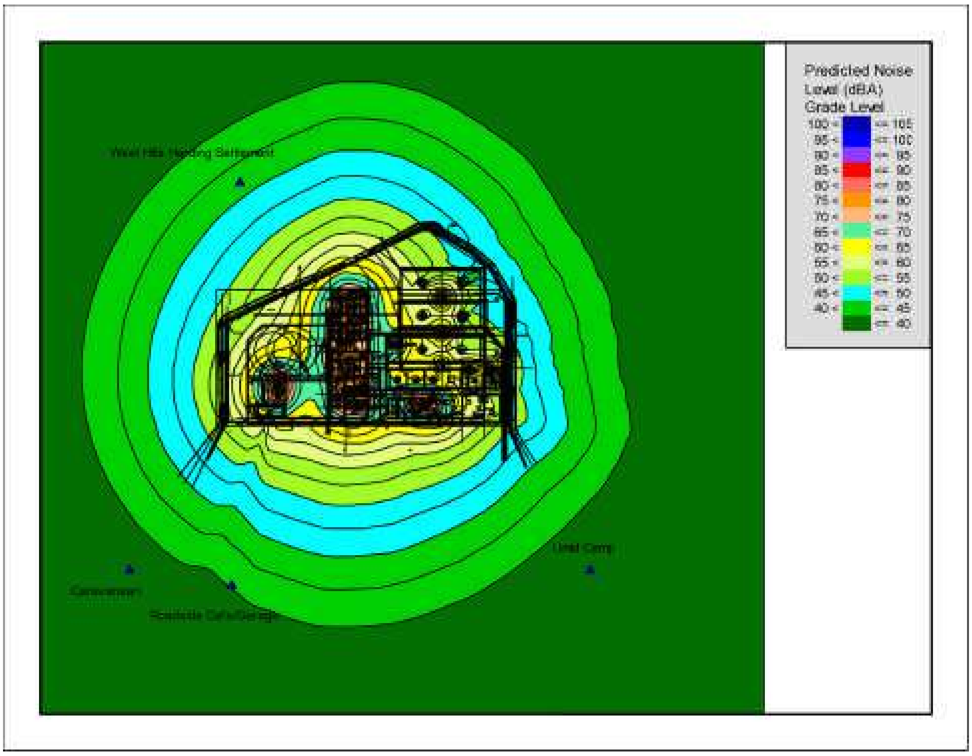


Figure 12.5 Noise emission levels for combined ACG FFD and Shah Deniz FFD terminals under normal operating conditions



Emergency shut-down flaring

As discussed in the Socio-economic Impact Assessment (Chapter 11) preliminary noise modelling of ACG Phase 1 emergency blow-down flaring events predicts that the ACG HP flare, when operating at full blow-down capacity, would result in noise exceedences at nearby residential receptors including the Umid Camp, the Herding Settlement and Umbaki/Sangachal (see Figure 11.3). The exceedence would however, be short-lived as each flare event would be of a maximum of 15 minutes duration with the maximum flow lasting for only three to four minutes. Preliminary modelling of the Shah Deniz Stage 1 HP flare (alone) also indicated that exceedences would be incurred at nearby receptors.

Based on the results of the preliminary noise modelling of the stand-alone ACG and Shah Deniz HP flares, it can be concluded that, in the rare event that both were blowing-down simultaneously, noise levels would be in excess of the World Bank Environmental Guidelines. As a result of the findings of the stand-alone and combined flare operating scenarios, the projects are investigating ways in which flare noise can be reduced (e.g. flare tip design modification; reduction in rate of flow of hydrocarbon product). Further modelling of design options will be undertaken in order to identify alternative flaring arrangements as appropriate that comply with the Guidelines.

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. pipelaying and platform installation) for each of the ACG construction phases (i.e. Phase 1, 2 and 3) would result in the release of atmospheric emissions. There would be a considerable period of time between each phase of activity and therefore, emissions from preceding phases would be well dispersed by the time latter phase emissions were released. There would therefore, be no cumulative impact in terms of degradation of local air quality.

The cumulative emission of greenhouse gases is discussed in Section 12.4.2.3.

Onshore

The main onshore construction activities for the Phase 1 development comprising the expansion of the Sangachal terminal and the assembly of the offshore components will take place simultaneously. Assembly of offshore components would however, take place at the SPS yard sited approximately 18 km from Sangachal town and 14 km north of the existing terminal facility 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 (comprising platform assembly and terminal expansion) associated with each phase of the ACG FFD and potentially Shah Deniz FFD may overlap. If they do overlap, activity from Phase 1 will reduce as Phase 2 activity increases and so on for Phase 3 so that overall, activity would remain at a high level for a longer period but would not necessarily continually increase.

While scheduling of ACG and Shah Deniz works remains to be finalised, at this stage it is 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 phase nears completion would also contribute to minimising the risk of impacting in a cumulative sense, on air quality.

The cumulative emission of greenhouse gases is discussed in Section 12.4.2.3.

Operational activities

Offshore

As discussed in the Environmental Impact Assessment (Chapter 10) emissions from Phase 1 offshore activities would, as a result of good dispersion, not impact on sensitive receptors onshore. Similarly, even when operating at the same time, ACG Phase 2, Phase 3 and Shah Deniz FFD operational activities would not expected to lead to a degradation of air quality offshore or onshore.

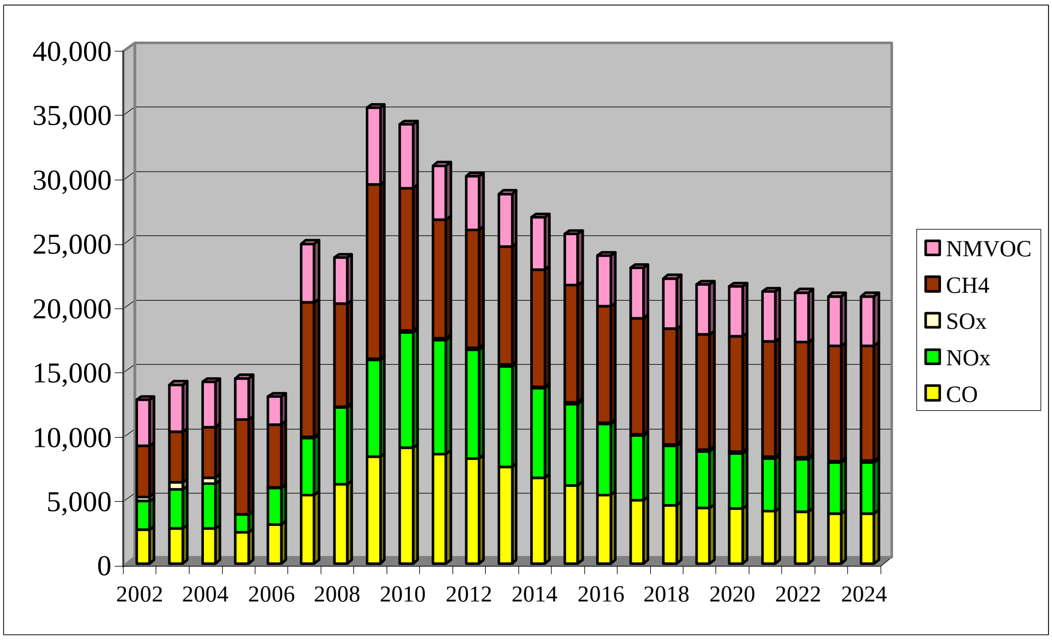
Onshore

Atmospheric emissions from Phase 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 were however, considered to be significant.

Emissions for ACG FFD (offshore and onshore) have been estimated using available data and are presented in Figures 12.6 and 12.7. Similarly, using available data, total emissions from the combined ACG FFD and Shah Deniz FFD (offshore and onshore) have been estimated as illustrated in Figures 12.8 and 12.9.

[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 (tonnes)



Note: gaseous species are combined for presentational purposes only

Figure 12.7 Estimated cumulative CO_2 emissions generated from ACG FFD (tonnes)

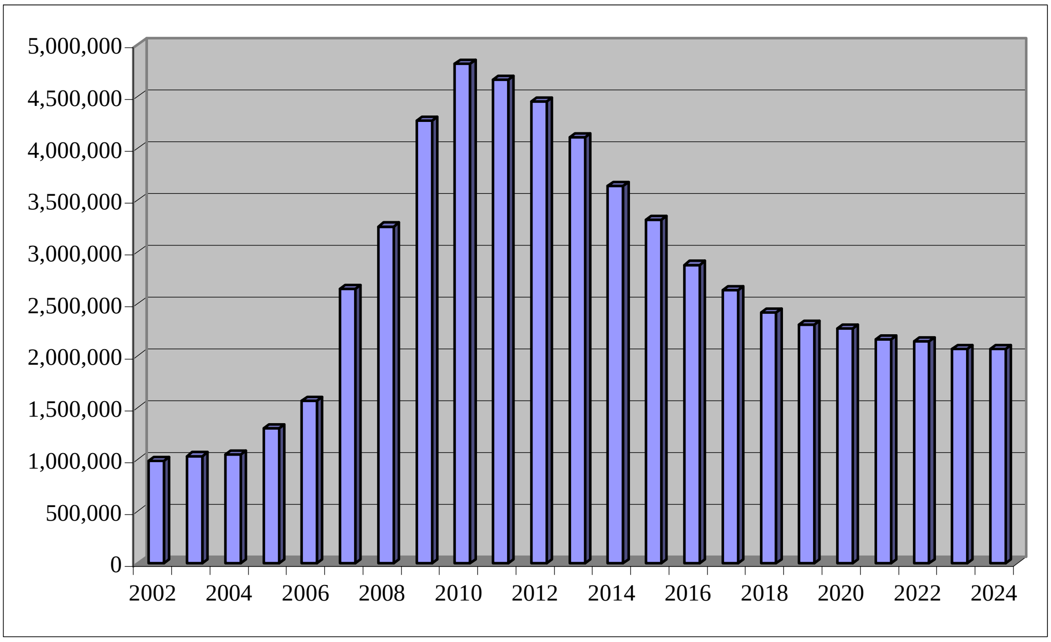


Figure 12.8 Estimated cumulative emissions by species generated from ACG FFD and Shah Deniz FFD (tonnes)

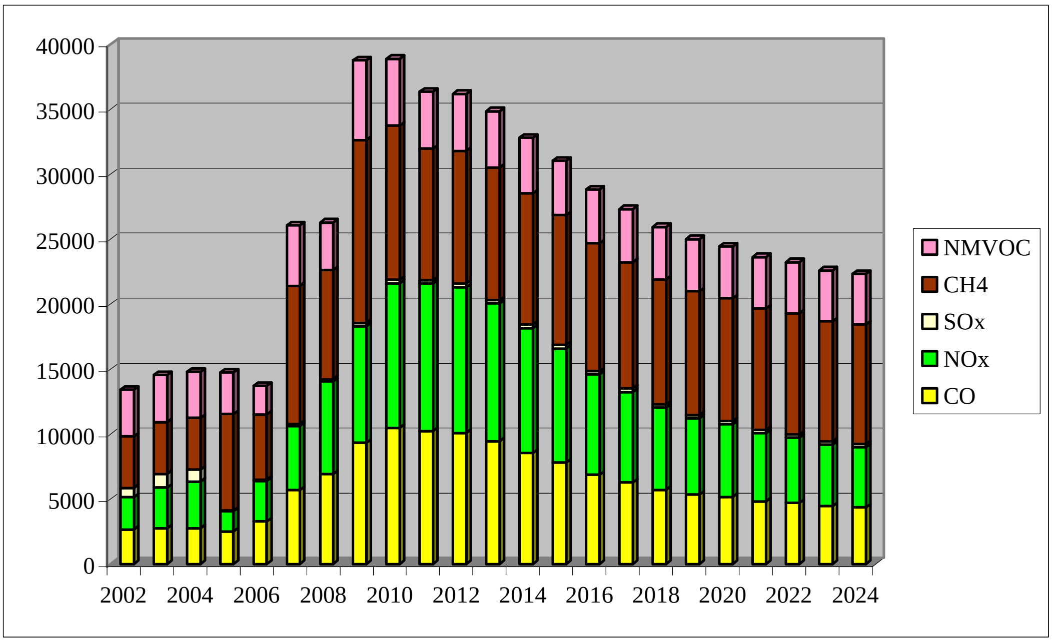
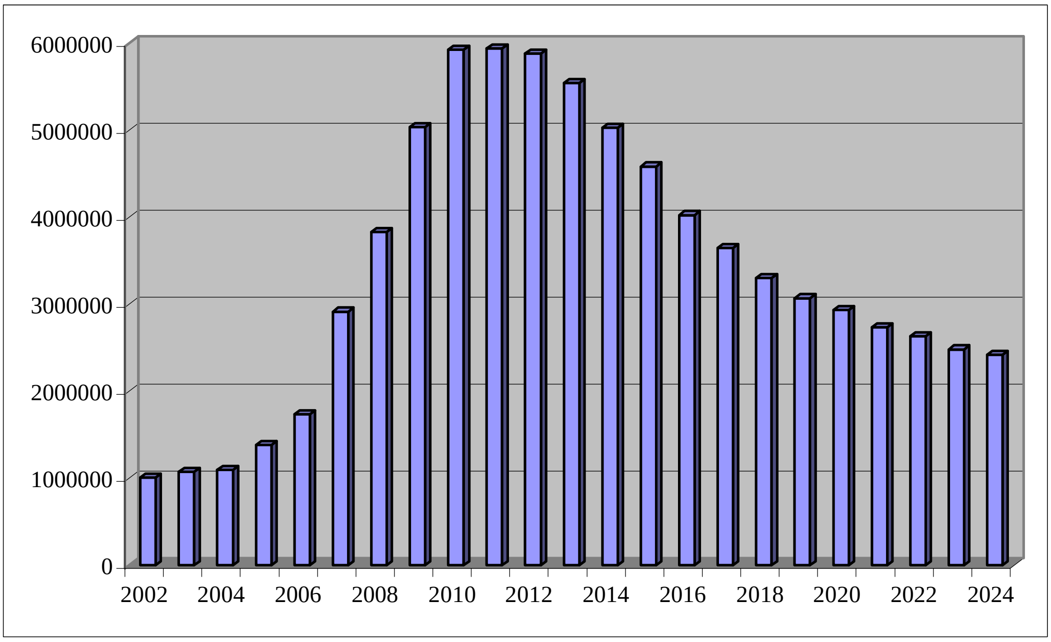


Figure 12.9 Estimated cumulative CO_2 emissions generated from ACG FFD and Shah Deniz FFD (tonnes)



From the above figures it can be seen that the total combined tonnage of ACG FFD and Shah Deniz FFD emissions would be significant. Emissions would be mainly attributable to the ACG development.

Initial air dispersion modelling (Environmental Impact Assessment; Chapter 10) undertaken in 2001 predicted that for combined EOP, ACG Phase 1 and Shah Deniz Stage 1 operations, compliance with AQS standards will be maintained except potentially for emissions of SO_x that were predicted to exceed limits (maximum hourly average, annual average and maximum

15 minute average). No exceedence was measured at any of the nearby communities studied, but was within the terminal boundary. The quantity of H_2S assumed to be in the ACG oil stream for modelling was however, likely to be an over-estimate.

The January 2002 air dispersion modelling, using revised and updated ACG 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 all phases of ACG terminal operation (i.e. Phase 1, Phases 1 and 2, Phases 1, 2 and 3). Further, concentrations of NO_X are also within the AQS limits when the Shah Deniz Stage 1 terminal commences operation. As the production rate of the Shah Deniz terminal will remain constant at a target 900 MMscfd, the addition of further stages to the development will not increase the level of NO_X emissions and therefore, compliance with AQS levels is assured.

The 2002 air dispersion modelling also assessed the dispersion of SO_X. The H_2S content of the ACG oil stream used in this modelling was 500 ppm. SO_X concentrations at nearby sensitive receptors are predicted to be at their highest in 2005 when flaring at the ACG Phase 1 terminal will be most frequent; that is, during the first year of Phase 1 terminal operation. Maximum predicted annual concentrations of SO_X were 2.01 $\mu g/m^3$ in comparison to 15 $\mu g/m^3$ predicted by the 2001 modelling. 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 Stage 2 and Stage 3 terminals.
At the time of writing, development schedules for the various phases of terminal construction, commissioning and operations for ACG FFD and Shah Deniz FFD had not been finalised. Based on 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 EOP, ACG FFD and Shah Deniz FFD 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:

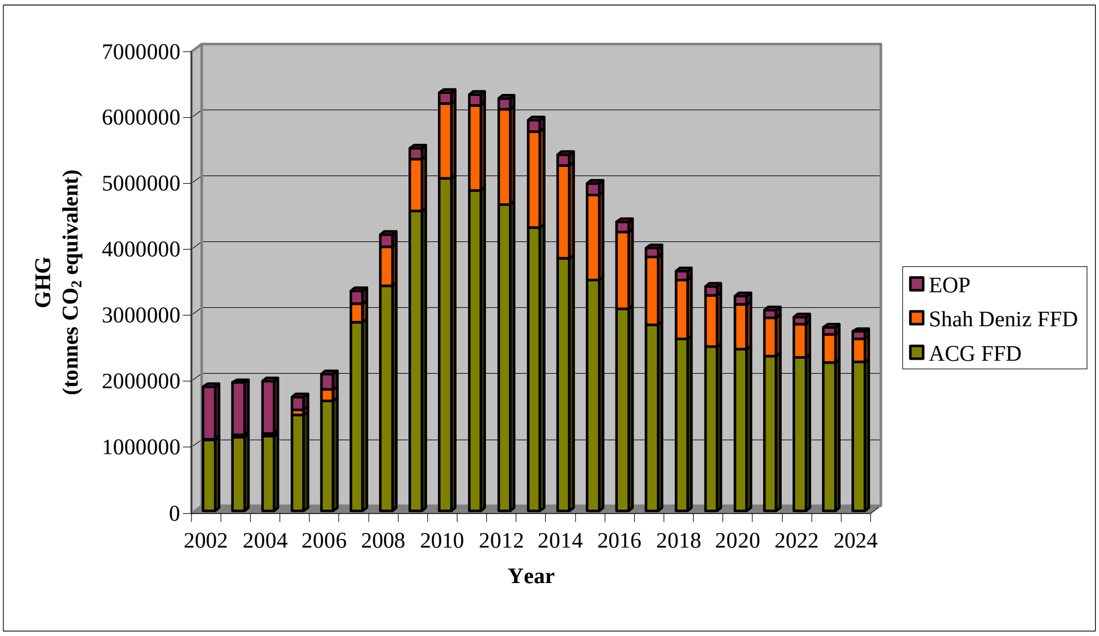
- modifying release points to improve dispersion;
- consideration of other mitigating measures for turbine driven plants such as low NO_x technology; and
- where technically possible, reducing the amount of flaring during commissioning activities.

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 would include mitigation measures for such gases.

The total forecasted greenhouse gas emissions from the EOP, ACG FFD and Shah Deniz FFD are presented in Figure 12.10.

Figure 12.10 Estimated annual GHG emissions for the EOP, ACG FFD and Shah Deniz FFD (tonnes CO_2 equivalent)



Projected greenhouse gas emissions from the EOP, ACG FFD and Shah Deniz FFD 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 EOP, ACG and Shah Deniz FFD 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.

There is no immediate and easy solution to the emission of greenhouse gases from the Phase 1 project. Certainly the provisions of the project's base case are such that the predicted levels of emissions are less than what they would have been without the following base-case mitigation measures:

- stopping flaring from Chirag-1;
- onshore flare gas recovery;
- onshore inert purge;
- centralised power offshore;
- no continuous flaring offshore for production;
- gas re-injection (as opposed to flaring); and
- SOCAR gas-take agreement.

Despite these positive initiatives, it is considered appropriate that AIOC continue to examine ways in which greenhouse emissions can be reduced or mitigated.

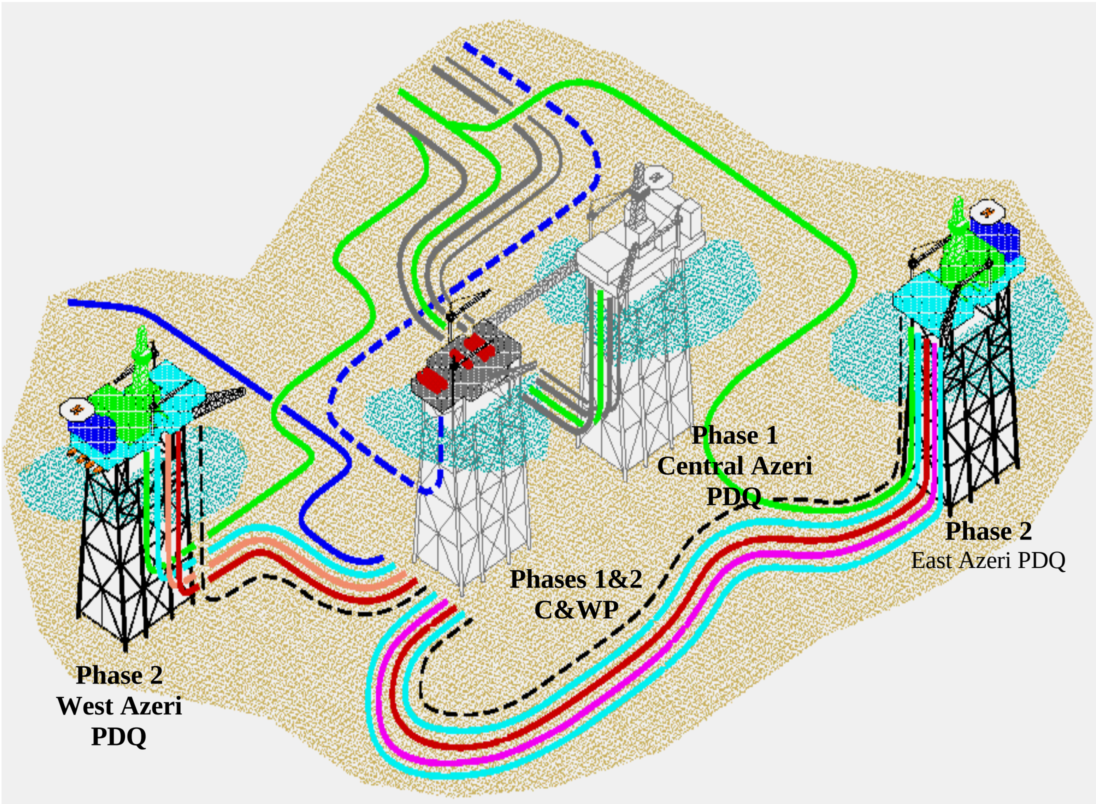
12.4.3 Offshore marine environment

12.4.3.1 Overview

Phase 1 drilling and production facilities are to be located in the central part of the Azeri field. Existing production facilities in the area include the Chirag-1 platform, located 24 km to the north, the SOCAR operated Shallow-Water Gunashli field further to the north and the Oil Rocks facility to the northwest of the ACG Contract Area (Figure 12.1). Anticipated future offshore drilling and production developments that are presently planned include ACG FFD (see Figure 12.2) and the Shah Deniz field development.

Proposed Phase 2 offshore facilities will include two offshore drilling and production platforms similar to the Phase 1 PDQ and expansion of the C&WP installed during Phase 1. These platforms will be designed to exploit the hydrocarbon reserves from the East and West Azeri fields. The East Azeri platform will be installed at a distance of some 9-10 km from the Phase 1 PDQ and C&WP, whilst the West Azeri platform will be installed some 5 km from the Phase 1 facilities (Figure 12.11). Planned Phase 3 development will involve offshore facilities in the Deep-Water Gunashli field some 40 km to the north of Phase 1.

Figure 12.11 Proposed Phase 1 and Phase 2 offshore facilities



12.4.4 Seawater and seawater biology

As described in the Environmental Impact Assessment (Chapter 10), Phase 1 normal offshore oil production operations would result in a number of discharges to the water column as follows:

- surface hole and 26" well section cuttings during drilling operations;
- treated black and grey water;
- treated putrescible wastes;
- treated drainage water;
- cooling water (temperature and chemical plume); and
- produced water when re-injection facilities are not available.

It has been assumed that the Phase 2 and Phase 3 offshore installations will contribute similar types and amounts of discharges to those generated by the Phase 1 facilities. While the Phase 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 particular concern is the potential effect of cooling water discharges that has been treated with antifoulant chemicals (e.g. copper and chlorine). The cumulative discharges of surface hole and 26" 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.

12.4.4.1 26" surface hole section cuttings

The temporal and spatial separation of cuttings discharge to water column as undertaken for the Phase 1, Phase 2 and Phase 3 developments 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.

12.4.4.2 Black and grey water and putrescible wastes

As discussed in the Project Description (Chapter 5), aqueous waste (black and grey waters) generated at the Phase 1 PDQ (including support vessels) would be treated in such a way that the final discharged effluent would have residual chlorine levels of between 0.5 mg/l and 2.0 mg/l. The total quantity of discharge would be in the order of approximately 1,200 kg BOD per year (Table 5.13). Over the anticipated 25 year life of the Phase 1 project, an approximate total of 30,000 kg BOD would be discharged.

For assessing potential cumulative effects of the combined Phase 1, 2 and 3 discharges, it is assumed that the latter two developments would discharge similar amounts of BOD. In total therefore, ACG FFD would result in the discharge of up to 100,000 kg BOD over the life of the combined projects (i.e approximately 45 years). 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.

12.4.4.3 Treated drainage water

All ACG Phase 1 clean water discharges will be processed through a three filter system prior to discharge to ensure that discharges contain no more than 15 ppm oil in water. It is assumed that the Phase 2 and Phase 3 installations would employ a similar system. This, combined with the fact that the combined FFD total amount of clean water discharged would be small, implies that there would be no significant cumulative impact.

12.4.4.4 Cooling water

As discussed in Chapter 10, the combined cooling water discharge of the Phase 1 PDQ and C&WP, assuming a BFCC antifoulant system is used, results in a steady state dispersion plume that has maximum copper and chlorine concentrations of 0.006 ppb and 0.06 ppb respectively under worse-case (i.e. least plume dispersion) conditions. The total lateral extent of the plume is predicted to be approximately 25 km after seven days with copper and chlorine concentrations at the edge of this area being approximately 0.001 ppb and 0.01 ppb respectively.

Given the distance between the offshore ACG Phase 1 and 2 installations (i.e. approximately 20 km) and if it is assumed that the Phase 2 installations discharge similar amounts of cooling water with similar concentrations of copper and chlorine, then there is a potential for the respective cooling water discharge plumes to overlap. Being some distance removed from the

Phase 1 and 2 installations, the Phase 3 installation's plume is unlikely to overlap with the former plumes but may with that of the Chirag-1 EOP installation.

Copper and chlorine concentrations in areas where an overlap of cooling water discharge plumes occurs may be in the order of 0.002 ppb and 0.02 ppb respectively. As discussed in the Environmental Impact Assessment (Chapter 10) these concentrations would not have an acute toxic effect on marine organisms. What is uncertain is to what level and in what way the marine ecology of the area occupied by the ACG offshore installations would be affected by slight increases in background copper and chlorine concentrations over the area and over an extended period of time.

As no Caspian specific test have been done on copper and chlorine in the marine environment, it is not possible to quantify any long-term effects combined cooling water discharge plumes would have. Even if such data were available, 'mapping' the ecological fate of copper and chlorine in Caspian marine environment would be a difficult task. Given that is highly unlikely that acute toxic effects would occur, it is considered sufficient and appropriate that any effects of combined plumes be monitored by way of a long-term programme that includes water quality sampling, benthic sediment sampling and marine organism population/density sampling within the ACG Contract Area. Should any adverse effects be identified in the future, consideration can be given at that time as to how the impact could be mitigated.

12.4.5 Seabed and seabed biology

The installation of facility jackets offshore for the ACG FFD would result in further physical disturbance of the seabed and resultant impacts on benthic organisms. These impacts would occur within the footprint of each jacket structure installed. The cumulative loss from platform jacket footprints per installation (i.e. approximately 1 ha) is considered insignificant in terms of the ACG Contract Area and wider Caspian environment.

ACG Phase 1 drilling discharges (drilled cuttings and WBM from the surface hole and 26" hole sections) are discussed in Chapter 10. Modelling of discharges suggests that the maximum horizontal distance travelled by released cuttings/WBM before settling on the seafloor occurs during discharges from the Dada Gorgud pre-drill rig. Under worst-case winter conditions, the finest cuttings settled some 4.5 km from the facility. By way of comparison, releases from the PDQ during worst-case winter conditions settled a maximum distance of 3.5 km from the installation. It should be noted that depth of cuttings at these maximum distance settling points was less than 1 µm for the Dada Gorgud and between 10 and 50 µm for the PDQ. It is noted that PDQ discharges would overlie those of the Dada Gorgud.

Assuming that all cuttings/WBM would settle within 4.5 km of the ACG Phase 1 drill site, then the total maximum area that could be impacted would be approximately 6,300 ha. In reality however, the area impacted would be less because cuttings do not travel in every direction away from the discharge point but rather move under the influence of prevailing currents resulting in heavier deposition in some areas and less in others.

If it assumed that the Phase 2 and Phase 3 drilling programmes led to a similar amount of discharge as the Phase 1 drilling operations, the total maximum combined area that could be affected by ACG FFD drilling activities would be almost 20,000 ha. In reality the total area would be less as it can be reasonably assumed that cuttings from Phase 2 and 3 would behave (i.e. travel) similarly to those from Phase 1.

If it estimated that 20% (likely to be an over-estimate) of the area is covered by cuttings of sufficient depth to lead to the mortality of benthic organisms, then drilling for the ACG FFD development would result in the loss of these organisms over an area of approximately 4,000 ha. While not an inconsiderable area, this is not considered as constituting a significant percentage of the total ACG 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 ACG and Shah Deniz FFD programmes is considered (i.e. say twice that lost as a result of the ACG FFD), 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 36" surface and 26" top-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.

12.4.6 Pipelines

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.

Anticipated Shah Deniz FFD pipelines include a 26" gas line, a 14" condensate line and a 4" MEG line with a possible further two gas lines to shore planned for installation later in the FFD programme.

Subsea pipelines from the ACG and Shah Deniz offshore facilities to the terminal at Sangachal will 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 ACG and Shah Deniz 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 Shah Deniz pipelines is likely to be installed in the same corridor as the ACG pipeline route although an alternative option slightly to the south also exists. 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 ACG FFD Phases and Shah Deniz FFD Stages 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 FFD 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 infield pipelines are also be required for the transfer of hydrocarbons from satellite installations (e.g. Shah Deniz subsea completions) to the main platforms. The construction of these interfield 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.

12.4.7 Physical presence

The potential impacts associated with the physical presence of the ACG Phase 1 facilities are discussed in the Socio-economic Impact Assessment (Chapter 11). As 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 fishing. Based on available information there is no active demersal fishery in Azerbaijan. It should be noted however, that the proposed ACG pipelines will share the existing EOP pipeline corridor; that is, the 1,000 m safety zone over this feature is already in place and the EOP pipeline already lies within it. In this sense, the construction of the Phase 1 pipelines will not result in any significant additional area being demarcated as a safety zone.

To minimise the potential for interference of other maritime activities in the vicinity of the offshore ACG Phase 1 facilities, mariners will be informed by a published notice notifying the timing and location of construction/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.

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. While not a formal exclusion zone, 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. The greatest impact of this designation would probably be incurred by the local fishing industry. As discussed in the Socio-economic Mitigation, Monitoring and Management (Chapter 14), measures would be put in place to mitigate adverse impacts on the (legal) fishing industry.

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 a jetty across the shoreline and the landfall point and some distance into Sangachal Bay.

The ACG Phase 1 pipeline landfall corridor has a planned width of 200 m and lies coincident with the existing EOP pipeline landfall. Assuming a total length of 2 km, the total maximum area that would be impacted as a result of pipeline installation would be approximately 40 ha. If the Shah Deniz pipelines use the ACG corridor, the width will be increased to approximately 300 m. Shah Deniz may also use this common onshore corridor, although an alternative landfall and onshore corridor is also under consideration. If the alternative route is selected, an additional pipeline corridor approximately 200 m wide will be required. Whilst 40 ha is not a large area, as discussed in the Environmental Impact Assessment (Chapter 10), it does support habitat that is important for a range of species including a number of nationally and internationally red-listed species.

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 ACG FFD construction scheduling has pipeline installations occurring successively as the construction phase of each FFD Phase 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 FFD 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.

As described, the two optional pipeline routes for the Shah Deniz FFD project have separate landfall sites. The preferred option would result in the ACG pipeline landfall areas being used, the alternative option would require a separate landfall being constructed approximately 1 km to the south and closer to the mouth of the Sangachal River. Minimising the area of disturbance is optimum and integrating the ACG and Shah Deniz landfalls would therefore, be the preferred option.

Two separate landfalls would necessitate the construction of two temporary pipeline jetties into Sangachal Bay, resulting in impacts on the benthic communities including seagrass and algae beds. In addition the jetties are 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 jetties are presently being evaluated, however at the time of writing temporary finger jetties are the favoured option.

Overall, the construction of pipeline landfalls and beach-haul jetties for both the ACG and Shah Deniz 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 jetties and by undertaking the installation of all required pipelines simultaneously.

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12.6 Onshore environment

The proposed land acquisition at Sangachal for the development of terminal facilities would take enough land for both the ACG and Shah Deniz 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 ACG FFD Phases and Shah Deniz FFD Stages.

The estimated timeline for these activities is illustrated in Figure 12.3. As discussed above Phase 1 offshore facility assembly would occur at the SPS yard at the same time as Phase 1 terminal construction and it is anticipated that the Shah Deniz terminal construction would occur whilst Phase 1 terminal construction is ongoing. It is also possible that, as with Phase 1 facility construction, the assembly of Phase 2 and Phase 3 offshore facilities would also take place at SPS and it is likely that the terminal assembly programme for each of these Phases of the development would be concurrent with the offshore construction programme.

12.6.1 Land

The land that would be required for the ACG and Shah Deniz terminal facilities (and BTC pumping station), although alongside the existing EOP terminal, is currently undeveloped. The land acquisition for the terminal facilities amounts to 730.6 ha of which 302 ha has been designated as a “no development zone” and 40.5 ha is currently developed where the existing EOP terminal is located. Allocated areas within the remaining area designated for terminal facilities and associated 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

Early civil engineering works would include the clearing of vegetation and obstructions in areas where the new ACG Phase 1 and Shah Deniz Stage 1 terminal facilities are to be located. In addition, land clearance in preparation for the new terminal access roads, drainage channel and metering facility would also be necessary. Areas that have been allocated for FFD terminal facilities and utilities would be utilised as lay-down areas and temporary office space during the Phase 1 and Stage 1 construction programmes.

Construction of the drainage channel would be undertaken as part of the ACG Phase 1 early civil engineering work but the structure would service both ACG FFD and Shah Deniz FFD terminals. The total surface area of the channel would be 27.5 ha of which an estimated 5 ha lie outside the ACG and Shah Deniz terminal in the “no development zone”. Excavated earth from the drainage channel would be used in the construction of the bund wall that would lie between the channel and terminal development area. Construction of the terminal access road would include earth works in an area of 7.5 ha of which approximately 2.5 ha lie within the “no development zone”.

As discussed in the Environmental Impact Assessment (Chapter 10), the area of habitat that would be lost during the early civil engineering work programme for the ACG Phase 1 and Shah Deniz Stage 1 has been estimated to amount to approximately 160 ha. FFD would result in additional early civil engineering and terminal construction and would result in the area within the perimeter fence being lost, a total area of approximately 230 ha for facilities alone. It is assumed however, that vegetation would be lost from most of the 230 ha during the Phase 1 and Stage 1 early civil works.
In addition to the above, approximately 30 ha of area would be affected as a result of pipeline installation through the existing 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. Phase 1 pipeline installation activities would 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 locally important wetlands.

In total therefore, the ACG FFD and Shah Deniz FFD programmes would be likely to lead to the loss of habitat over a total area of between 260-280 ha if the second Shah Deniz pipeline corridor is pursued and between 250 and 270 ha if not. It should also be noted that habitat in the area surrounding the terminal development site perhaps while not directly impacted by the FFD terminal development programme would be subject to indirect impacts (e.g. dust emissions; alteration of existing hydrological system and flows). The ecological footprint of the terminal construction programme is larger than the actual construction site itself and as discussed in Chapter 10, pathways for activity-receptor interactions are often complex and difficult to predict.

Habitat loss would persist until some years after decommissioning of the terminal site and as such, the impact would be ongoing and effectively permanent. The additional loss of habitat in the terminal area would represent a further degradation of the semi-desert habitats that are already subject to a considerable level of stress as a result of 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), current land use in the vicinity of the proposed terminal site would be disrupted during the terminal development programme with a resultant loss of access to the terminal area within the perimeter fence. The wider area that would be subject to land acquisition would remain available to other users but would be restricted from future development.

The loss of the terminal area within the perimeter fence would be of greatest significance to the local herders due to the reduction in available grazing land and would be in addition to the loss already incurred as a result of the EOP terminal project. As the proposed land-take is for all phases of the ACG and Shah Deniz 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 Phase 1 development would result in additional employment opportunities. Jobs created during Phase 1 would grow beyond this programme of work as the main terminal and offshore facilities construction programmes get underway.

It is expected that much of the Phase 1 workforce would likely move on to these other construction projects as they come on line, as the skills developed and the experience gained would be relevant to these subsequent projects.

If the potential oil terminal construction project (south of Sangachal) referred to above proceeds, there may be positive and synergistic interactions between it and the ACG Phase 1 / Shah Deniz Stage 1 projects in terms of employment opportunities for local people. Skill gained during the ACG Phase 1 / Shah Deniz Stage 1 projects may be applicable to the oil terminal project. Additionally, there may be cumulative impacts associated with loads on local transport systems and with international procurement. Without the necessary data regarding the possible oil terminal project, it is however, difficult to qualify the nature and level of these potential cumulative impacts.

12.7.3 Supplier network

A considerable amount of equipment and materials would be required for the ACG and Shah Deniz field developments commencing with the Phase 1 early civil engineering work programme. Wherever possible these would be sourced in Azerbaijan. As the Azerbaijani supplier network is at present relatively 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 phases and on to operations, the continued demand for goods and services would result in the development of Azerbaijani companies that would be able to service the oil and gas industry. An established service industry would increase employment opportunities in the region. Whilst a long term proposition, the development of a strong Azerbaijani supplier network can be regarded as a positive cumulative impact resulting from the ACG and Shah Deniz FFD projects.

12.7.4 Transport systems

The ACG Phase 1 project would result in an increase in the movement of plant equipment, materials and people into the Garadag District. This increased transportation activity would be in addition to the existing activities in the region.

It is expected that the assembly of the Phase 1 offshore facilities would begin at the SPS yard some 14 km to the north of the terminal site prior to the completion of the early civil engineering component of the Phase 1 development. These construction works would also require significant movement of plant, equipment and construction personnel into the area. At the same time, the plant and materials required for the terminal construction phase of the development programme would be starting to arrive in the area.

This increase in transportation would result in a cumulative impact on the main transport corridors throughout Azerbaijan and on the transport infrastructure in the Garadag District in particular. A detailed logistics plan is being developed that will take into account the existing infrastructure, road safety and transportation management in the area in order to reduce congestion, the potential for accidents and inconvenience to other road (and rail) users. The contractors will also be required to prepare Transport Management Plans. All staff requiring transport to and from the site would commute using private buses so as not to impact on the public system.

The increased pressure on the transport system would be obvious to the local population and may be considered by some to be a nuisance. It is anticipated however, that based on community feedback gained during consultation, the majority of the local population considers that the benefit of increased employment opportunities that increased activity would bring would be of great value and would in some respects, counteract the negative effects of disruptions to their lifestyles (e.g Phase 1 transport systems) and existing levels of amenity.

12.7.5 Waste (refuse) issues

A large number of waste sources arising from the Phase 1 development have been identified in Section 5. Routine waste streams generated during each of the stages of the development through construction, installation and commissioning activities to operations and finally decommissioning have also been identified and their preferred disposal route discussed within Chapter 5.

BP has developed a waste management strategy, which classifies all waste types and identifies strategies for their preferred disposal route. Many 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 and upgrade (where necessary) 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 is believed that transboundary effects are possible in neighbouring states from the Phase 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 (Socio-economic Impact Assessment).

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 five Caspian littoral states.

13.3 Potential for environmental transboundary impacts from ACG Phase 1

The ACG Contract Area is located approximately 120 km south east of Baku and covers an offshore area of 432 square kilometres in water depths ranging from 100 m to 400 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 Phase 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;
- oil pollution in the event of a large oil 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. Nor are the potential impacts of oil export once the hydrocarbon has left the Sangachal terminal, as this falls under the scope of the BTC project.

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 (NOx);
- Sulphur Oxides (SO_x);
- Carbon Monoxide (CO);
- Particulate Matter (PM) and
- Volatile Organic Compounds (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 and the behaviour of the gas once released to the atmosphere. For the majority of gases, the residence time (atmospheric lifetime) in the atmosphere following release is one or two days. Therefore, the majority of gases that would be released continuously during normal onshore and offshore operations would not persist or result in any transboundary impacts.

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 and $SO_{x.}$. 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 and SO_x are 1.5 and 16 days respectively. Hence, only a fraction of NO_x and SO_x emitted to the atmosphere may persist in the atmosphere and be transported up to distances of several thousand 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 Phase 1 development (Chapter 10) where predicted concentrations of these emissions at communities nearby the terminal location were all below the Air Quality Standards for these gases. Therefore transboundary impacts to human health from atmospheric emissions as a result of the Phase 1 development are 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_2 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	$NO_2 + OH^- > HNO_3$
SO_2	$SO_2 + OH^- > HSO_3$
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 which 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 SO_2 and NO_x in the atmosphere 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_2 and NO_x respectively (Year 2000 data, NETCEN UK National Inventory). Currently, reliable historical or forecast inventories for emissions of NO_x and SO_2 for Azerbaijan are not available.

At present, there is no available evidence indicating the existence of significant local or upwind sources of acid rain (from a cumulative point of view) that large-scale acid rain scenarios take place in the Caspian region. The Phase 1 proposed development is anticipated to lead to the generation of 1,876 tonnes/yr of NO_x and 475 tonnes/yr of SO_2 on annual average basis. As major combustion processes associated with the development will operate on natural gas (which would contain a negligible amount of sulphur), these SO_2 emissions are therefore predominantly attributable to mobile sources (for example marine vessels and trucks,) or stationary construction plant (for example cranes and generators). These emissions would however be 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 Phase 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 (GWP)

An important feature of atmospheric emissions comprises their contribution to global warming; that is, their Global Warming Potential (GWP) 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), hydrofluorocarbons (HFCs), 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 no emissions of HFCs, PFCs and SF_6 are anticipated from Phase 1 activities; hence the predominant contribution from the development would be from Phase 1 CO_2 and CH_4 emissions. 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 GWP of methane as compared to CO_2[1] and added to the forecasted CO_2 emissions)

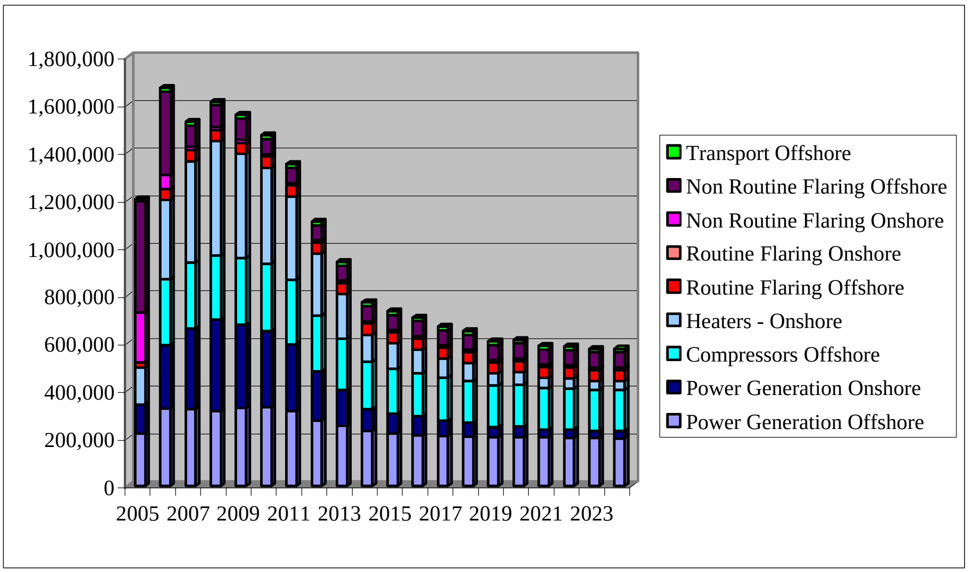
Greenhouse gases would be generated continuously during the Phase 1 construction and operational activities, with the predominant inputs resulting from operations, in particular from the following:

- power generation gas turbines both offshore and onshore;
- gas turbine powered gas compressors on the C&WP;
- process heaters at the terminal; and
- planned non-routine flaring of gas both offshore and onshore during facility commissioning and periods of plant unavailability.

The estimated quantities of GHG from the Phase 1 operations are shown in Figure 13.1.

1 The GWP factor applied in all CH_4 estimates is 21

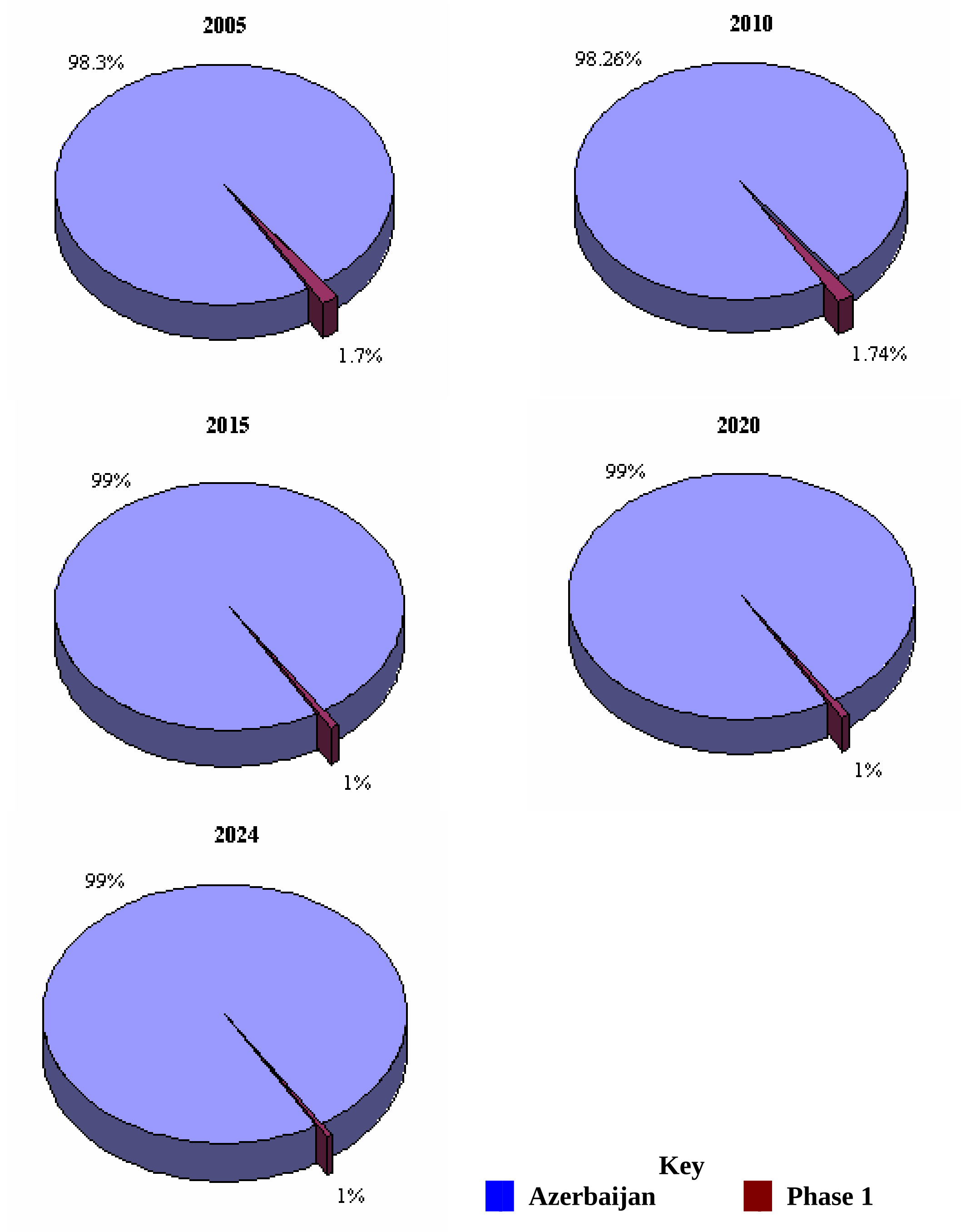
Figure 13.1 Estimated total GHG quantities from Phase 1 operations (tonnes CO_2 Eq)



The combined releases of GHG from Phase 1 operations would be appreciable and as Azerbaijan ratified United Nations Framework Convention on Climate Change (UNFCCC) in January 1995, and as such and has committed to develop, implement and publish national and regional programmes that would include mitigation measures for such gases, GHG emissions as a result of Phase 1 project activities remains a key issue.

Greenhouse gas emissions for Azerbaijan have been forecasted by the UNFCCC for the next 25 years. Projected emissions from Phase 1 activities were compared against the UNFCCC forecast and illustrated in Figure 13.2.

Figure 13.2 Relative GHG emissions from the ACG Phase 1 Project against projected UNFCCC emissions for Azerbaijan



The annual GHG generated by the Phase 1 development has been estimated not to exceed 2% of the forecasted GHG emissions for Azerbaijan for the entire proposed production period. Projected greenhouse gas emissions from the combined EOP, ACG FFD and Shah Deniz FFD when compared against the UNFCCC forecast are estimated to constitute approximately 5% of Azerbaijan national emissions in 2010, the year in which maximum emissions from the combined projects are predicted.

13.3.2 Accidental spills

Oil spill modelling has been conducted for a number of potential accidental events from Phase 1 operations that would result in the loss of hydrocarbons. It should be emphasised that there is only a very low probability of an oil spill occurrence during Phase 1 operations due to the incorporation of comprehensive oil spill prevention measures that will be in place for the project. Modelling was conducted using trajectory (directional) and stochastic (taking account of seasonal changes in wind regimes) model runs to address the potential movement and behaviour of the oil under the following accidental release scenarios:

Scenario 1
- Catastrophic well blowout at the offshore location with surface release of crude oil;

Scenario 2
- Catastrophic failure of the 30” export pipeline to shore with subsea release of oil including;
  - 2a) spill in the nearshore (c.1.25 km from shore);
  - 2b) spill at the offshore location.

Scenario 3
- Small process equipment leak/spillage.
- 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).

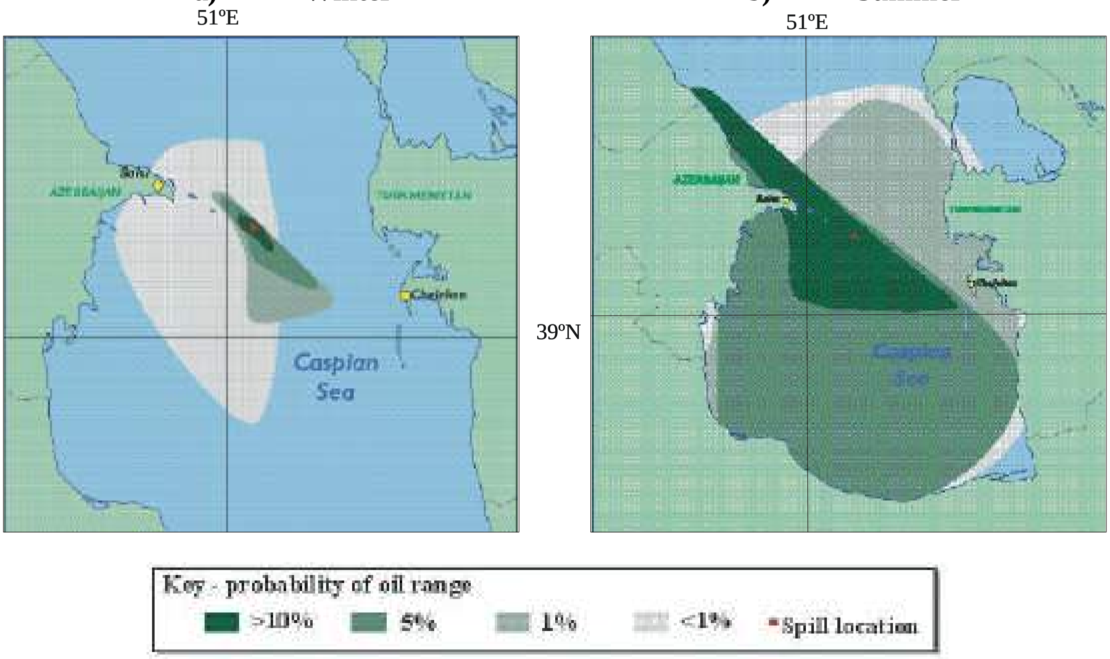
The modelling has shown that spills of smaller volumes (Scenario 3) of product would be unlikely to impact the coastline of neighbouring countries. Spill scenarios 1 and 2 however, have the potential to result in the movement of oil into foreign waters and the stranding of oil on foreign country shorelines. From the modelling runs, the countries at risk from such an occurrence are Turkmenistan and Iran (Chapter 10). The results of the modelling which are specific to ppotential transboundary impacts are summarised below.

Scenario 1 Worst-case well blowout event at the offshore location

Whilst the movement of the oil under the modelled scenario shows a much different distribution under winter conditions than in summer, in both model runs oil was transported predominantly to the northwest, south and south east of the field into the Southern Central Caspian Sea area, with the heaviest area of oiling also occurring in these directions. In summer, the probabilities of transboundary pollution from an oil spill are greater (Figure 13.3).

Figure 13.3. Stochastic modelling of an accidental release of oil resulting from a well blow out, during:

a) Winter **b) Summer**



It can be seen that the oil spill simulation under summer conditions shows a high probability (>10%) of oil reaching the waters of neighbouring Caspian littoral states, although the probability of oil beaching at these locations is 5% for the coast of Iran and 1% probability of oil reaching the Cheleken Peninsula in the east. This represents the worst-case scenario and the sensitive resources identified along these coastlines are listed in Table 13.2 and illustrated in Figure 13.4.

Scenario 2a Loss of 30" oil pipeline inventory in the nearshore

The modelling results show that there is a consistent pattern of oil movement in winter and summer conditions with the oil being transported predominantly to the south of the field into the Southern Caspian Sea area. Heaviest oiling is in the area directly to the south and south east of the release location. Even under these extreme conditions, there is only a 1% probability of oil reaching territorial waters of the neighbouring states (Chapter 10).

Scenario 2b Loss of 30" oil pipeline inventory at the offshore location

The modelling results show that during the winter run, oil from the offshore pipeline rupture is transported predominantly to the southeast and northwest of the field into the Central and Southern Caspian Sea areas with the heaviest area of oiling directly to the southeast and northwest of the release location. In the summer run scenario, the oil was transported predominantly to the southeast of the field into the Southern Caspian Sea area with the heaviest area of oiling directly to the south and south east of the release location. In both winter and summer scenarios, there was a 5% probability of oil reaching transboundary waters but only a 1% probability of oil beaching along transboundary coastlines in winter conditions (Chapter 10).

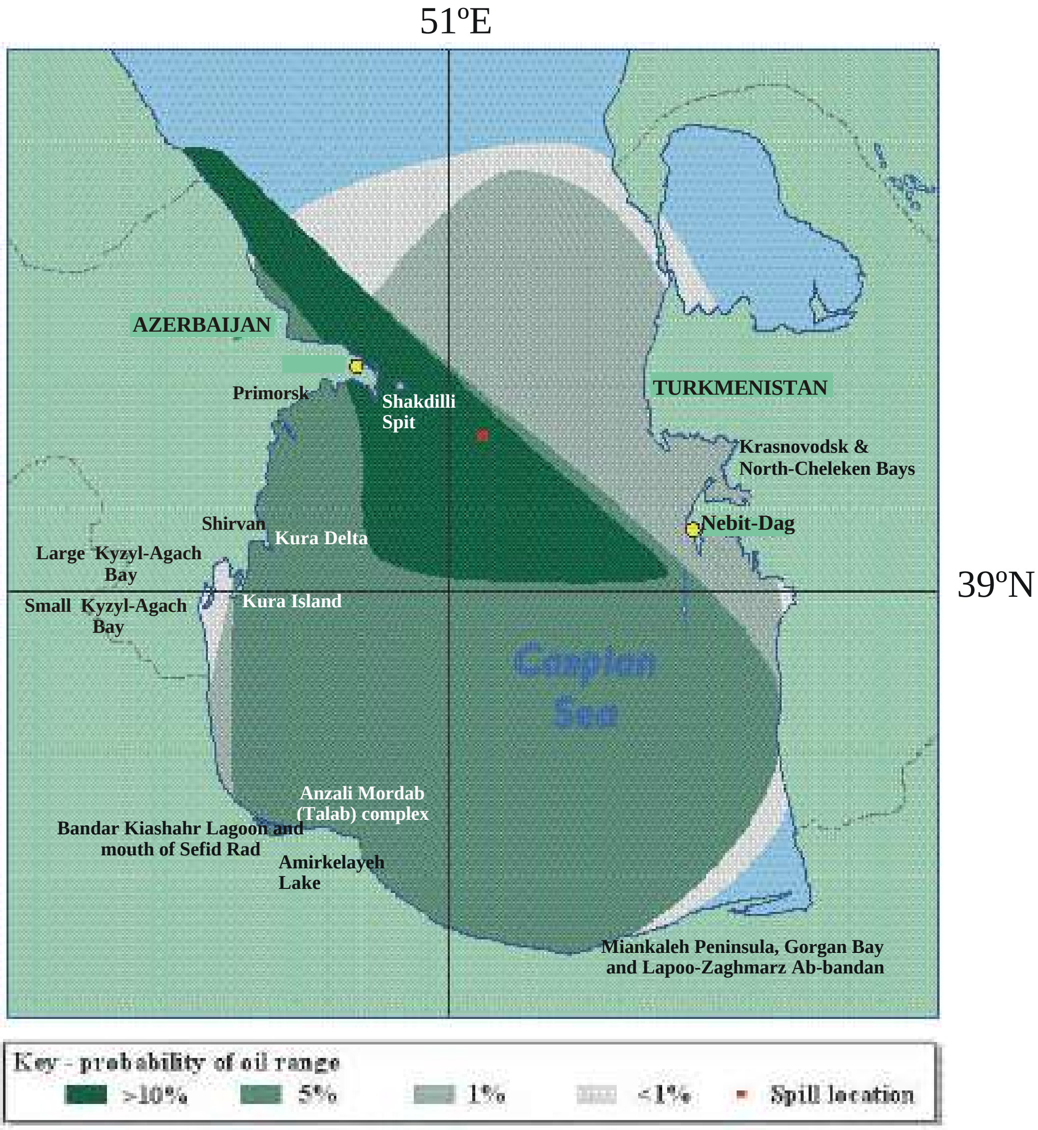
Figures illustrating these results are presented and discussed in the Impact Assessment Chapter (Chapter 10) and so are not repeated here. BP has commissioned a number of studies to assess the status of the coastline between Azerbaijan and Iran, in order to identify areas of vulnerability and assist 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 13.2). The potential areas impacted by the worst-case scenario (blow-out event) are illustrated in Figure 13.4.

Table 13.2 Sensitive Sites Identified Along The Caspian Coast That May Be Impacted by a Transboundary Oil 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
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 13.4 Modelling (Winter scenario) of an accidental release of Azeri Crude resulting from a well blow, showing the locations of sensitive receptors identified in Table 13.2



It should be noted that the oil spill modelling assumes that the oil is allowed to move without any interference from response activities. 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 Phase 1 and future phases of the development.

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). The predicted level of traffic movement would be likely to place a significant additional load on the existing infrastructure of the neighbouring regions, although the increase in road, 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), increased vessel movements as a result of the project are 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 Phase 1 development if selected as the transportation route, will use all of the existing freight carriages that have the capacity to carry the size and weight of pipe required. This would remove the availability of these carriages for other industries or freight transportation. Based on project data, eight vessels are proposed for transportation of the equipment to Azerbaijan. 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 for Phase 1 components at the beginning of the project is shown in Table 13.3. The impact of these increased vessel movement are deemed to be negligible.

Table 13.3 Proposed Vessel Movements Through The Bosphorus From ACG Phase 1

Period	Tonnes	Commodity	Vessel types
Spring 02	3628	Steel Plate	1 part charter/ possible existing sailings
Aug-02	336	Mechanical packages	1 Russian rivership
Apr-03	266	Mechanical packages	1 Russian rivership
Apr-03	2596	Mechanical packages	2 heavylift ship
Apr-03	16400	Piles	1 heavylift ship
Spring 03	2996	Drilling modules	1 barge, 1 Russian rivership

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). Additionally, all ships would be required to comply with MARPOL in terms of ship waste management. 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 ACG Phase 1

The Phase 1 socio-economic impacts are felt at local, regional and national level. The impact assessment chapter (Chapter 11) has outlined a number of impacts 'in country' that may also be felt across the borders with Azerbaijans' immediate neighbouring states and, to a lesser extent, worldwide. The immediate neighbouring states include both those with land borders with Azerbaijan (Russia, Georgia, Armenia, Iran) and the four other littoral states of the Caspian Sea (Russia, Kazakhstan, Turkmenistan, Iran) who all have oil and gas interests in the area. Effects on both these neighbouring countries and other countries worldwide will vary depending on the issue and impact being addressed. Potential transboundary impacts from the ACG Phase 1 development may include:

- regional economic effects that may have a destabilising impact on the region as a whole if Azerbaijan benefits significantly from oil and gas revenues whilst its' neighbouring states do not;
- regional political effects that may have a destabilising impact on the region as a whole resulting from inter-country economic tensions, which may become associated with ethnicity issues, and include both offensive and defensive moves by Azerbaijan and neighbouring countries;
- regional effects experienced as a result of sourcing both supplies and employment outside Azerbaijan; and
- regional health effects in that negative impacts on health may be experienced within Azerbaijan and in neighbouring countries as a result of cross-border migration of official workers and unofficial employment seeking populations.

The regional economic and political effects are being addressed as part of a formal regional review being undertaken by BP with the assistance of independent specialists. This will outline the possible regional effects of ACG Phase 1 and related oil and gas developments in the region. These effects will not therefore be discussed within this chapter. The regional sourcing and health effects are not part of the overall regional review and are discussed in more detail below.

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. A summary of the construction costs related to the ACG Phase 1 project, along with the envisaged location of such expenditure, is presented in Table 13.4. The figures illustrate that approximately 55% of the total construction expenditure will occur outside Azerbaijan.

Table 13.4 ACG Phase 1 construction costs ($)

Item	Costs (million US $)		
	Azerbaijan	Elsewhere	Total
Terminal	175	175	350
Offshore	713.1	891.9	1,605
Total	**888.1**	**1,066.9**	**1,955**

These costs include not only the capital costs of the infrastructure, but also the installation costs (i.e all associated marine elements and contracts), owners costs and contingency. The costs are defined as Class 2 costs (i.e. cost estimate is +/- 20%). In addition, it is envisaged that there will be up to 4,000 employees required for the onshore construction and onshore assembly of offshore components of the Phase 1 Project, 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.

The operating and maintenance costs for Phase 1 over an operating life of 21 years have been estimated at a total of $1.1 billion. This cost estimate is +/- 10%. The extent to which this expenditure will occur within Azerbaijan is difficult to calculate, however it is estimated that overall 70% of expenditure may occur within the country.

Current information shows that the operation of Phase 1 will require approximately 300 personnel for the offshore operations and a further 34 for the onshore operations. It is envisaged that from day one of operation 50% of positions will be held by Azerbaijani nationals. It is hoped that this will increase over time as skills are developed and experienced gained, with 75% of positions being held by Azerbaijani nationals after 5 years and 95% after 10 years.

Table 13.5 Expected employment during Phase 1 operations

Item	Number of Positions	Number of Employees
Offshore	150	300
Onshore	15	27
Onshore support	7	7
Total	**172**	**334**

13.4.2 Regional health effects

The main transboundary health impacts that may arise as a result of the Phase 1 development are associated with 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 risk 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. The risks from any cross-border migrating population will not be able to addressed using measures such as education, immunisation and regulation of contact with the local and regional community.

14 Mitigation and Monitoring

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 Phase 1 project activities.

This Chapter considers all impacts that were identified as being significant and, presents AIOC's commitments in regards to implementing additional mitigation measures and monitoring programmes to address identified significant impacts. Identified significant impacts are summarised in Table 10.39 (Section 10.8). It should be 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 Phase 1 project. Environmental management procedures will be incorporated into the Environmental Management System (EMS) that will also be developed for the project.

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.
- **Management:** an overview of the project'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 project against the predictions made within this ESIA report.

14.2 Mitigation

14.2.1 Routine project activities

The following Phase 1 routine project activities have been identified as resulting in significant environmental impacts:

- the discharge of drilled cuttings, drilling fluids and water based muds (WBM) to the sea during template and platform drilling of the 36"/30" and 26" hole sections;
- installation of the 30" oil pipeline in Sangachal Bay including the construction of the finger pier and excavation of the nearshore trench;
- construction of the onshore section of the 30" pipeline between the landfall and the terminal site and in particular the excavation of the pipeline trench;
- ground clearance and grading of the area required for construction of the terminal facilities;
- construction and operation of the terminal drainage channel;
- construction of the new access road;
- offshore and onshore power generation
- gas compression on the C&WP; and
- terminal process fired heaters.

Planned non-routine flaring events during the periods of equipment upsets and unavailability, particularly during the early commissioning phase of the facilities will also result in significant emissions to the atmosphere.

14.2.1.1 Drilled cuttings, drilling fluids and WBM discharge

As discussed in Chapter 10 the discharge of drilled cuttings and water based muds to the sea will result in the smothering of the seabed in the vicinity of the discharge point with resultant physical alteration to the seabed and subsequent biological change to the seabed habitat. Dispersion modelling has predicted that the majority of the cuttings particles would principally accumulate within 250 m to 350 m of the discharge point. As up to 48 wells will be drilled, approximately 39,120 m^3 of cuttings and mud from the Phase 1 drilling programme will be discharged and cumulative coverage on the seabed would be in excess of 70,000 m^2 or approximately 7 ha. Further lighter deposition would also result at greater distance. While the total area impacted is not considered to be significant in terms of the whole ACG Contract Area, the drilling programme would last for approximately 10 years and the re-colonisation of the area by benthic organisms in this area of deposition would not occur until drilling stops. The impacts will be principally physical as drilling fluids to be used for the top-hole drilling will either be seawater based or a water based mud (WBM) systems that have been carefully formulated to ensure that all additives used have no intrinsic toxic properties.

The BPEO that assessed the current options available for disposal of the top-hole section drilled cuttings concluded that discharge to the sea was the most practicable option in terms of both technological and engineering constraints and environmental outcomes. Discharges from the 36” surface holes will be directly to the seabed from the open hole thereby minimising the lateral spreading of the cuttings. The 26” top-hole cuttings will be returned to the drilling facility and separated from the drilling fluids/WBM prior to discharge. No cuttings will be discharged from lower hole sections that will be drilled with non water based mud (NWBM) systems.

Discharges from the 26” hole sections will be released as deep in the water column as is technically possible (-11 m and -97 m from the Dada Gorgud and PDQ respectively) in order to minimise the lateral spreading of the drilling cuttings on the seabed.

The drilling team will record all volumes of discharged drilled cuttings, muds and additives used in the drilling fluid systems as well as the use of any contingency chemicals used in the drilling programme. Chemical use will be audited to ensure that compliance with international toxicity/discharge standards and all chemicals will have been tested and classified according to OCNS. The use of any chemicals that may cause tainting and known endocrine disruptors will be forbidden.

The impacts associated with drilling cuttings discharge will be monitored by means of periodic benthic surveys around the platform installations. The project will continue to evaluate alternative options to discharge especially if it is found that cuttings discharge is resulting in more significant adverse effects than predicted.

14.2.1.2 Installation of the 30” oil pipeline in Sangachal Bay

Any pipelay activities in Sangachal Bay will to some extent impact the benthic environment and result in potential loss of seagrass habitat along and adjacent to the pipeline route. The base case pipeline route is alongside the existing Early Oil Project (EOP) 24”pipeline. Seagrass habitat distribution in the nearshore along the selected route is limited 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 utilise the narrowest route possible through the nearshore zone. The pipeline trench will be mechanically excavated out to the 2 m water depth contour and will be only as wide as technically required for pipeline installation. Burial of the pipeline from 2 m out to the 5 m depth contour will be via "jetting" or a similar method. This method of pipeline installation will minimise the aerial extent of disturbance to the nearshore benthic habitat. 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 the excavation equipment. The presence of such a pier may also alter the nearshore hydrodynamic regime with a resultant change to natural sediment transport processes (i.e. erosion and deposition) in the Bay. If the pier is not removed this may result in a change to coastline configuration beyond the pier.

The project is therefore considering mitigation alternatives to the construction of the finger pier such as:

- floating pontoons;
- floating barge; and
- amphibious excavator.

The selection of the techniques used on 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.

Pipelay activities will also mobilise seabed sediments to 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 pipelay activities that will trap and limit the lateral movement of these mobilised sediments.

The pipeline contractor will develop a mitigation plan specific to the shore approach that will identify measures that will be employed to remove or reduce negative impacts. This plan will be approved by AIOC prior to any works being carried out. In addition, the selected contractor will maintain an active monitoring and recording programme during all pipelaying 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 unless it enhances the environment. 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 monitoring surveys to ascertain how rapidly and effectively the habitat is becoming re-colonised.

The trench will be back filled with the removed material thus reducing the need for further environmental disruption following installation. As a result, the seabed profile will be returned to its natural condition in- a relatively short period of time but disturbed seagrass habitat could take several years to recover.

Recovery of the seabed and associated communities around the pipeline route following the installation of the 30" pipeline would be hampered by the subsequent installation of the future pipeline requirements for ACG FFD and Shah Deniz FFD. This implies a significant cumulative impact on resident benthic communities.

All opportunities to reduce these impacts will be pursued including evaluating the possibility of concurrently laying all required pipelines in the nearshore zone for FFD. Were this to be possible, pipelay impacts would all occur over a limited period of time and post-installation surveys in the Bay could determine the extent of impact and rate of recovery. If it is determined that significant areas of seagrass have been lost, the option of designing a compensatory habitat programme and seagrass restoration programme could be assessed.

14.2.1.3 Installation of the onshore section of the 30" oil pipeline

Onshore pipeline installation between the sea shore 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 an 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 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 pipelay 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 installation and 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 becoming 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 the direct planting of relevant flora species.

14.2.1.4 Clearing and grading of land for construction of terminal, construction of the new access road and drainage channel

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 semi-desert habitat as the terminal facilities to be constructed on the cleared and graded area, the drainage channel and bund wall and the new access road would be permanent fixtures. The habitat that would be lost has been identified to host a number of red-listed flora and fauna species (flora: *Calligonum bakuense, Astragalus bacuensis, Iris acutiloba*; fauna: *Testudo graeca iberica, Pterocles orientalis, Falco naumanni*). In addition to direct habitat loss there is also the potential to directly impact specific fauna resulting in mortality, during construction activities.

The contractor will develop an environmental management plan in order to minimise direct impacts to animals in the area. This will be approved by AIOC and will include provision 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, the possibility of having on-site presence of an HSE representative to monitor construction activities and to identify vulnerable fauna, such as the red-listed Spur-thighed tortoise (*Testudo graeca iberica*), for removal where and when appropriate is being evaluated. A procedural outline for what to do with tortoises found during construction efforts will be developed.

A mitigation programme to compensate for habitat loss is also under evaluation. This mitigation programme will assist in counteracting direct habitat loss resulting from terminal and associated facility 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 seek to mitigate, through semi-desert habitat rehabilitation/restoration, the habitats lost to the potentially impacted flora, birds and herpetofauna. Measures taken to rehabilitate semi-desert habitat will not only provide compensatory habitat for these potentially impacted species 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.

The objectives of the programme would include:

- prevention and/or reduction of land degradation;
- rehabilitation of partly degraded land; and
- reclamation of land that has been desertified.

The programme would require that a section of semi-desert habitat be identified in an area removed from the project activities that has been degraded in the past. This land would then be restored using various approaches such as the implementation of measures against erosion of the area, the re-planting of vulnerable flora and continual monitoring of recovery. In development of this programme the following key issues will be considered:

- utilisation of local scientific expertise in the development of the pilot programmes;
- public participation; and
- community development.

This approach to impact abatement will not only assist in mitigating project impacts but will also assist in addressing historical and cumulative environmental damage in the project area incurred as a result of industrial activity over the past few decades.

In addition to habitat compensation, a Spur-thighed tortoise augmentation programme is under development in order to compensate for potential impacts associated with construction activities. This conservation programme is likely to include 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. The Spur-thighed tortoise was chosen among the red-listed fauna identified in the project activity area due to the following:

- the species is nationally and internationally protected (red-listed);
- the species is included in International conventions such as the Convention on the International Trade of Endangered Species (CITES), to which Azerbaijan is a signatory;
- individuals of the species are considered to be most vulnerable to direct impacts resulting in mortality; and
- particular species reaction(s) to construction and general disturbance.

Azerbaijani scientists and NGOs will be closely involved with the development of this programme and local educational institutions will be included in the programmes implementation. This conservation programme 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.

14.2.1.5 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 watershed analysis will include the development of a digital terrain model (DTM) of the terminal area so that flow directions of channel discharge waters can be modelled. The model will be developed from existing topographical data and by using computer based geographical information system (GIS) technologies. 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.

14.2.1.6 Activities resulting in emissions to the atmosphere (in particular, greenhouse gas emissions)

There are a number of sources of atmospheric emissions from the Phase 1 project:

- vessel and vehicle emissions;
- diesel driven generators during construction;
- power generation offshore and onshore;
- gas driven gas compressors on the C&WP offshore;
- fired heaters onshore;
- flaring; and
- fugitive emissions.

Emission levels have been estimated based on fuel use, with the largest contributors to the greenhouse gas emissions under routine operating conditions attributable to combustion emissions from offshore and onshore power generation, turbine driven gas compressors on the C&WP and onshore terminal fired heaters.

The key to the reduction in combustion emissions is high energy efficiency and this will be achieved by using centralised power operated to meet demand only, careful equipment selection and further consideration of waste heat recovery. Indeed there has been an allowance for future waste heat recovery to be incorporated into the terminal facilities in the future.

The project will monitor and record fuel gas use for temporary sources, compressors and generator sets and the volume of diesel burned as back-up will also be monitored. All platform and terminal generators will have provisions installed for emissions monitoring.

Flaring will be minimised through the re-injection of gas, the use of gas as fuel for the platforms and terminal facilities and transfer of the remainder to SOCAR for onward delivery to the national grid. There will be no continuous flaring as part of the production process, although relatively small volumes of gas will be routinely flared offshore to dispose of leakage from process sources such as compressor seal leaks, passing valves and off-gas from the closed drains system and in order to maintain purge pressure. Routine flaring onshore will be limited to the continually lit pilot light. There have been a number of key design decisions included into the Phase 1 design to reduce the emissions from operational flaring. These include:

- flare gas metering both offshore and onshore;
- flare gas recovery onshore; and
- use of inert purge gas onshore.

In addition, once the C&WP is operational, any continuous flaring to produce on the Chirag-1 platform will be eliminated.

There will be occasions when plant upsets will occur and gas will be flared to allow continued production during safe repair and restart of equipment. These occasions will be kept to a minimum by designing equipment with spare capacity, regular equipment maintenance and limiting flare quantities. Overall facility design availability has been based on achieving 95% availability, although during the first and second year of operations equipment reliability will be lower due to the commissioning of the facilities and it is at this time that flaring quantities will be at their highest. Flaring quantities will be monitored and recorded.

A flaring policy will be developed for steady state operations that will be defined and agreed with the AIOC partners. The policy will stipulate the maximum duration and/or volume of gas flared annually and beyond this maximum level production will be reduced until the facility upset is rectified.

Cumulative greenhouse gas emissions from future ACG FFD and other projects such as the BP operated Shah Deniz project will add to the overall input.

The Phase 1 project team has considered a number of design options for the development with the objective of reducing total emissions to the atmosphere (Chapter 4) and it should be noted that several of these options have been selected for base case design. Figures 14.1a and 14.1b illustrate the project design decisions that have been implemented for this purpose and indicate the reduction in greenhouse gas emissions that each selected component contributes.

Figure 14.1a Reduction in greenhouse gas emissions through SOCAR gas take agreement and elimination of flaring at Chirag (tonnes CO_2 Eq)

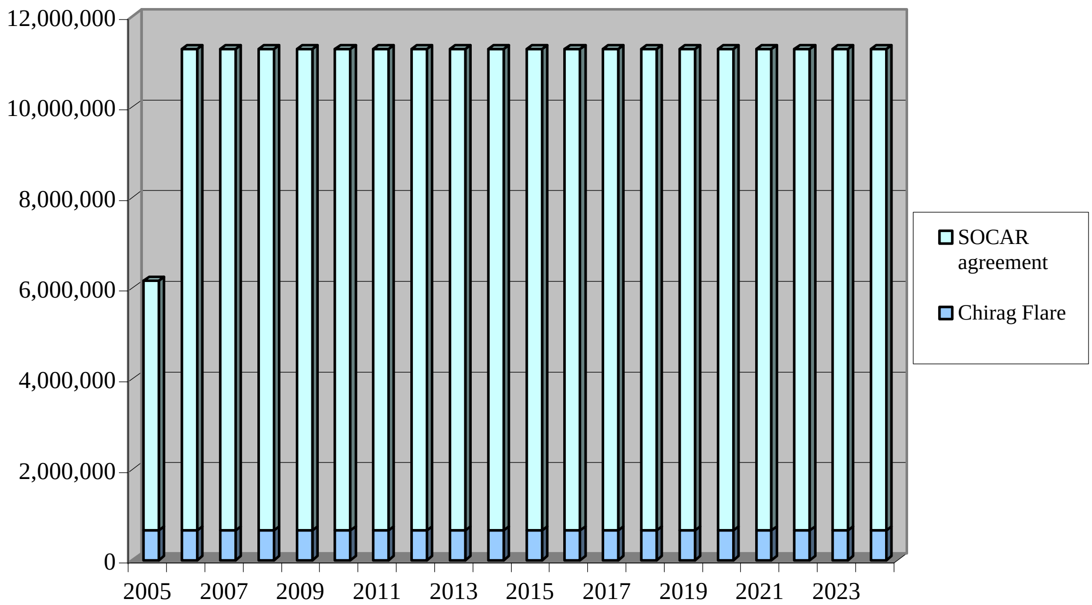
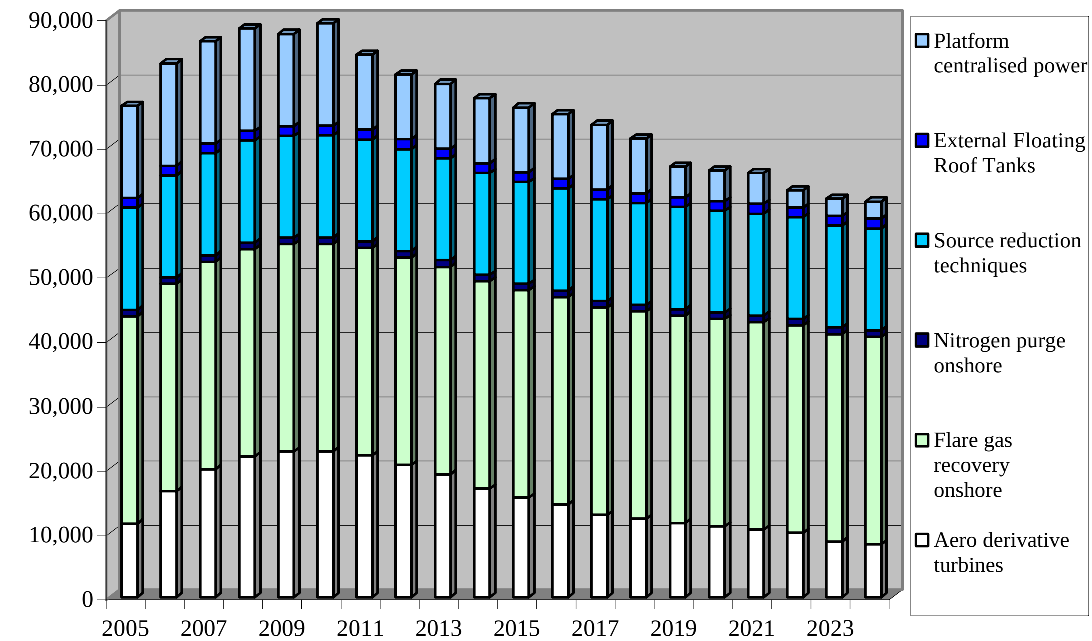


Figure 14.1b Reduction in greenhouse gas emissions from further design decisions for Phase 1 (tonnes CO_2 Eq)



14.2.2 Accidental events

The potential for oil spills resulting from accidental events has been considered in the early stages of the Phase 1 design and the focus has been on oil spill prevention. As such the facilities have been designed to reduce the likelihood of oil 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 oil and hydrocarbon inventories on the offshore facilities (including diesel storage) have been minimised and the potential for overfilling these storage tanks has been reduced through good tank design. Subsea pipelines for the export of oil and gas have been designed with adequate corrosion allowance for the life of field and shutdown control sub sea valve's (SCSSV's) 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 shutdown control sub sea valve's (SCSSV's) will be conducted to ensure that they are properly maintained and in good working order. 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 spill releases however small, will be recorded and reported.

The environmental impact assessment considered that the only accidental event warranting further investigation is the potential for a well blow-out during drilling operations. A well blow-out event would result in an uncontrolled release of hydrocarbons to the sea, although, it should be emphasised that the likelihood of the occurrence of a well blow-out is extremely remote.

The behaviour of an oil spill in the Caspian marine environment has been investigated using OSIS modelling for spill scenarios identified during the oil spill risk analysis for Phase 1 (Technical Appendix 5 and 6; Chapter 10). These simulations have shown that oil may beach on the coastline of Azerbaijan and pass into other Caspian littoral states such as Iran and Turkministan in the event of a large spill of oil, such as an uncontrolled release of hydrocarbons following a well blow-out. As discussed in Section 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 oil spill response planning. These include sensitivity studies, coastal surveys to assess shoreline types and accessibility and regional Oil Spill Contingency Planning.

The key tool for reducing or removing negative impacts as the result of a spill is the Oil Spill Contingency Plan (OSCP). The purpose of which 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 pollution on the environment. The primary step in BP's response to an accidental release of oil is to first notify the relevant contacts of the occurrence of the incident and to categorise the size of the oil 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.

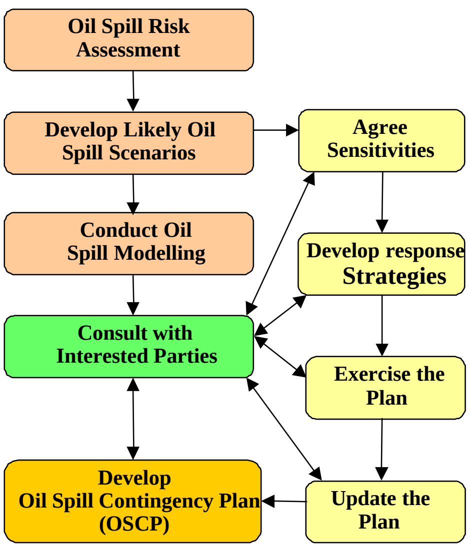
This system is internationally recognised as the most pragmatic approach, avoiding excessive costs and seeking shared resources for large, infrequent events. Using this system, the level of response will be dependant on a number of factors including:

- the quantity of oil spilled and spill location;
- the nature of the oil; and
- the proximity of the oil spill to available resources.

BP has prepared an OSCP for the Azerbaijan Business Unit which addresses; onshore and offshore incidents, incident reporting, oil spill remediation contractor databases and response resource availability. This plan will be updated to incorporate Phase 1 and future phases of development and an OSCP specific to the Phase 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 an oil 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 with 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 oil spill. A sensitivity map and coastal protection plan have been developed.

The process for developing the OSCP is summarised in Figure 14.2.

Figure 14.2 Summary of the OSCP process



The littoral states of the Caspian Sea are working towards developing National Oil Spill Contingency Plans. Azerbaijan has yet to prepare a plan, whilst other states are believed to have plans in various states of completion. Therefore, in the event of an international oil spill incident (Chapter 13), where there is a potential for oil to travel into the territorial waters of for example Iran or Turkmenistan, oil spill response would be complicated by this fact. As a result, discussions to ensure cooperation and coordination of international effort between neighbouring countries on a spill response exercise will be conducted. This would present a difficult political and logistical situation for any response exercise and this situation is currently under discussion, with an aim of securing agreements on the appropriate response to an international oil 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:

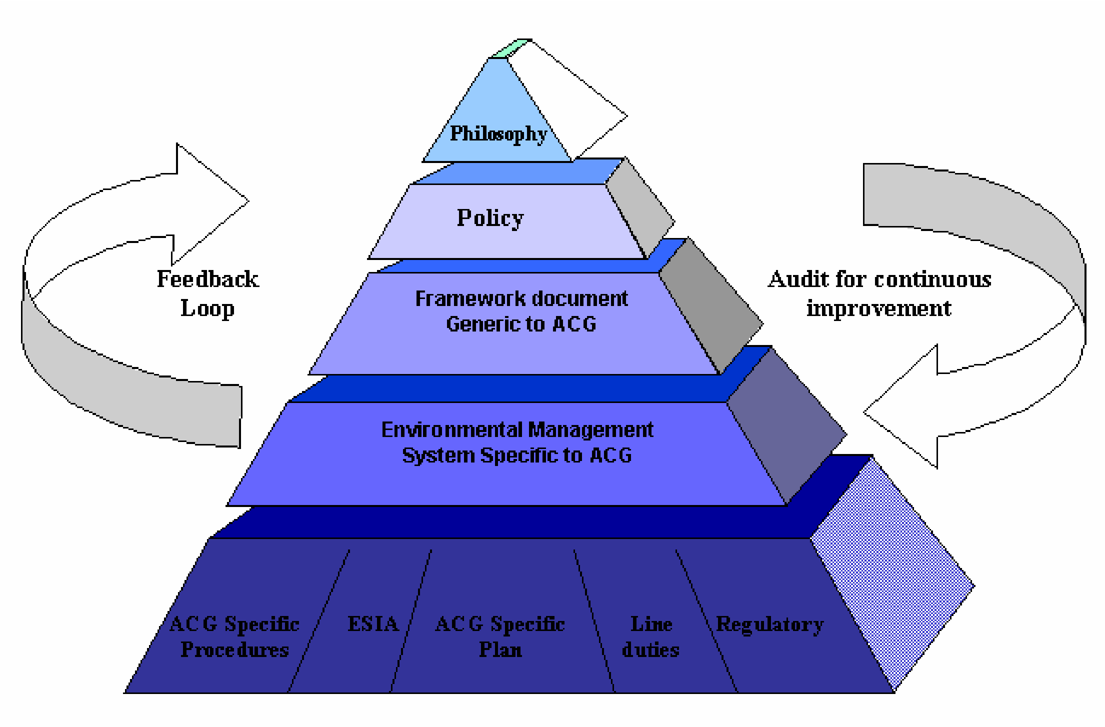
- Financial and technical support and involvement in the delivery of the National Oil Spill Plan Workshop in Baku (November 2001)
- Participation in the Caspian mutual aid initiative and workshop (November 2001)
- Financial and technical input with the industry 'steering group' looking at spill response 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 Health, Safety and Environmental (HSE) expectations to be adopted by BP managers are described in the document 'Getting HSE Right' (GHSER). This Corporate standard is 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. The policy is then supported by a number of documents, procedures and practice that, taken together, form the basis of the Environmental Management System (EMS). In order to provide the basis on development of the EMS in Azerbaijan, BP has provided a framework document entitled the "Environmental Management System Manual".

Environmental management follows a hierarchical structure as shown in the Figure 14.3. The philosophy sets the requirement for policy that in turn sets the requirements for the management system to be developed. The management system requires a 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.

Figure 14.3 Hierarchy of the environmental management system (EMS)



The Azerbaijan Business Unit 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.

When the operational phase 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 Phase 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 Design stage of the project. The process will continue through further project definition during 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 environmental management of the project. The implementation of site-specific environmental procedures will be the responsibility of the principal contractors involved including:

- the drilling contractor;
- the offshore facilities construction contractors;
- the pipelay contractor;
- the terminal construction contractors;
- the shipping contractor; and
- the waste management contractor.

BP will implement contractor management procedures to ensure 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 the AIOC standards and procedures with contractor procedures. The bridging document will consist of information on the following:

1. Commitment and Accountability;
2. Human Resource Management;
3. Communications;
4. Incident Reporting and Documentation;
5. Emergency Preparedness;
6. Documentation; and
7. Change Management.

A series of contractor audits will be conducted by AIOC 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. All personnel will receive such 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

A waste stream inventory for the ACG Phase 1 project has been compiled by Total Waste Management International. The inventory identifies predicted wastes for the spectrum of activities for offshore and onshore, for the lifetime of the project. Overall, the ACG Phase 1 waste management strategy adopts the following hierarchy:

- reduction;
- re-use;
- recover;
- recycle; and
- disposal.

Ultimate responsibility for correct waste disposal lies firmly with BP and in this role it will ensure that:

- project contractor(s) have adequate training and follow stipulated waste management procedures for minimising, handling and storing waste;
- waste disposal contractor(s) use facilities for treatment and disposal of waste that meet acceptable standards; and
- audits are carried out to ensure these are achieved.

Detailed waste management procedures will be put in place including the requirement for consignment notes giving an accurate description of the waste. Consignment notes follow wastes to the ultimate disposal site/operator and provide an auditable trail. All personnel employed at the project facilities will receive formal waste management awareness training, particularly regarding the correct waste segregation, storage and labelling procedures and potential recycling of waste.

14.4 Monitoring

The environmental management of the project will continue to be subject to assurance review 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 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 and physical disturbance on benthic communities, including drilled cuttings discharges. Including sediment chemistry, water column chemistry and temperature and sediment grain size analysis, macrofaunal community assessment.
Nearshore flora and fauna monitoring	Effects of pipeline installation and recovery rates. Including seagrass distribution, benthic communities and fish monitoring.
Mammals and herpetofauna at Sangachal	Effects of construction and operations. Mid-March daytime and night-time surveys
Flora at Sangachal	Effects of construction and operations. Mid-March
Terrestrial and coastal birds at Sangachal	Effects of construction and operations. Overwintering populations - December/January Nesting populations – late May/early June Migration – March/April
Groundwater	Presence and chemistry
Wadis at Sangachal	Water turbidity at defined sampling location
Waste water treatment ponds	Water chemistry and bacteria levels
Noise survey	Noise from terminal operations
Air monitoring	Ambient air quality Source emissions monitoring
Drainage	Flow and composition

15 Socio-Economic Mitigation, Monitoring and Management

15.1 Introduction

This section summarises the socio-economic mitigation, monitoring and management measures proposed for ACG Phase 1 and 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 AIOC/BP policies, management systems and procedures as applicable.

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 AIOC/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.

AIOC/BP are 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 ACG Phase 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;
- 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 ACG project and contractors, and

[1] This section draws on the social policy objectives drawn up for the BP midstream projects.

- establish a social investment programme that delivers mutual benefits to AIOC/BP and communities in and near the project area..

15.2 Methodology for developing mitigation measures

The methodology for determining mitigation measures for ACG Phase 1 included the following:

- Drafting of an initial list of mitigation measures by the ESIA team. An initial list was based on the ESIA and project team's knowledge as gained through the investigation and documentation of both the socio-economic baseline (Chapter 7) and the socio-economic impact assessment (Chapter 11);
- A discussion of the initial list of mitigation measures at a workshop held with representatives from BP project teams and the ESIA team; and
- Consideration of written comments received from those who were unable to attend the workshop.

The ESIA team fully considered the comments received both during and following the workshop. A set of mitigation measures was developed as detailed below. These measures have been agreed by the ESIA team and the ACG Phase 1 Project teams (onshore and offshore) as appropriate.

There are three distinct construction activities as outlined in Chapter 5 - onshore terminal construction (early civils and main construction work), upgrade of the yards to be used for offshore construction and offshore construction (onshore assembly of offshore components). All of this work will be undertaken by BP via contractors and/or third party owner/operators. The scope of the ACG Phase 1 ESIA covers only the onshore terminal construction and the offshore construction. The upgrades of the offshore construction yards is not formally included in the ESIA process and therefore is not formally subject to the ESIA requirements such as impact assessment and mitigation measures. However, as both the yard upgrades and the offshore construction itself will be undertaken by the same contractors as part of one construction process BP has included the yard upgrades in the mitigation measures agreed for offshore construction (onshore assembly of offshore components) activities.

In addition all mitigation measures apply to the construction phase of the project only, except the training strategy outlined in Section 14.5.4 which applies to the operations phase of both onshore and offshore activities.

15.3 Community relations

15.3.1 Overview

This section sets out the proposed mechanisms for liaison with communities affected by the ACG Phase 1 Project. These mechanisms will be outlined in detail in a Community Relations Programme (CRP) to be developed by AIOC/BP, the Project Management Team and the contractors prior to work commencing. There is a desire, as expressed by stakeholders during the consultation exercise, for all stakeholders to be involved in the project decision-making process and to have access to all relevant information.

15.3.2 Mitigation measures

15.3.2.1 Community relations programme (CRP) – onshore terminal construction only

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 AIOC/BP of any community related issues that may impact on any ACG Phase 1 works;
- identify any significant new issues that may arise during ACG Phase 1 works;
- develop a community dispute procedure and manage any disputes between AIOC/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; and
- monitor community attitudes to the development and to AIOC/BP
- ensure gender sensitive and culturally appropriate processes are utilised in communication and implementation activities.

The responsibility for the CRP will be divided between AIOC/BP, the Onshore Terminal Construction Project Management Team, and the contractors.

15.3.2.2 Community relations manager

The HSE Terminal Construction Manager, in the capacity of Community Relations Manager, will have overall responsibility for liaison with communities adjacent to the Terminal during the ACG Phase 1 construction process.

15.3.2.3 Community liaison officer

A dedicated Community Liaison Officer will be assigned to ACG Phase 1 during the construction phase of the project.[2] The continuation of the Community Liaison Officer role during the operational aspects of the project will be considered at a later date. The Community Liaison Officer will be a key member of ACG Phase 1 team and will be responsible for community support and assistance to ACG Phase 1. The programme will require the Community Liaison Officer to spend a large period of time with the local communities and the ACG Phase 1 team. The CLO's responsibilities will include:

1) continue public consultation with local communities affected by ACG Phase 1, using appropriate communication processes including consideration of gender and cultural issues;
2) provide input for 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;

[2] A Community Liaison Officer was appointed in December 2001 to liaise with local communities in Sangachal, Umid and Sahil.

7) identify any significant new issues that may arise during the construction period;
8) work with AIOC/BP, local communities and the ACG Phase 1 contractor to resolve any disputes between the parties;
9) provide input to ACG Phase 1 Social Investment Programme; and
10) maintain records of all consultations, and collation and preparation of internal and external reports.

15.4 Land Use

15.4.1 Existing Land Use

The majority of the land in the vicinity of the terminal site is 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 Sahil (Primorsk);
- 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 Sahil 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 Sahil facility in early November where they are held in cages and fed for 3-6 months till they are released. Until recently, the Sahil 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. Azerbalyk State Fisheries Concern employs 3-4 workers.

Like much of the Sangachal Bay foreshore, the coast 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 Table 15.1

Figure 15.1 Land use impacts from the ACG Phase 1 project

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 Sahil	Requirement for the Azerbalyk State Fisheries Concern at Sahil to relocate a set net from within the pipeline exclusion zone.	Azerbalyk State Fisheries Concern –Sahil (3-4 employees)
Recreational Fishing	Loss of access to a 500 metre length of foreshore during construction. Possible restriction on use of more limited shore zone during operations.	Small no. of recreational fishermen.

15.4.3 Mitigation Measures

The nature and extent of the Qobu State Cattle Breeding Enterprise herders' grazing rights are presently being investigated. In the event 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.

Land acquisition will be carried out in accordance with the requirements of Azerbaijani law and provisions regarding payment of compensation for land and damages contained in the PSA. In addition, the project will comply with the policies and guidelines of the World Bank Group, in particular with World Bank Operational Directive 4:30 on Involuntary Resettlement which establishes good international practice for projects involving land acquisition, relocation of people or impacts on livelihood. Commitments and procedures to be followed for project land acquisition will be documented in a Resettlement Action Plan prepared in accordance with Operational Directive 4:30.

Specific principles and actions to be followed to mitigate impacts arising from land acquisition, loss of assets or disruption of livelihood will include:

- Full compliance with World Bank OD 4:30
- Preparation and public disclosure of a Resettlement Action Plan
- Planning and design of the project to minimise the need for land acquisition and resettlement
- Compensation based on full replacement cost
- Commitment to ensuring that people affected by loss of land are assisted to improve their former living standards, income earning capacity and production levels or at least to fully restore them
- Thorough consultation with project affected people and taking account of their preferences with respect to arrangements for compensation
- Recognition of entitlement to compensation even in cases where affected people do not have legal title to their land (eg. in the case of the herders)
- Establishment of a social monitoring program to identify any cases of hardship or address any grievances arising from the land acquisition process.

Azerbalyk State Fisheries Concern has received cash compensation from SOCAR/BP for the cost of relocating its set net and a cage outside of the ACG Phase 1 pipeline exclusion zone. It is understood that the change in location will not affect the productivity of the nets or cages.

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. As it is currently understood that 30-40% of the catch from the nets and cage was taken by the fishermen in lieu of wages[3], negotiations are ongoing with the 4 fishermen employed by Azerbalyk to ensure that their livelihoods are not affected by the removal of the nets and the destruction of the cage.[4]

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 however, when considering mitigation the focal point is the local population that would be most exposed to the potential negative impacts discussed in Chapter 11. The main impacts identified are:

- social and cultural interaction issues;
    - tensions caused from labour outside the local area and / or Azerbaijan
    - the informal economy
    - market distortion
- health and security issues.
- noise, dust and ground-borne vibrations.

These impacts will occur as a result of both onshore terminal construction activities and offshore construction (onshore assembly of offshore components).

There are three distinct construction activities as outlined in Chapter 5 - onshore terminal construction (early civils and main construction work), upgrade of the yards to be used for offshore construction and offshore construction (onshore assembly of offshore components). All of this work will be undertaken by BP via contractors and/or third party owner/operators. The scope of the ACG Phase 1 ESIA covers only the onshore terminal construction and the offshore construction. The upgrades of the offshore construction yards is not formally included in the ESIA process and therefore is not formally subject to the ESIA requirements such as impact assessment and mitigation measures. However, as both the yard upgrades and the offshore construction itself will be undertaken by the same contractors as part of one construction process BP has included the yard upgrades in the mitigation measures agreed for offshore construction (onshore assembly of offshore components) activities.

Tensions caused from labour outside the local area and/or Azerbaijan, along with health and security issues, are dealt with in this section. After the noise modelling analysis, noise and ground borne vibration were assessed as insignificant impacts in that noise levels would not be increased above recommended guidelines except in occasional flaring instances. As a result no specific mitigation measures have been agreed, although WHO and World Bank Guidelines on maximum noise levels will be adhered to and toolbox talks dealing with noise at work issues will be delivered to site employees at the onshore terminal. Dust is dealt with in the Environmental Mitigation, Monitoring and Management Chapter (Chapter 14). Impacts on the informal economy and the local market, such as market distortion, were seen to be significant and diffuse. These impacts will be addressed as part of BPs wider Social Investment Strategy (Section 14.9).

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[3] See Chapter 7 Socio-economic Baseline
[4] These negotiations will be documented as part of the Resettlement Action Plan which will be publicly available.

15.5.2 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 14.3.2);
- encouraging involvement of the workforce in the community relations programme and community initiatives and social investment programmes where possible (Section 14.9);
- effective and open complaints procedure to be developed as part of the CRP (Section 14.3.2);
- application of AIOC/BP and Azerbaijani standards, policies and expectations;
- project social objectives (Section 14.1.1);
- commitments with respect to local and national Azerbaijani content of workforce and appropriate advertisement of job opportunities (Section 14.5);
- code of conduct policy;
- consideration by the contractor of all aspects of construction worker management included in the Social Impact Considerations attached to the contractors Invitations to Tender (ITTs);
- construction camp management plan;
- management of construction workers;
- site inductions to include an aspect of cultural awareness;
- entertainment facilities in construction camp; and
- provision of information on communicable diseases awareness and prevention.

The latter points are discussed in more detail below.

15.5.2.1 Code of conduct policy

AIOC/BP has formulated a Code of Conduct to apply to all AIOC/BP and contractor personnel working in offices and associated facilities managed by the ACG Phase 1 Terminal Construction Project Management Team. The Code of Conduct covers issues such as:

- appropriate behaviour and dress
- drug and alcohol use
- compliance with relevant laws and policies

The Code of Conduct contains 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 AIOC/BP or their contractors. Failure to comply with the Code of Conduct will result in disciplinary action.

15.5.3 Social Impact Considerations in Invitations to Tender

Social Impact Considerations have been attached to the Invitations to Tender (ITTs) for the early civils 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 14.5)
- impact on local infrastructure (Section 14.7)

Successful contractors will be expected to present a Social Impact Management Plan (SIMP), consistent with the mitigation measures already agreed by the Project Management Team, to the Project Management Team for approval. Contractors will be monitored on adherence to these plans.

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 AIOC/BP in the Invitation to Tender. This will be developed following the appointment of the preferred construction contractor, and reviewed and finalised by AIOC/BP. The construction camp management plan will include measures to address the four key issues identified by the project to date in relation to construction camps, namely discipline, community liaison, ethnic tensions and market distortion.

15.5.3.2 Management of construction workers

The construction camp for the early civils and main works onshore terminal construction will be "open", and workers will be entitled to leave camps outside working hours. However this will be subject to a code of conduct to minimise the risk of disputes and incidents between workers and local communities. The Code of Conduct (see above) 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 that there is to be 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.

15.5.3.3 Training for workers on cultural awareness

The construction contractor 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.

15.5.3.4 Entertainment facilities in construction camp

The construction camp will include entertainment facilities to reduce the need for workers to leave the camp. These have been incorporated into the HSE specification for construction camps, which will be issued to the construction contractor.

15.5.3.5 Communicable diseases awareness and prevention plan

Management of the risks of contracting a communicable disease[5] 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 BPs 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. Community liaison

[5] Communicable diseases such as tuberculosis, cholera, typhoid are present within Azerbaijan as outlined in Chapter 7.

personnel on the project will also provide information on sexually transmitted diseases and the risks of prostitution to the local community. AIOC/BP will develop this material, for use by the construction contractor. BP will develop this strategy through collaboration with other organisations working on this issue in Azerbaijan.

15.5.4 Mitigation measures for offshore construction (assembly of offshore components)

The following measures will be applied in order to mitigate potential impacts on the population from the offshore construction (onshore assembly of offshore components) activities:

- application of AIOC/BP and Azerbaijani standards, policies and expectations;
- project social objectives (Section 14.1.1);
- commitments with respect to local and national Azerbaijani content of workforce and appropriate advertisement of job opportunities (Section 14.5);
- consideration by the contractor of social issues associated with construction work included in the Invitations to Tender (ITTs);
- management of construction workers;
- entertainment facilities in construction camp; and

The latter points are discussed in more detail below.

15.5.5 Social Impact Considerations in Invitations to Tender

Social Impact Considerations have been attached to the Invitations to Tender (ITTs) for the early civils and main construction works for the offshore construction activity. These considerations specifically cover contractor plans for dealing with:

- management of construction workers
- impact on local employment (Section 14.5)
- impact on local infrastructure (Section 14.7)

Successful contractors will be expected to present a Social Impact Management Plan (SIMP) , consistent with the mitigation measures already agreed by the Project Management Team, to the Project Management Team for approval. Contractors will be monitored on adherence to these plans.

15.5.5.1 Management of construction workers

The construction camp for the offshore construction work will 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.

15.5.5.2 Entertainment facilities in construction camp

The construction camp will include entertainment facilities to reduce the need for workers to leave the camp.

15.6 National employment

15.6.1 Overview

ACG Phase 1 will provide an opportunity for the employment of local and other Azerbaijani nationals. Tender specifications for the ACG Phase 1 contract include a pro-active element towards favouring employing from local/national sources and investing in the development of this workforce through skills training programmes.

15.6.2 Mitigation measures for offshore facility construction and terminal construction

The sections below discuss the measures that will be applied, by both the offshore facility construction and onshore terminal construction Project Management Teams, in order 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 ACG Phase 1 Project Statement of Social Objectives. Finally, contractors will be required to abide by the International Labour Organisation standards on employee terms and conditions.

Onshore 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*[6]*, 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.

Offshore construction tenderers are required through the Invitation to Tender (ITT) to develop an employment strategy which:

"shall provide for preferential employment of local labour."

For both onshore and offshore construction, the employment strategy will be finalised and implemented by the construction contractor, although BP will approve the strategy during the contract negotiations.[7]

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[6] Company employees' policy, recruitment principles, training for construction workers, local sourcing.
[7] As of February 2002, the employment strategy for the onshore and offshore construction process has been finalised and is currently being implemented. For the onshore terminal construction process the employment strategy is as follows:

a) recruitment will be based on the "best person for
the job"
b) the successful personnel will be recruited as trained employees for a certain discipline according to the competency assessment

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 AIOC/BP to finalise and implement this training programme for potential employees. Contractors will be required to include within the training programme training to raise the skill levels of local employees to international standards, and long-term skills enhancement.

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 AIOC/BP to ensure that the strategy can be implemented prior to the works programme period. AIOC/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. AIOC/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 ACG Phase 1. This will be achieved by identifying activities for which Azerbaijani nationals can be trained within the budget and time available. 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 ACG Phase 1 enabling local people to take advantage of employment opportunities.[8]

15.6.2.3 Strategy on employment

AIOC/BP support projects that increase the proportion of Azerbaijani staff in employment and specifically those resident within the local project area. The potential for the employment being created through ACG Phase 1 to be captured by Azerbaijanis, and specifically local residents, was a key issue raised during the consultation exercise undertaken for the ESIA. AIOC/BP will agree a level with the contractor for the proportion of local employment to be used on the project and this level of local input will be written into the contractors 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.

AIOC/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

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c) preference will be given to the employment of personnel from the Sangachal or Umid communities for particular skilled or unskilled positions. Only if suitable personnel are not available from these communities, then the particular skilled or unskilled position will go to potential candidates from Sahil town.

For the offshore assembly work, all labour is being provided by SPS (the owners of the assembly yard) as they have a large number of existing employees, the majority living locally in Sahil.

[8] As the contract selection has moved forward, the selected contractors are currently devising and finalising their training strategies.

construction contractors contract. The monitoring process will be overseen by the AIOC/BP Onshore Terminal Construction Project Management Team. A summary of this information will be compiled every three months during the construction period and will be made available upon request.

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 that will be agreed with the successful construction contractor and which will be contained in their contract.

15.6.2.5 Recruitment principles and recruitment plan

BP has drawn up a set of principles that will be applied to recruitment by AIOC/BP and 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 offshore 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;
- AIOC/BP will use existing mechanisms for employment at national and regional levels, wherever appropriate, and
- AIOC/BP will monitor recruitment practices to ensure that 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 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 (e.g projected number and duration of employment) is communicated at national and local levels during the ESIA consultation process. This will help manage expectations of the levels of employment associated with the project. Employment information provided will include recruitment principles, the likely scale of employment and the level of demand that is anticipated. Leaflets will be available at the reception desk of the BP head office in Baku giving information on how to apply for jobs along with contact details for further information.

Following appointment of the contractor, information on employment will be available to the local community. This information will enable the local community to assess employment prospects and apply for jobs if they choose to do so. Information will be provided on:

- 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 be available through local recruitment centres in Sangachal, Umid Camp and Sahil, established by the contractor, prior to construction activities commencing.[9] 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

15.6.4 Training proposals

The ACG Phase 1 project has an objective of employing a minimum 50% of the operations staff both onshore and offshore from the local Azerbaijani population, with a view to increasing this ratio with 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 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 2 and 3 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 will cover the more specialised technical training required for each of the four trade disciplines.

In addition to the offshore and onshore trade technicians, BP will also recruit Azerbaijani University graduates into the BP Challenge Graduate programme. This programme gives both operational, engineering and other onshore support responsibility training over a three year programme. It is envisaged that Azerbaijani staff from both the Challenge and technician training programmes will join the project teams in the UK and other areas before then mobilising to Baku for the Hook-up and Commissioning of both the Sangachal terminal and offshore platforms.

A training centre will be established at Sangachal to provide a range of training for the local community. This training will include, but will not be limited to, job specific training for ACG Phase 1. 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 outside of the ACG Phase 1 and Shah Deniz projects.

The contractors for the offshore works have also implemented a training programme for employees. Training for the drilling activities, one element of the training programme, began in late 2001 with 200 Azerbaijani personnel currently undertaking training in Dubai.

[9] The recruitment centres in Sangachal, Umid and Sahil are operational as of February 2001.

15.7 National industrial base and national procurement

15.7.1 Overview

ACG Phase 1 will offer business opportunities for companies at the national, regional and possibly local level. Increased supply from these sources should deliver cost benefits to the project and sub-contractors, if safety, technical and commercial requirements are satisfied. These sourcing opportunities will help to maximise positive benefits to the national industrial base. For the onshore and offshore construction activities the specific measures below will be implemented. Where specific measures below come to form part of the ACG Phase 1 Social Investment Strategy they will apply across both onshore and offshore activities.

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.

The latter points are discussed in more detail below.

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 SME programmes
- Creating new initiatives to assist small and medium sized enterprises (SMEs)
- 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 event will be for potential suppliers to BP projects. 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.

Also the creation of an Azerbaijan Supplier Database. This is already 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 – identificaton 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.

15.7.3 Effective communication of requirements to sub-contractors

BP, through the ShareFair event, will provide a forum for potential sub-contractors in Azerbaijan to better understand potential opportunities within ACG Phase 1, other potential projects and existing operations.
This will be provided on an ongoing basis via the Enterprise Centre.

15.8 Community infrastructure and utilities

15.8.1 Overview

The ACG Phase 1 project will pursue the objective of "No Net Loss" in relation to infrastructure and utilities during onshore terminal construction, wherever possible. AIOC/BP has integrated requirements for 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

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 (e.g. electricity for the stone mine);
- 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.

AIOC/BP will publish information describing how electrical power will be generated, water supplies sourced, telecommunications accessed 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. AIOC/BP will disclose information of the proposed electrical power demands under ACG Phase 1.

The construction contractor, with assistance from AIOC/BP, will be required to consult with service providers prior to the use of any utilities. AIOC/BP will require the construction contractor to apply the "No Net Loss" approach.

15.8.3 Mitigation measures for offshore construction (onshore assembly of offshore components)

Measures to mitigate potential negative effects on community infrastructure and utilities during offshore terminal construction include:

- identification of potential impacts;
- discussion of these impacts with affected communities in advance; and
- avoidance of or compensation for any impacts.

Procedures and plans will be required for waste management and use of community water sources.

15.9 Transport

15.9.1 Overview

In the context of the ESIA, the term transport refers to the local and regional transport system.

15.9.2 Mitigation measures for onshore terminal construction

Mitigation measures to be employed by the onshore terminal construction contractor to reduce impacts on the local transport systems are discussed below.

15.9.2.1 Transport Management Plan

The ACG Phase 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. Consideration will also be given to avoiding reliance on public transport and contractors will be required to use private buses. The provisions made in the tender submissions will be reviewed during the selection process for the preferred construction contractor and finalised upon selection.

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 be required to document road quality prior to, and following, construction. The construction contractor will be required to restore all roads to at least their pre-construction standard. This requirement has been included in the Social Impact Considerations attached to the contractors ITT.

15.9.3 Mitigation measures for offshore construction (onshore assembly of offshore components)

Mitigation measures to be employed by the offshore construction contractor to reduce impacts on the local transport systems are discussed below.

Offshore construction (onshore assembly of offshore components) activities contractors will 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.

The need for social investment local to the project area was a key concern raised by a number of individuals during the ESIA consultation process.

Social investment is defined here as:

- social projects in communities, that are impacted by the AIOC/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 AIOC/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 AIOC/BP.

As such the Social Investment Strategy works across all the project affected communities (relating to both onshore and offshore construction work) 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 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 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 AIOC/BP's business objectives in several ways. The programme will:

- reinforce AIOC/BP business policy commitments;
- enable a constructive relationship between AIOC/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 AIOC/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 AIOC/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.

As part of the ESIA consultations with the Sangachal, Sahil and Umid settlements, a number of issues were identified by those settlements, which fall into three categories:

- Community-based micro-projects targeting social infrastructure, such as rehabilitation of schools, road repair, and rehabilitation of sewage and sanitation systems;
- Social services, such as health support;

- Economic skills development and fostering economic opportunities.

BP plans to evolve and grow its social investment programme over time. However, the communities in the Sangachal, Sahil 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. It is likely that the short-term projects will focus on infrastucture improvements whereas longer-term projects will emphasise fostering economic opportunities.

BP is also interested in promoting a participatory manner involving beneficiaries as much as possible in program design, implementation and evaluation, and as such, 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

AIOC/BP is currently developing the Social Investment Strategy for ACG Phase 1. In developing the strategy, AIOC/BP has drawn heavily on the findings of the Socio-economic Impact Assessment (Chapter 11) that was undertaken as part of the ESIA, in addition to the conclusions of the sociological survey that was undertaken of Umid, Sangachal and Sahil by the Azerbaijan-Holland Friendship Society. Discussions have also been held with a number of the main NGOs represented 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 AIOC/BP to undertake this work was highlighted. Following the meeting a decision was made by AIOC/BP to advance with the essential and necessary repair work to the school gym in an effort to complete the work 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, AIOC/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, a safety induction course was run and a ‘tool box’ meeting and a job safety talk was held. This is illustrative of the steps that AIOC/BP wish to take in building a sustainable service industry in Azerbaijan. The project provided an opportunity to familiarise and train a local contractor to AIOC/BP standards, from tendering process to HSE, quality assurance, until completion and hand over.

15.11 Archaeology and cultural heritage

It was determined (Chapter 11) that the ACG Phase 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) will be implemented. The Plan includes procedures for a “watching brief”; that is, for a specialist to be on-site during the early civils works programme of the ACG Phase 1 terminal construction programme to advise the construction contractor on an appropriate course of action should a site be encountered. The specialist is likely to be an expert from the local Institute of Archaeology and Ethnography, Azerbaijan Academy of Sciences.[10]

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, will be established and documented in advance of the commencement of ECEWP activities. Possible archaeological features identified during 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.

[10] As of February 2002 with the commencement of the early civils works, two archaeological specialists from the Azerbiajan Academy of Sciences have been rotating in order to provide a 7 day 'watching brief' during working hours at the onshore terminal site. In addition archaeology 'toolbox' talks have been developed and delivered to site workers.

16 Conclusions

16.1 Introduction

The ACG FFD Phase 1 project has the potential to deliver major economic benefits to Azerbaijan. The project together with the linked investments including ACG FFD, the BTC project and possible Shah Deniz Gas Export project 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 projects can lead to positive social and environmental change within Azerbaijan. The economic assessment for the three proposed phases of ACG FFD development so far indicates that revenues from oil and gas production and transit would be very significant especially over the ten years from about 2007 to 2017. Over the peak period it is likely that these revenues would exceed all other sources of public revenue. 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.

ACG FFD has the potential to either result in, 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 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 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 that have been included in the project's base case to mitigate potentially significant environmental impacts include but are not limited to:

- the decision to re-inject drilled cuttings from lower hole sections drilled with non-water based mud systems rather than discharge to sea;
- the decision to use a cooling water antifouling system that will result in far lower concentrations of chlorine being discharged to sea;
- the decision to re-inject produced water offshore rather than discharge to sea;
- the decision to pursue onshore injection of produced water generated at the terminal into dedicated disposal wells;
- use of associated gas as fuel gas for offshore and onshore facilities and for re-injection offshore for reservoir pressure maintenance, with the remainder to be delivered to SOCAR, resulting in no requirement for routine flaring of gas to produce oil;
- the decision to co-mingle Chirag-1 oil and gas with Phase 1 production offshore resulting in the elimination of any routine flaring required at the Chirag-1 platform;
- the decision to install flare gas recovery at the terminal to remove the requirement to flare internal process valve and seal leakage;
- use of the existing EOP pipeline corridor route for the Phase 1 30" oil pipeline so as to avoid disturbing previously undisturbed benthic habitat;
- scheduling pipeline installation activities in the nearshore as far as is practicable to avoid environmentally sensitive times (e.g. breeding seasons);
- the decision to locate the Phase 1 terminal alongside the existing EOP terminal resulting in a reduced land-take requirement; 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.

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.

16.2 Environmental impact assessment

The impact assessment concluded that the majority of the activities associated with the Phase 1 development would result in only negligible or low impacts on the surrounding environment.

Of the 84 routine and planned non-routine project activities identified for each of the elements of the proposed project, 13 were identified as having the potential to cause environmental impacts ranked as being of "high" significance on 12 separate receptors. It should be 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 along with the receptors affected are summarised in Table 16.1.

Table 16.1 Summary of Phase 1 activities resulting in "high" significance environmental impacts

Project Component	Contributing Activities	Impacted Receptors
Offshore activities	Template well cuttings discharge	Benthos
	Platform well cuttings discharge	Benthos
	C&WP gas compression	Atmosphere
	PDQ and C&WP power generation	Atmosphere
	Planned non-routine flaring	Atmosphere
Subsea pipeline activities	Pipeline trench construction nearshore	Seabed, marine habitat/flora, benthos, coastline
	Finger-pier construction	Marine habitat/flora, benthos and coastline
	Pipeline trench construction onshore	Coastal habitat/flora, terrestrial habitat/flora and reptiles/amphibians
Terminal activities	Ground clearance and grading	Soil, terrestrial habitat/flora, terrestrial/coastal birds and reptiles/amphibians
	Excavation of drainage channel	Soil, surface water, hydrological systems and terrestrial/coastal birds
	Construction of access road / railway crossing	Terrestrial/coastal birds
	Terminal power generation	Atmosphere
	Planned non-routine flaring	Atmosphere

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. The additional mitigation measures are summarised in Table 16.2.

Table 16.2 Summary of additional environmental mitigation measures for Phase 1

Project Component	Impact	Additional mitigation
Offshore activities	Well cuttings discharge physical impacts on benthos.	Monitoring of effects. Continued evaluation of the impact.
	Contribution to greenhouse gas emissions from offshore operational emissions.	Minimise flaring through flaring policy.
Subsea pipeline activities	Pipeline trench construction nearshore direct and indirect impacts on flora and fauna.	Shore approach installation management plan. Consideration of silt screens.
	Finger-pier construction, nearshore direct and indirect impacts on flora and fauna. Potential interference with natural sediment transport mechanisms	Consideration of alternatives to the fingerpier. Removal of finger pier following installation.
	Pipeline trench construction onshore, direct and indirect impacts on terrestrial flora and fauna.	Pipeline installation management plan. Spur-thighed tortoise augmentation programme.
Terminal activities	Ground clearance and grading of terminal location resulting in a permanent loss of habitat. Direct and indirect impacts on flora and fauna.	Spur-thighed tortoise augmentation programme. Evaluation of a habitat compensation programmes.

Project Component	Impact	Additional mitigation
	Excavation and operation of drainage channel resulting in the loss of habitat.. Direct and indirect impacts on flora and fauna. Potential alteration to hydrological systems	Spur-thighed tortoise augmentation programme. Evaluation of a habitat compensation programmes. Watershed analysis.
	Construction of access road / railway crossing resulting in the loss of habitat. Direct and indirect impacts on flora and fauna.	Spur-thighed tortoise augmentation programme Evaluation of a habitat compensation programmes
	Contribution to greenhouse gas emissions from terminal emissions	Minimise flaring through flaring policy

Full consideration has also been given to cumulative impacts resulting from existing and foreseeable future activities in the Phase 1 project area, as well as any potential transboundary impacts associated with Phase 1.

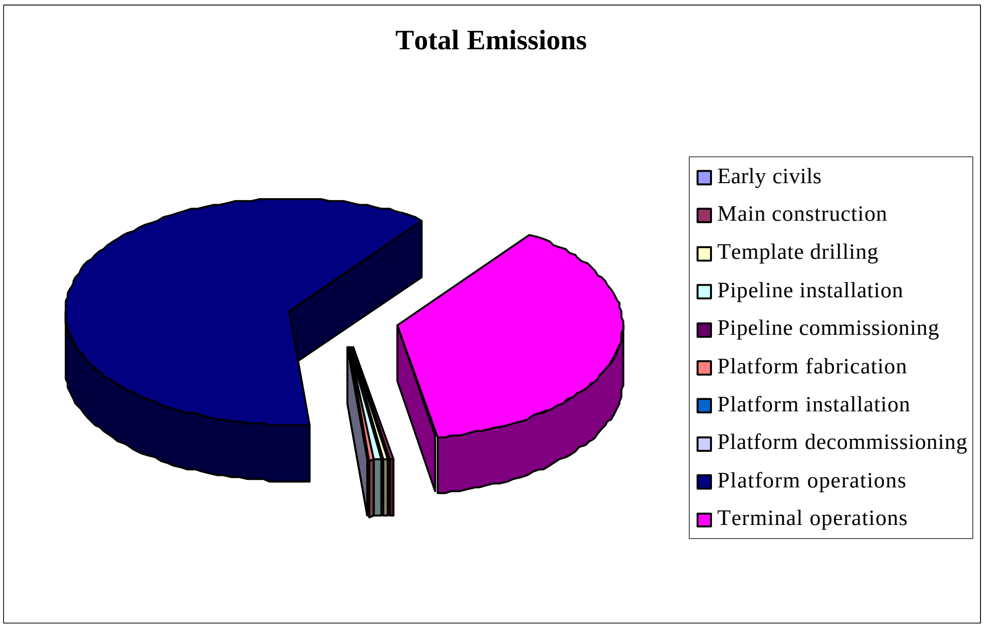
The following summarises the key environmental issues and residual impacts associated with the project.

16.2.1 Residual environmental impacts

16.2.1.1 Atmosphere

The principal contributing activities that result in emissions to the atmosphere occur during the project operational phase. Figure 16.1 shows the total atmospheric emissions from the Phase 1 programme over the life-time of the PSA.

Figure 16.1 Estimated total emissions to the atmosphere from the Phase 1 project



The key contributors are related to combustion emissions from offshore platform and terminal power generation turbines, turbine driven gas compressors on the C&WP, process heaters at the terminal and the planned non-routine flaring of gas during times of equipment unavailability.

Interim air dispersion modelling of the offshore and onshore emissions has predicted that no effects on local human receptors from potentially polluting species would result from Phase 1 operations. This model included consideration of Phase 1 operational emissions in conjunction with the existing emissions from the EOP terminal and estimated emissions from the proposed Shah Deniz gas processing terminal that may be constructed at the same location. Further modelling will be conducted to assess the dispersion of emissions at the terminal form ACG and proposed Shah Deniz FFD.

Appreciable emissions of greenhouse gases (GHG), principally carbon dioxide and methane, will result from the Phase 1 project operations, these amount to between 1.7 and 1.74% of the United Nations Framework Convention on Climate Change (UNFCCC) predictions for Azerbaijan in the earlier years of the project (2005 and 2010). When added to the cumulative input predicted from ACG FFD and proposed Shah Deniz FFD, GHG emissions of up to 5% of the UNFCC prediction for Azerbaijan's GHG emissions would result. In the context of global warming there arises a transboundary environmental impact issue. The combined ACG and Shah Deniz FFD emissions may also 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 and BP.

A flaring policy will be defined for the operating phase of the Phase 1 project. The operational flaring policy will be agreed with the AIOC partners and it will stipulate the maximum volumes of gas that may be flared annually in the event of plant upset or inability of SOCAR to take delivery of the excess gas at the terminal, prior to production shutdown.

16.2.1.2 Marine habitat, flora and fauna

Drilling

Drilling of the surface and top hole sections at each well will result in the release of the generated drilled cuttings at the seabed. Options for the disposal of the drilled cuttings generated from the 26" hole section that are returned to the drilling facility from the well were evaluated using a Best Practicable Environmental Option (BPEO) study. The options considered included:

- discharge to the sea through a sub-surface caisson;
- re-injection down a dedicated injection well; and
- containment then ship-to-shore for disposal.

The study, which considered environmental impact along with safety, compliance with legislation and project criteria (technology and cost), concluded that the most appropriate disposal method would be discharge to the marine environment from both the template well drilling programme (from the drilling rig Dada Gorgud) and the platform drilling programme from the PDQ. This will however, result in an impact to the benthos in the vicinity of the discharge location. Dispersion modelling has predicted that the majority of the cuttings particles would principally accumulate within 250 m to 350 m of the discharge point. As up to 48 wells will be drilled, approximately 16,900 m^3 of cuttings from the Phase 1 drilling will be discharged and cumulative coverage on the seabed would be around 70,000 m^2 or approximately 7 ha.

This deposition will physically smother the benthic habitat. While the total area impacted is not considered to be significant in terms of the whole ACG Contract Area, the fact that the drilling programme would last for approximately 10 years and the re-colonisation of the area by benthic organisms in this area of deposition would not occur until drilling stops, the impacts on benthos are considered on a local scale to be of "high" significance. No chemical contamination from these discharges is anticipated as the drilling fluids for the surface and top-hole drilling would be either seawater based or a water based mud system. The mud systems have also been carefully formulated to ensure that all additives used have no intrinsic toxic properties.

Impacts resulting from these drilled cuttings discharges will be monitored over the life of the project to confirm the predicted impacts.

If future Phases of the ACG FFD (Phases 2 and 3) also result in the discharge of drilled cuttings to the sea then areas of the seabed in the vicinity of the Phase 2 and Phase 3 locations will also be impacted by cuttings accumulations. Assuming, similar amounts of cuttings are discharged, then in total around 50,000 m^3 of cuttings will be discharged.

Installation of 30" oil pipeline

The construction of the trench as well as the finger-pier to allow access by a mechanical excavator for excavation in the nearshore zone of Sangachal Bay will result in impacts to marine flora and fauna. Approximately 25% of the proposed pipeline route in the nearshore and inshore areas is covered by seagrass. This and the benthic organisms it hosts would be directly impacted (lost) as a result of construction of the pipeline trench. 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 trench 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. These options are under evaluation, however availability of suitable and appropriate alternative equipment in the region has proved difficult to date. The 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. If the pier is not removed this may result in a change to coastline configuration beyond the pier. It is noted that the project's base case is to remove the pier if required.

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 is the successive disturbance that will occur as a result of installation of the future pipeline required for ACG FFD and the proposed Shah Deniz project pipelines. The possibility of concurrently installing all required pipelines for FFD is being evaluated. If this were possible, pipe-lay impacts would occur over a limited period of time and recovery of the Bay, to its original status, would be accelerated.

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. Limited disturbance of the coastal area and land between the coastline and terminal location will also result from the construction of the trench for installation of the onshore section of the 30" oil pipeline. While the pipeline corridor route will be re-instated, the terminal location site will be permanently lost due to the construction of the terminal.

A survey of the area surrounding the proposed development site carried out for the ESIA 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 habitat loss resulting from terminal and associated facility construction is under evaluation. This programme would 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.

In addition, a Spur-thighed tortoise augmentation programme is under development in order to compensate for any potential impacts to this species associated with the Phase 1 construction activities. This conservation programme is likely to include 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 will be closely involved with the development of these programmes and local educational institutions will be included in their implementation.

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 ACG Phase 1 development would result in only "negligible" or "low" impacts on the surrounding socio-economic environment.

Of the 84 routine and planned non-routine project activities identified for each of the elements of the proposed project, 16 were identified as having the potential to cause 20 different socio-economic impacts ranked as being of "high" significance on 6 separate receptors. Only one routine activity was assessed as having the potential to result in a socio-economic impact of "critical" significance and this impact (on the local herding population) is being addressed through a mitigation process, which aims to determine an acceptable outcome to all parties. The contributing 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 Phase 1 activities resulting in "high" or "critical" significance socio-economic impacts

Project Component	Contributing Activities	Impacted Receptors
Onshore construction of offshore facilities	Fabrication and construction activities.	Population in the vicinity, transport.
	Mobilisation of workforce.	Population in the vicinity.
	Demobilisation of workforce.	Population in the vicinity, national employment base.
Subsea pipeline activities	Pipeline crossings of existing onshore services.	Transport.
	Construction of nearshore trench.	Fishing.
	Pipelaying (including vessel operations, anchor drag).	Fishing, shipping.
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.	Fishing, shipping.
	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 ACG Phase 1

Project Component	Impact	Additional mitigation
Onshore construction of offshore facilities	Community tensions surrounding employment issues, health, informal market and market distortion effects on local economy associated with workforce and inward migrating population in search of employment.	Requirements of tender regarding local and Azerbaijan national workforce percentages. Camp and worker management plans. Social investment strategy.
	Impact on direct, indirect and induced employment.	Training plans. Social investment strategy.
Subsea pipeline activities	Impacts on the transport system and infrastructure including congestion, deterioration, nuisance to other users.	Requirements of tender including Transport management plans. Detailed transport planning. Avoidance of public transport system.
	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.
	Pipelaying 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 and shipping activities in the Caspian and sea routes in to 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 ACG Phase 1 project area, as well as any potential transboundary impacts associated with ACG Phase 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

The terminal construction activities themselves will impact on the local herder population. Land acquisition 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 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 ACG Phase 1 terminal facilities and the proposed Shah Deniz gas terminal to be constructed alongside, there will be no further need for 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 responsiblity for the Qobu State Cattle Breeding Enterprise). So 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.

Land acquisition will be carried out in accordance with the requirements of Azerbaijani law and provisions regarding payment of compensation for land and damages contained in the PSA. In addition, the project will comply with the policies and guidelines of the World Bank Group, in particular with World Bank Operational Directive 4:30 on Involuntary Resettlement which establishes good international practice for projects involving land acquisition, relocation of people or impacts on livelihood. Commitments and procedures to be followed for project land acquisition will be documented in a Resettlement Action Plan prepared in accordance with Operational Directive 4:30.

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. This will not affect the productivity of the nets or cages or the livelihood of the fishermen involved. In the process of removal however, the cage in the pipeline corridor was destroyed and is not available for use by the Azerbalyk fishermen in the alternative fishing grounds. As 30-40% of the catch from the nets and cage was taken by the fishermen in lieu of wages[1],

[1] See Chapter 7 Socio-economic Baseline

negotiations are ongoing with the 4 fishermen employed by Azerbalyk to ensure that their livelihoods are not affected by the removal of the nets and the destruction of the cage.[2]

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.[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

The offshore installation, hook-up and commissioning and operations of the pipeline and the various platform components will have an impact on offshore fishing and shipping activities. During installation, commissioning and hook-up activities at the ACG Phase 1 location a number of vessels will be present on the sea surface that will effectively exclude the area 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 pipelay barge will come into water depths of 8 m (around 5 to 7 km offshore).

When the drilling rig is on location during the pre-drilling operations, and once the fixed platform structures are installed offshore, their physical presence will 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.

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. 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 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; an increase in activity in the informal economy in the area; market distortion as a result of increased wages and possible associated price inflation; and health impacts associated with reproductive health issues and communicable diseases.

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[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.

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 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.

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.

Noise levels from the terminal were modelled for FFD terminal operations and interim results predicted that under normal operating conditions, the World Bank Guidelines would be met at all nearby receptors. Under emergency shut-down flaring events however, minor exceedence of the Guideline limits may be experienced for a few minutes.

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 causing 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 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 public transport system in the local area is already an overstretched resource. A an increase in users of the system would negatively impact the local population. Contractors for both offshore and onshore construction will use private buses to transport day site workers to avoid placing extra pressure on the system. 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 sourcing of employment during construction is to be determined by the selected contractors. Current tender information indicates that both offshore and onshore contractors will source between 70-85% of labour from within Azerbaijan. 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 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. The % of local content will form one of the evaluation criteria in the tender selection process for all contractors.

It should be borne in mind that whilst there may be a pool of labour large enough to cater for the demands of ACG Phase 1 (and later ACG Phases and Shah Deniz Stage 1 projects), some training of this workforce would be required.

The proposed cost in relation to the construction of the terminal for ACG Phase 1 is estimated at $350 million[4]. It has been estimated that some 50% of this expenditure will occur within Azerbaijan. These costs include the capital costs of the infrastructure, the installation costs (i.e. all associated contracts), owner's costs and contingency. The costs are defined as +/- 20%.

The **proposed cost** in relation to the construction of the offshore elements of ACG Phase 1 is estimated at $1,605[5]. It has been estimated that some 44% of this expenditure will occur within Azerbaijan. These costs include the capital costs of the infrastructure, the installation costs (i.e. all associated contracts), owner's costs and contingency. The costs are defined as +/- 30%.

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 ACG Phase 1 is detailed in Table 16.6 below.

[4] Source : BP.
[5] Source : BP.

Table 16.6 Direct and estimated total (offshore and onshore) impact ($ million)

	Azerbaijan
Direct	888.1
Indirect and Induced	381.9
Total	1,270.0

Source: Consultants estimates.

Operational phase

Direct effects

The workforce required for the onshore and offshore operations will be smaller than that required for construction. In total, taking both offshore and onshore together, 335 employees will be needed to fill 190 positions. It is envisaged that from day one of operation, Azerbaijani nationals will occupy some 50% of the jobs. It is expected that this will increase over time as skills are developed through training and experienced gained, with 75% of positions being held by Azerbaijani's after 5 years and 95% after 10 years.

The operating and maintenance costs for ACG Phase 1 over an operating life of 21 years have been estimated at a total of $1.1 billion[6]. This cost estimate is +/- 10%. The extent to which this expenditure will occur within Azerbaijan is difficult to estimate, however it is estimated that overall some 70% of expenditure may occur within the country.

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 ACG Phase 1 on the Azeri economy is as detailed in Table 16.7 below.

Table 16.7 Direct and estimated total impact ($ million)

	Azerbaijan
Direct	770.0
Indirect and Induced	331.1
Total	1,101.1

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. Skills enhancement as a result of employment opportunities associated with the ACG Phase 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

[6] BP's ACG Phase 1 Operations Manager.

did not experience substantial trade, nor were they long lived.[7] 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.

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. The ACG and Shah Deniz 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 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 mean its degeneration to a ghost-town. These effects may be offset 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.

16.4 Summary

The ACG Phase 1 project has the potential to deliver major economic benefits to Azerbaijan. Collectively, the ACG FFD, the BTC Project and possible Shah Deniz Gas Export 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 ACG Phase 1, account was taken of those mitigation measures that are incorporated in the Phase 1 project's 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, AIOC are committed to the development of an improved

[7] ACG FFD Environmental and Socio-economic Overview, p.72.

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 at project level.

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 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[8], which is crucial and urgent and similar processes elsewhere have demonstrated that this is a painful 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 wealth, in which petroleum 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 and a positive impact on quality of life issues for the population of Azerbaijan. Given these factors, the project together with the subsequent development proposals, has the potential to make a very significant contribution to sustainable development within Azerbaijan.

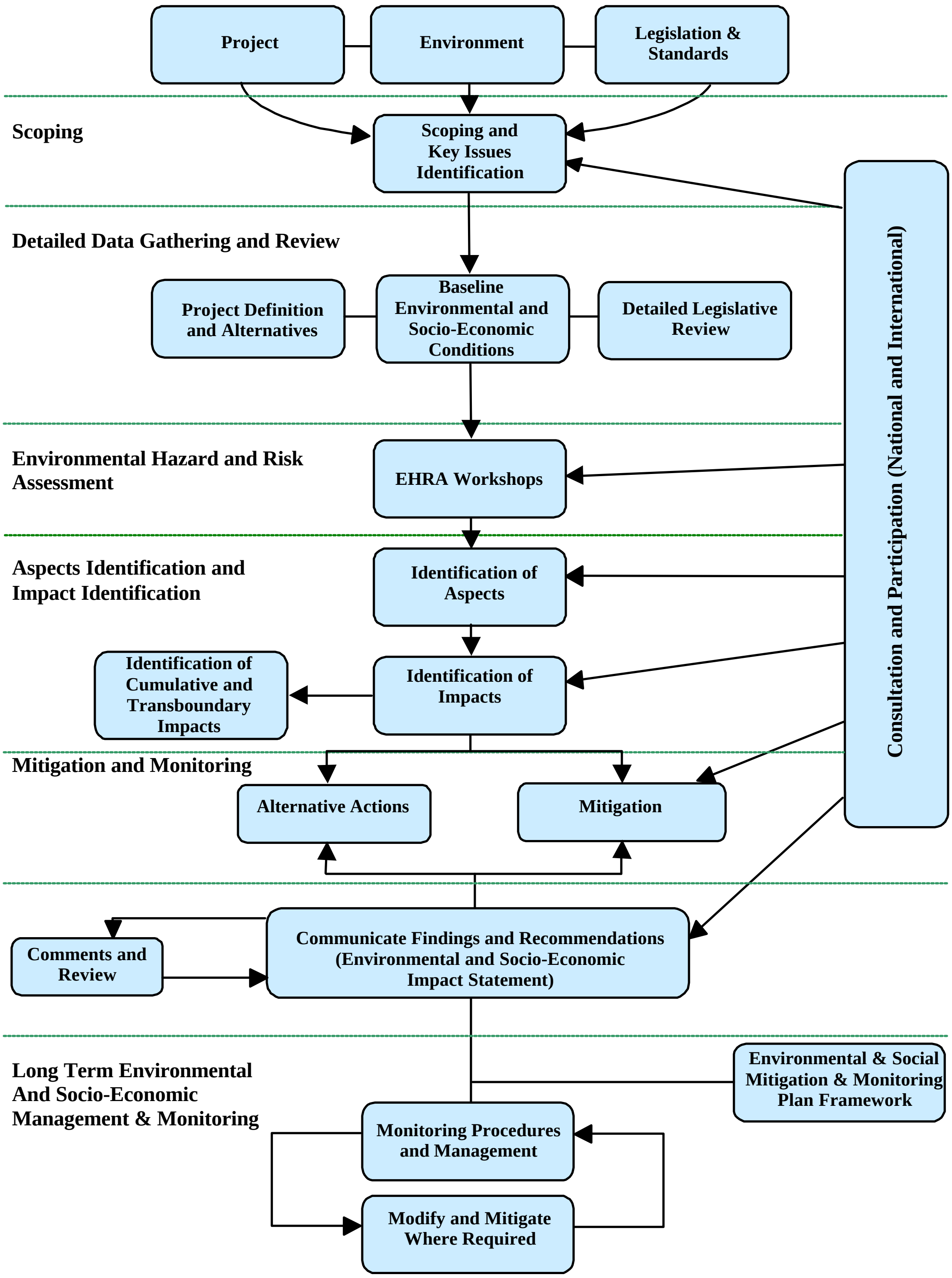
[8] The productive base of a country is its industrial network (i.e services and products). This base can be restructured so that its sectoral make-up and reliance can change (i.e the sectors/supplies/products that make up the industrial network change in a way that effects the overall industrial base).

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.

3.1.1.1 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 AIOC partner policy and standards.
- 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 this project's Scoping exercise were presented in a Scoping Report that was submitted to International Funding Institutions (IFIs) and the Azerbaijan Ministry of Ecology and Natural Resources, Baku, Azerbaijan.

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 ACG PSA Contract Area offshore. Such studies include the AIOC Early Oil Project (EOP) EIA and the ongoing monitoring of EOP operations. 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 tasks of the ESIA process to supplement the existing information base especially where existing data was found 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.

Both 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 the Environmental Description (Chapter 6) and Socio-economic Baseline (Chapter 7). Technical reports detailing the results of the primary studies are presented in the Technical Appendices.

3.3.2 Project alternatives and definition

3.3.2.1 Alternatives

The initial step in defining a project is to identify, at a conceptual level, viable alternatives to the project so that a viable base-case design may be realised. Consideration of project alternatives occurs at two levels as follows:

- to the development as a whole including the “no development” option, and
- engineering alternatives within the selected project’s design definition.

Once project alternatives are defined in the Project Concept stages, they are assessed and compared on financial, logistical, technical design, safety and environmental/socio-economic criteria. The project alternative that is determined to be likely to result in the best balance in regards these criteria is typically, the one that moves forward into the detailed design phase.

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 in the base case design still exist, the opportunity to provide feedback on environmental and socio-economic factors was exploited as discussed below.

3.3.2.2 Definition

ESIA environmental engineers have worked alongside design engineers to gather and interpret relevant engineering design information. Information gathered for the proposed ACG phase 1 project was reviewed, assessed and passed on to the assessment team.

The continuous interaction between the various project team components allowed the impact assessment team to identify and feedback to the design engineers in areas where there was a requirement for greater definition on the programme and the mitigation measures that are proposed as 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 ACG Phase 1 project is described in Chapter 2. The definition of relevant national and international standards and requirements has ensured that the project development has been assessed against all relevant existing environmental regulations and guidelines as well as AIOC partners' environmental and other policies and 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 was 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. Further, each was 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 relevant 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 ACG Phase 1 began during the Scoping phase and continues throughout the entire ESIA process and will continue into the construction and operational phases of the developments. 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. The ESIA Public Consultation and Disclosure Plan (PCDP) as presented at Technical Appendices 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:

"*An 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 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 operator and partner standards and operator/partner 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 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 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 environmental and socio-economic 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	+

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					
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**
	1	2	3	4	5

CONSEQUENCE

Based on its consequence-likelihood score, each environmental aspect was again ranked into five categories or orders of significance as illustrated in Table 3.3.

Table 3.3 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 (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 the 'significance' 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 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 ACG Phase 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 ACG Phase 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
- oil 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

Many 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. 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 Framework will be developed for the ACG Phase 1 project, and will be further developed as the project progresses. It will describe the various environmental management strategies and generic procedures for their implementation. Further, it will identify 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 ACG Phase 1 contractor(s) to consider the provisions and requirements of the Plan when developing their own environmental management arrangements for the works programme. Bridging documents linking contractor Environmental Plans, to those detailed in this ESIA will be developed.

ES1 Introduction

ES1.1 Project outline

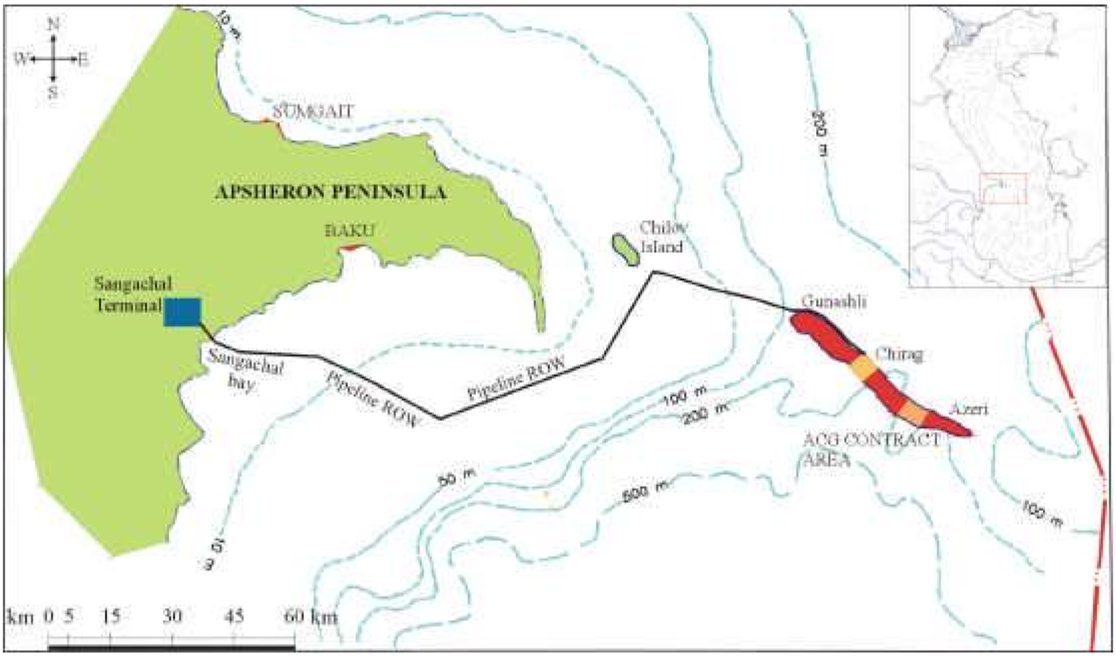
The Azerbaijan International Operating Company (AIOC), operated by BP is planning to begin development of Phase 1 of the Azeri Chirag and Deep Water Gunashli (ACG) Full Field Development (FFD) Project.

The ACG Contract Area has estimated oil reserves of 4.6 billion barrels of oil and 3.5 trillion cubic feet of associated natural gas representing roughly half of the proven oil reserves in Azerbaijan's offshore fields. It lies in the Azerbaijan sector of the Caspian Sea approximately 120 km south east of Baku (Figure ES.1). It is currently proposed that the planned ACG FFD will be achieved by a further three phases of development (Figure ES.2).

The primary objective of the ACG FFD Phase 1 project is to produce the recoverable reserves in the central part of the Azeri Field. Phase 1 production is anticipated to be over 400,000 barrels of oil per day and the lifetime of the operation is at least 20 years.

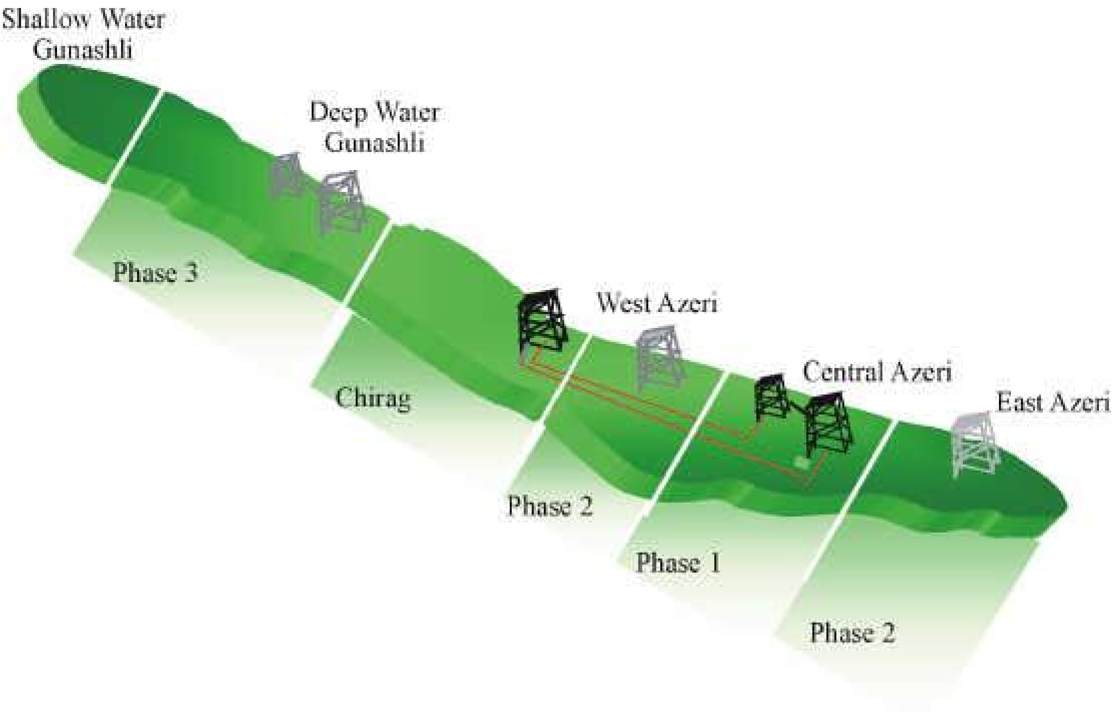
The project will require offshore drilling and production facilities, a means of transferring the produced hydrocarbons to shore and a hydrocarbon reception and processing facility onshore that will also provide storage and onward delivery facilities for the export product.

Figure ES.1 ACG Contract Area Development Location



Under the 1994 Production Sharing Agreement (PSA) signed between AIOC and the State Oil Company of the Azerbaijan Republic (SOCAR), AIOC was required to implement an initial development stage to ensure early production, referred to as the Early Oil Project (EOP) and centres on the Chirag-1 platform. Production from the Chirag-1 platform is transferred by subsea pipeline to an oil reception terminal situated 38 km south of Baku at Sangachal. EOP was in place in 1997 and is currently producing 120,000 barrels per day (bpd) of oil and around 100 million standard cubic feet per day (MMscfd) of gas.

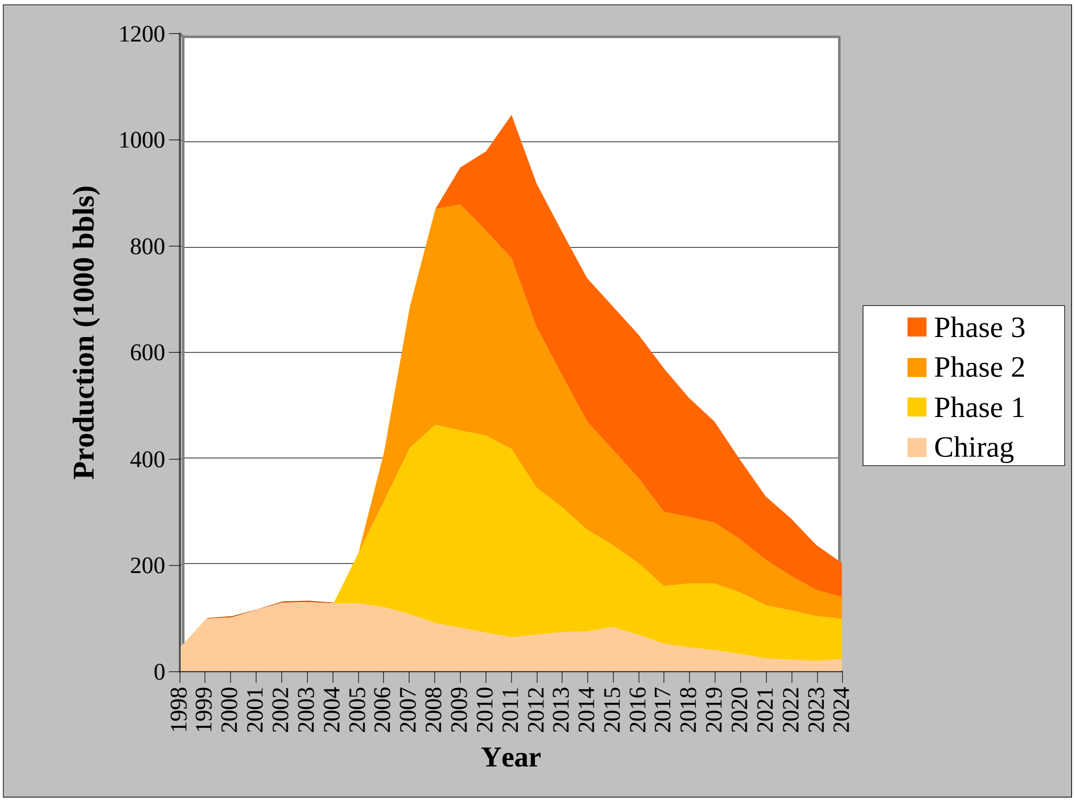
Figure ES.2 ACG Full Field Development (FFD)



Phase 1 as described in this document, represents the first phase of ACG FFD following EOP. Phase 2 plans to develop the remaining part of the Azeri field and Phase 3 the deep water Gunashli field (Figure ES.2). Potential oil production rates in excess of one million barrels per day are anticipated following FFD. The predicted oil production profile for Phase1 is presented in the context of each subsequent phase of the ACG development in Figure ES.3.

Overall, FFD is expected to cost approximately $10 billion over the phased life of the project representing about 10% of the investment required to extract the Caspian region's anticipated reserves.

Figure ES.3 Predicted oil production profile from ACG FFD



ES1.2 Environmental assessment

This Environment Statement (ES) has been prepared following a detailed Environmental and Socio-economic Impact Assessment (ESIA) of the proposed Phase 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. In addition, the assessment has been carried out to satisfy International Finance Institutions (IFIs) requirements. The ESIA process has been undertaken in the context of BP's Health, Safety and Environment (HSE) Policy and the HSE policies of the AIOC partners.

The Environmental Statement for the proposed ACG Phase 1 project represents the latest environmental work programme to be conducted to date. A full list of environmental and socio-economic programmes of work carried out by 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 AIOC 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 adverse effects.

Table ES.1 AIOC ACG FFD environmental and social programmes undertaken to date

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
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

ES1.3 Benefits of ACG FFD

The ACG FFD project has the potential to deliver major economic benefits to Azerbaijan. With prudent revenue management, these benefits can lead to positive social and environmental change. The economic assessment for the three phases of development so far indicates that revenues, from oil and gas production and transit, will be significant in Azerbaijan, especially over the ten years between approximately 2007 and 2017. Most of the national share will go to the government rather than to SOCAR. Over the peak period it is likely that these revenues will exceed all other sources of public revenue.

Another indication of the size of project in relation to the economy of Azerbaijan, is that estimated capital spending on oil projects in Azerbaijan on ACG Phase 1 (and the associated Baku-Tblisi-Ceyhan (BTC) pipeline that will be used to export the oil) could total $US6,000 million. This compares to the agreed potential lending by IMF and the World Bank to Azerbaijan (the major international institutions investing in the country) of around $US400 million over 2000-2002.

The ACG FFD and BTC pipeline projects represent a very substantial injection of new resources into Azerbaijan.

ACG FFD has the potential to either result in, or create the climate for, the following positive impacts.

- The project will contribute to ending Government budget deficits – assuming that spending remains restrained.
- The project will yield revenues that could be used for investment in the non-oil sector.
- The project should have 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 modernisation of customs procedures.
- The successful completion of the project could create an environment that is domestically more favourable to private sector investment, and set an example making other private sector investors more open to invest.
- Current estimates suggest that between 10% and 30% of spend on oil projects in Azerbaijan goes to local Azerbaijani firms, despite the fact that the rapid construction schedule militates against development of the local supply base. This is exacerbated by

the barriers that exist to effective private sector operations (e.g. weak regulatory and legal framework.)

- The project has the potential to 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).
- The project has the potential to contribute to poverty alleviation and sustainable development via the revenues generated, assuming prudent revenue management.
- The project has and will continue to enhance public awareness and education in the environment.
- The project will create both direct and indirect employment opportunities.

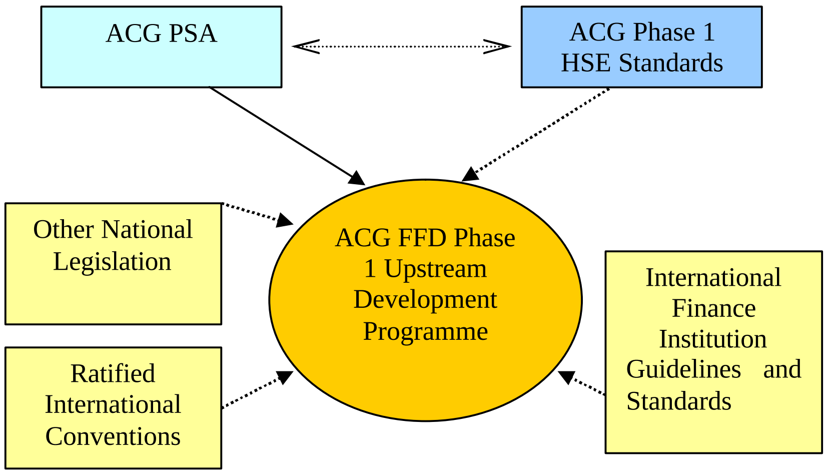
ES2 Policy, legal and administrative framework

The ACG FFD Phase 1 project is subject to the terms and conditions of the ACG Production Sharing Agreement (PSA). Using the PSA Appendix IX Environmental Standards as a basis, the AIOC partners developed and approved the Phase 1 Health, Safety & Environment (HSE) Design Standards in 1999. These were based on and incorporated elements of international standards.

According to Article 26.3 of the PSA, AIOC 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 current international petroleum standards and practices at the execution date of the PSA.

Beyond the framework of the PSAs and Phase 1 HSE standards, the project will also be undertaken with due regard to international conventions as ratified by the Azerbaijan government (Figure ES.4). Applicable national and international guidelines and standards, including the requirements of the International Finance Institutions (IFIs), 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.4 Legislative framework of ACG Phase 1 project



Statutory Requirements

Phase 1 HSE Standards adopted (Voluntary)

Other legislation reviewed

ES2.1 International Finance Institutions guidelines and standards

As external project finance will be sought on behalf of some shareholders of AIOC, environmental and social standards, practices and guidelines set forth by IFIs have been reviewed in the preparation of this ESIA. Potential IFIs 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).

ES2.2 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 published in 1996, with the assistance of the United Nations Development Programme (UNDP). 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.

ES2.2.1 Azerbaijani regulatory agencies

The main environmental regulatory body is the Ministry of Ecology and Natural Resources (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 ESIAs.

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

ES2.3 Ratified international conventions

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

ES3 Environmental and socio-economic impact assessment

The ESIA process incorporates a number of steps. A key element of the Phase 1 ESIA process has been the on-going interaction with the engineering design team 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 needs, and stakeholder concerns.

A critical element of the ESIA process has been the public consultation and disclosure programme carried out with 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 will be granted is typically forthcoming from the regulatory authority 30 days after submission.

ES4 Options

ES4.1 Introduction

A number of alternative engineering design options were considered for the development starting at a conceptual level including the “no development option” and subsequently adding detail for each conceptual option through the design and planning process. Project design 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. The screening criteria used during the option evaluation process are as follows:

- safety;
- technical feasibility;
- logistical feasibility;
- environmental implications;
- capital expenditure (CAPEX);
- schedule and ability to execute the project;
- operating expenditure (OPEX);
- availability;
- operability;
- partner and government agreement; and
- reputation.

AIOC also considered Best Available Control Technology (BACT) in its selection process as a mechanism for minimising releases to the environment in a cost effective and legislatively compliant manner. BACT uses 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 through to the least appropriate for the requirement. Each technology was considered on a cost benefit basis, taking into account technical and operational limitations. Where potentially significant environmental issues were identified, BACT was determined by using Best Practicable Environmental Option (BPEO) studies.

ES4.2 No development option

The “no development” option would mean that the potentially significant benefits described in Section ES-1.3 (Benefits of ACG FFD) would not be realised as a decision not to proceed with Phase 1 would also mean that subsequent phases of the ACG FFD would not proceed. The ACG FFD and associated projects, particularly the BTC pipeline export project, represents a unique opportunity for Azerbaijan to develop a stable economy, improve social equity and alleviate poverty. No other currently identified prospect offers this potential.

ES4.3 Selected option

A summary of the different conceptual design alternatives considered, together with an overview of the environmental outcome of the preferred alternative, is summarised in Table ES.2.

Table ES.2 Key options for project design and configuration

Issue	Preferred Option	Environmental Consequence
Number and configuration of drilling and production centres	Single drilling platform and production centre achieved through directional drilling technology.	Minimisation of area impacted by offshore structures, and reduced impact on benthic environment
Reservoir maintenance	Single compression and water injection platform designed to service all Azeri field production (Phase 1 and Phase 2)	Minimisation of area impacted by offshore structures, and reduced impact on benthic environment
Transportation of product to shore via pipeline or shuttle tankers	Pipeline	Reduced risk of oil spill
Hydrocarbon reception	Expansion of the existing EOP terminal at Sangachal	Eliminates the requirement for additional land-take at a separate new location. Commingled oil and gas from Phase 1 and EOP at one location minimising subsea pipeline requirement.

Once the preferred options for the projects main facilities were selected, a project Best Practicable Environmental Option (BPEO) study was carried out to identify areas of potentially high environmental impact associated with the component and utility configuration options for these facilities. The results of the BPEO study provided recommendations for approaches to reduce impacts. The study was endorsed by the AIOC partners and ultimately led to the development of the Phase 1 design standards.

ES5 Project description

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

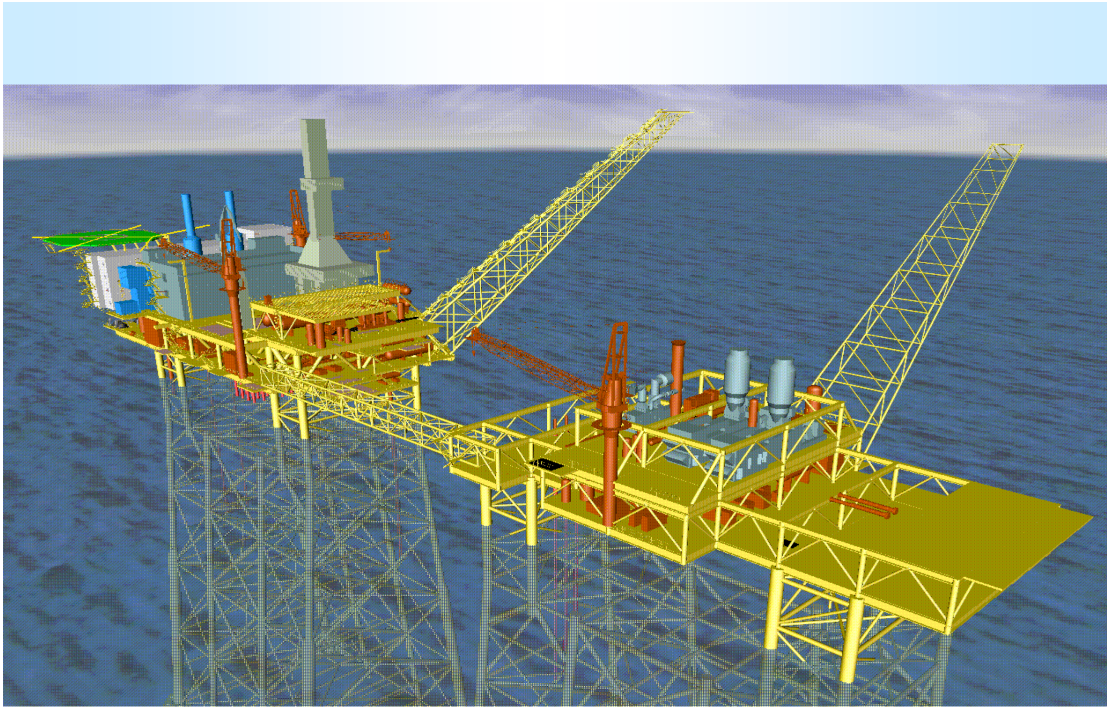
- offshore drilling, production and compression facilities;
- subsea pipelines for the transportation of oil and gas; and
- an onshore terminal for the reception and processing of oil and gas.

ES5.1 Offshore facilities

Offshore drilling and production operations will be carried out from a new drilling, production and quarters (PDQ) platform to be installed over a pre-installed drilling template. Prior to installation of the PDQ, a number of wells will be drilled from a semi-submersible drilling rig to enable early production to begin soon after installation of the fixed facility.

To optimise production from the reservoir it will be necessary to maintain pressure within it. This will be achieved by re-injecting associated gas liberated from the production process in addition to water injection. A compression and water injection platform (C&WP) will be installed alongside the PDQ for this purpose approximately one year after the installation of the PDQ (Figure ES.5). The C&WP will provide space for future gas compression and water injection facilities for the whole Azeri field development (FFD Phase 1 and 2).

Figure ES.5 PDQ (left), bridge and C&WP



ES5.1.1 Pre-template and template drilling

As stated above, to accelerate oil production from Phase 1, drilling will begin at the offshore location prior to the installation of the PDQ. This early drilling will be carried out from the semi-submersible drilling rig (the Dada Gorgud) to be towed out and anchored on location. Between eight and ten wells will be drilled from the rig through a drilling template to be installed on the seabed, although the first well may be drilled prior to the installation of this template (subject to a separate environmental impact assessment[1]).

The wells will be drilled in sections with hole diameters of 36”/30”, 26”, 16”, 12 ¼” and possibly 8 ½” using different drilling fluids. The surface-hole section (i.e. 36”/30”) will be drilled with seawater (intermittently dosed with clay (bentonite) gel and a water based mud system containing weighting materials and other additives) and will be used for the 26” top-hole section. A mud system containing an organic phase fluid will be used in the lower-hole sections.

Drilled cuttings generated from the surface-hole section will be deposited directly on the seabed around the well. Cuttings from the 26” top-hole section, drilled with water based mud, will be discharged to the sea after separation of the cuttings from the mud system on the drilling facility. Cuttings from the lower hole sections will either be slurrified and re-injected through a dedicated cuttings re-injection well into a deep formation or contained and shipped to shore for treatment and disposal. No drilled cuttings generated from the lower-hole sections will be discharged to the sea.

A total of three well tests are planned during this early drilling programme. Following testing, the hydrocarbons will be sent to the burner boom for disposal by flaring in a high efficiency burner.

[1] ACG FFD Phase 1 Pre-drill Well, Environmental Impact Assessment, AIOC, 2001

The rig will be supported by a number of utilities including diesel fired power generation, sewage treatment systems, cooling water system, drainage systems, support and supply vessels. Up to 120 people will be accommodated on the rig during the drilling programme.

ES5.1.2 Platform drilling

Drilling will continue from the PDQ once it is installed on location. Up to 48 wells may be drilled for Phase 1 which means an additional 38 to 40 wells may be drilled from the platform. The well design will be similar to that for wells drilled from the drilling rig although it is expected that the 30" surface-hole section will be constructed by hammering the conductor pipe into position and seawater, rather than water based mud, will be used in the 26" top-hole section as a drilling fluid. Drilled cuttings from the surface-hole will be released directly to the seabed and those from the 26" hole section will be discharged to sea following separation from the drilling fluid onboard the platform. All cuttings from the lower-hole sections will be slurrified and re-injected into a dedicated cuttings re-injection well. Should the re-injection system be unavailable at any time, the cuttings will be contained and shipped to shore for treatment and disposal.

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

ES5.2 Construction and installation of the offshore facilities

Many of the components for construction of the PDQ and C&WP will be pre-fabricated overseas and transported to Azerbaijan for assembly. Both steel jacket structures that support the platforms and the platform topside facilities for the PDQ will be assembled at the Shelfprojectstroi (SPS) yard located 20 km south of Baku. The assembly site for the C&WP topsides is yet to be determined.

The contractor for the offshore works (including the associated yard upgrades work) has been selected and it has been estimated that approximately 4,000 people would be employed for the offshore elements of ACG Phase 1. Employment will gradually build up from January 2002 to September 2002, when it will continue at peak levels until February/March 2004. It is known that the contractors for the offshore construction propose to source between 70 and 85% of the required personnel within Azerbaijan. At this stage it is envisaged that a maximum of 400 workers will be housed in an "open" camp and these workers would be drawn from outside Azerbaijan.

Following assembly each structure will be tested and commissioned before loading onto a transportation barge for transfer to the offshore location and installation. The jacket structures are slid from the barge into the water and then manoeuvred into position using the flotation chambers that have been fitted onshore. By reducing the buoyancy provided by the chambers the jacket is gently lowered onto the seabed and is then secured into place by piling each of the legs.

The jacket and topsides facilities for both platforms have been designed to allow the topsides to be "mated" with the jacket by means of a float-over operation. The barge transporting the topside platform facilities is floated within the structure of the jacket such that the topsides are positioned above their intended installation position. The barge is then ballasted down until the topsides reach the jacket structure. The topsides are then secured to the jacket and the barge is manoeuvred away.

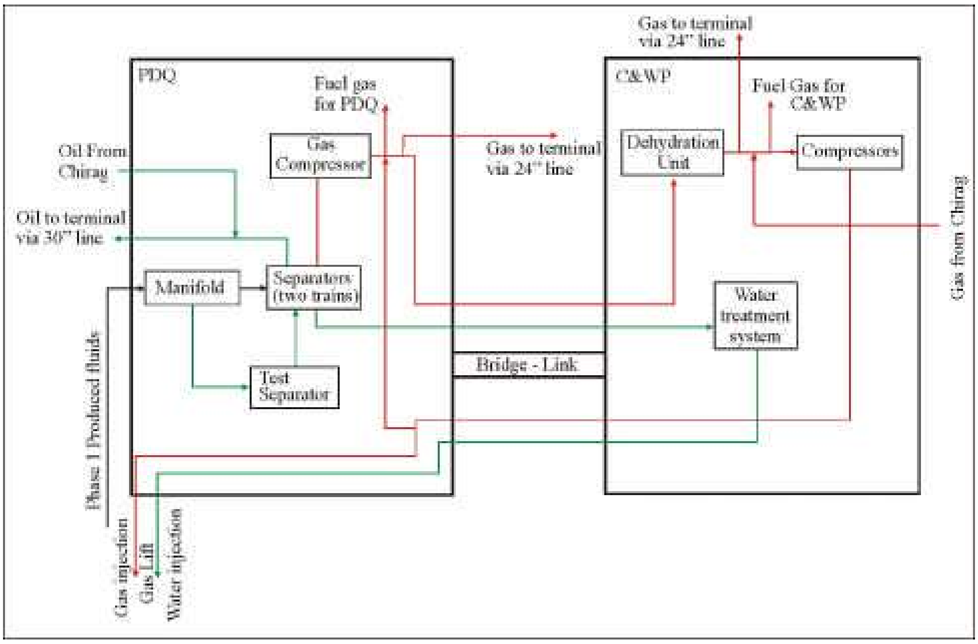
ES5.3 Production process

The fluids produced from the wells will be separated into gas and liquid (oil and produced water) onboard the PDQ. The liquid stream will be pumped at the required pressure and transported through the new oil pipeline (to be installed) to the terminal at Sangachal. Until the produced water treatment facilities are installed offshore, all produced water will be sent with the oil to the terminal for separation and disposal. Oil from Chirag-1 installation will be transferred to the PDQ through a new interfield pipeline and commingled with the Phase 1 oil for transportation to shore.

Prior to installation of the C&WP, the gas stream will be sent to shore through the existing EOP oil pipeline that will be converted to gas service. Part of the produced gas will however, be used on the platform as fuel gas. Following installation of the C&WP, all produced gas will be transferred from the PDQ across the bridge-link for dehydration. Subsequently, it will be compressed to injection pressure and sent back to the PDQ for re-injection down-hole for reservoir maintenance purposes. Excess gas will be transferred to shore. Produced water will also be sent to the C&WP for treatment and pumped to water injection pressure and as with the gas, will be sent to the PDQ with pressurised treated seawater for injection down-hole. In the event that the water injection facilities are unavailable, produced water will be released to the sea following treatment to IFC standards to remove any excess oil.

A simplified process flow diagram illustrating the production process offshore is shown in Figure ES.6

Figure ES.6 The offshore oil and gas production process



The C&WP will also host a dedicated gas compressor for gas received from Chirag-1 when it will either enter the gas injection system or will be routed to the terminal.

The flare system, comprising flare booms on both the PDQ and C&WP, is designed to flare gas during periods of process equipment unavailability or in the event of an emergency. Under normal operating conditions there will be no routine flaring of associated gas for oil production purposes. Small volumes of purge gas, used to prevent the ingress of air, and process leakage from valves and seals will however, be routinely flared.

Seawater will be drawn to the platform topsides by pumps, treated with antifouling chemicals and once passed over the cooling medium system (in order to cool the drilling and process equipment) will be discharged back into the sea.

Power generation for the offshore facilities will be supplied by two gas turbine driven generators on the PDQ and one gas turbine driven generator on the C&WP. All turbines will have dual fuel capabilities to enable operations using diesel as a fuel. Use of diesel as a fuel will be required prior to the generation of fuel gas as well as during abnormal operations when fuel gas is not available. Each platform will also be fitted with a diesel driven emergency generator.

The PDQ will be sized to accommodate 200 personnel on a permanent basis but will have the ability to accommodate an additional 100 personnel on a temporary basis to support commissioning and maintenance activities. All sewage generated will be treated in a marine sanitation unit prior to discharge to the sea.

The platform will be supplied by vessel and helicopter, all excess solid and liquid wastes will be backloaded to the supply ships and returned to shore for treatment and disposal.

ES5.4 Pipelines

A new 30" diameter pipeline 188 km long will be installed along the route of the existing EOP 24" oil pipeline from Chirag-1 for the export of oil from the PDQ to the terminal at Sangachal (Figure ES.1). It is intended to convert the existing 24" oil pipeline from oil to gas service for the export of gas to shore. Three additional interfield pipelines between Chirag-1 and the Phase 1 platforms will also be installed. Pipelines will be constructed of carbon steel and are designed according to a set of established design criteria for the offshore and onshore developments.

The outer wall of each pipeline will be coated with a three-layer polypropylene and/or polyethylene coating for corrosion protection purposes. Each pipeline will also be externally coated with concrete to provide mechanical protection against impact and the weight required to ensure that the structure remains in place and in a stable condition on the seabed. The pipelines will also be fitted with sacrificial anodes for cathodic protection. Additional wall thickness has also been provided to provide internal corrosion allowance.

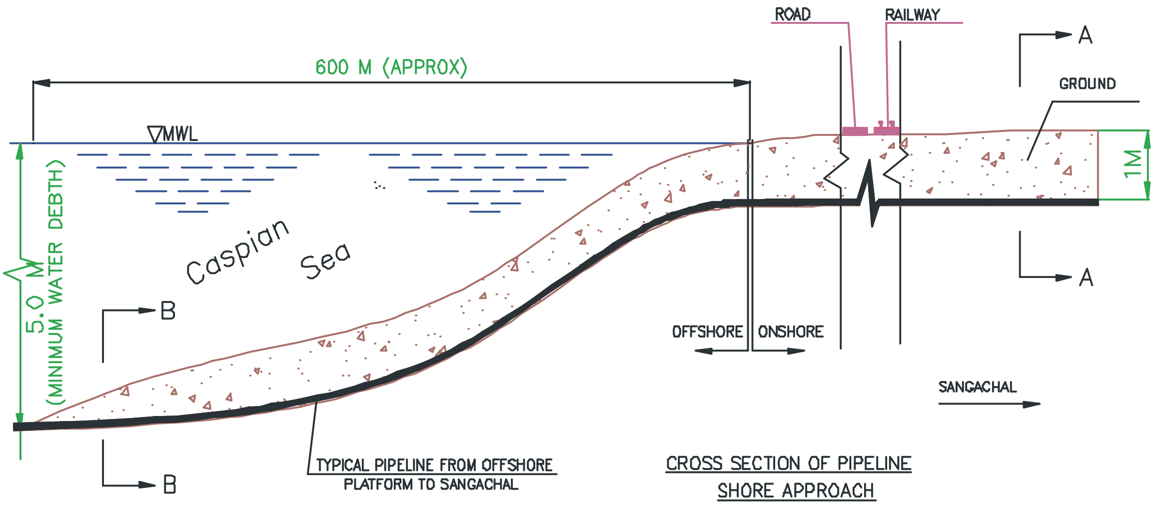
ES5.4.1 Installation and commissioning

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 8 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 pipeline trench will be excavated in water depths of up to 2 m and will be approximately 3 m in width. Beyond the 2m water depth mark, the pipeline will be jetted beneath the seabed out to water depths of 5 m. A typical pipeline shore approach is shown in Figure ES.7.

Figure ES.7 Typical pipeline shore approach



A finger pier, approximately 10 m wide at its base and between 250 and 300 m long, will be built from the shoreline into Sangachal Bay to allow an excavator to trench for pipeline installation from the shoreline out to water depths of approximately 2 m. The pier will be a rock groyne type constructed by placing rock aggregate in the shallow inshore zone.

Marine installation operations will occur within the existing exclusion zone that extends for 1,000 m across the EOP pipeline corridor. During installation, exclusion buoys will be placed around the barge 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 onshore section of the pipeline from the shoreline to the terminal will be buried in a trench to a nominal depth of 1 m from top-of-pipe. All topsoil removed from the trench will be placed aside and stored so that it may be used for later reinstatement of the route and work site.

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 the treated water left in the pipeline following installation. Following a successful test, test waters will be flowed to the terminal for disposal.

ES5.4.2 Pipeline operation

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

ES5.5 Onshore facilities

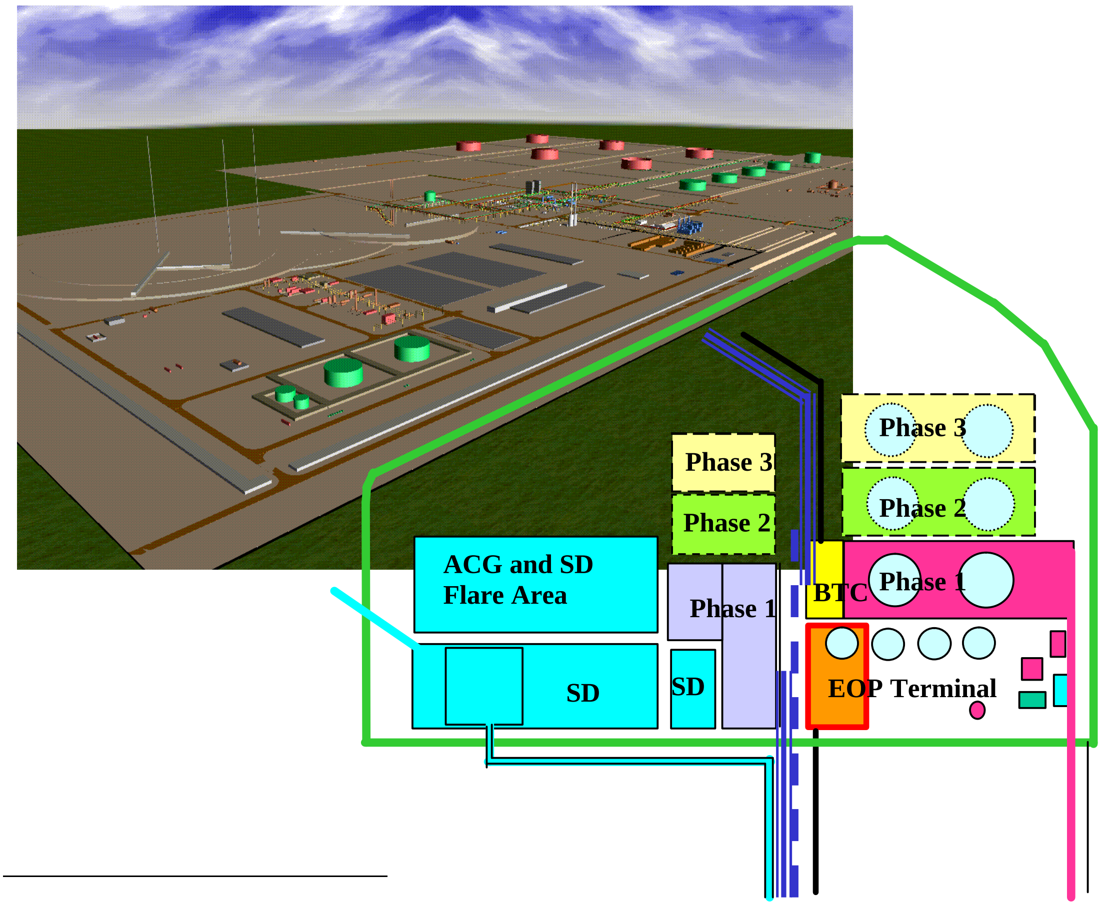
The existing EOP onshore terminal at Sangachal will be expanded to accommodate production from Phase 1. Phase 1 expansion will be designed to operate in parallel to the existing facilities and will comprise two new oil production trains, resulting in an additional throughput of oil at the terminal site of 360,000 bpd. Combined, the current EOP processing train and new Phase 1 terminal will be able to receive and process up to 490,000 bpd.

Two new oil storage tanks will be constructed each with a current design capacity of 500,000 bbl[1]. When added to the four existing EOP oil storage tanks, total oil storage volume at the terminal site will be approximately 1.5 million barrels.

Facilities to handle the associated gas exported to shore from the field will consist of reception and dewpoint control sized for 250 MMscfd. The gas system will also consist of gas pressure control. Gas received from offshore will be commingled with gas recovered during the oil stabilisation process where it will undergo dewpoint control before delivery to SOCAR at the boundary of the terminal site.

In the event that the Shah Deniz project is sanctioned, the Shah Deniz gas and condensate-processing terminal will be built adjacent to the AIOC terminal facilities. Space will also be set aside for ACG FFD and the pumping and metering facilities for the BTC oil pipeline. The proposed layout of terminal facilities is illustrated in Figure ES.8.

Figure ES.8 Proposed EOP, ACG FFD, Shah Deniz FFD terminals and BTC pumping station layout



[1] It is noted that developing the Phase 1 oil storage tanks with a greater design capacity is under consideration. A greater storage capacity at the terminal will provide greater operational security.

ES5.5.1 Construction

The ACG terminal development requires the use of additional land to that acquired for the EOP terminal. The total land requirement for all terminal facilities is 730 ha. This includes 256 ha previously acquired by AIOC of which 40.5 ha is presently occupied by the existing EOP terminal. Within the land acquisition area, a total 428 ha will be required for the new facilities with the remaining 302 ha being designated as a development exclusion zone around the terminal facilities. 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 ES.3 presents the areas that will be occupied by each component of the terminal facilities.

Table ES.3 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

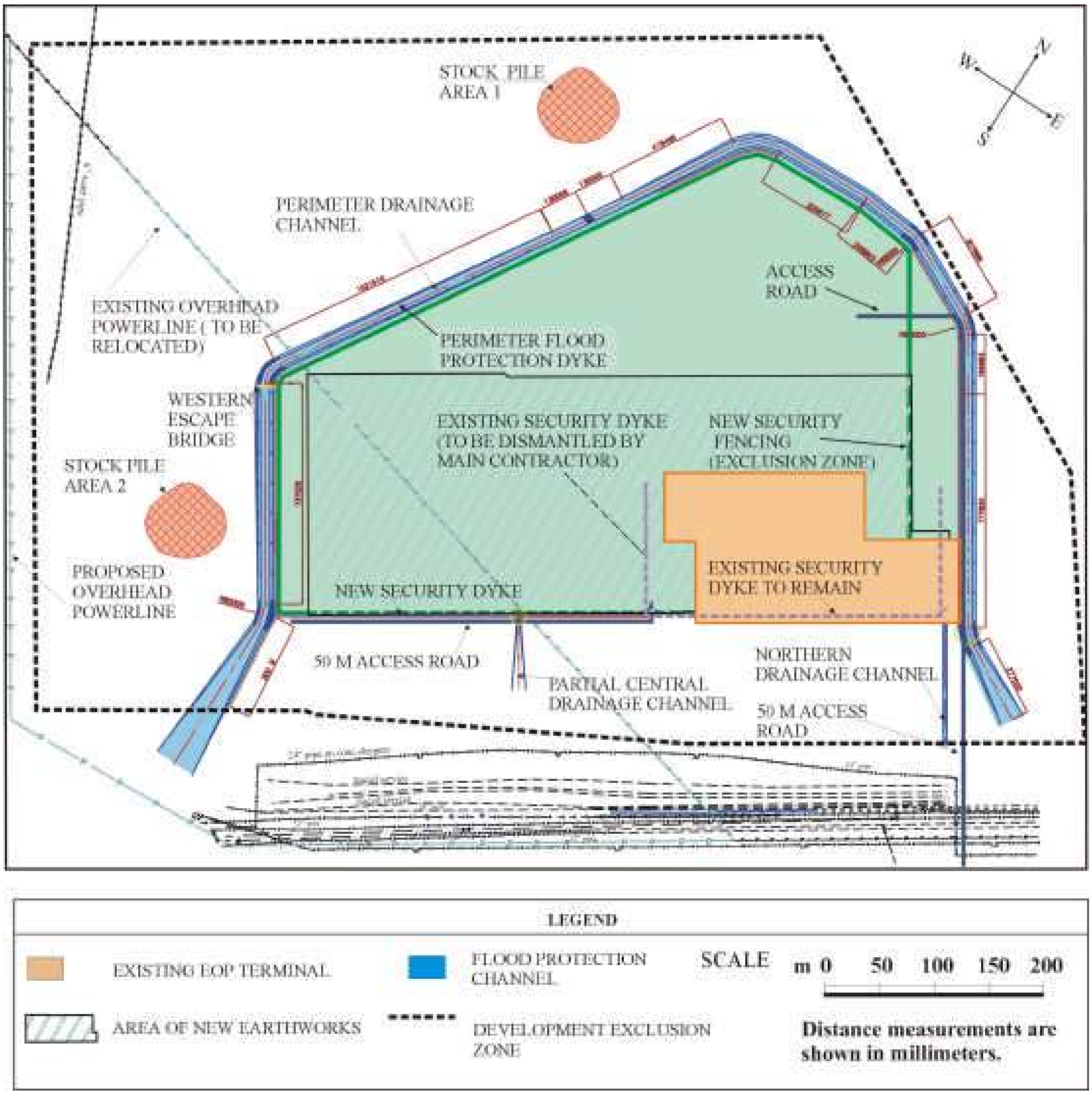
An early civil engineering works programme (subject of a separate ESIA[1]) will be carried out prior to the construction of the Phase 1 terminal facilities. The programme will prepare the terminal area for both the Phase 1 and Shah Deniz Gas Export Project Stage 1 terminal facilities and will include:

- 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;
- 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; and
- relocation and potential modification of utilities services.

Figure ES.9 illustrates the location and extent of the above features within the terminal land acquisition area.

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

Figure ES.9 Early civil engineering work programme activities



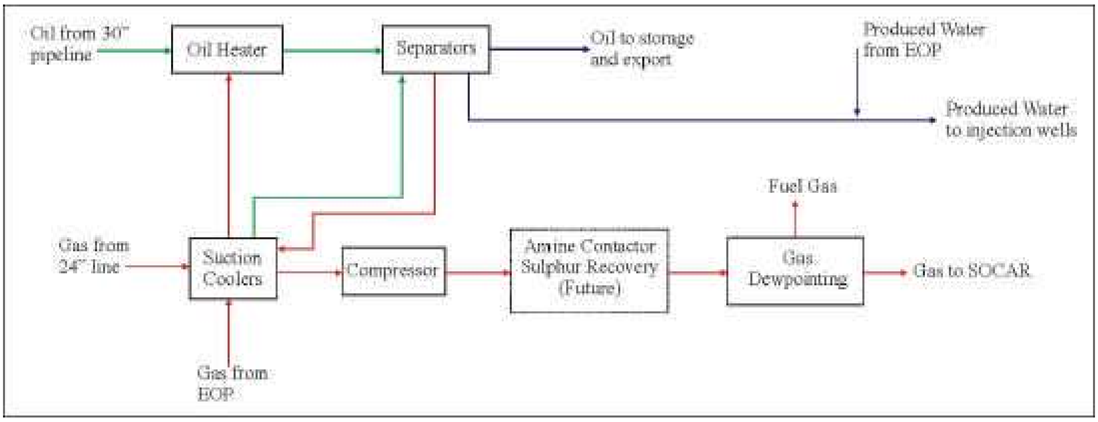
Phase 1 terminal foundations and underground services will be constructed prior to pre-fabricated components arriving on site. Once on site, these components will be positioned and secured in their appropriate locations. While process modules will be commissioned prior to transportation to the terminal 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 disposal.

Whilst the contractor has not been selected for the construction of the terminal it is possible to estimate that approximately 800 people would be employed during the construction of the terminal. Employment will gradually build up from January 2002 to September 2002, when it will continue at peak levels until February/March 2004. It is not 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 however, 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 this may equate to some 30% of total personnel. It is envisaged that a maximum of 350 workers will be housed in an 'open' camp on the terminal construction site. These workers will be drawn from outside Azerbaijan.

ES5.5.2 Terminal operations

Oil received at the terminal will be heated to the temperature required for efficient stabilisation and water removal. It will then be sent to the separators to further remove any residual gas and water from where it will be delivered to the onsite storage tanks prior to pipeline transport. Liberated gas will be compressed and combined with the free gas arriving from the offshore facilities and combined gas will undergo dew-point control to prepare it for delivery to SOCAR at the terminal boundary. A simplified process flow diagram is shown in Figure 5.10.

Figure ES.10 The terminal process system



The terminal design includes space for the provision of future installation of facilities to remove hydrogen sulphide from the hydrocarbon stream should such facilities be required.

There will be no routine flaring of gas at the terminal under normal operating conditions. A flare gas recovery system will be installed which will direct recovered gas that would normally be flared back into the process train. Purge gas will be provided by inert gas. As with the offshore facilities, non-routine flaring may be required in the event of process failure or loss of the gas export route to SOCAR.

Produced water will be transferred to an onsite produced water storage tank. The principal option for disposal of produced water is injection at the Lokbatan field some 22 km to the north of the terminal. Water will be transferred to the injection site by a dedicated water pipeline that will be installed when required. It is envisaged that a proportion of the water may also be sent to the Garadag Cement Plant for use in the cement manufacturing process. Test waters used for commissioning and testing of the Phase 1 facilities, including subsea pipelines will also be disposed of via these routes.

ES5.5.2.1 Power generation

Power generation at the terminal will be provided by three dual-fuel gas turbines. During start-up diesel will be used. Once the terminal is producing, fuel gas from production will be used with diesel as a backup. Construction power will be provided by means of diesel generators.

ES5.5.2.2 Water treatment

A waste water treatment plant using a stabilisation pond system will be installed at the terminal site for sewage waters generated during the construction programme. The water effluent from this system will be used for trickle irrigation purposes and dust suppression provided it is of sufficient quality. Waste water treatment for the terminal will be pumped to the construction camp while it is in use with a permanent system being installed at a later date.

ES5.6 Transportation and logistics

Many of the ACG Phase 1 project components require specialist materials and construction techniques not currently available in Azerbaijan. They will therefore, need to be imported.

There are a number of transport options available including existing road, rail and canal networks. Table ES.4 summarises the preferred mode of transportation for the major project components.

Table ES.4 Modes of transportation

Development Sector	Components	Mode of Transport
Offshore	PDQ & C&WP tubular elements for jackets	Rail transport via Poti (Georgia) during winter months, then by Russian inland river system to Caspian (i.e. after river thaw)
	Topside modules, mechanical gauge equipment, piping and other bulk equipment	Combination of road, rail and river depending on exact source of materials
Pipelines	Marine - grade pipeline, wye pieces and associated protection structures and valves	Pipeline sections: River and rail (dependent on seasonal conditions); other materials by road
Onshore	All major items	Combination of road rail and river

ES5.7 Decommissioning

The 1989 International Maritime Organisation (IMO) Guidelines for Offshore Installations Removal state that structures in waters deeper than 100 m must be removed to give a clear water column of 55 m for safety of navigation. In addition, all structures installed after 1998 must be designed so as to be feasible for complete removal.

According to the terms of the PSA, AIOC is required to produce a Field Abandonment Plan one year prior to the completion of 70% production of identified reserves. At this time, all partners involved in the project must contribute a proportionate share of the decommissioning costs to an “Abandonment Fund”. Thereafter, the Abandonment Plan will be considered and reviewed in discussion between the operator and the authorities. This timing will allow consideration of the most appropriate decommissioning options and may allow for changes in the management of the field in order to facilitate the best abandonment options.

ES6 Existing natural environment

ES6.1 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 waste water is discharged into the Caspian annually. This discharge, along with variety of chronic sources of industrial pollution, has resulted in almost 30% of the Azeri 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.

ES6.2 Offshore environment

The dominant morphological feature in the ACG Contract Area is the Apsheron Sill that runs south-east across the Caspian Sea from the tip of the Apsheron Peninsula. The Contract Area straddles the western end of the sill. The area is characterised by natural gas seeps, gas charged sediments and subsea mudflows. The Contract Area contains three large mud volcanoes.

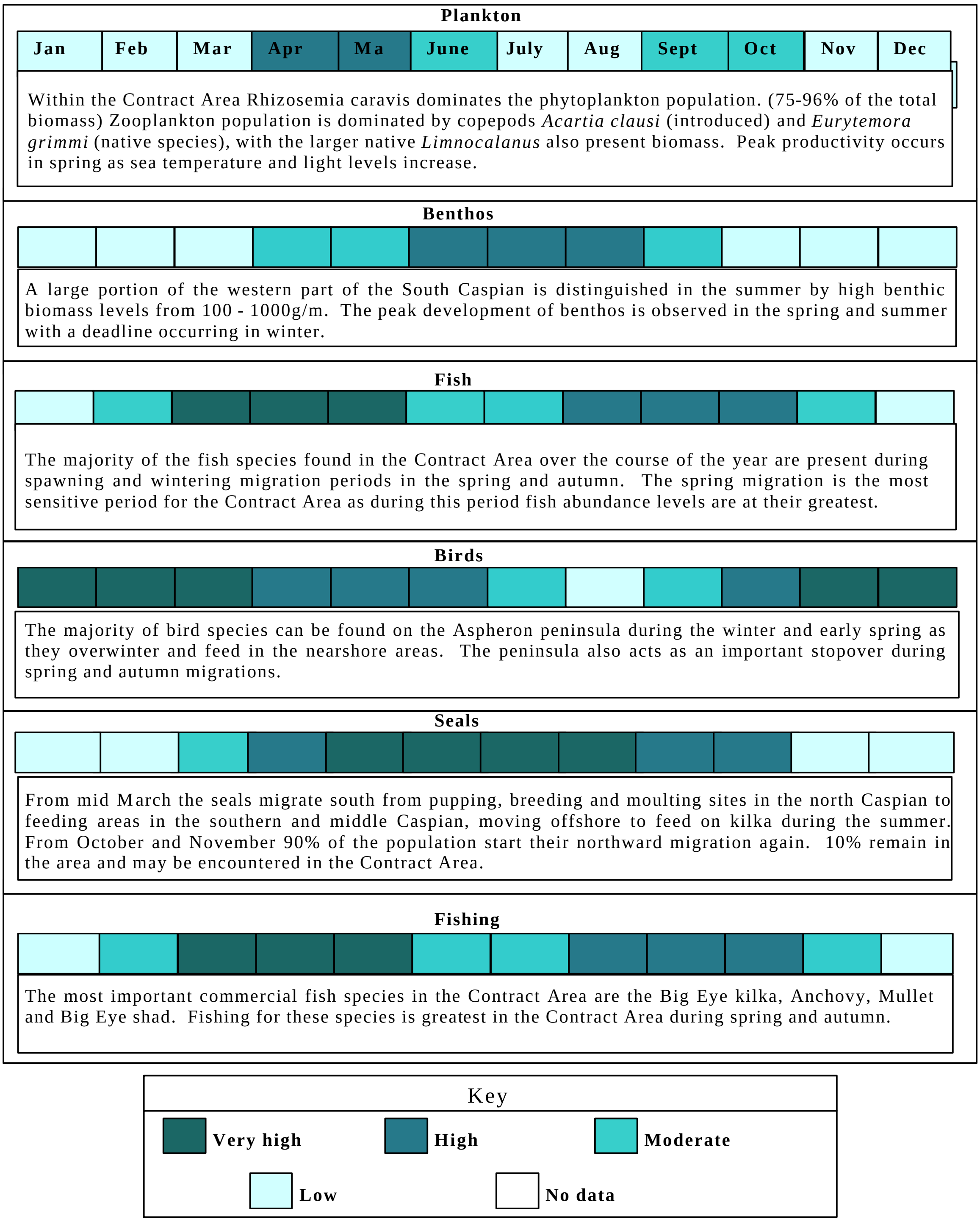
The water depth at the Phase 1 location is 128 m. The surface waters are highly oxygenated in the winter months, reaching saturation levels in the spring due to increased water mixing during the winter and phytoplankton activity in the spring. During summer months, as the surface water temperature increases, the water column becomes stratified.

Benthic abundance in the Contract Area is high. There appears to be a transition from crustacean-dominated communities in the northwest of the Area to annelid-dominated communities in the southeast. Because of the high amounts of benthic biomass during the summer months, the area plays an important role in the life cycle of Caspian Sea fish stocks.

A summary of the environmental sensitivities in and adjacent to the ACG Contract Area is provided in Figure ES.11. 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 in productivity.

Figure ES.11 Summary of offshore environmental sensitivities



ES6.3 Nearshore and coastal environment

There are several ecological features and temporal processes 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.12. The 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 occurs during this period.

Figure ES.12 Seasonal changes in sensitivity

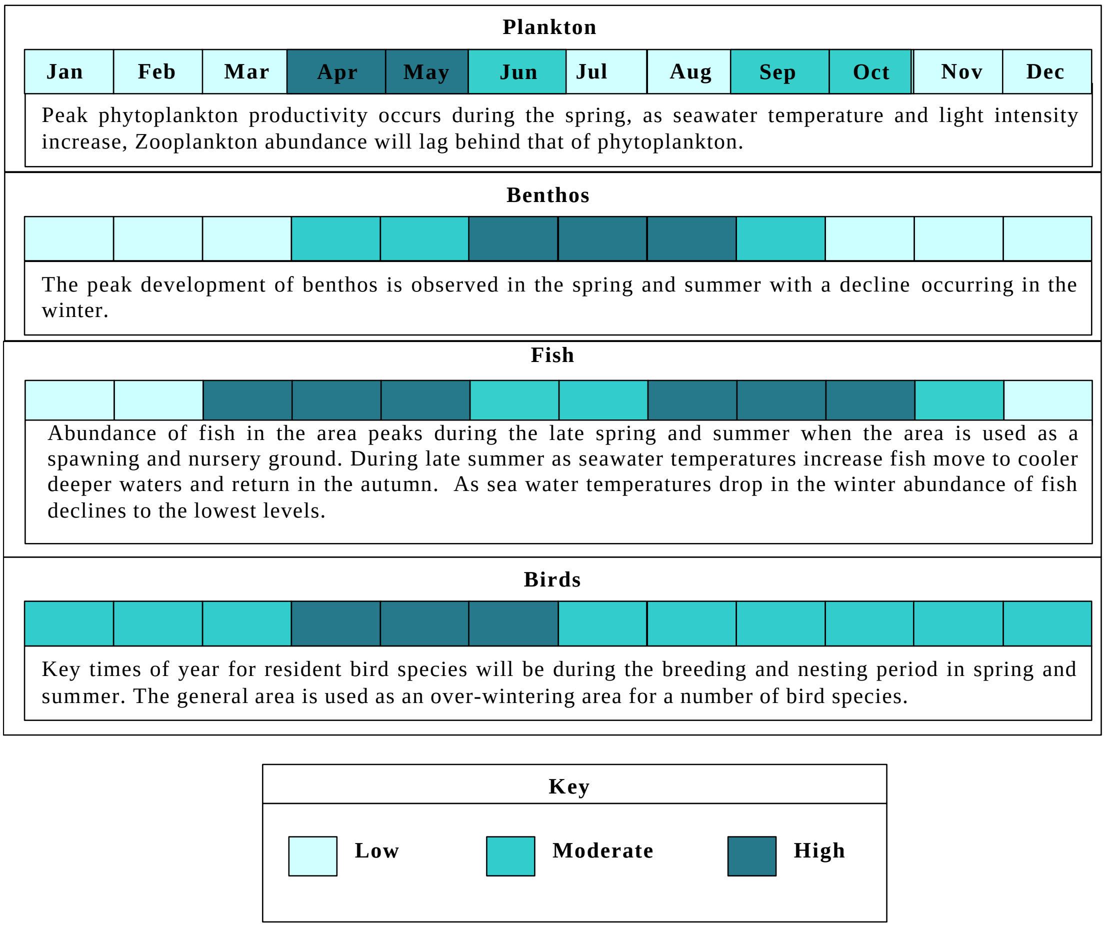
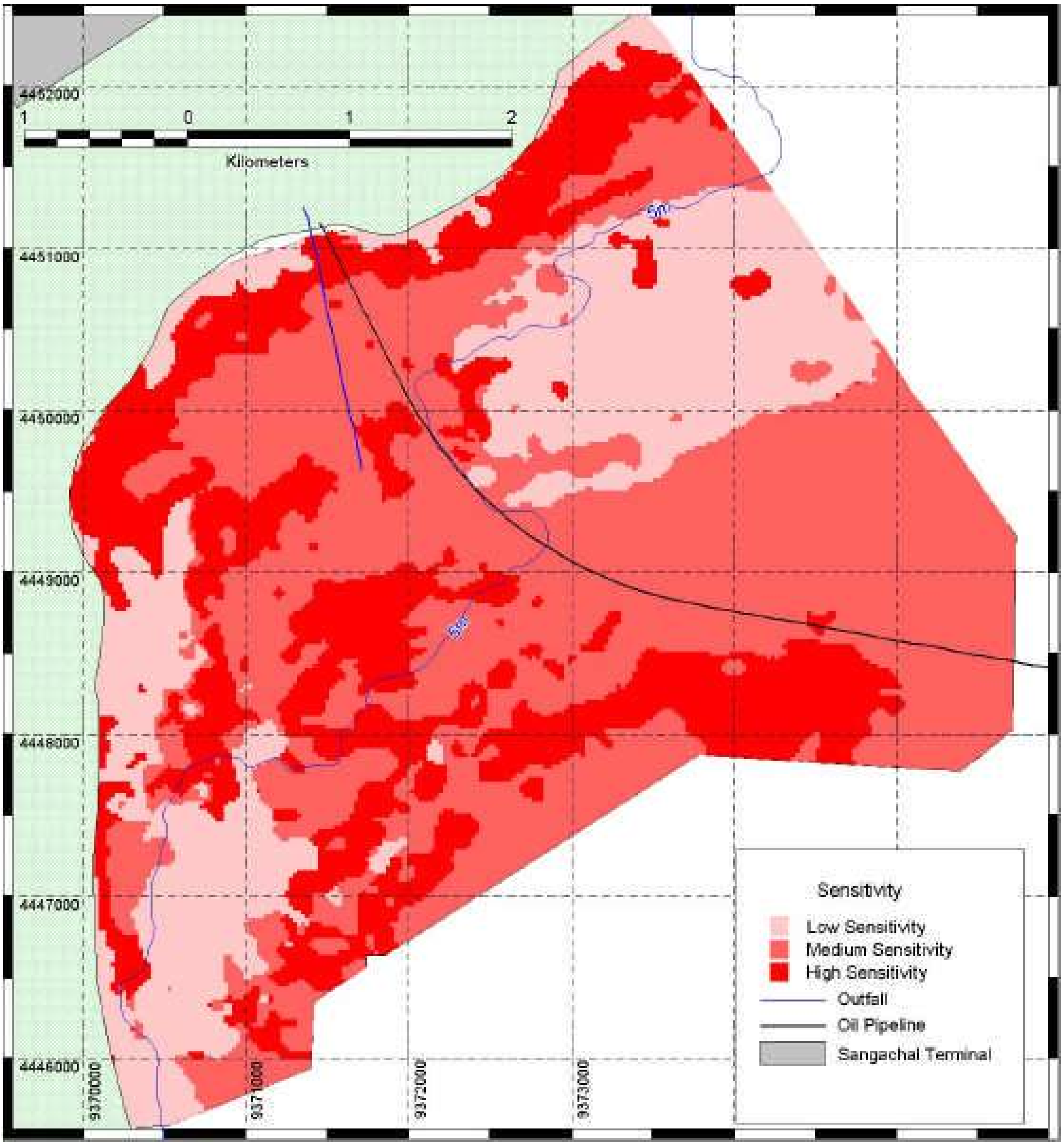


Figure ES.13 illustrates spatial variations in the seabed sensitivity. This has been developed using information on the distribution of seagrass and algae as well as sediment types and their mobility. Areas that support seagrass and red algae are considered the most sensitive as well as fine-grained 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 was not observed during the survey and areas composed of silty sand were assigned the lowest sensitivity.

Figure ES.13 Seabed sensitivity in Sangachal Bay



ES6.4 Onshore environment

ES6.4.1 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 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, *Calligonum bakuense* and *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.

ES6.4.2 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.

ES7 Existing Socio-economic environment

ES7.1 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. Ethnic minorities such as 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 due to the fact that the government only counts the number of those registered as unemployed. Registration is complicated and little benefit is gained from being registered so the figures are not viewed as accurate. Changes in the public sector profile can be tracked showing public sector employment falling steadily in the past decade but offset by increases in the private sector. There is a large degree of underemployment in the public sector with posts remaining filled when there is insufficient work to do and other employees continuing on the workforce with reduced wages. 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. There was a sharp decline in merchant shipping levels in the early and mid 1990s followed by a substantial increase beginning in 1996. The majority of the increase has been related to new oil activities. 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 has moved slowly and the private sector remains small in relation to state concerns. There has however, been a significant increase in the volume of output over the last few years and a corresponding increase in the number of employees. In addition, there is a steady growth of joint venture enterprises involving foreign companies within Azerbaijan. Tax system reforms began in 1995 in response to rampant national tax evasion, declining revenues and pressure from International Financial Institutions. Following this, key tax administration measures were adopted in January 1999. Despite these measures however, taxation remains unpredictable.

Privatisation in the agricultural sector began in 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. The privatisation of livestock is nearing completion.

Most of Azerbaijan's infrastructure is in poor condition as there has been inadequate public investment and maintenance of infrastructure since independence. Clean water is a scarce resource and water quality is poor. The problem of clean water scarcity is compounded by inefficient water use.

The health care system consists of a complex, hierarchical network of medical structures that remain almost completely within the public sector. 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. 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 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 inherited a strong and comprehensive system of education from the Soviet Union characterised by total centralisation and standardisation in approaches to education. Azerbaijan's educational progress is however, jeopardised 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 uneasy peace 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.[2] . 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.

ES7.2 Regional baseline

The terminal site at Sangachal is located in the Garadag District (Figure ES.14), 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. In addition to the key settlements of the district, namely Lokbatan, Sahil (previously Primorsk), Gobustan, Elet, Gizildash, Mushfigabad, Sangachal, Buta, Cheyildag (previously Umbaku), Korgoz and Shangar, there are three small villages Umid, Shikhlar, and Kotel.

The majority of the population in the District is Muslim with only a small minority, (approximately 7.4%) being Christian

[2] Baku Sun, 2002

Figure ES.14 Garadag region

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 ACG Phase 1 project which indicate that approximately 35% of those surveyed in Sangachal, Sahil and Umid receive no income at all.

Employment in Garadag District is dominated by its proximity to the industrial and economic activities in Baku and Sahil. 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.

For the first six months of 2001, the oil sector and its associated industries contributed approximately 50% of total GDP in Garadag District with the construction industry accounting for approximately 30%.

The Baku-Alyaty highway routed along the Sangachal Bay coastline passes to the south of the terminal location. This section of road is a main highway in Azerbaijan being part of the main transportation route north from Baku to Boyuk and to Kesik at the Georgian border and south from Baku to Astara to the Iranian border. In addition, the Baku-Alyaty railway runs parallel to the highway through the Garadag District and is part of the main transportation route for Azerbaijan in terms of its capacity. 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.

There are 22 secondary schools and 4 colleges in the Garadag District with a capacity for approximately 13,700 students at any one time. In total however, between 25,000 and 27,000 children are studying in these schools. These figures indicate problems of overcrowding. Although no figures are available on the percentage of graduates from the total school population, 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 IDPs 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.

ES7.3 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 follow the Islamic faith (97%) while the remainder are believed to be Christians. 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)[3].

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.

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 employed, including manual workers, cleaners and a number of welding specialists.

Only a few residents in Sangachal are involved in agriculture. It seems that for those few residents within Sangachal who are practising some form of agriculture it forms a subsistence livelihood. The Sangachal 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. The fishing 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. There is no hot water supply and this is normal for the area. Bottled water is not used for drinking, washing or cooking. The sewage system is basic. Enclosed canals are utilised 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.

[3] 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.

From the collection point, sewage is transport out to sea without any treatment. There are five garbage disposal sites in the town and they are emptied once or twice a week. The waste is taken to the main landfill site near Sangachal, where the material is either burnt or covered. There are very few roads in and around Sangachal and most of these are covered in gravel.

Based on discussions with Garadag Executive Power, it appears there are no major health problems in Sangachal town. The issue of health though was discussed during a recent survey of those in the area and over 50% of the Sangachal population assessed their health as poor. No official figures were however available to support this assertion. An immunisation campaign is being undertaken within the town, administered by the doctors from the United Hospital in Primorsk. There is no hospital or pharmacy in Sangachal however an ambulance station provides basic first aid.

Sangachal has only one school and thus several children travel to Primorsk for extra-curricula activities which are not available at Sangachal School. Last year approximately 10 children went onto university education. According to Garadag Executive Power, 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. IDPs in Sangachal do not live in permanent accommodation but are housed in either public buildings or abandoned homes. Whilst IDPs receive free medical services and also education, they do have to pay for medication. The receipt of foreign aid for IDPs 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 according to Garadag Executive Power, although exact figures are unavailable. 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. Their 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 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. The camp has been given permanent status in that it is now recognised as a formal settlement. In total there are more than 1,000 people living in Umid Camp. 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.

It is estimated that almost 37% of family's within the IDP part of Umid camp do not earn anything. Meanwhile a further 57% earn between AZM0 and AZM200,000[4]. Information also 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. No data was available for income levels for the cement camp.

It is estimated that approximately 70 (i.e. 7%) of residents in Umid camp are employed. 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

[4] AFHS survey 2001.

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.

The IDP camp now has 130 households and there are no plans for expansion, although there may be some expansion through natural increases in the size of the population. Meanwhile, the cement camp is being extended by the addition of around 10 houses.

The Camp houses a school, medical office, bakery and post office. Households are supplied with gas, electricity and running water. The sewage system is a simple open drainage ditch around the camp. The roads in and around the camp are gravel based, although the main road to Baku is covered in asphalt.

All households have access to electricity and gas within their homes. Sufficient quantities of water are piped to households and the supply is regular. There is no hot water supply, which is normal for the area and no use is made of bottled water nor wood for cooking and heating purposes. There are three waste disposal points in the IDP camp and one in the cement camp. Waste is collected every week and transported to the landfill site at the cement works. Sewage is transported via simple open drainage ditches. The IDP population is housed independently in normal houses and flats.

According to Garadag Executive Power, Umid Camp has not experienced any health problems to date. 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 it is attended by approximately 120 children.
All of the households in the IDP Umid Camp have telephones and radios but they do not have access to newspapers. There is only one telephone in the cement camp. Any decisions about the community are undertaken by either Garadag district or Baku region. There is however, also a committee of elders who discuss issues, make decision, resolve disputes and take the ideas, concerns to the head of the camp.

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[5].

The West Hills settlement is used by herders during the winter months and they report to the Qobu cattle breeding enterprise. There are approximately 31 people living at the West Hills settlement during the winter months. The herders spend around 8 months a year at the settlements from approximately mid-August to mid-May each year. During the summer the majority of them travel to Kuba in the north whilst one family of approximately 4-5 people remains at the settlement for security reasons. According to the herder supervisor of the West Hills herding settlement 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 Umid school.

The Central North settlement is used by herders during both the winter and summer seasons and is believed to report to the Guzdek cattle breeding enterprise. The Central North settlement consists of a two main buildings and a number of out houses. There are approximately 10 buildings in total in the West Hills settlement, some of which are for living whilst others are for housing animals. There are no water, gas or electricity supplies to these settlements. Those living in the Central North settlement sustain a living through grazing

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

sheep and cattle. Overall, those living in the Central North settlement appeared to be in a poor nutritional state with signs of malnutrition in the younger children. However no accurate health data has been obtained to date. If there is a need for medical assistance the herders generally attempt to seek help from the Sangachal terminal site. It is understood that the remain in Shamahar during the winter to attend school.[6]. The children of the West Hills settlement attend Sangachal school.

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.

Sangachal Bay attracts a large quantity of commercial fish and their fry for spawning and wintering. The only commercial fishing authorised by Azerbalyk State Fisheries Concern in the Bay is to support the fish hatchery plant nearby. Azerbalyk has two fishing nets positioned in the Bay which remain there all year round, 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.[7] There are some 3 or 4 fishermen employed to work these nets and cages. There is a temporary building near the shore where the fishermen can shelter.

In addition to the fishing undertaken near the shore, fishing is also undertaken some 1-2km from the coast via nets are thrown into the sea. This fish is reported to be low quality and as a result is not sold commercially but used for subsistence purposes. Fishing vessels also catch sprats some 40-60km 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.
- **archeological finds** are scattered around the local area and the proposed terminal site. Survey work undertaken as part of the ACG Phase 1 ESIA identified some surface finds in the area along with the possibility of sub-surface archeological features.

[6] This information has been taken from the BP Resettlement Action Plan process for the ACG Project 2001/2.
[7] Information provided by BP and gathered as part of the Resettlement Action Plan process, 2002

ES8 Environmental impact assessment

For the purposes of the environmental impact assessment process, the ACG Phase 1 project was defined as comprising 84 routine and planned non-routine activities. Each of these activities was assessed for its potential to interact with 23 identified environmental receptors. Where an interaction was identified, it was denoted as an environmental aspect. A total of 313 environmental aspects were identified. Each aspect was 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. Of the 84 routine and planned non-routine project activities identified, 13 have the potential to cause 25 different "high" significance impacts on 16 separate environmental receptors. No routine activities were assessed as having the potential to result in environmental impacts of "critical" significance. 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:

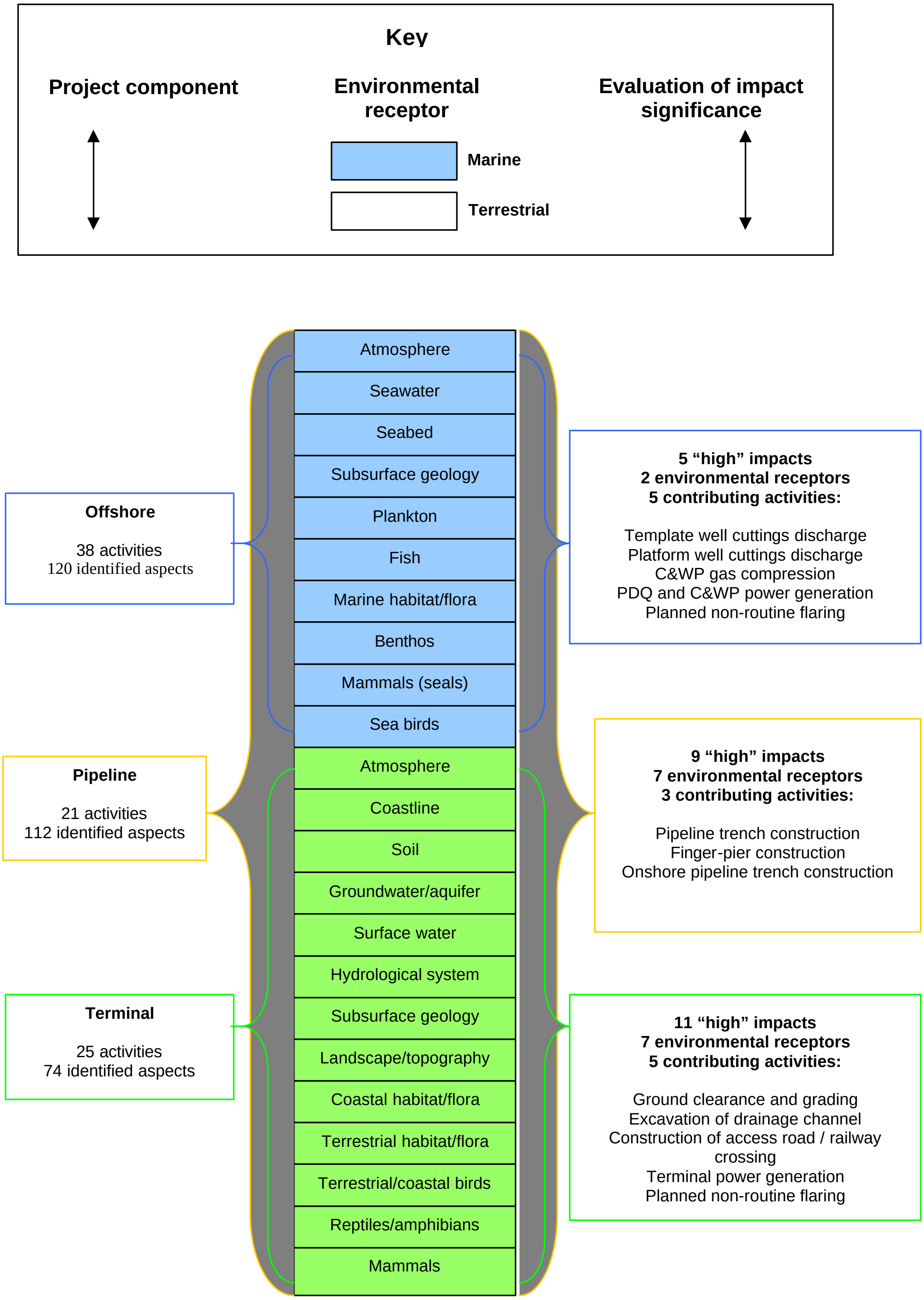
- eliminating the cause of the potential impact through design modifications;
- reducing the negative effects through design and/or operational practices; and
- development of mitigation procedures to minimise the harmful effects of residual impacts.

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

- the decision to re-inject drilled cuttings from lower hole sections drilled with non-water based mud systems rather than discharge to sea;
- the decision to use a cooling water antifouling system that will result in far lower concentrations of chlorine being discharged to sea;
- the decision to re-inject produced water offshore rather than discharge to sea;
- the decision to pursue onshore injection of produced water generated at the terminal into dedicated disposal wells;
- use of associated gas as fuel gas for offshore and onshore facilities and for re-injection offshore for reservoir pressure maintenance, with the remainder to be delivered to SOCAR, resulting in no requirement for routine flaring of gas to produce;
- the decision to commingle Chirag-1 oil and gas with Phase 1 production offshore resulting in the elimination of any routine flaring required at the Chirag-1 platform;
- the decision to install flare gas recovery at the terminal to remove the requirement to flare internal process valve and seal leakage;
- use of the existing EOP pipeline corridor route for the Phase 1 30" oil pipeline so as to avoid disturbing previously undisturbed benthic habitat;
- scheduling pipeline installation activities in the nearshore as far as is practicable to avoid environmentally sensitive time (e.g. breeding seasons);
- the decision to locate the Phase 1 terminal alongside the existing EOP terminal resulting in a reduced land-take requirement; 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.

Figure ES.15 illustrates these assessment results in terms of the project's offshore, subsea pipeline and terminal components.

Figure ES.15 Environmental impact assessment results (routine and planned non-routine activities)



The specific environmental issues and proposed additional mitigation measures associated with the 13 activities identified as having the potential to result in “high” significance environmental impacts (right hand boxes in Figure ES.15) are discussed in the following sections. A brief overview of the relevant project activity is also presented.

ES8.1 Discharge of drilled cuttings and drilling fluid/WBM

A Best Practicable Environmental Option (BPEO) study was completed in parallel with this impact assessment to determine the disposal method for drilled cuttings generated from the 26” surface-hole section of wells drilled as part of Phase 1. The BPEO considered five factors as follows:

- environmental risk;
- risk to personnel;
- compliance with legislation, international best practice and AIOC/BP standards;
- cost of alternatives; and
- current available technology.

The BPEO study concluded that, on balance, the best disposal method for surface-hole drilled cuttings and drilling fluids/water based mud (WBM) is discharge to the marine environment.

The discharge of drilling cuttings will result in a physical alteration of the seabed and smothering of the seabed habitat in the near vicinity of the drilling facilities. Resident organisms in the impacted area will be lost. The drilling fluids to be used have been carefully formulated so as to ensure that they contain no toxic chemical additives, hence no persistent chemical impacts are anticipated and it is predicted that recolonisation of impacted habitat would commence after the drilling programme has been completed.

While not significant in the context of the whole ACG Contract Area, on a local scale the amount of seabed habitat that will be physically smothered by cuttings discharge from the full Phase 1 drilling programme is considered to be appreciable. In addition, the drilling programme will continue for up to 10 years. Impacts associated with these discharges have therefore, been assessed as being significant.

Discharges from the 26” hole section will be released as deep in the water column as is technically possible in order to minimise lateral spreading of the drilled cuttings on the seabed.

The drilling team will record all discharged volumes of drilled cuttings, drilling fluids/WBM and additives and contingency chemicals used in the drilling fluid systems. Chemical use will be audited to ensure that compliance with international toxicity/discharge standards. The use of chemicals that may cause tainting and known endocrine disruptors will be forbidden.

The project will continue to evaluate alternative options to discharge to sea of surface hole cuttings to ensure that the BPEO is still valid. In the meantime, impacts associated with discharges will be monitored by means of regular benthic surveys around the installations.

ES8.2 Installation of 30” pipeline in Sangachal Bay

Any pipelay activities in Sangachal Bay will, to some extent, impact the benthic environment and result in potential loss of seagrass habitat along and adjacent to the pipeline route. 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 Early Oil Project (EOP) 24”pipeline.

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 30" pipeline from offshore will be trenched between the shoreline and the 5 m water depth contour. The decision to trench the pipeline is however, governed by pipeline integrity considerations and mitigates the risk of third party damage leading to rupture and more widespread environmental damage. The pipeline trench would be mechanically excavated out to the 2 m water depth contour then "jetted" into the seabed between the 2 m and 5 m water depth contours. There will be no requirement for rock-blasting using explosives.

The trench will be approximately 3 m wide with a total length of approximately 1.5 km. Trenching will result in the direct loss of seabed habitat over an area of approximately 0.5 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 1.5 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 between 250 and 300 m long. The total area of seabed that will be directly impacted by the structure will therefore, be approximately 0.3 ha.

It is planned to remove the finger pier following installation and to return the area to its original status. It is possible that if the pier was not removed this may result in a change to coastline configuration beyond 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.

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. Approximately 450 ha of sensitive seagrass habitat are present in Sangachal Bay (c.12% of the Bay) and it is estimated that between 20% and 25% of the pipeline corridor has seagrass beds. The total area of 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%).

The excavation activities 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. Consideration is being given to the use of silt screens around the pipelay activities that will trap and limit the lateral movement of mobilised sediments. In light of these direct and indirect impacts, the ecological value of and long restoration times (i.e. years) for seagrass habitat, impacts resulting from pipeline installation in the nearshore activities are considered to be significant.

The pipeline contractor will develop a shore approach mitigation 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 to its pre-project condition including 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 monitoring surveys to ascertain how rapidly and effectively the habitat is becoming re-colonised.

The offshore trench (beyond the 2m water depth) will be left to back-fill naturally thus reducing the need for further environmental disruption following installation. The trench would be expected to in-fill over a relatively short period of time.

Recovery of the seabed and associated communities around the pipeline route following installation would however, be hampered by the subsequent installation of the pipelines required for ACG FFD and Shah Deniz FFD. These activities would lead to additional and cumulative impacts on seagrass habitats and benthos within the Bay. All opportunities to reduce impacts in the Bay will be pursued including evaluating the possibility of concurrently laying all required pipelines in the nearshore zone for these developments.

ES8.3 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. It should be noted however that ground clearance and levelling would be carried out for both the Phase 1 terminal facilities and the proposed Shah Deniz gas terminal to be constructed alongside. As the features will be long term, there is no opportunity for habitat restoration within this footprint. Construction of the onshore section of the 30" pipeline would result in the temporary loss of approximately 2 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 (including seasonal differences) 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.

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 (*Calligonum bakuense*), the Baku Astragalus (*Astragalus bacuensis*), and the Sharp-edged Darling Iris (*Iris acutiloba*). 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 of the pipeline 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 pipelay 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 becoming 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 will include 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, the possibility of having on-site presence of an HSE representative to monitor construction activities and to identify vulnerable fauna, such as the red-listed Spur-thighed tortoise, for rescue where and when appropriate, is being evaluated.

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 herpatofauna 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.

ES8.4 Emissions of greenhouse gases resulting from Phase 1 operations

The principal contributing activities that result in emissions to the atmosphere occur during the project operational phase. The key contributors are related to the following:

- combustion emissions from offshore platform and onshore terminal power generation turbines;
- combustion emissions from the turbine driven gas compressors on the C&WP;
- emissions from the process heaters at the terminal; and
- flaring.

The key to the reduction in combustion emissions is high energy efficiency and this will be achieved by using centralised power operated to meet demand only, careful equipment selection and further consideration of waste heat recovery. In fact there has been an allowance for future waste heat recovery to be incorporated into the terminal facilities in the future.

Flaring will be minimised through the re-injection of gas, the use of gas as fuel for the platforms and terminal facilities and transfer of the remainder to SOCAR for onward delivery to the national grid. There will be no continuous flaring as part of the production process. In addition, there have been a number of key design decisions included into the Phase 1 design to reduce the emissions from operational flaring. These include:

- flare gas metering both offshore and onshore;

- flare gas recovery onshore (that collects the low level process train gas leakage from valves and seals and returns it to the process); and
- use of inert purge gas onshore.

In addition, once the C&WP is operational, any continuous flaring requirements on the Chirag-1 platform will be eliminated.

There will however, be occasions when plant upsets occur and gas will be flared to allow continued production during safe repair and restart of equipment. These occasions will be kept to a minimum by designing equipment with additional capacity, maintaining the equipment and limiting flare quantities. Overall facility design availability has been based on achieving 95% availability, although during the first and second year of operations equipment reliability will be lower due to the commissioning of the facilities and it is at this time that flaring quantities will be at their highest. Flaring quantities will be monitored and recorded.

A flaring policy will be developed that will be defined and agreed with the AIOC partners. The policy will stipulate the maximum duration and/or volume of gas flared annually and beyond this maximum production will be halted until the facility upset is rectified.

Appreciable emissions of greenhouse gases (principally carbon dioxide and methane) will result from the Phase 1 project operations. These amount to between 1.7% and 1.74% of the United Nations Framework Convention on Climate Change (UNFCCC) predictions for Azerbaijan in the earlier years of the project (2005 and 2010). The cumulative input from EOP, ACG FFD and potential Shah Deniz FFD would, in 2010, be approximately 5% of the UNFCC prediction for Azerbaijan. In the context of global warming there arises therefore, a transboundary environmental impact issue.

ES8.5 Potential unplanned (accidental) events

A total of 22 potential accidental events were identified for the Phase 1 project, each would result in significant impacts on the environment were they to occur. However, the likelihood of occurrence of each of the accidental events identified was considered remote. The only accidental event considered as warranting further investigation is the potential for a well blow-out event during drilling operations resulting in an uncontrolled release of hydrocarbons to the sea. It should be emphasised however that the likelihood of occurrence of such an event is considered to be extremely remote.

AIOC has invested considerable effort in the implementation of high engineering standards and control measures to remove the likelihood of accidental spills of oil to the sea. Through high maintenance of spill prevention equipment, as well as good operating practice, the likelihood of an oil spill is very low.

Well blow-outs are mitigated against by two independent barriers; the weighted drilling mud system and the blow out preventor which will close-in the well in the event that the formation pressure overcomes the hydrostatic pressure applied by the weighted mud. Whilst the likelihood of a blow-out is extremely small, the consequences of an uncontrolled release of hydrocarbons to the sea represents the worst-case oil spill scenario.

Coastal areas can be particularly vulnerable to oil spills. Dispersion modelling of a worst-case spill scenario such as that following a well blow-out determined that the oil released following such an event could potentially impact the coastline of Azerbaijan and possibly Iran and Turkmenistan thus constituting a potential transboundary impact.

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 as well as the regional Oil Spill Contingency Planning (OSCP).

The key tool for reducing or removing negative impacts as the result of a spill is the OSCP. 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 pollution on the environment of the development area. The primary step in BP's response to an accidental release of oil is to first notify the relevant contacts of the occurrence of the incident and to categorise the size of the oil spill.

BP has prepared an overview 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 Phase 1 and future phases of development. In addition, the specific OSCP will be based on the results of the spill risk assessment and dispersion modelling. The plan will include an assessment of the adequacy of available response equipment and mobilisation effort required for the spill scenarios identified. Particular attention will 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 oil spill. A sensitivity map and coastal protection plan have been developed.

An important feature of the OSCP will be the role of the Azerbaijani Government and the interaction with adjacent littoral states in the event that the spill moves into international waters. The littoral states of the Caspian Sea are working towards developing National Oil Spill Contingency Plans. Azerbaijan has yet to prepare a plan, whilst other states are believed to have plans in various stages of completion. Therefore, in the event of an international oil spill incident, where there is a potential for oil to travel into the territorial waters of neighbouring states, oil spill response would be complicated by this fact. This situation is currently under discussion, with an aim of securing agreements on the appropriate response to an international oil 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.

ES9 Socio-economic impact

For the purposes of the socio-economic impact assessment process, the ACG Phase 1 project was defined as comprising 84 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. A total of 246 socio-economic aspects were identified. Each aspect was 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. Of the 84 routine and planned non-routine project activities identified, 14 activities have the potential to cause 20 "high" impacts and one "critical" significance impact on 6 separate socio-economic receptors. Only one routine activity was assessed as having the potential to result in a socio-economic impact of "critical" significance and this impact (on the local herding population) is being addressed through a mitigation process seeking an acceptable outcome to all parties. 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.

Figure ES.16 illustrates these assessment results in terms of the project's offshore, subsea pipeline and terminal components.

ES9.1 Transportation of equipment and materials to Azerbaijan for onshore and offshore construction and assembly

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

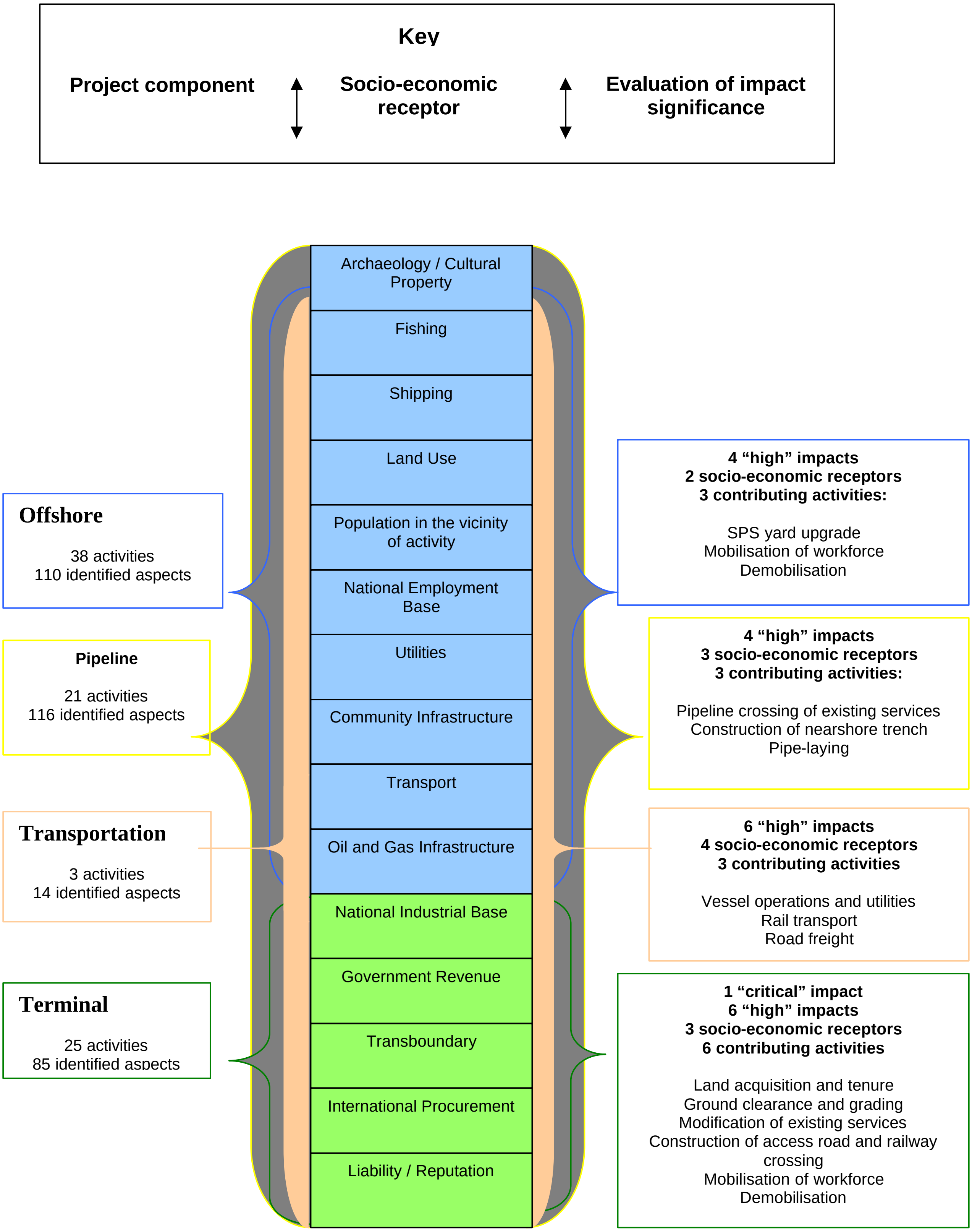
The transportation methods for the offshore installation of pre-fabricated components and pipe sections for the subsea pipelines are still under evaluation and are not yet finalised. A number of transportation methods and routes are under consideration. It is likely that a considerable volume of the facility components and pipe sections will be transported by sea and the number of vessels required for this transportation is significant. Sea transportation routes could include:

- from Europe to the Black Sea and into the Caspian through the Don Volga canal;
- from Europe to the Baltic Sea and into the Caspian through the Baltic Volga canal; and
- from the Middle East across the Persian Gulf to Iran.

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 extremely high in the Turkish Straits generally, and especially in the Bosphorus Strait. At this stage of the development of transportation logistics it is unknown how many vessel transfers will be made through the Straits, however there is expected to be a significant volume of vessel traffic, which may interfere with other shipping movements in the area.

Some of the loads into the Black Sea will be transferred onto rail wagons or international road trailer for onward transfer. At this stage it is also unknown how many loads will pass onto the Caspian Sea through the Baltic-Don and Volga-Don. There is no historical data on vessel numbers passing through the Baltic-Volga or Don-Volga canals, however the number and frequency of vessel movements anticipated for this project may result in a level of interference with other shipping activities by increasing the load on these waterways. Once into the Caspian, the vessels will transfer to Baku using the recognized Astrakhan to Baku transit route. Increased vessel movements, due to transportation of Phase 1 components from the Middle East across the Persian Gulf to Iran, are not expected to be as significant and will cause less inconvenience to other users of the sea.

Figure ES.16 Socio-economic impact assessment results (routine and planned non-routine activities)



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. 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 impacted significantly. The onshore construction contractors will also be required to restore any transport access routes used to at least their pre-construction state 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.

ES9.2 Terminal construction and onshore pipeline installation

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

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 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 ACG Phase 1 terminal facilities and the proposed Shah Deniz gas terminal to be constructed alongside, 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.

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.

Land acquisition will be carried out in accordance with the requirements of Azerbaijani law and provisions regarding payment of compensation for land and damages contained in the PSA. In addition, the project will comply with the policies and guidelines of the World Bank Group, in particular with World Bank Operational Directive 4:30 on Involuntary Resettlement which establishes good international practice for projects involving land acquisition, relocation of people or impacts on livelihood. Commitments and procedures to be followed for project land acquisition will be documented in a Resettlement Action Plan prepared in accordance with Operational Directive 4:30.

The workforce, and any inward migrating population seeking employment, associated with the terminal and onshore pipeline construction activities (including the early civils engineering work 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, an increase in activity in the informal economy in the area, 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 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. Direction will be sought through the BP Social Investment Strategy as to the best way to compensate for, or mitigate, such activities.

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 an inward migrating population in search of employment.

Initial noise modelling undertaken for the proposed ACG FFD terminal has determined that under normal operating conditions, the World bank Guidelines would be met; that is, noise levels would be at or below 45 dB(A) (night-time) and 55 dB(A) (daytime) at the nearest residential receptors (i.e. Umid Camp) and at or below 75 dB(A) at the nearest commercial/industrial receptors (i.e. caravansari; café/garage complex). The noise modelling predicted that under emergency shut-down flaring events, minor and short-term exceedence of the Guideline limits may be experienced. The duration of such events is likely to be only for a few minutes.

The terminal and onshore pipeline construction activity is likely to lead to an increased road traffic load on the main Baku-Alyat highway causing 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) will exacerbate this and impact negatively on the local population. To avoid placing extra pressure on these systems, contractors for both offshore and onshore construction will use private buses to transport day workers to the site. There will however, 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.

ES9.3 Onshore construction and assembly of offshore components (and associated yard upgrade)

The onshore construction and assembly of offshore components to take place at the SPS yard adjacent to Sahil will have many of the same impacts on the local community and the transport infrastructure as the onshore terminal and pipeline construction programme. This activity includes the upgrade of the SPS yard which, although not included within the scope of the ACG Phase 1 ESIA, is being subjected to the same ESIA requirements as the rest of the offshore construction programme as it is being included as part of the same contract as the rest of onshore construction and assembly of offshore components and will be handled by the same contractor.

The workforce associated with the onshore construction and assembly of offshore components 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. The impacts and associated project measures are outlined in Section ES-9.2 above and are not repeated here. Similarly, the impacts on the transport system are as for ES-9.2 above.

ES9.4 Nearshore pipeline installation

The fishing currently undertaken within Sangachal Bay will be directly affected by the proposed ACG Phase 1 developments, as there will be restrictions on access and use of the Bay during construction and there will be some disruption to the subsistence and recreational fishing undertaken in the Bay by local residents.

Azerbalyk use nets and cages in the Bay for spawning activities and employ 3-4 fishermen to manage this activity. As a result of the restrictions on access and use, an agreement has been reached with Azerbalyk to move the nets and cages. This will not affect the productivity of the nets and cages In the process of removal however, the cage in the pipeline corridor was destroyed and is not available for use by the Azerbalyk fishermen in the alternative fishing grounds. As 30-40% of the catch from the nets and cage was taken by the fishermen in lieu of wages, negotiations are ongoing with the 4 fishermen employed by Azerbalyk to ensure that their livelihoods are not affected by the removal of the nets and the destruction of the cage.[8]

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 however, be disruption to the subsistence and recreational fishing undertaken in the Bay by local residents.

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. Current understanding is that the only legal commercial fishing activity is the spawning nets and cages of Azerbalyk and, as outlined in the preceding paragraph, a satisfactory agreement has been reached on an alternative site for relocation of the nets. 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

[8] These negotiations will be documented as part of the Resettlement Action Plan which will be publicly available.

subsistence/recreational fishing activities to local livelihoods is unclear and clarification may not be possible. 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.

ES9.5 Offshore installation, hook-up and commissioning and operations

The offshore installation, hook-up and commissioning and operations at the offshore facilities will have an impact on sea use, specifically fishing and shipping activities. During installation, commissioning and hook-up activities at the ACG Phase 1 location a number of vessels will be present on the sea surface 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 pipelay barge will come into water depths of 8 m (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 ES.5.

Table ES.5 Estimated time periods and number of vessels on the sea

Activity	Estimated Duration	Number of vessels
Tow out, launch and installation of PDQ jacket	50-60 days	1 jacket barge 3 support tugs (1 on standby)
Tow out PDQ topsides and install	14-21 days	1 jacket barge 3 support tugs (1 on standby)
Pipeline installation (offshore)	180 days	1 laybarge 3 support tugs (1 on standby) 1 supply vessel
Tow out, launch and installation of C&WP jacket	50-60 days	1 jacket barge 3 support tugs (1 on standby)
Tow out C&WP topsides and install	14-21 days	1 jacket barge 3 support tugs (1 on standby)
Pipeline tie ins	150 days	1 DSV 2 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 means 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.

Some 100 fishing boats operate 40-60km 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 re-routed during construction.

ES9.6 National employment and industrial base

ES9.6.1 Construction phase

ES9.6.1.1 Direct effects

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.

Whilst the contractor has not been selected for the construction of the terminal it is possible to estimate that approximately 800 people will be employed during terminal construction.[9] 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.

At present it is not possible to give full details on the proposed sourcing of the construction workforce for the terminal as the terminal contractor has not yet been selected. However, it is understood 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%. However 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.

The proposed cost in relation to the construction of the terminal for ACG Phase 1 is estimated at $US350 million[10]. It has been estimated that some 50% of this expenditure will occur within Azerbaijan. These costs include the capital costs of the infrastructure and the installation costs (i.e all associated contracts), owners costs and contingency. The costs are defined as +/- 20%.

The contractors for the offshore works have been selected and it has been estimated that approximately 4,000 people[11] will be employed for the offshore elements of ACG Phase 1. Employment will gradually build up from January 2002 to September 2002, when it will continue at peak levels until February/March 2004. It is known that the contractors for the offshore construction propose to source between 70 and 80% of the required personnel within Azerbaijan. It is understood that the offshore construction contractor will only source labour from the international market where the national labour force cannot supply the skills required for the programme. The contractors for the upgrade of the SPS yard (a related project) propose to locally source between 60% and 70% of the required workforce.

It should be borne in mind that whilst there may be a pool of labour in Azerbaijan large enough to cater for the demands of ACG Phase 1 (and later ACG Phases and Shah Deniz Stage 1 projects), some training would be required of this labour source to make it suitable for the tasks required.

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

The proposed cost in relation to the construction of the offshore elements of ACG Phase 1 is estimated at $US1,605 million[12]. It has been estimated that some 44% of this expenditure will occur within Azerbaijan. These costs include the capital costs of the infrastructure, the installation costs (i.e all associated contracts), owners costs and contingency. The costs are defined as +/- 30%.

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 ACG Phase 1 is detailed in Table ES.6 below.

Table ES.6 Direct and estimated total (onshore and offshore) impact ($ million)

	Azerbaijan
Direct	888.1
Indirect and Induced	381.9
Total	1,270.0

Source: Consultants estimates.

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 materials.

ES9.6.1.3 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[13].

Clearly the local employment created through this expenditure will be lower for construction workers who will most likely be 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. However, there is 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 as outlined above.

Skills enhancement as a result of employment opportunities associated with the ACG Phase 1 project construction and operational activities may have a positive impact on the local

[12] Source : BP.
[13] ACG FFD Environmental and Socio-economic Overview p72

community. Skills enhancement may come as a result of skills transfer from employees from elsewhere in Azerbaijan or from expatriate personnel. In more recent years the involvement of expatriate personnel in 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 maximise 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.

ES9.6.2 Operational phase

ES9.6.2.1 Direct effects

During the operational phase of ACG Phase 1 approximately 170 AIOC/BP positions will be created between the onshore and offshore elements. Due to the nature of the work involved a number of the positions will entail shift work and it will be necessary to employ approximately 300 personnel for the offshore operations to support the 150 positions. The requirement for shift work is not as high onshore, however it is required in a number of instances. As a result, for the 20 positions created onshore, some 35 people will be employed. It is envisaged that from day one of operation, some 50% of the jobs would be occupied by Azerbaijani nationals. It is expected that this will increase over time as skills are developed through training and experienced gained, with 75% of positions being held by Azerbaijani's after 5 years and 95% after 10 years.

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 will also be inviting individuals to register at recruitment centres in early 2002 to ensure that those workers to be hired can undertake the necessary training in advance of project operational requirements.

The operating and maintenance costs for ACG Phase 1 over an operating life of 21 years have been estimated at a total of $US1.1 billion[14]. This cost estimate is +/- 10%. The extent to which this expenditure will occur within Azerbaijan is difficult to estimate, however it is estimated that overall some 70% of expenditure may occur within the country.

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.

Based on the above, it has been estimated that the impact during the operation of ACG Phase 1 on the Azeri economy is detailed in Table ES.7 below.

[14] BP's ACG Phase 1 Operations Manager.

Table ES.7 Direct and estimated total impact ($ million)

	Azerbaijan
Direct	770.0
Indirect and Induced	331.1
Total	1,101.1

Source: Consultants estimates.

ES9.6.2.3 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 mean its degeneration to a ghost-town. These effects may be offset 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.

ES10 Conclusions

The ACG FFD Phase 1 project has the potential to deliver major economic benefits to Azerbaijan. The project together with the linked investments including ACG FFD, the BTC project and possible Shah Deniz Gas Export project, are collectively by far the largest investments ever committed in Azerbaijan. They will have a major positive effect on the national economy of Azerbaijan.

This Environmental and Socio-economic Impact assessment has described the extensive engineering design and environmental evaluations conducted over a number of years. One of the prime objectives of these studies has been to identify and characterise the potential environmental and socio-economic impacts at each iteration of the conceptual and detailed engineering design process and either eliminate the cause or contributing factors leading to the impact through re-design, or reduce the potential effect to an acceptable or manageable level, through mitigation measures and operations management.

There are a number of residual environmental impacts that have been assessed as being significant. These include potential physical impacts to selected offshore and onshore habitats (and to several important species of plants and animals) and the emission of Greenhouse Gases. The potential impact of a large oil spill incident would be significant, however the likelihood of such an event occurring is very small. In addition, a number of residual socio-economic impacts have been assessed as being significant. These include potential impacts on fishing and shipping activities, the transport infrastructure, social and cultural interaction issues, land use and impacts on the national employment and procurement base.
A range of other important but less significant environmental and socio-economic impacts are associated with the project and 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, as well as committing to a programme of continued improvement in socio-economic and environmental performance.

Notwithstanding the predicted adverse effects, the project, together with the subsequent development proposals, have the potential to make a very significant contribution to sustainable development in Azerbaijan. This contribution will, to a large extent, depend on the Government's responsible management of the revenues generated from the project. Importantly, the project could indirectly 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). 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.

GLOSSARY

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 colorless, white, gray, blue or lilac mineral of anhydrous calcium sulfate 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 tributyltin (TBT) which inhibit fouling of plant or vessels by organisms.

Anthropogenic
Relating to humans.

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

Appraisal well
A well drilled to confirm the size or quality of an oil 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 authoratative standards such as calculation tables etc.

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).

Beached Oil
The part of an oil spill that reaches 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.

Blowout
Uncontrolled or uncontrollable release of downhole pressure upward through the wellbore or casing.

Blowout 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.

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 key 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.

Coliform
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 upflowing 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 entitity 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
Any member of 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 or 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 comblike 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).

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.

Desiccant
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
Relating to a 24-hour period, 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 downhole through the drill pipe (string) and drill bit. The mud cools the rapidly rotating bit, lubricates the drillpipe 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.

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 porcess.

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
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.

Facies
The composition and characteristics of a rock formation.

Fate
Dispostion 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 thorugh 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.

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 mixure.

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.

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.

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 compartments 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 enviromental disciplines including the basic management system.

Isobath
A seabed contour line.

Jacket
The structure of an offshore steel, piled platform, which supports the topsides facilities.

Juvenile fish
Immature fish.

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

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 through metamorphosis.

Lay Barge / Pipelay 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 longline 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 formationss.

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 class of warm-blooded vertebrates, Mammalia, 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 negative 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.

Mussel
Marine bivalve.

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

Naturally Ocurring 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 which 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.

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.

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.

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.

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.

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.

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 (H_2S).

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
Dintinct, 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.

Taxon
Plural -Taxa. A taxonomic category or group.

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.

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

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.

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 that 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.

Zooplankton
Plankton that consist of animals such as .corals and jellyfish, usually small and often microscopic.

References

Abasov (1997). Abasov, MT. (Ed). Theory and practice of geological – geophysical studies and development of marine oil and gas fields (on the example from the South Caspian Depression), 1997.

Abdulrahmanov Y. A. "Fresh water fishes of Azerbaijan" Publish house of Academy of Science of Azerbaijan SSR, Baku, 1962

AET (1999). Azerbaijan Economic Trends, 1999

AET (2000). Azerbaijan Economic Trends, Quarterly Issue, Oct-Dec, 2000.

AHFS (2001). Azerbaijan-Holland Friendship Society, Sociological Survey, Baku 2001.

AIOC (1994). Azeri, Chirag and Deep Water Gunashli Production Sharing Agreement, 1994.

AIOC (1995). Enviromental Baseline Study Literature Review, 1995, Woodward Clyde International

AIOC (1995). AIOC Environmental Baseline Study, 1995, Woodward Clyde International

AIOC (1995). AIOC Environmental Baseline Study Final Report, 1995, Woodward Clyde International.

AIOC (1996). Environmental Impact Assessment of the Early Oil Project, 1996, Det Norske Veritas.

AIOC (1996). AIOC Appraisal Well Drilling Environmental Impact Assessments for GCA Wells 5,6, 1996, ERT.

AIOC (1996). Northern Route Export Pipeline Environmental Impact Assessment, 1996, DNV.

AIOC (1997). Western Route Export Pipeline Environmental Impact Assessment, 1997, DNV.

AIOC (1999). Phase 1 Health, Safety & Environmental Design Standards, 1999, AIOC Contracts Management Committee.

AIOC Full Field Development Project, Caspian Construction Capacity Report Rev06, April 2000.

AIOC (2000a). Full Field Development Environmental and Socio-Economic Overview, 2000, URS Dames and Moore.

AIOC (2000b). Environmental Assessment of Alternative Export Options Volume 4 Social Scoping Study, 2000, URS Dames and Moore.

Alekperov Kh. M., Erofeyeva S.N. Fauna and ecology of Chiroptera genus in Nagorno-Karabakh autonomous region of Azerbaijan SSR. Papers of Scientific session. Baku, 1961.

Alekperov Kh. M. Mammals of Southwestern Azerbaijan.

Alekperov Kh. M., Kuliyev S. Rare fauna species of Azerbaijan. "Elm ve hejat" ("Science and Life" journal), ? 6, 1977.

Alekperov A. M. Amphibious and reptiles of Azerbaijan. "? lm" publishing house. Baku, 1978.

Americal Conference of Government Industrial Hygienists – Threshold Limited Values for Chemical Substances in the Work Environment.

Applicable International Labour Organisation conventions.

ASPI. Draft description of systems as part of INOGATE Programme /96.02/ - Rehabilitation of Existing Crude oil and Oil-Products Transportation Networks, June 1998.

ASSC (1999). Azerbaijan State Statistics Committee, Women and men in Azerbaijan, 1999

ASY. Azerbaijan State Statistics Committee. Azerbaijan Statistical Yearbook, 2000

Azeravtoyol. Traffic information as part of the TRACECA Programme, 2001.

Azerbaijan State Department of Railways. Railway information as part of the TRACECA Programme, 2001.

Babayev I.R. Quantity of rare and disappearing water-marsh species of the Kura-Araz Lowland, Stavropol, Azerbaijan, 1991

BP Clair field development (UKCS Block 206/8) seabed environmental survey, April/May 2000. A report produced for BP (ERTSL R00/203).

BP. Shah Deniz Production Sharing Agreement, 1996.

BP. BP Health, Safety and Environment (HSE) Policy, 1999.

BP. Getting HSE Right, 1999.

BP Business Policies. What We Stand For, June 2000.

BP Environmental and Social Programme Briefing. Caspian Oil & Gas Developments and Associated Pipelines, April 2001.

Brown, J S; Sauer, T C; Wade, M J; and Neff, J M (1992) Chemical and toxicological characterization of produced water Freon extracts, p113-132: J P Ray and F R Engelhardt, Eds, Produced Water. Technological/Environmental Issues and Solutions.

Brown & Root (2001). Shah Deniz and ACG Third Party Pipelines, Road and Rail Crossings, Information Packet, Shah Deniz Gas Export Project (Doc. BRCDZZZZCMGUI0006 Rev A1).

British Standard 5228. Noise and Vibration Control on Construction and Open Sites, 1997.

British Standard 4142. Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas, 1997.

Cherepanov S.K. Vascular Plants Of The USSRLeningrad 1981pp.7-510

Council of Europe Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), 1979.

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

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

Convention on Wetlands International Importance Especially as Waterfowl Habitat, Ramsar, 1971.

Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (The London Convention), 1972.

Derevyagin V.A., (1979), Biology of big-eye kilka and perspectives of its commercial use, Materials of a workshop on resources and dynamics of pelagic fish of the World Ocean.

Derjavin A. N. "Catalogue of fresh water fishes of Azerbaijan" Publish house of Academy of Science of Azerbaijan SSR, Baku, 1949

De Margerie, S; 1989. Modelling drill cuttings discharges. Drilling Wastes: Engelhardt, F R; Ray, J P; Gillam, A H (eds). Elsevier. P627-646.

Duck, (1996), Preliminary report on Caspian seal fieldwork. Unpublished report produced for AIOC.

EBRD Public Information Policy, 2000

EBRD Environmental Procedures

ERM (undated). Environmental and Socio-Economic Impact Assessment, Chapter 8 rev02. 2001 in press, Azerbaijan.

ERT (undated). Sangachal Bay Monitoring, 2001 in press, Azerbaijan.

ESCAP (2000). Statistics Division ESCAP, 2000.

Evans, P G H and Nice, H 1996. Review of the effects of underwater sound generated by seismic surveys on cetaceans. Report to UKOOA, Sea Watch Foundation, Oxford.

European Harmonised Offshore Chemical Notification Format (HOCNF) and UK OCNS classification.

FAO, (2001), Assessment of Drought Damage and Priority Needs for Assistance Mission Report 06-15 January 2001, Food and Agriculture Organization of the United Nations pp36

Flora Of Azerbaijan. Baku 1950-1961Volumes I-VIII

Fugro (1996). Sangachal Terminal and Waste Disposal Facilities. Chirag 1 Early Oil Development Project (Report No. K-2435/031), 1996.

Jadin V. I., "Methods of hydro-biological study" Moscow, 1960.

Gajiyev V.D. – Vegetation cover of Azerbaijan, Baku, Ed. Elm, 1976.

Gambarov, K.M. (1958), Birds of the Apsheron peninsula. Scientific notes, ASU, biology, ? 1.

Gambarov, K.M. (1968), Additions to the list of the birds of the Apsheron peninsula. Scientific notes, ASU, biology, ? 6.

Garadag Executive Power. Personal Interview with Head of Garadag Executive Power on 05/07/01 at Umid Settlement.

Garadag Executive Power. Personal Interview 23/07/01.

Gasimov A. G. "Hydro fauna of Lower Kura and Mingechaur Water Storage Reservoir" Baku, 1965.

GEOS, (1997), Dada Gorgud ACP Current Measurements, First Appraisal Well, Caspian Sea. October to December 1996. Report to Azerbaijan International Operating Company from Global Environmental and Ocean Sciences, February 1997.

Gidayatov Y.Kh. Burrow type (or Class) of fox in Azerbaijan. Fauna and ecology of Azerbaijan vertebrate animals. Volume XXV, 1965.

GOA IPRSP (2001). Government of Azerbaijan Interim Poverty Reduction Strategy Paper, 2001.

Government of Azerbaijan. Land Code of the Republic of Azerbaijan. 25 June 1999.

Government of Azerbaijan. Law of the Azerbaijan Republic on Environmental Protection, 1999.

Government of Azerbaijan. Rules for the Submission and Consideration of Petitions for the Withdrawal and Allotment of Land Lots for State and Public Needs. 15 March 2000.

Grosgeim A.A. – Studies on Shirvan desert vegetation Ed. Narkomizdat, 1939

Gundlach, E R; and Hayes, M O (1979). Investigations of beach processes. The Amoco Cadiz Oil Spill, A Preliminary Scientific Report. Ed. W N Hess, p281. National Oceanic & Atmospheric Administration, Boulder.

Hajiyev, Dr. V. Personal communication 4 June 2001

Hajiyev, Dr. V. Personal communication 5 June 2001.

International Maritime Organisation (IMO) 1989 Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone, Resolution A.672(16), 1989, International Maritime Organisation (IMO), London.

International Union for the Conservation of Nature (IUCN) Red List of Threatened Plants, 1997.

International Union for the Conservation of Nature (IUCN) Red List of Threatened Animals, 1994.

International Finance Corporation. Environmental, Health and Safety Guidelines, Oil & Gas Development (Offshore), 2000.

International Finance Corporation. Environmental, Health and Safety Guidelines, Gas Terminal Systems, 1998.

International Finance Corporation. Procedure for Environmental and Social Review of Projects, Draft Guidance Note #G; OP 4.01, 1998.

ISO 14001. Environmental Management Systems – Specification with Guidance for Use, 1996.

Israilov, A., (1977) *Single and two dimensional functions for the distribution of winds and waves in the Caspian*, Trudi Zakavkazkogo Nauch. Isst Gidrometeorolog. Instituta. Issue 70 (76) Pp 3-14

Karyagin I.I. Flora Of Apsheron Baku 1952 pp. 7-439

Kazancheyev Y. N. “Fishes of the Caspian Sea” Moscow, 1981.

Koblitskaya A. F. «Determinant of young fresh water fishes” Moscow, 1981.

Kosarev, A N Yablonskaya, E A (1994) *The Caspian Sea*. SPB Academic Publishing. The Hague.

Koshinsky S D (ed) (1975) Regime characteristics of strong winds over the seas of the Soviet Union. Part 1, Caspian Sea. Leningrad, Gidrometeoizdat. Pp260-268

Lovetskaya, A.A., (1956), Kilka of the Middle and South Caspian (commercial and biological articles). Candidate dissertation. Baku, p.25

McCauley, 1994. Environmental Implications of offshore oil and Gas Development in Australia – Seismic Surveys.

M-Scan. (1996), Analysis of Azerbaijan Pipeline Landfall Sediment Samples. Certificate of Analysis no 9605/8414 from M-Scan to AIOC.

Mustafaev, G., (1968), *Second addtion to the list of birds of the Apsheron peninsula*. Scientific notes of ASU, ? 2, , p. 70-73.

Mustafayev G.T. Tuayev D.G. and others. Fauna of Azerbaijan (birds), Baku 1979

Mustafayev G.T. Structure of wintering population of birds within land biogeocenoses/Fauna and ecology of land and water animals of the Kura-Araz Lowland and the Small Caucasus, Baku 1982.

Nations in Transit (2000). Freedom House, Nations in Transit 1999-2000 - Azerbaijan, 2000.

Neff, J M; Hillman, R E and Waugh, J J, 1989a. Bioaccumulation of trace metals from drilling mud barite by benthic marine animals. In: Englehardt, F R; Ray, J P and Gillam, A H (Eds). Drilling wastes. Elsevier Applied Science, New York. p. 867.

Neff, J M; Bretler, R J and Carr, R S, 1989b. Bioaccumulation, food chain transfer and biological effects of barium and chromium from drilling muds by flounder (*Pseudopleuronectes americanus*) and lobster (*Homarus americanus*). In: Englehardt, F R; Ray, J P and Gillam, A H (Eds). Drilling wastes. Elsevier Applied Science, New York. p. 867.

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"; A2/1

OPRU, (1996), (Heavy metals in fish)

OSPAR, (1992). Oslo and Paris Convention for the Protection of the Marine Environment of the North East Athlantic, 1992

PD, (1999). Presidential Decree on Measures to Accelerate Reforms in the Agriculture Sector, Azerbaijan, 1999.

Pravdin I. F. "Manual of fishes study" Moscow, 1966.

Prikhodko, B.I., (1961), Migration of Anchovy kilka and role of feeding conditions in its distribution, Kaspnirkh. p. 9-12

Red Book of Azerbaijan, 1989.

Salinities recorded by ERT (1997)

Somerville, H J; Bennett, D; Davenport, J N; Holt, M S; Lynes, A; Maheiu, A; McCourt, B; Parker, J G; Stephenson, R R; Watkinson, R J; Wilkinson, T G, 1987. Environmental Effect of Produced Water from North Sea Oil Operations. Mar. Pollut. Bull, 18 (10): 549-558.

Sultanov, E.G. and Kerimov, T. 1998. Nesting of waterfowl inAzeri sector fo the Caspian Sea. Environment protection in Azerbaijan (materials for conference), Baku, p. 61-63.

Sultanov, E.G. and Kerimov, T. 1999. Distribution of birds in the Apsheron peninsular and seasonal dynamics, Long term monitoring of Baku and Sumgait coastal waters, Baku, p. 130-137.

Sultanov, E.G., 1996. Draft reports and other material based on fieldwork undertaken by Dr. Sultanov, including work in winter 1996

Tambovtseva L P., 1975). Regime characteristics of wave action in the middle and south Caspian. In:Koshinsky S D (ed) Regime characteristics of strong winds over the seas of the Soviet Union. Part 1, Caspian Sea. Leningrad, Gidrometeoizdat. Pp260-268

UK Health and Safety Executive. Methods for Determining Hazardous Substances.

UNAIDS (2001). United Nations Agency for International Development, 2001.

UNECE Convention on Access to Information, to Public Participation in the Decision Making Process and the Administration of Justice concerning Environmental Matters (Aarhus Convention), 1998.

United Nations Convention on Biological Diversity, 1992.

United Nations Convention on Combating Desertification, 1994.

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

United Kingdom Offshore Operators Association, 1993. Environmental Impacts of Platform Decommissioning, UKOOA, 1993, Aberdeen, Scotland.

United Nations Convention for the Protection of the World Cultural and National Heritage, 1972.

UNDP (1999). United Nations Development Programme, Azerbaijan Human Development Report 1999.

United Nations Development Programme. Azerbaijan Human Development Report, 2000.

United Nations Framework Convention on Climate Change, 1992.

UN (2000). United Nations Field Report, Joint UN Project to Prevent STDs and HIV/AIDS in Azerbaijan, March 2000.

United Nations Framework Convention on Climate Change, 1992.

URS (2001). URS Dames & Moore, Soil and Groundwater Investigation Report – Technical Appendix to ACG Phase 1 Upstream Development Project Environmental & Socio-economic Impact Assessment, 2001 in press, Azerbaijan.

USSR Red Data Book, 1978: Karyagin, 1952; Soskov, Akhmedzade, 1974; Khalilov, Djalilov, 1976; Rzazade, 1954, Akhundov, 1967.

USSR Red Data Book, 1978: Grossgeym, 1940; Karyagin, 1952, a, b.

Vienna Convention for the Protection of the Ozone Layer, 1985 and Montreal Protocol, 1990 and Copenhagen amendments, 1992.

UNDP, Handbook for the Environmental Impact Assessment Process, 1996.

Verbitski, V. and Zalesky, R. 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.

Vereshagin N.K. Mammals of Caucasus, Moscow-Leningrad, Publishing House of USSR Academy of Science, 1959.

Vinogradov B.S. Way to the knowledge of Transcaucasia rodents. Scientific papers, Tbilisi, 1916.

World Bank Standards. Oil & Gas Development (Onshore), 1998.

World Bank. Operational Policy 4.01- Environmental Assessment, 1999.

World Health Organisation. Guideline for Community Noise.

Yusifli, I. “The Return of Infections and Contagious Diseases”, Azerbaijan International, (3.4) Winter 1995.

Zarbaliyeva T. S., “Materials of the present condition of ship sturgeon (Kura) (Achpenser nudiventris derjavini Borzenko) and development of measures on its protection as endangered specie.” Baku, 1991

Zarbaliyeva T. S., Agayeva V. R. “Description of hydro fauna life existence of Kura river and its changes” “Biological resources of the Caspian Sea” Astrakhan, 1962w

APPENDICES

Units and abbreviations

Units

Barg	1 bar (guage) = 14.5 psi
bbl	Barrel (6.2898 barrels = 1 m^3)
bopd	Barrels of oil per day
Bpd	Barrels per day
cms^{-1}	Centimeter per second
cm	Centimetre
dB	Decibel
^0C	Degrees centigrade
gm^{-1}	grams per meter
gm^{-2}	grams per square meter
ha	Hectare
km	Kilometre
mbgl	meters below ground level
ms^{-1}	meters per second
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
ppm	Parts per million
ppmv	Parts per million by volume
%	Percent
‰	Parts per thousand
km^2	Square kilometre
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
AIDS	Acquired Immune Deficiency Syndrome
AIOC	Azerbaijan International Operating Company
AET	Azerbaijan Economic Trends
AMP	Archaeological Management Plan
API	American Petroleum Institute
ASCE	Azerbaijan State Committee for Ecology
ASFC	Azerbaijan State Fisheries Concern
ASSC	Azerbaijan State Statistical Committee
ASY	Azerbaijan Statistical Yearbook
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
CDV	Canine Distemper Virus
CERC	Cambridge Environmental Research Consultants
CFC	Chlorofluorocarbon
CH_4	Methane
CIS	Commonwealth of Independent States
CITES	Convention on the International Trade of Endangered Species
CLO	Community Liason Officer
CMC	Contracts Management Committee
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CRI	Cuttings Reinjection
CRM	Community Relations Manager
CRP	Community Relations Programme
CRRP	Coastal Rehabilitation and Reinstatement Programme
CVP	Capital Value Process
DBA	Derrick Barge Azerbaijan
DDT / DDE	Dichlorodiphenyltrichloroethane
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
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
ERT	Environment & Resource Technology Ltd
ES	Environmental Statement
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
FOCs	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
HOVHL	High Voltage Overhead Line
HSE	Health, Safety & Environment
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
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
KAP	Knowledge, attitudes, practices
KP	Kilometer 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
LSA	Low specific activity
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
MDHS	Method for Determining Hazardous Substances
MEL	Maximum Exposure Level
MENR	Ministry of Ecology and Natural Resources
MEPC	Marine Environmental Protection Committee
MIGA	Multilateral Investment Guarantee Agency
Min	Minimum
MLA	Multilateral Lending Agency
MOD	Ministry of Defense
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
N_2O	Nitrous oxide
NDT	Non Destructive Testing
NE	Northeast
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 Ocurring Radioactive Material
NWBM	Non Water Based Mud
OBM	Oil Based Mud
OCNS	Offshore Chemical Notification Scheme
OECD	Organisation for Economic Cooperation and Development
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
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
PM	Particulate matter
POB	Persons on Board
PPAH	Pollution Prevention and Abatement Handbook
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
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
SCR	Selective Catalytic Reduction
SD	Shah Deniz
SDGP	Shah Deniz Gas Pipeline
SE	Southeast
SF_6	Sulphur hexafluoride
SIC	Sound Immission Contours

SO_2	Sulfur dioxide
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
STRAI	Spur-thighed Tortoise Rescue and Awareness Initiative
SWOT	Strengths, Weaknesses, Opportunities and Threats
TACIS	Technical Assistance for the Commonwealth of Independent States
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
TPH	Total Petroleum Hydrocarbons
TWA	Time Weighted Average
TWMI	Total Waste Management International
UCM	Unresolved complex mixture
UK	United Kingdom
UN	United Nations
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
UNICEF	United Nations Children's Fund
USA	United States of America
USExIm	United States Export-Import Bank
USSR	Union of Soviet Socicialist Republics
UTM	Universe Transverse Mercator
VOCs	Volatile Organic Compounds
WBG	World Bank Group
WBM	Water Based Mud
WER	Western Export Route
WHO	World Health Organisation
WTO	World Trade Organisation

APPENDIX 1
ACG PSA EXTRACT

ARTICLE XXVI

ENVIRONMENTAL PROTECTION AND SAFETY

26.1 Conduct of Operations

Contractor shall conduct the Petroleum Operations in a diligent, safe and efficient manner in accordance with generally accepted international Petroleum industry standards and shall take all reasonable actions in accordance with said 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.

26.2 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 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.

26.3 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 then current international Petroleum industry standards and practices being at the date of execution of this Contract those shown in Appendix IX, with which Contractor shall comply. If Appendix IX specifies more than one standard with respect to a matter, Contractor will use the standard most appropriate relative to the ecosystem of the Caspian Sea. 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.

26.4 Baseline Study and Ongoing Environmental Monitoring

(a) In order to determine the state of the environment in the Contract Area at the Effective Date, Contractor shall cause an environmental base line study (under the Minimum Obligatory Work Programme as referred to in Appendix X) to be carried out by a recognized international environmental consulting firm selected by Contractor, and acceptable to SOCAR. SOCAR shall nominate representatives to participate in preparation of the study in collaboration with such firm and Contractor representatives. The costs of such study shall be borne by Contractor, except that SOCAR shall be liable for all costs associated with the representatives nominated by SOCAR. The costs associated with this study shall be subject to Cost Recovery in accordance with Article XI. Contractor shall conduct ongoing environmental monitoring of its operations. Data collected will be evaluated at least annually to determine if any practices and discharge standards need to be revised.

The Environmental Strategy included in Appendix IX outlines the environmental program that Contractor (and SOCAR in the event it carries out operations on the Chirag-1 platform pursuant to Article 10.3 or operations with or without a Third Party pursuant to Article 15.2(e)) will follow during the course of Petroleum Operations within the Contract Area. The evaluation of data collected during the ongoing monitoring program, together with the baseline study, will provide a basis for determining whether any unacceptable environmental impact has been caused by Contractor in the course of conducting Petroleum Operations and for which Contractor may be liable under Article 20.2, or whether the conditions leading to such impact existed prior to the commencement of Petroleum Operations or otherwise from activities conducted by a party other than Contractor. SOCAR and Contractor shall review the environmental base line study and consult to determine whether any remedial action is warranted to mitigate the effects of any impact which occurs or has occurred from such prior conditions, and if so, whether a programme of remediation could be carried out by Contractor, it being agreed among the Parties that Contractor shall not be liable for any of the expense of such a remedial programme. Any such remedial program undertaken will be considered outside the scope of the Environmental Strategy and will be conducted pursuant to the terms of a separate agreement between SOCAR and Contractor.

(b) In the event SOCAR operates the Chirag-1 platform as provided pursuant to Article 10.3 and/or SOCAR and/or any Third Party operates any other facilities with respect to development of Non- Associated Natural Gas pursuant to Article 15.2(e), then in connection with performance of the ongoing monitoring program Contractor shall have the right to make periodic inspections of the Chirag-1 platform and such other facilities and SOCAR's and/or any Third Party's operations with respect thereto, including, but not limited to, the placement of monitoring devices and collection of samples relevant to the monitoring program. Contractor's above referenced inspections, sampling and placement of monitoring devices shall be performed by Contractor in a manner which does not unreasonably interfere with SOCAR's and/or any such Third Party's operations on the Chirag-1 platform or such other facilities.

26.5 Environmental Damage

(a) Contractor shall be liable for those direct losses or damages incurred by a Third Party (other than the Government) 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 Contract, as well as any environmental pollution or other environmental damage, condition or problems arising out of SOCAR's operation of the Chirag-1 platform pursuant to Article 10.3 and SOCAR's and/or any Third Party's development of Non-Associated Natural Gas pursuant to Article 15.2(d);

and SOCAR shall indemnify and hold harmless Contractor, its Sub-contractors and its 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 the 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 the Contractor shall be included in Petroleum Costs.

APPENDIX IX

ENVIRONMENTAL STANDARDS AND PRACTICES

I. Environmental Sub-Committee

A. The formation and organization of an environmental sub-committee shall be set forth in a proposal of Contractor which will be submitted to the Steering Committee for approval. Once approved by the Steering Committee, 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, Gipromorneftegaz, other research institutes, and State Committee of the Azerbaijan Republic on Ecology and Control over the Use of Natural Resources.

B. Responsibilities of the environmental sub-committee

(i) - Design Annual Monitoring Program for monitoring of selected environmental parameters

- Coordinate Annual Monitoring Program
- Review results and propose recommendations
- Publish annual report

(ii) Select research projects

- Administer environmental protection research projects
- Allocate funding as designated for this purpose in any Annual Work Programme and Budget
- Review progress
- Publish results

II. Environmental Strategy

The environmental strategy to be pursued pursuant to Article 26.4 shall be as follows:

A. Baseline Data

1. Literature review

2. International standards review

3. Audit of existing operations and practices

4. Environmental data collection
   - Atmospheric
   - Water Quality
   - Benthic
   - Flora and Fauna
   - Meteorological and Oceanographic
   - Sediment
   - Background Radiation

B. Environmental Impact Assessment (existing facilities, exploration and production activities and new facilities)

Project description

2. Environment description

3. Technology assessment

4. Air emission inventory
   - Dispersion modelling
   - Impact evaluation

5. Water discharge inventory
   - Fate and effects modelling
   - Impact evaluation
     - Treat and discharge offshore
     - Treat onshore and discharge
     - Injection onshore or offshore

6. Waste Inventory
   - Disposal options
   - Impact evaluation
   - Offshore treatment and disposal
   - Transportation and onshore disposal

7. Abandonment studies
   - Disposal options
   - Impact evaluation

8. Cost benefit analysis

9. Environment statement of preferred options

C. Oil Spill Response Planning

1. Sensitivity mapping

    - Habitats
    - Fisheries
    - Birds
    - Animals
    - Benthic organisms
    - Marine flora

2. Risk Assessment

3. Prediction modelling

4. Equipment and material resourcing

5. Evaluation of chemical treatments

6. Response organizations

7. Treatment and disposal of oil and chemical contaminated material

III. Effluent Guidelines

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 sixty (60) centimeters below the surface of the sea.

B. Discharge Guidelines and Monitoring

1. Produced Water

(a) Contractor will endeavor 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. Treatment of produced water will result in an oil and grease concentration that does not exceed 72 mg/l on a daily basis or 48 mg/l on a monthly average. The gravimetric (extraction) test method EPA 413.1 (79) shall be used to measure the oil and grease concentration.

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 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. Those muds that achieve an LC50 value in concentrations of more than 30,000 ppm 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) Monitoring of floating solids shall be accomplished during daylight by visual observation of the surface of the receiving water in the vicinity of the sanitary and domestic waste outfalls. Observations shall be made following either the morning or midday meals and at a time during daylight and maximum estimated discharge.

(d) Desalinization unit wastes shall be discharged.

(e) Deck drainage and wash water may be discharged as long as no visible sheen is observable.

(f) Trash shall not be discharged offshore. Trash shall be transported to an appropriate land-based disposal facility.

(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 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.

(c) Other Wastes

1. The estimated volume of other wastes discharged shall be recorded daily and reported monthly to include:

- Sanitary waste
- Domestic waste
- Deck drainage and wash water

IV. Air Emission Guidelines and Monitoring

Contractor is authorized to discharge air emissions. Such discharges will be limited and monitored as follows:

A. Any building, structure, facility, or installation that emits or may emit nitrogen oxides (NOx), sulphur dioxides (SOx), carbon monoxide (CO), volatile organic compounds (VOCs), or particulate (PT) in an
amount equal to or greater than 227 metric tons per year (MTPY) per individual pollutant (250 short tons per year) shall install the best available control technology on all equipment creating the emissions suitable for the equipment creating the emissions and its location. If the source is above 227 MTPY, screening modelling will be conducted to determine potential impacts on sensitive receptors. This trigger amount may be less in cases where sensitive receptors are in close proximity to the source. (NOTE: Any individual item of equipment emitting less than 23 MTPY (25 short TPY) or IC engines/turbines below 500 break horsepower would be exempt from this requirement.) Emergency flares on facilities will be designed to operate smokeless and with continuous pilots or equivalent ignition systems.

B. Any storage vessel with a capacity greater than 1,590 cubic meters (10,000 Barrels) used for Petroleum or condensate storage shall install necessary control technology to minimize emissions.

C. IC engines/turbines larger than 500 HP should be monitored on an annual basis to assure that the NOx and CO emissions are at the specified levels. Portable analyzers for monitoring the NOx and CO should be calibrated before each test using a known reference gas sample.

All new facilities will comply with the above standards. Existing facilities within the Contract Area being operated by Contractor will be brought into compliance with these standards according to a schedule to be negotiated, taking into account the condition, function and economic viability of the facilities.

V. Safety Guidelines

Contractor shall take into account the following international safety and industrial hygiene standards in conducting its Petroleum Operations under the Contract:

A. Oil Industry International Exploration and Production Forum (E&P Forum) Reports - Safety.
B. International Association of Drilling Contractors (IADC) – Drilling Safety Manual.
C. International Association of Geophysical Contractors (IAGC) - Operations Safety Manual.
D. American Conference of Governmental Industrial Hygienists – Threshold Limited Values for Chemical Substances in the Work Environment

APPENDIX 2
ACG PHASE 1 HSE DESIGN STANDARDS

HEALTH

DESCRIPTION	STANDARD
MEDICALS	• All project personnel will be medically screened prior to starting work offshore, with particular consideration to hearing and dermatitis checks; • 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).
WATER BASED DRILL FLUIDS AND CUTTINGS	• Water-based drill cuttings and fluids shall be discharged to sea providing the following conditions are met: 1. The mud systems used are tested and meet US EPA 96 Hour LC 50 toxicity tests (i.e., > 30,000 ppm) or Caspian Specific Ecotoxicity Tests, should these be agreed; 2. Discharge is via a caisson which will be at a depth of at least 15m to 20m below the sea surface; 3. All barite used will meet the following heavy metal criteria: Hg < 1 mg/kg and Cd < 3 mg/kg dry weight (TOTAL); 4. Products 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; 5. There will be no discharge of drill cuttings or fluids unless the maximum chloride concentration is less than four times the ambient concentration in the receiving water.
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.

ENVIRONMENT (cont'd)

DESCRIPTION	STANDARD
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.
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.

ENVIRONMENT (cont'd.)

<table>
<tr><th>DESCRIPTION</th><th>STANDARD</th></tr>
<tr><td>SAND</td><td>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.</td></tr>
<tr><td>LIQUID AND SOLID WASTE</td><td>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.</td></tr>
<tr><td>SEAWATER ABSTRACTION FOR OPERATIONS</td><td>The design will allow seawater to be abstracted during operations at depths > or = 50m.</td></tr>
<tr><td>PRODUCED WATER OFFSHORE (FFD)</td><td>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.</td></tr>
<tr><td>COMBUSTION EMISSIONS</td><td>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 ACG Phase 1 Project 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
<table>
<tr><th>Pollutant</th><th>Concentration Limits (mg/m^3)</th><th>Averaging Period</th></tr>
<tr><td>Carbon Monoxide</td><td>10,000
30,000
60,000
100,000</td><td>8 hours
1 hour
30 minutes
15 minutes</td></tr>
<tr><td>NO_2</td><td>200
40</td><td>1 hour
1 year</td></tr>
<tr><td>SO_2</td><td>500
350
125
50</td><td>10 minutes
1 hour
24 hours
1 year</td></tr>
<tr><td>PM_{10}</td><td>50
40</td><td>24 hours
1 year</td></tr>
<tr><td>Benzene</td><td>16.25</td><td>1 year</td></tr>
</table></td></tr>
</table>

ENVIRONMENT (cont'd.)

DESCRIPTION	STANDARD
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
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
ROUTINE FLARING - OFFSHORE	• 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, where appropriate, and installation of conservation pilots. • Source gas reduction measures will be implemented. • An operational flare policy will be developed during the Execute Stage
NON-WATER BASED DRILLING FLUIDS AND CUTTINGS	• The base case is cuttings reinjection with a contingency option of shipment to shore and treatment onshore at an approved location. • There will be no discharge of oil based or synthetic based drilling fluids or cuttings from multiple well locations within the GCA PSA contract area, where there has been no previous discharge. Should drilling fluids be developed that meet international and Caspain acceptability criteria for discharge then they will be evaluated and the option to use and discharge considered. • An operating policy will be developed to address the actions to be taken in the event of downtime of cuttings reinjection equipment. • All barite used will meet the following heavy metal criteria: Hg < 1 mg/kg and Cd < 3 mg/kg dry weight; (TOTAL) • Products known or suspected to cause taint, endocrine disruption or contain heavy metals as defined by UK Offshore Chemical Notification Scheme (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. • System will be designed to prevent mud loss on cuttings so far as technologically practical and economically justifiable.
DECOMMISSIONING	• Design will ensure that the facility can be safely decommissioned without long term impact on the environment.
ENERGY EFFICIENCY	• Waste heat recovery schemes, evaluated during advance define, should not be implemented onshore or offshore.

TECHNICAL DOCUMENTATION FRONT SHEET

Azerbaijan International

Operating Company

&

BP Exploration (Shah Deniz) Limited

Total pages: 23

AIR DISPERSION MODELLING

Rev	Date	Reason for Issue	Prepared Disc. Eng.	Checked Disc. Lead	Contr. Rep AIOC	Contr. Rep SD	Prepared Disc. Eng.	Reviewed Proj. Eng	Reviewed AIOC	Reviewed SD
D1	03-10-01	AFD	AW	AJW						
A1	28-08-01	IDC	AW	PM			PH			

Brown & Root

Contract Number: N/A

AIOC / BP Shah Deniz

Disk Ref.

Category	**Code**	**Description**
Area Code	CDZZZZ	
Document Type	REP	Report
System Number		General
Life Cycle		

Contractor	Area Code	Disc	Document Type	Sequence Number	Lang.	Revision
BR	**CDZZZZ**	**EV**	**REP**	**0009**		**D1**

1. Shah Deniz offshore flaring scenario	Paul Hill, SD
2. Future phases to be included for project use.	Annette Watlow, ACG
3. Shah Deniz offshore scenario	Paul Hill, SD
4. Shah Deniz offshore results	

Executive Summary

Air dispersion modelling was carried out for the future developments of ACG FFD Phase 1 and Shah Deniz Stage 1 to ensure that the proposed developments would not exceed the internationally recognised air quality standards and guidelines. The Air Dispersion Modelling is used to assess the ambient air quality in the area of concern and compares predicted concentrations with the international air quality standards, this report does not address safety or occupational health standards that may be applicable.

Onshore the air dispersion modelling took into account the emissions from the Sangachal Terminal with the current operation of Early Oil Project and the proposed development of ACG FFD Phase 1 and Shah Deniz Stage 1 under normal operating conditions. Further modelling was carried out during assumed periods of flaring from the terminal. Emissions of NO_x, SO_2, CO and VOC's were modelled to give a conservative prediction of future air quality in the Sangachal Terminal area. The emissions of SO_2 were based on an assumed level of H_2S in the gas, as the actual amount of H_2S that may be present in the reservoir is unknown. Further modelling for SO_2 levels will need to be carried out when the H_2S content of the reservoir is known.

Offshore the air dispersion modelling assessed the likely impact that the offshore developments may have on land, although the accuracy of air dispersion models over these distances is questionable.

Onshore modelling results show that the predicted emissions of NO_x, CO and SO_2 (except the extremely rigorous 15 minute mean for SO_2), are all well within the internationally recognised air quality standards and guidelines.

An assessment was also carried out of predicted emissions compared to the AIOC internal Air Quality Criteria, attached at the end of this document [ref: 5]. This was developed early on in the project to ensure that the impact on air quality in the vicinity of the Sangachal Terminal is kept to a minimum. The AIOC Air Quality Criteria has set 20% of the internationally recognised standards as a guideline. The comparison of the air dispersion modelling results with the AIOC Air Quality criteria shows that during periods of flaring from either ACG and EOP, or Shah Deniz, the maximum hourly average of NO_x exceeds the internal Air Quality Criteria, namely $40\mu gm^{-3}$. Flaring from ACG and EOP will result in a maximum hourly average NOx concentration of $44\mu gm^{-3}$ and from Shah Deniz $45\ \mu gm^{-3}$.

This study indicates that the AIOC Air Quality Criteria cannot be met during periods of flaring, but the Internationally recognised air quality standards are not exceeded. Flaring is necessary from a safety viewpoint and would only occur intermittently, therefore it is the recommendation that the AIOC Air Quality Criteria should be amended to allow for periods of flaring.

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Glossary

ACG	Azeri, Chirag, Gunashli
AIOC	Azerbaijan International Operating Company
AQS	Air Quality Standards
BBLS	Barrels
C&WP	Compression and water injection platform
CERC	Cambridge Environmental Resources Company
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DETR	Department of Environment Transport and the regions
DLE	Dry Low emissions
DQ	Drilling Quarters
EOP	Early Oil Project
ESD	Emergency Shutdown
FFD	Full field development
FOC	Foreign Oil Companies
HP	High Pressure
H_2S	Hydrogen Sulphide
MEG	Mono Ethylene Glycol
MMSCFD	Million Standard cubic feet per day
MBWD	Thousand barrels of water per day
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
PC	Process Contribution
PD	Production-Drilling Platform
PEC	Predicted Environmental concentration
PSA	Production Sharing Agreement
SD	Shah Deniz
SO_2	Sulphur Dioxide
VOC	Volatile Organic Compounds

1 Introduction

1.1 Assessment Basis

An assessment of atmospheric emissions from the Sangachal Terminal and offshore developments for ACG FFD Phase 1 and Shah Deniz Stage 1 projects has been carried out. The aim of the air quality study is to provide an assessment of air quality impacts in the vicinity of the Sangachal Terminal and the offshore impacts due to operations of the proposed development.

This air quality study report includes:

An assessment of environmental effects, comparing levels of released substances with international standards and guidelines for ambient air quality. This covers both potential human health effects and possible effects on vegetation.

A conservative presentation of ground level concentrations of substances of concern and ground level concentrations at identified sensitive receptors.

An assessment of these concentrations against international air quality standards and guidelines to identify any substances that should be considered a priority for control;

Onshore the study has considered the air quality impacts of the existing Early Oil Project (EOP) project at Sangachal terminal as well as the air quality effects associated with the addition of the ACG FFD Phase 1 development and the Shah Deniz Stage 1 gas development intended to be located adjacent to ACG on the onshore terminal.

Offshore the study has considered the air quality impacts of the proposed Drilling and Quarters platform and the Compression and water injection platform for ACG FFD Phase 1.

Future expansion of the Sangachal terminal for Phase 2 and 3 was assessed by using the previous air dispersion modelling carried out by bp in 2000.

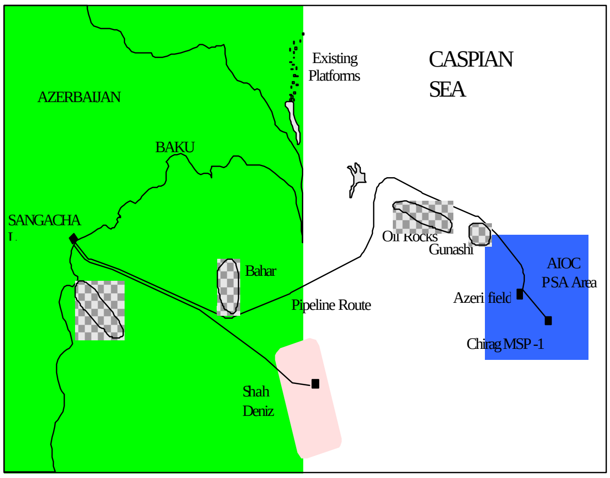
The model inputs used to assess the operations Onshore and Offshore, and the methodology used are presented in chapter 2.

Results are presented in Chapter 3

The interpretation and conclusions are presented in Chapter 4.

1.2 ACG Project Background

The AIOC offshore development is located in the Azerbaijan sector of the Caspian Sea, approximately 120 km south east of Baku. The onshore terminal is located 2km from Sangachal, approximately 50 km south west of Baku.



In September 1994 a Production Sharing Agreement (PSA) was signed by the Azerbaijan Government and the Azerbaijan International Operating Company (AIOC) in which bp are a majority shareholder. The PSA lasts for a period of 30 years and covers an offshore contract area of 432 square kilometres in the Azeri and Chirag fields, together with the deep water portion of Gunashli field.

The PSA grants rights to the Foreign Oil Companies (FOCs) to invest in and develop the fields, to produce and market the oil. The Full Field Development is planned to be implemented as a phased development.

ACG FFD Phase 1 - The objective is to produce and deliver the recoverable reserves in the central part of the Azeri Field and to tie-in production of reserves from the operational Chirag-1 field. The Phase 1 Project will consist of :-

- Expansion of the existing onshore Terminal facilities at Sangachal;
- a Drilling and Quarters Platform (DQ);
- a Compression and Water Injection Platform (C&WP), bridge linked to the DQ;
- pipelines connecting the various fields together and to convey oil and gas to the onshore terminal at Sangachal;
- conversion of the existing Chirag-1 field which will be tied in to Phase I production facilities and pipelines.

ACG FFD Phase 1 first oil is scheduled for 2004.

The future phases of development of ACG FFD are:

Phase 2 comprises of Drilling and Quarters facilities intended for simultaneous development of the East and West Azeri field and further development of the onshore terminal.

Phase 3 comprises a Drilling, Production, Utilities and Quarters facility intended for development of the Deep Water Gunashli field.

Given the locality of the Shah-Deniz gas export project, and with both schemes using the terminal facility onshore at Sangachal, there are likely to be many synergies between the two developments. This report has taken into account the emissions from the Sangachal terminal for both the ACG FFD Phase 1 and Shah Deniz Stage 1developments.

1.2.1 Onshore –Sangachal Terminal

Onshore, the terminal at Sangachal currently processes reserves from the Early Oil Project (EOP) from Chirag-1, and will be expanded to accept 490 Mbd Oil & 250 MMSCFD Gas from Chirag-1 and ACG FFD Phase 1. Facilities will include :-

- Expansion of the terminal storage tankage by one million barrels;
- Produced water storage and pumping facilities for 125,000 barrels of produced water storage (5 days capacity).
- Booster pumping facilities, export custody transfer metering system.
- Inlet gas receiving facilities, dewpoint and dehydration facilities for 250 MMSCFD.
- Utilities-power generation/services
- High Pressure and Low pressure Flares

Future plans include provision for an amine-based hydrogen sulphide (H_2S) removal facility and sulphur recovery plant in the event of H_2S being present in the reserves.

1.2.2 Offshore - Drilling Quarters Platform

The development, located in 128 meters of water depth, includes new offshore drilling and production facilities, living quarters and subsea pipelines required to produce and transport oil and gas to the Sangachal Terminal, comprising :-

- One drilling and quarters (DQ) platform with 48 slots and process facilities;
- A 12 slot pre-drilling template, to allow the drilling of 9 wells through this template in advance of the installation of the drilling and quarters platform;
- A full size drilling rig;
- Offshore oil production separation facilities
- High Pressure and Low pressure Flares
- Offshore oil pumping facilities, including all oil from the Chirag-1 Platform;
- Utilities – power generation/services, telecommunications, living quarters for 200 persons on board

1.2.3 Offshore - Compression & Water Platform

ACG FFD Phase 1 also provides for a gas Compression and Water Injection Platform (C&WP) scheduled for 2005, with associated subsea pipelines, allowing future gas export and water and gas injection into the reservoir. This platform will be bridge-linked to the Drilling Quarters (DQ), providing the following facilities :-

- A dedicated compressor to receive and compress all Chirag-1 gas at 125 MMSCFD for injection or export as needed;
- Gas injection compression for 350 MMSCFD;
- Gas dehydration of 475 MMSCFD;
- High Pressure and Low pressure flares, linked to the DQ flares.

- Seawater treatment and water injection pumping facilities for 225 MBWD;

1.3 Shah Deniz Project background

The Shah Deniz offshore development is located in the Azerbaijan sector of the Caspian Sea, approximately 100 km south of Baku. The onshore terminal is located 2km from Sangachal, approximately 30 km south west of Baku, adjacent to the previously described ACG terminal.

A Production Sharing Agreement (PSA) has been signed between the Azerbaijan Government and a consortium of seven Foreign Oil Companies (FOCs) of which bp is the major shareholder and operator.

The objective of the project is to provide a low unit cost gas and condensate production system. Gas conditioned for transportation and sales will be transferred from the Sangachal terminal to an export pipeline system, ultimately delivering gas to the Turkish and Georgian markets. Stabilised liquid condensate will also be produced at the terminal, for export as a product co-mingled with crude oil from ACG oil and gas project.

1.3.1 Onshore – Sangachal Terminal

The onshore terminal for the Shah Deniz gas development is to receive well fluid from offshore and to dehydrate and condition the gas to meet sales gas specifications and stabilised condensate for export. The export gas shall be metered to fiscal standard before transfer to the export pipeline. The stabilised condensate will be exported via one of the crude main export pipelines. The terminal will be designed for a nominal throughput volume of 900 MMSCFD of gas and 52,700 barrels per day (bpd) of condensate.

The facility includes :-

- Gas and condensate receiving facilities from offshore via separate condensate and wet gas pipelines
- Gas processing via two trains through dehydration and conditioning
- Gas compression and export metering
- Condensate storage to 165,000 bbls on spec., and 26,000 bbls off spec. capacity
- Process systems for condensate at 62,000 bpd capacity
- Mono Ethylene Glycol (MEG) regeneration plant sized to regenerate 10,000 kg/h of MEG.
- Produced water storage 1,000 bbls capacity
- Stand alone Shah-Deniz utilities, including power generation

In addition the design will allow for space required for future process trains and utilities to plan for future expansion.

1.3.2 Offshore

The offshore development will comprise a single in-field Production-Drilling platform supporting integrated drilling facilities and a minimum scope process facility. The platform will be located on the east flank of the field in water depth of approximately 101m. Gas and condensate will be delivered via two dedicated marine pipelines to the onshore terminal at Sangachal.

- A fully integrated in-field development Production-Drilling platform with 16 well slots;
- Drilling rig

- Production separator designed for 900 MMSCFD
- Provision for 6 subsea satellite production wells
- A gas pipeline and riser for gas transportation to the onshore terminal;
- Export of the condensate will be via a separate pipeline designed to convey 52,700 bpd condensate.
- Utilities – power generation/services, telecommunications, accommodation and helideck for 110 persons on board

2 Methodology

2.1 Scenarios

The air dispersion modelling study has considered the air quality impacts at Sangachal Terminal including the existing Early Oil Project (EOP) and the potential new developments of ACG FFD Phase 1 and Shah Deniz stage 1. The offshore facilities for ACG Phase 1, DQ1 and C&WP, and the offshore facilities for Shah Deniz stage 1 have been included in the study, but due to their relative distance apart the air dispersion modelling has been completed separately. The potential impact of the offshore platforms on the air quality at locations on land has been assessed.

Different scenarios were modelled to take into account as far as possible the likely operational scenarios at Sangachal terminal and the offshore platforms. The scenarios modelled onshore were:

1) Normal operations
2) Normal operations incorporating Gas Turbines with DLE NOx burners
3) Flaring during an Emergency shutdown (ESD) or upset from EOP and ACG FFD Phase 1 HP Flares.
4) Flaring during an ESD or upset from the Shah Deniz Stage 1 HP Flare only.

The scenarios modelled offshore were:

1) ACG All sources, including flaring from DQ1 and C&WP during ESD or upset conditions.

2) Shah Deniz all sources, during an Emergency shutdown.

The emissions from the process were modelled by the Cambridge Environmental Research Company (CERC) using the ADMS3 model for dispersion from a point source. Information needed for input into a dispersion model are process conditions, meteorological data, topography of the area and buildings in the vicinity.

The ground level concentrations attributable to emissions from the plant were combined with background concentrations of pollutants to estimate the overall concentration of NO_2, SO_2, VOC's and CO in the vicinity of the plant. These concentrations were compared to international air quality standards and guidelines.

This method was carried out for the onshore and offshore developments. Throughout the study a conservative approach was adopted. This means that the estimated concentrations of pollutants are almost certainly over estimates of the levels that will arise in practise.

2.1.1 Onshore

The air dispersion modelling study has considered the air quality impacts of the existing EOP project at Sangachal Terminal and the future operating scenario with the potential new developments of ACG FFD Phase 1 and Shah Deniz stage 1, including the addition of sulphur treatment facilities on ACG.

Terminal operation in 2005 has been considered in order to assess the air quality impacts of the terminal against International Air Quality Standards and Guidelines shown in Table 2.4.

The future expansion of the Sangachal Terminal with regards to ACG FFD Phase 2 and 3 and future phases of Shah Deniz has been considered by using previous Air Dispersion Modelling carried out by bp in 2000 [Ref: 6]. This is discussed further in section.

Planned shutdowns for maintenance occur every 4 years. There is the possibility of emergencies resulting in unplanned shutdowns giving rise to emissions due to flaring. ACG and Shah Deniz facilities do not share a common flare system and are independent from each other, therefore the chance of both facilities going into an ESD is extremely unlikely. The modelling has taken into account the possibility of flaring from ACG FFD Phase 1 and EOP only, and also from Shah Deniz only. Flaring episodes attributable to ACG Phase 1 have been assumed as 48 hours three times per year. Flaring episodes attributable to Shah Deniz have been assumed as 1 hour three times per year. There is currently no flaring philosophies issued and this scenario is an assumption and could therefore change. For the purposes of this study all the units are assumed to be continuously operating for the whole year.

For start up of the ACG FFD Phase 1 at the Sangachal Terminal it is predicted that there will be insufficient gas to start up with DLE gas fired turbines. Dual fuel turbines are proposed to be installed initially with the option to retrofit to DLE NOx at a future date. Therefore air dispersion modelling has also been carried out for the normal operations at Sangachal Terminal with no flaring, but with the ACG FFD Phase 1 gas turbines being modelled with the NOx emissions attributed to DLE.

2.1.2 Offshore - ACG

The air dispersion modelling study considered the air quality impacts of the offshore ACG FFD Phase 1 DQ1 and C&WP platforms on the air quality at the sensitive receptors onshore to ensure air quality standards are met. The modelling has taken into account emissions due to flaring episodes in the event of flaring due to an emergency shutdown, or maintenance. The assumed flaring episodes have been for 48 hours three times per year.

2.1.3 Offshore – Shah Deniz

The air dispersion modelling study considered the air quality impacts of the offshore Shah Deniz platform on the air quality at the sensitive receptors onshore to ensure air qulaity standards are met. The modelling has taken into account emissions due to flaring episodes in the event of flaring due to an emergency. The assumed flaring episodes have been [HOLD 3].

2.2 Emissions data

Emissions from the terminal are a result of combustion of fuel gas, which gives rise to emissions that consist mainly of carbon dioxide (CO_2) and water. Carbon monoxide (CO) and oxides of nitrogen (NO_x) are also emitted in smaller quantities. The breathing losses from the tanks on the terminal are classed as fugitive emissions and are mainly VOC's.

The process releases to air from the terminal and offshore platforms, which have the potential for effects on human health and vegetation in the vicinity of the plant are $NO_{x,}$ $SO_{2,}$ CO and VOC's. This report has focused on the potential local Air Quality effects of emissions of NO_x, CO, SO_2 and VOC's.

NO_x emitted from the combustion source comprises a mixture of the relatively low toxicity nitric oxide (NO) and the more toxic nitrogen dioxide (NO_2). The majority of NO_x produced from a combustion process is in the form of NO. The NO is converted to NO_2 by oxidation in the presence of ozone and sunlight in the atmosphere. NO_2 is also a contributor to acid rain. This study has concentrated on levels of NO_2 in view of the greater potential of this substance for adverse health effects.

Exposure to SO_2 can cause constriction of the airways in particularly sensitive individuals, hence the air quality standards and objectives have been derived to reduce exposure to this section of the population. SO_2 is also a contributor to acid rain. Emissions of SO_2 on the terminal are likely as a result of H_2S in the oil and gas and H_2S will be removed from the gas prior to further use by means of an amine plant and a sulphur recovery plant, resulting in emissions of SO_2. Offshore, the fuel gas used will contain some H_2S. The actual value of the H_2S in the gas is yet to be clarified, an estimated value of 500 ppm has been assumed for this modelling.

2.2.1 Onshore

The terminal consists of various units that emit flue gases and tanks that may emit some fugitive emissions of VOC's. Table 2.1 lists the sources and the fuel used in the units.

Table 2.1: Sources at Sangachal terminal

No.	Source	Fuel	Location	
			Easting (m)	Northing (m)
EOP				
1	Gas Turbine A	Gas	9371033	4452930
2	Gas Turbine B	Gas	9371027	4452939
3	Fired Heater A	Gas	9370892	4452856
4	Fired Heater B	Gas	9370882	4452871
5	Fired Heater C	Gas	9370870	4452889
6	Fired Heater D	Gas	9370860	4452905
7	Flare	Gas	9371132	4453011
8	Crude oil storage Tank 1	Fugitive emissions	9370615	4452971
9	Crude oil storage Tank 2	Fugitive emissions	9370730	4453046
10	Crude oil storage Tank 3	Fugitive emissions	9370850	4453125
11	Crude oil storage Tank 4	Fugitive emissions	9370965	4453199
12	Offspec Tank	Fugitive emissions	9370910	4452951
ACG FFD Phase 1				
13	Gas Turbine A	Gas	9370380	4452611
14	Gas Turbine B	Gas	9370392	4452619
15	Gas Turbine C	Gas	9370404	4452627
16	Fired heater A	Gas	9370275	4452969
17	Fired Heater B	Gas	9370293	4452981
18	Sulphur Plant	Gas	9370163	4452746
19	Flare	Gas	9369663	4452607
20	Storage Tank 1	Fugitive Emissions	9370923	4453457
21	Storage Tank 2	Fugitive Emissions	9370662	4453287
Shah Deniz				
22	Gas Turbine A	Gas	9370704	4452653
23	Gas Turbine B	Gas	9370704	4452653
24	Fired Heater A	Gas	9370704	4452653
25	Fired Heater B	Gas	9370704	4452653
26	Flare	Gas	9370704	4452653

2.2.2 Offshore

Offshore the stack heights of the turbines are set according to the safety margin necessary for helicopter flights. Therefore the stacks heights modelled were according to any safety considerations. The stack heights of the turbines on DQ1 platform are assumed to be 22m.

Table 2.2: Emission sources

Source	Location	
	Easting (m)	Northing (m)
ACG - DQ1	530085	4433190
ACG - C&WP		
Shah Deniz	HOLD	

2.2.3 Process data

NO_x CO and SO_2 emissions were modelled as gaseous pollutants emitted in continuous bouyant plumes from the terminal. The release conditions likely to result in the highest ground level concentrations were assumed. For EOP the flue gases velocity, concentration and temperature data have been taken from the monitoring data of the existing terminal for

1999 (Reference 1; PSA Compliance Testing, 6 July 1999, Dames & Moore 31648-019-456). The emissions from the future terminal expansion for ACG FFD Phase 1 and Shah Deniz have used manufacturers data in the air dispersion modelling. The height of the stacks for ACG was assessed using preliminary air dispersion modelling, which show that 20m are necessary for the gas turbines at Sangachal Terminal. The stack heights for the Shah Deniz fired heaters and gas turbines are left the same as the EOP stack heights for similar equipment. The stack heights on Shah Deniz are likely to be installed higher than this and hence this air dispersion modelling report will give an over estimate of ground level concentrations than will occur in practice. The NO_x CO, SO_2 and VOC's mass emissions have been calculated on the basis of continual normal operations. The SO_2 mass emissions have been based on an assumed level of H_2S at 500ppm, until the level of H_2S in the reservoir is confirmed the project is assuming this concentration.

2.3 Modelling Approach

The emissions from the process were modelled using atmospheric dispersion model ADMS3. Information needed for input into a dispersion model includes process conditions, meteorological data, topography of the area and buildings in the vicinity.

The maximum predicted ground level concentrations attributable to emissions from the plant were assessed, including background concentrations of pollutants to estimate the overall maximum concentration of $NO_{2,}$ CO, SO_2 and VOC's in the vicinity of the plant. These combined concentrations were compared to air quality standards and guidelines.

This method was carried out at the Sangachal Terminal for the existing facilities, EOP, and the future facilites, ACG FFD Phase 1 and SD Stage 1, and the offshore platforms, DQ1 & C&WP.

2.3.1 Air Dispersion Model

ADMS was used to model releases from the Sangachal Terminal and Offshore platforms. ADMS is a "new generation" computer based model widely accepted as the industry standard in the UK. It is capable of modelling dispersion in the atmosphere of passive, buoyant or slightly dense, continuous or finite duration of releases from single or multiple sources. The current version is ADMS3, which can take into account topography of the area and the influence of buildings on the dispersion of material released from the source.

ADMS uses the atmospheric boundary layer and the reciprocal of the Monin-Obukhov length to calculate the effect of dispersion in the atmosphere. The boundary layer is defined by measurable physical parameters obtained from meteorological data, which allows for a more realistic representation of the changing characteristics of dispersion with height. This results in a more soundly based prediction of the concentration of pollutants than Gaussian dispersion models.

The model can take into account emissions from the source, location of nearby buildings, topography and meteorological data for the local area. The model will then provide a predicted concentration of the substance of interest at a specified point. The process is re-iterated for a large number of meteorological conditions and at a large number of receptor points to build up a prediction of the long term mean and short term peak concentrations over the area of interest.

Models of atmospheric dispersion are generally more reliable for long period averages, than short period means and are generally more reliable over intermediate distances (100m – 1000m) than very close to the source, or further away from the source, due to the range of data that is used to compile the models. Where emissions data is unreliable or the averaging periods are short, the results may become less reliable. For this reason a conservative approach has been used throughout the study, which will ensure that the modelled results are over estimates of the levels that would arise in practice.

2.3.2 Meteorological data

The meteorological data used for the study at Sangachal was sequential data from Mahackhala, 1997. Sequential data uses actual values that have been recorded for each hour at the Meteorological station; hence the meteorological condition that gives rise to the worst ground level concentration will be included. This site is located on the coast north of Baku and was considered to be the only representative data available for the Sangachal area. This data was also used for the offshore area for the same reasons. Meteorological data required by the model includes wind speed, wind direction, temperature and cloud cover.

2.3.3 Buildings and Topography

There were no buildings of significant size and proximity to the sources of emissions that were necessary to include in the modelling. The area around the terminal is a rural area and the gradient of the land to the west of the terminal rises gradually towards the mountains which were judged to be far enough away to not significantly influence the ground level concentrations. The modelling took the terrain into account by using a roughness factor of 0.1.

2.3.4 Receptors and Contours

Predictions of pollutant concentrations are made at user defined locations known as receptors. In this study the location of receptors has been defined This will result in the calculation of ground level concentration at sensitive locations.

The locations identified onshore were:

Location	X (m)	Y (m)
Sangachal terminal, ACG FFD Phase 1	9370555	4452844
Sangachal Town	9367000	4450400
Nearest landfall	9447000	4459000
Shah Deniz terminal	9370704	4452653
Zilhoy island	9465000	4466000

The modelled concentrations were processed using the widely used contour plotting package Surfer (version 6.04) to produce contour plots of the model results for the base case. These are for illustrative purposes only as the assessment of the modelled results is based on the numerical results predicted by ADMS.

2.3.5 Baseline Air Quality

The background concentration of NO_x SO2 and CO has been taken from the Air Monitoring report (Reference 2: AIOC Air Quality Survey 2000, R. Finney) undertaken in 2000 by bp. These background levels have been added to the results of the Air dispersion modelling to allow comparison with the appropriate Air Quality Standard.

Baseline Air Quality was monitored by bp in 1997 prior to the start of EOP, and in 2000, when EOP was in operation. Ambient levels of NO_x, SO_2 and hydrocarbons were monitored and reported. Diffusion tubes were deployed and analysed during the surveys, and were set up at pre-determined locations. Diffusion tubes give average concentrations over the exposure time, hence these results are used for background annual average concentrations. Both 1997 and 2000 survey results were assessed to ensure that there will be no ‘double counting’ of the EOP emissions in the air dispersion modelling results.

The baseline ambient air quality data reviewed as part of this study is presented in Table 2.3, following.

Table 2.3: Baseline data

Background concentrations	Nitrogen Dioxide		Sulphur Dioxide	
	Hourly mgm^{-3}	Annual mgm^{-3}	Hourly mgm^{-3}	Annual mgm^{-3}
Terminal	6	3	56	28
Sangachal Town	8	4	12	6
Landfall	4	2	12	6

In estimating the background level appropriate for assessing the impact of short term predicted concentrations the procedure has been followed from the UK Technical Guidance on local air quality management (TG4), 'Pollution specific guidance', [ref: 3]. The report recommends that twice the annual mean be used as a background concentration for consideration of short term mean concentrations. Therefore the annual mean taken from the diffusion tube results was doubled for the background hourly mean.

2.3.6 Air Quality Standards and Guidelines

The current air quality standards and guidelines were used in assessing the significance of the predicted concentrations of CO, SO_2 and NO_2. These are presented below in Table 2.3. There are currently no air quality standards for VOC's.

Table 2.4: International Standards and Guidelines of Air Quality

Pollutant	Air Quality Objectives		
	Concentration mgm^{-3}	Averaging period	International Standard or guideline
Nitrogen Dioxide	200	1 hour mean (99.8%ile)	WHO, EC, UK
	40	Annual mean	WHO, EC, UK
Sulphur Dioxide	500	10 minutes	WHO
	266	15 minutes (99.9%ile)	EC, UK
	350	1 hour mean (99.7%ile)	EC, UK
	125	24 hour mean (99.2%ile)	WHO, EC, UK
	50	Annual mean	WHO
Carbon Monoxide	10000	Rolling 8 hour average	WHO, UK

NB 99.8%ile = standard not to be exceeded more than 18 times per year
99.9%ile = standard not to be exceeded more than 35 times per year
99.7%ile = standard not to be exceeded more than 24 times per year
99.2%ile = standard not to be exceeded more than 3 times per year.

There are two standards for SO_2 short term averages; namely 15 minute EU standard is 266 μgm^{-3} and the WHO standard of 500 μgm^{-3} for a 10 minute average. This comparison has used the more stringent EU standard of 266 μgm^{-3} not to be exceeded more than 35 times per year.

There is currently no standard for VOC's, therefore the air dispersion modelling of VOC's as fugitive emissions has been carried out for future reference and use.

2.4 Assumptions

2.3.7 NO:NO_2 ratio

The emissions data were given in the form of emissions of total NO_x, that is NO and NO_2. NO_2 would normally be expected to make up only 20% of the NOx released. This is consistent with information provided by the DETR (1998) [Ref: 4], which indicates that when evaluating the environmental effects of combustion point sources, it is reasonable to assume 20% of the NO is converted to NO_2 by the time it reaches ground level. However, the guidance recommends a conservative approach of using 50% of the NO_x present is NO_2. This approach has been used in this study.

2.3.8 Operating hours

The worst-case scenario of the Terminal operating for 8760 hours per year was assumed for the modelling study.

2.3.9 Worst Case Assumptions

The worst-case assumptions are summarised below.

- Continuous operation was assumed in evaluating the effects of the emissions
- The air dispersion modelling was conducted for normal operations and for Emergency shut down situations with emissions from flaring included for ACG FFD Phase 1 and EOP, and separately for Shah Deniz Stage 1.
- The modelled concentration at pre-determined sensitive receptors has been predicted in the study.
- NO:NO_2 ratio. The emissions data were given in the form of total NO_x. DETR guidance suggests 20% of the NOx is present as NO_2, thereby using 50% is taking a conservative approach.
- The concentration of H_2S in the reservoir is as yet unknown, therefore an assumed value of 500 ppm has been taken.

3 Results

3.1 Dispersion Model results

3.1.1 Onshore

The spatial distribution of the predicted concentrations of NOx, CO, VOC's and SO_2 emitted from the Sangachal Terminal are presented as contour plots. The plots present the results for annual and hourly mean predictions of NO_2 during normal operations, with DLE Gas Turbines and during flaring episodes from ACG and EOP and independently from Shah Deniz. There are also contour plots for annual mean SO_2, CO plots are for rolling 8 hour mean and VOC's are annual average.

The peak predicted ground level concentration resulting from Sangachal Terminal emissions in 2005 have been assessed for their impact on air quality. The peak represents the highest concentration predicted at any location. The results show the expected concentration at the predetermined receptors.

The numerical values have been assessed as follows. The predicted background concentration in the area was added to the predicted Process Contribution (PC) from the terminal site to give a Predicted Environmental Concentration (PEC), which has then been compared to the relevant Air Quality Standard (AQS) for NO_x CO and SO_2 concentrations, as shown in Tables 3.1 to 3.6 following.

Table 3.1: Nitrogen Dioxide Normal Operations, no flares

Receptor	AQS *ugm^{-3}*	Background *ugm^{-3}*	NOx *ugm^{-3}*	PEC *ugm^{-3}*	PEC/AQS %
Maximum hourly average					
Terminal	200	6	97	103	51.5
Sangachal Town	200	8	24	32	16
Nearest Landfall	200	4	1.5	5.5	3
Shah Deniz site	200	6	114	120	60
Zilhoy island	200	4	1	5	3
Maximum Value	200	6	127	133	66.5
Location of maximum value = 9370500,4452700					
Annual Average					
Terminal	40	3	3	6	15
Sangachal Town	40	4	0.2	4.2	10.5
Nearest Landfall	40	2	0.045	2.045	5.1
Shah Deniz site	40	3	3	6	15
Zilhoy island	40	2	0.035	2.035	5.1
Maximum value	40	3	10	13	32.5
Location of Maximum value = 9370100, 4452700					

Table 3.2: Nitrogen Dioxide Normal Operations, flaring from ACG FFD Phase 1and EOP

Receptor	AQS *ugm^{-3}*	Background *ugm^{-3}*	NOx *ugm^{-3}*	PEC *ugm^{-3}*	PEC/AQS %
Maximum hourly average					
Terminal	200	6	97	103	51.5
Sangachal Town	200	8	44	52	26
Nearest Landfall	200	4	3.5	7.5	3.75
Shah Deniz site	200	6	135	141	70.5
Zilhoy island	200	4	2.5	6.5	3.25
Maximum Value	200	6	138	144	72

Location of maximum value = 9370900, 4452700					
Annual Average					
Terminal	40	3	3	6	15
Sangachal Town	40	4	0.2	4.2	10.5
Nearest Landfall	40	2	0.045	2.05	5.1
Shah Deniz site	40	3	3	6	15
Zilhoy island	40	2	0.04	2.04	5.1
Maximum value	40	3	10	13	32.5
Location of maximum value = 9370100, 4452700					

Table 3.3: Nitrogen Dioxide Normal Operations, flaring from Shah Deniz

Receptor	AQS *ugm^{-3}*	Background *ugm^{-3}*	NOx *ugm^{-3}*	PEC *ugm^{-3}*	PEC/AQS %
Maximum hourly average					
Terminal	200	6	97	103	51.5
Sangachal Town	200	8	45	53	26.5
Nearest Landfall	200	4	5.5	9.5	4.8
Zilhoy island	200	4	4.5	8.5	4.3
Maximum Value	200	6	146	152	76
Location of maximum value = 9370100, 4452500					
Annual Average					
Terminal	40	3	3	6	15
Sangachal Town	40	4	0.2	4.2	10.5
Nearest Landfall	40	2	0.05	2.05	5.1
Zilhoy island	40	2	0.04	2.04	5.1
Maximum value	40	3	10	13	32.5
Location of maximum value = 9370100, 4452700					

Table 3.4: Nitrogen Dioxide Normal Operations, No flaring, Gas turbines fitted with DLE NOx

Receptor	AQS *ugm^{-3}*	Background *ugm^{-3}*	NOx *ugm^{-3}*	PEC *ugm^{-3}*	PEC/AQS %
Maximum hourly average					
Terminal	200	6	33	39	20
Sangachal Town	200	8	7	15	7.5
Nearest Landfall	200	4	0.5	4.5	2.3
Shah Deniz site	200	6	32	38	19
Zilhoy island	200	4	0.4	4.4	2.2
Maximum Value	200	6	50	56	11
Location of maximum value = 9370700, 4452900					
Annual Average					
Terminal	40	3	2.5	5.5	13.8
Sangachal Town	40	4	0.05	4.05	10
Nearest Landfall	40	2	0.02	2.02	5
Shah Deniz site	40	3	1	4	10
Zilhoy island	40	2	0.02	2.02	5
Maximum value	40	3	6	9	22.5
Location of maximum value = 9370700, 4452900					

Table 3.5: Sulphur Dioxide All sources

Receptor	AQS *ugm^{-3}*	Background *ugm^{-3}*	SO_2 *ugm^{-3}*	PEC *ugm^{-3}*	PEC/AQS %
Maximum hourly average					
Terminal	350	30	306	336	96
Sangachal Town	350	12	38	50	14
Nearest Landfall	350	12	3	15	4.3
Shah Deniz site	350	30	205	235	67
Zilhoy island	350	12	2	14	4
Maximum Value	350	30	1040	1070	305
Location of maximum value = 9370300, 4452700					
Annual Average					
Terminal	50	15	9	24	48
Sangachal Town	50	6	0.3	6.3	12.6
Nearest Landfall	50	6	0.08	6.08	12
Shah Deniz site	50	15	17	32	64
Zilhoy island	50	6	0.07	6.07	12
Maximum Value	50	15	42	57	114
Location of maximum value = 9370300, 4452700					
Maximum 15 minute average					
Terminal	266	N/A	352		132
Sangachal Town	266	N/A	62		23.3
Nearest Landfall	266	N/A	5		2
Shah Deniz site	266	N/A	249		94
Zilhoy island	266	N/A	4		1.5
Maximum value	266		1140		429
Location of maximum value = 9370300, 4452700					

Table 3.6: Carbon Monoxide All sources

Receptor	AQS *ugm^{-3}*	Background *ugm^{-3}*	CO *ugm^{-3}*	PC/AQS %
Rolling 8 hour average				
Terminal	10000	N/A	395	3.95
Sangachal Town	10000	N/A	214	2.14
Nearest Landfall	10000	N/A	46	0.5
Shah Deniz site	10000	N/A	296	3
Zilhoy island	10000	N/A	35	0.35
Maximum Value	10000	N/A	1170	11.7
Location of maximum value = 9369300, 4452700				

Table 3.7: VOC's All sources

Receptor	AQS *ugm^{-3}*	Background *ugm^{-3}*	VOC *ugm^{-3}*	PC/AQS %
Annual Average				
Terminal	N/A		42	
Sangachal Town	N/A		2	
Nearest Landfall	N/A		0.5	
Shah Deniz site	N/A		17	
Zilhoy island	N/A		0.4	

3.1.2 ACG - Offshore

The situation offshore differs from onshore as there are no significant receptors in the offshore area, the nearest island is 25 km away at Oily Rocks and the closest mainland is 100 km away. The model is not accurate at distances this far away, but the results have been incorporated to assess the impacts of the offshore facilities on the sensitive receptors on land.

The predicted concentrations of NO_x, SO_2 and CO, due to the operation of the DQ1 and C&WP, have been compared to the relevant AQS at the pre-determined locations onshore. The results of annual and hourly mean predictions for NOx, 15 minute, hourly and annual mean for SO_2, and 8 hour rolling average for CO have been compared with the internationally recognised air quality standards, as shown in the following tables. The numerical values have been assessed in the same way as for the onshore results, adding the predicted value to the background concentration at the pre-determined receptors.

Table 3.8: Nitrogen Dioxide Normal Operations

Receptor	AQS *ugm^{-3}*	Background *ugm^{-3}*	NOx *ugm^{-3}*	PEC *ugm^{-3}*	PEC/AQS %
Maximum hourly average					
Terminal	200	6	12	18	9
Sangachal Town	200	8	12	20	10
Nearest Landfall	200	4	22	26	13
Shah Deniz site	200	6	12	18	9
Zilhoy island	200	4	16	20	10
Location of maximum value = 9370500,4452700					
Annual Average					
Terminal	40	3	0.05	3.05	7.6
Sangachal Town	40	4	0.05	4.05	10
Nearest Landfall	40	2	0.02	2.02	5
Shah Deniz site	40	3	0.05	3.05	7.6
Zilhoy island	40	2	0.01	2.01	5
Location of Maximum value = 9370100, 4452700					

Table 3.9: Sulphur Dioxide All sources

Receptor	AQS *ugm^{-3}*	Background *ugm^{-3}*	SO_2 *ugm^{-3}*	PEC *ugm^{-3}*	PEC/AQS %
Maximum hourly average					
Terminal	350	30	5	35	10
Sangachal Town	350	12	5	17	5
Nearest Landfall	350	12	9	21	6
Shah Deniz site	350	30	5	35	10
Zilhoy island	350	12	7	19	5.4
Location of maximum value = 9370300, 4452700					
Annual Average					
Terminal	50	15	0.1	15.1	30
Sangachal Town	50	6	0.1	6.1	12
Nearest Landfall	50	6	0.03	6.03	12
Shah Deniz site	50	15	0.1	15.1	30
Zilhoy island	50	6	0.02	6.02	12
Location of maximum value = 9370300, 4452700					
Maximum 15 minute average					
Terminal	266	N/A	10		3.8
Sangachal Town	266	N/A	9		3.4
Nearest Landfall	266	N/A	18		6.8
Shah Deniz site	266	N/A	10		3.8
Zilhoy island	266	N/A	11		4
Location of maximum value = 9370300, 4452700					

Table 3.10: Carbon Monoxide All sources

Receptor	AQS *ugm^{-3}*	Background *ugm^{-3}*	CO *ugm^{-3}*	PC/AQS %
Rolling 8 hour average				
Terminal	10000		72	0.7
Sangachal Town	10000		65	0.7
Nearest Landfall	10000		40	0.4
Shah Deniz site	10000		72	0.7
Zilhoy island	10000		46	0.5
Location of maximum value = 9369300, 4452700				

4 Conclusions & Recommendations

The Air Dispersion Modelling has been carried out for the current operation of EOP at Sangachal Terminal and the proposed future development of ACG FFD Phase 1 and Shah Deniz Stage 1. It has also been carried out for the offshore platforms for ACG FFD Phase 1 and Shah Deniz Stage 1. The modelling shows that the predicted emissions of NO_x, SO_2 (except the extremely rigorous 15 minute mean) and CO are all well within the Internationally accepted Air Quality Standards.

4.1 Onshore

Bp has developed an Air Quality Criteria for AIOC that is intended as guidelines to limit the air quality impact at receptor locations in the vicinity of the Sangachal terminal. [reference AIOC Onshore and Offshore Crude Oil Production Operations; 18 August 2000]. The Air Quality Criteria suggests that 'the impact due to operations on ambient air quality should not exceed 20% of the concentration of the recognised Air Quality standards, for any pollutant at any receptor location, which is at a distance greater than 1 km from the boundary fence of the terminal'.

The results of this Air Quality study report show that locations greater than 1 km from the boundary fence fall within this criteria for CO and SO_2 (except the extremely rigid 15 minute average) under all conditions modelled. The concentration of H_2S is not yet known and further air dispersion will need to be carried out to assess the impacts of SO_2 when the information is available.

The predicted hourly average NO_x levels are greater than the 20% AIOC criteria during flaring episodes from either ACG and Shah Deniz. The hourly average NO_x levels at Sangachal town are predicted to be 44 μgm^{-3} during periods of ACG FFD Phase 1 and EOP flaring and 45 μgm^{-3} at Sangachal town during periods of Shah Deniz flaring. Flaring from ACG FFD Phase 1 and EOP has been modelled assuming a maximum time of 48 hour episode three times per year. Shah Deniz Stage 1 scenario flaring has assumed a one hour maximum flaring three times per year. The model will predict the conservative situation involving the meteorological condition that will result in highest ground level concentrations. Hence this modelling has shown the worst case situation that could occur if the meteorological conditions were such at the time of flaring.

Recommendations resulting from this would indicate that the AIOC Air Quality Criteria cannot be met during periods of flaring, but the Internationally recognised air quality standards are met, as flaring is necessary from a safety viewpoint and would only occur intermittently, the AIOC Air Quality Criteria should be amended to allow for this.

4.2 Offshore

Air Dispersion Models are not accurate over the long distance from the offshore platform to landfall, but the results show that the emissions from the offshore platforms are well dispersed and diluted over the distance to the mainland and offshore sources have very little contribution to air quality levels over the background concentration of local emission sources.

The impact of the offshore operations on the air quality onshore is extremely small and falls well within the AQS and the AIOC Air quality criteria of 20%.

REFERENCES

1. PSA Compliance Testing Dames & Moore 31648-019-456 July 1999
2. AIOC Air Quality Survey 2000 bp R. Finney
3. UK Technical Guidance of Local Air Quality Management TG4; Pollution Specific Guidance
4. DETR 1998NO:NO_2 ratio
5. AIOC onshore and offshore crude oil production operations bp August 2000
6. Dispersion Modelling during FFD of Shah Deniz facilities and in combination with AIOC Sangachal operations R. Finney Dec.2000

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ASA DRAFT REPORT

TITLE

Hydrodynamic and Dispersion Modeling for the Azeri, Chirag, Gunashi Field Offshore Baku, Azerbaijan

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CLIENT

URS Dames & Moore

PROJECT NUMBER

ASA 01-007

August 2001

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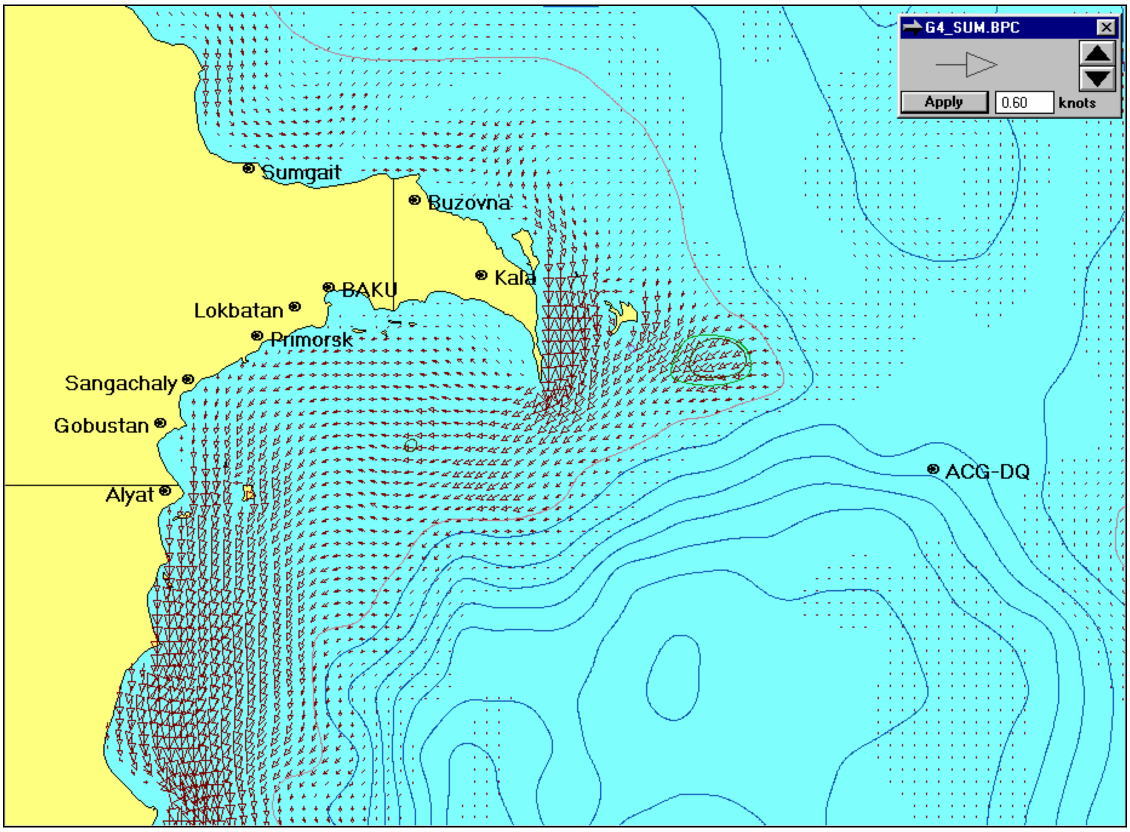

Executive Summary

URS Dames & Moore, contracted with Applied Science Associates, Inc. (ASA) of Narragansett, RI USA to provide environmental modeling support for an Environmental Impact Statement (EIS) to be developed for the Azeri, Chirag, Gunashi Field offshore Baku, Azerbaijan. The primary purpose of the environmental modeling was to simulate cooling water discharge and the dispersion of the associated antifouling fluid from the Production Drilling and Quarters (PDQ) and the Compression and Water (CW) Platforms as well as the deposition of mud and cuttings from drilling operations conducted by the PDQ Platform. In support of the above objectives hydrodynamic simulations were developed for the entire Caspian Sea with high resolution in the area offshore Baku using ASA's HYDROMAP; thermal dispersion simulations were conducted to characterize cooling water discharges using the CORMIX near field dispersion modeling system; cooling water antifoulant dispersion simulations were conducted using ASA's CHEMMAP; and mud and drill cutting simulations were conducted using ASA's MUDMAP.

Hydrodynamic simulations were conducted for the Caspian Sea using 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 in the northern Caspian on the order of 20 km and finer resolution in the southern Caspian with resolutions on the order of 5 and 2.5 km in the Baku region. The environmental forcing for the hydrodynamic model consisted of wind data obtained from the numerical atmospheric model: NCEP reanalysis, provided by NOAA-CIRES Climate Diagnostics Center, Boulder Colorado. The hydrodynamic model was validated using current meter data collected by the Azerbaijan International Operating Company along a pipeline route between Chirag and Sangachal Bay within the Caspian Sea 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 to reproduce the major current trends within the region very well with the model being 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 that can be attributed to local bathymetric or shoreline characteristics not resolved by the computational grid.

Thermal dispersion simulations were conducted for cooling water discharges of 600 m^3/hr, at 11 m depth, and 1700, 4200 and 5900 m^3/hr, at 60 m depth, from the Production Drilling and Quarters Platform and the Compression and Water Platform within the Azeri, Chirag and Gunshali Field during summer and winter using COREMIX. The location of these discharges is expected to be within 60 to 200 m of each other, which is less than the resolution of the hydrodynamic model. Therefore, simultaneous operation of the 1700 and 4200 m^3/hr, Production and Drilling Quarters Platform and the Compression and Water Platform, respectively, were combined to form a single 5900 m^3/hr discharge. A parametric study was conducted to study the seasonal dispersion characteristics of the cooling water for these various flow rates for horizontal and vertical discharge orientations. During the summer the thermal plume, for the 60 m discharges, reaches ambient conditions after traveling approximately 20 m upwards regardless of the discharge orientation. At this depth there exists a strong thermocline in which the upper layer temperature is approximately the same as the original discharge temperature. During the winter the thermal plume, for the 60m discharges, reaches ambient conditions after traveling approximately 40 m upwards, with the vertical discharges traveling slightly further. the greater upward extent of the thermal plume during the winter is due to the much colder vertical well mixed structure of the water column, relative to the summer. The upward extent of the thermal plume for the 600 m^3/hr discharges, released at 11 m depth, at which ambient conditions were achieved was between 4 and 6 m from the surface for both seasons. The horizontal distance the plume traveled away from the discharge and the maximum diameter were directly proportional to the discharge velocity, ambient current conditions and the discharge orientation relative to the current. For example a discharge released inline with the maximum current has a greater horizontal excursion and plume diameter relative to a vertical release under average conditions.

The dispersion of antifoulant, copper and chlorine, contained within the cooling water was simulated for 1700, 4200 and 5900 m^3/hr flow rates using CHEMMAP. A conservative approach was taken in which the antifoulant material was assumed to be completely dissolved in the cooling water and only begins to disperse after the thermal plume has reached its maximum vertical extent. The maximum concentration of each constituent was directly proportional to the discharge flow rate and the initial release concentration. The maximum concentration of copper ranged from 0.0008 ppb to 0.005 ppb for the 1 ppb release at 1700 m^3/hr and the 2 ppb release at 5900 m^3/hr, respectively. The maximum concentration of chlorine ranged from 0.007 ppb to 11.2 ppb for the 10 ppb release at 1700 m^3/hr and the 4000 ppb release at 5900 m^3/hr, respectively. The dispersion pattern never carried any constituent to the surface but rather showed a vertical spread on the order of 10 m around the release site.

A series of mud and drill cutting simulations were conducted for 9 and 34 wells during average and maximum current conditions for the summer and winter seasons. In general the heavier cuttings settled very near the drill site with lighter particle being carried downstream by the current before settling. The predicted deposition pattern during the average winter conditions is offset to the northwest with two distinct but attached regions with maximum deposition of 560000 and 2250000 µm near the drill site for the 9 and 34 wells, respectively. The predicted deposition pattern during the maximum winter conditions is elongated to the south-southeast with maximum deposition of 300000 and 1150000 µm near the drill site for the 9 and 34 wells, respectively. The predicted deposition pattern during the average summer conditions is roughly centered on the release with maximum deposition of 600000 and 1200000 µm near the drill site for the 9 and 34 wells, respectively. The predicted deposition pattern during the maximum summer conditions is offset to the southeast with two distinct separate regions with maximum deposition of 560000 and 2000000 µm near the drill site for the 9 and 34 wells, respectively.

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1. Introduction

URS Dames & Moore, contracted with Applied Science Associates, Inc. (ASA) of Narragansett, RI USA to provide environmental modeling support for an Environmental Impact Statement (EIS) to be developed for the Azeri, Chirag, Gunashi Field offshore Baku, Azerbaijan (Figure 1). The primary purpose of the environmental modeling was to simulate cooling water discharge and the dispersion of the associated antifouling fluid from the Production Drilling and Quarters (PDQ) and the Compression and Water (CW) Platforms as well as the deposition of mud and cuttings from drilling operations conducted by the PDQ Platform. In support of the above objectives hydrodynamic simulations were developed for the entire Caspian Sea with high resolution in the area offshore Baku using ASA's HYDROMAP; thermal dispersion simulations were conducted to characterize cooling water discharges using the CORMIX near field dispersion modeling system; cooling water antifoulant dispersion simulations were conducted using ASA's CHEMMAP; and mud and drill cutting simulations were conducted using ASA's MUDMAP.

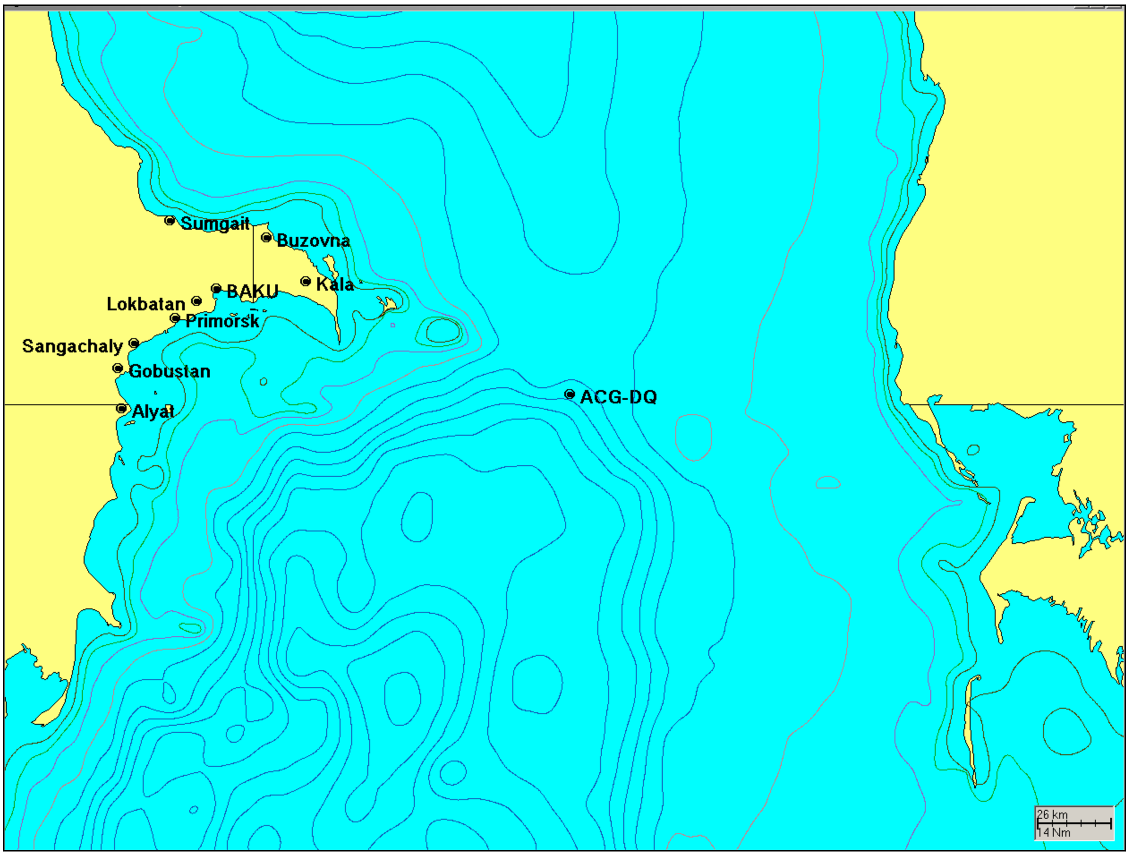

Figure 1. Northern Caspian Sea offshore Baku, Azerbaijan.

This reports documents the development of the hydrodynamic simulations and the objective environmental modeling. Section 1 discusses the purpose of the study and provides a description of the study area. Section 2 describes the models used for the environmental simulations. Section 3 presents the development, confirmation and application of the hydrodynamic model to the study area. Section 4 presents the simulation of the cooling water discharges. Section 5 presents the simulation of the dispersion of the cooling water antifouling chemicals. Section 6 documents the simulation deposition of drill cuttings and mud from the PDQ platform. Section 7 presents the major conclusions of the study and Section 8 list references.

1.1 Study Area

The Azeri, Chirag, Gunashi Field is located within the southern Caspian Sea approximately 75km offshore Baku, Azerbaijan (Figure 1). The Caspian Sea (Figure 2) is the largest inland water body on the planet and has no connections to the world oceans. It is elongated lattitudinally with a north to south length of 1030 km, a maximum width of 435 km and an average depth of 208 m. 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.

Figure 2. Caspian Sea.

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) but rather the currents correspond to the main wind fields and in calm weather only weak currents exist due to density difference. Thus the strongest and most stable of 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 the geometry of the region. Figure 3 presents typical current patterns for the Mid to Southern Caspian for northwesterly 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 are usually opposing 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.

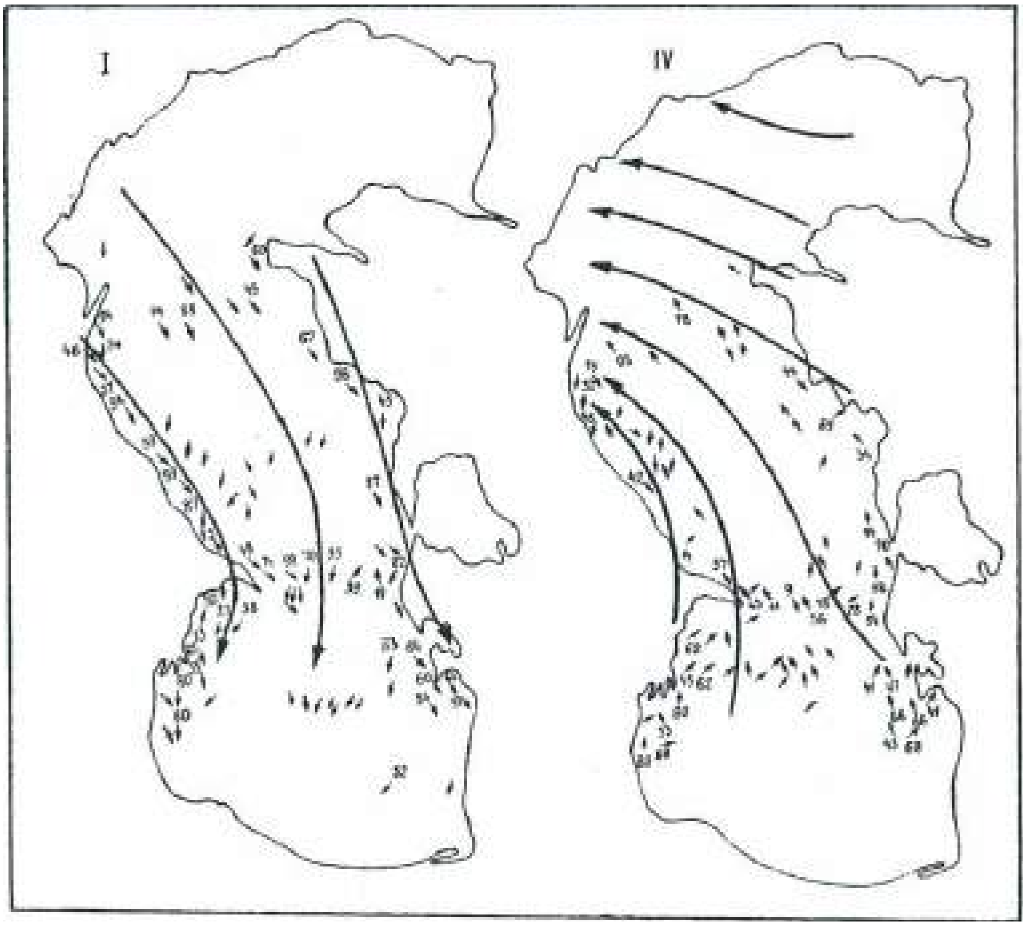

Figure 3. Surface currents developed from the influence of northwesterly (I) and southeasterly (IV) winds (Klevtsova, 1966). Long arrows represent wind direction, short arrows represent currents and the numbers indicate stability values in %.

Due to the large latitudinal variations of the Caspian Sea the distribution of temperature during the winter in the surface layers are not homogeneous and thermal gradients are small due to the intensive development of convectional mixing (Kosarev, 1994). During the summer the climatic conditions influencing the Caspian region are fairly uniform thus causing very little latitudinal thermal variation in the surface layers. However, during the summer thermoclines appear at 20-30 m with a characteristically strong thermal gradient (Kosarev, 1994). Figures 4 and 5 present characteristic water surface temperatures over the Caspian Sea, as presented in Kosarev (1994), for the months of February and August, respectively.

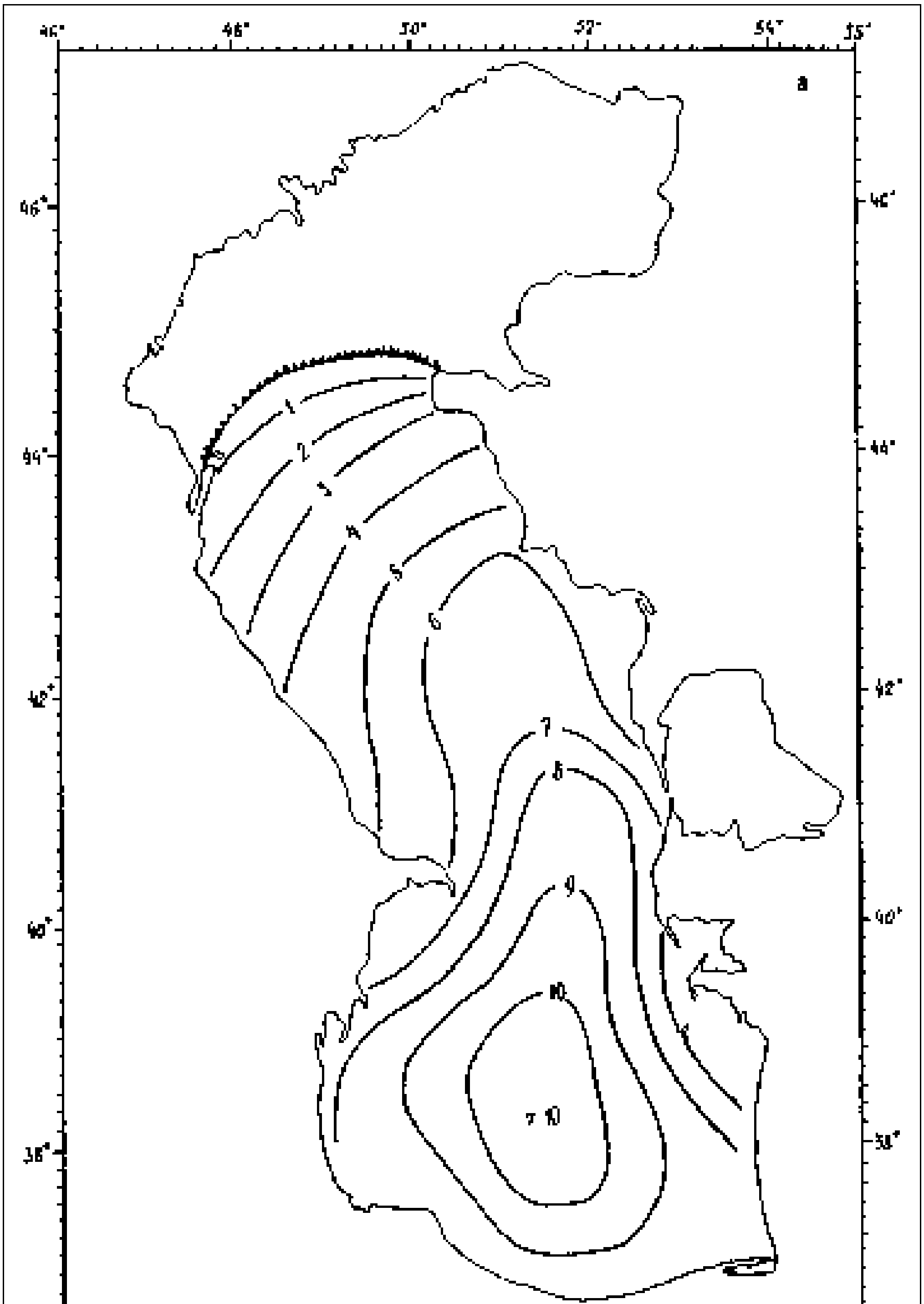

Figure 4. Characteristic surface water temperatures for the month of February (Kosarev, 1994).

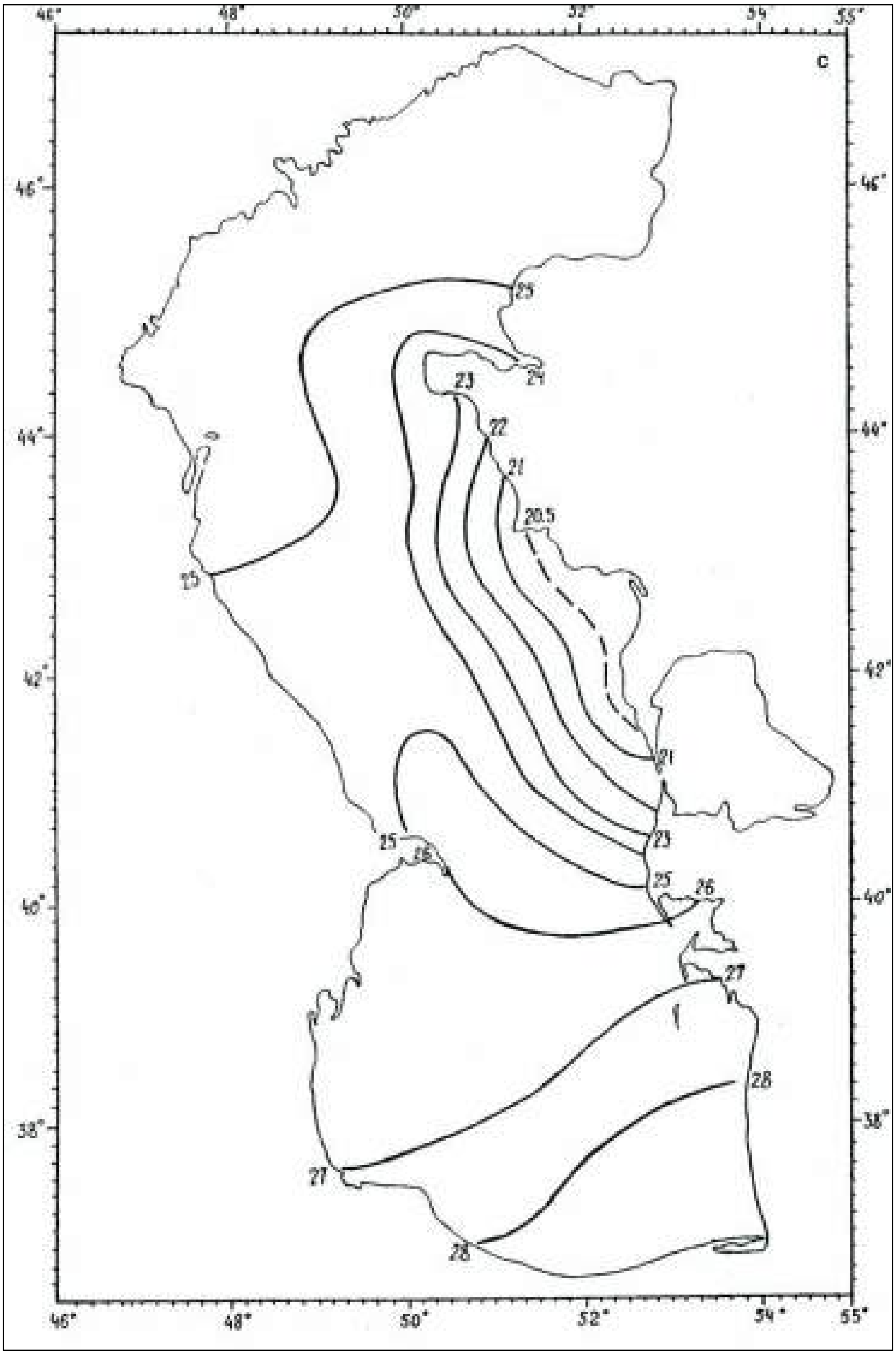

Figure 5. Characteristic surface water temperatures for the month of August (Kosarev, 1994).

2. Model Systems Description

In support of 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; thermal dispersion simulations were conducted to characterize cooling water discharges using the CORMIX near field dispersion modeling system; cooling water antifoulant dispersion simulations were conducted using ASA's CHEMMAP; and mud and drill cutting simulations were conducted using ASA's MUDMAP. The following sections provide a description of each modeling systems functionality and purpose.

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. The numerical solution methodology follows that of Davies (1977a, b) and Owen (1980). The vertical variations in horizontal velocity are described by an expansion of Legendre polynomials. The resulting equations are then solved by a Galerkin weighted residual method in the vertical and by an explicit finite difference algorithm in the horizontal. A space staggered-grid scheme in the horizontal plane is used 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 is used (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), for which the Courant-Friedrichs-Lewis (CFL) limit must be met, is solved first. The vertical structure of the horizontal components of the current then may be calculated such that the effects of surface gravity waves are separated from the three-dimensional equations of motion (internal mode). Surface gravity waves, therefore, 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).

2.2 COREMIX

CORMIX is an United States Environmental Protection Agency (USEPA) approved software system (USEPA 1991A, USEPA 1991B, and Jirka 1992) for the analysis, prediction and design of aqueous toxic or conventional pollutant discharges into diverse water bodies. The system is capable of simulating submerged single-port and multiport diffuser discharges as well as surface discharge sources for a variety of effluent types including conservative, non-conservative, heated or effluents containing suspended sediments. The model calculates a set of non-dimensional parameters based on ambient conditions, effluent data, and discharge geometry and then classifies the discharge flow into the appropriate flow regime. Once this is complete the model then calculates the plume centerline, plume width and depth, and centerline concentration and dilution as the plume moves through the receiving water body. A detailed description of CORMIX can be found in Jirka, Doneker and Hinton (1996).

2.3 CHEMMAP

CHEMMAP, developed by ASA, predicts the trajectory and fate of a wide variety of chemical products, including floating, sinking, soluble and insoluble chemicals and product mixtures. The chemical fates model estimates the distribution of chemical (as mass and concentrations) on the water surface, on shorelines, in the water column and in the sediments. The model is three-dimensional, separately tracking surface slicks, entrained droplets or particles of pure chemical, chemical adsorbed to suspended particulates, and dissolved chemical. Processes that are simulated include spreading, transport, dispersion, evaporation-volatilization, entrainment, dissolution, partitioning, sedimentation, and degradation.

The model uses physical-chemical properties to predict the fate of a chemical spill. These include density, vapor pressure, water solubility, environmental degradation rates, adsorbed/dissolved partitioning coefficients (K_{Ow}, K_{OC}), viscosity, and surface tension. These properties and others, required by the model to simulate the transport and fate of the spilled material, are contained within CHEMMAP's chemical database. The database includes a variety of text and numeric descriptors, with which the user may identify and characterize the spilled chemical or mixture. The model is capable of simulating spills of pure chemicals, chemicals in aqueous or hydrophobic solutions, or chemicals in emulsions (i.e., mixtures of particulate material suspended in an aqueous base). Thus, the database also includes characteristics that define these mixtures and solutions.

Chemical mass is transported in three-dimensional space and time, by surface wind drift, other currents, and vertical movement in accordance with buoyancy and dispersion. Stokes Law is used to compute the vertical velocity of pure chemical particles or suspended sediment with adsorbed chemical. If rise or settling velocity overcomes turbulent mixing, the particles will float or settle to the bottom and can be resuspended under the appropriate conditions. For surface slicks, the model estimates surface spreading, slick transport, entrainment into the water column, and evaporation, to determine trajectory and fate at the surface. Spreading is simulated using the algorithm of Fay (1971). Entrainment is modeled as for oil, using data in Delvigne and Sweeney (1988). Surface slicks interact with shorelines, depositing and releasing material according to whether the material is sticky and to shoreline type. The algorithms used are those developed for oil spills, as described in French et al. (1999).

2.4 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 (1996, 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. Hydrodynamic Simulations

3.1 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 gridding strategy (Isaji 2001). In the northern Caspian Sea coarse grid resolution, on the order of 20 km, is sufficient in order to capture the large scale dynamics and appropriate volumetric transport of water. The grid resolution was increased in the southern Caspian , 41.5°N southward, to approximately 5 km while a very fine scale grid of 2.5 km was applied within the Baku region of study. Figures 6 and 7 show the entire computational grid and the fine resolution grid within the Baku region, respectively.

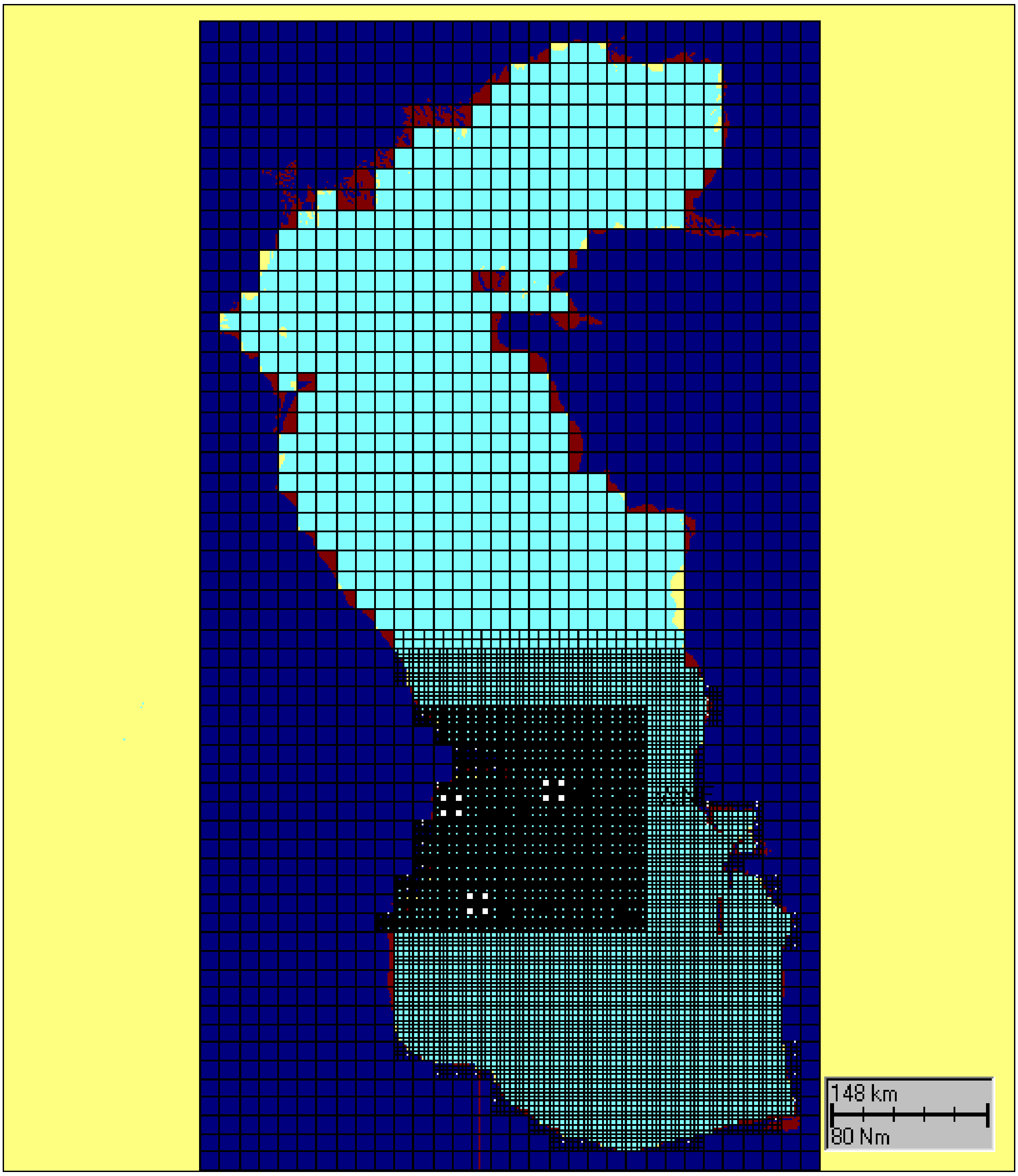

Figure 6. Caspian Sea hydrodynamic simulation computational grid.

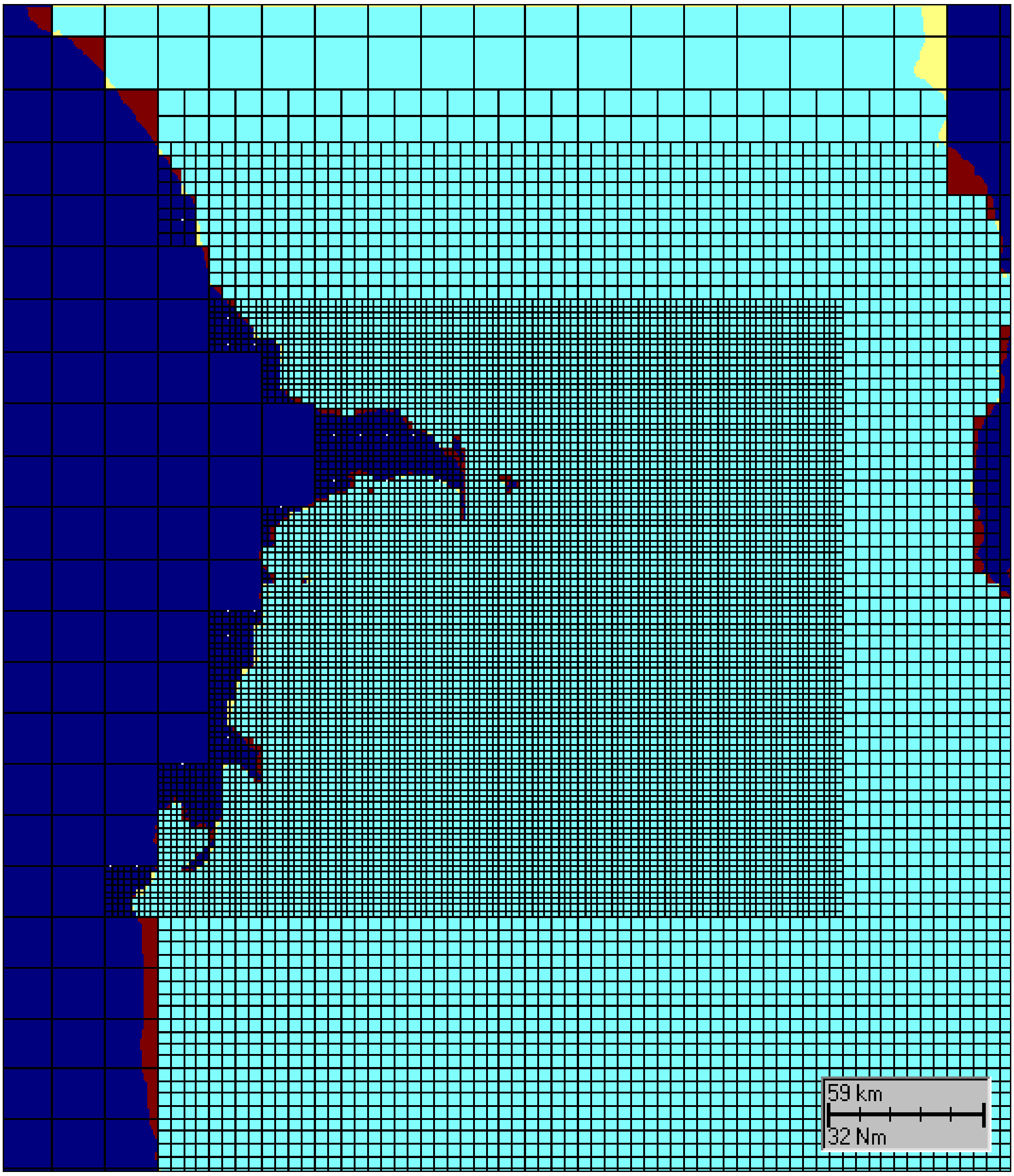

Figure 7. Computational grid offshore Baku.

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 Defense Ministry of the USSR and bathymetric isolines provided by the Caspian Environment Program (http://caspianenvironment.org). Figure 1 presents a sample of the bathymetric isoline offshore Baku.

3.2 Model Environmental Forcing Data

Environmental forcing data is used by the model to drive the circulation throughout the computational domain. These time varying data can be river flow input, 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 determine the seasonal time periods for the hydrodynamic simulations. Figure 8 presents monthly wind roses for these 10 years of data from a model grid location at 41.68° N 50.77° E.

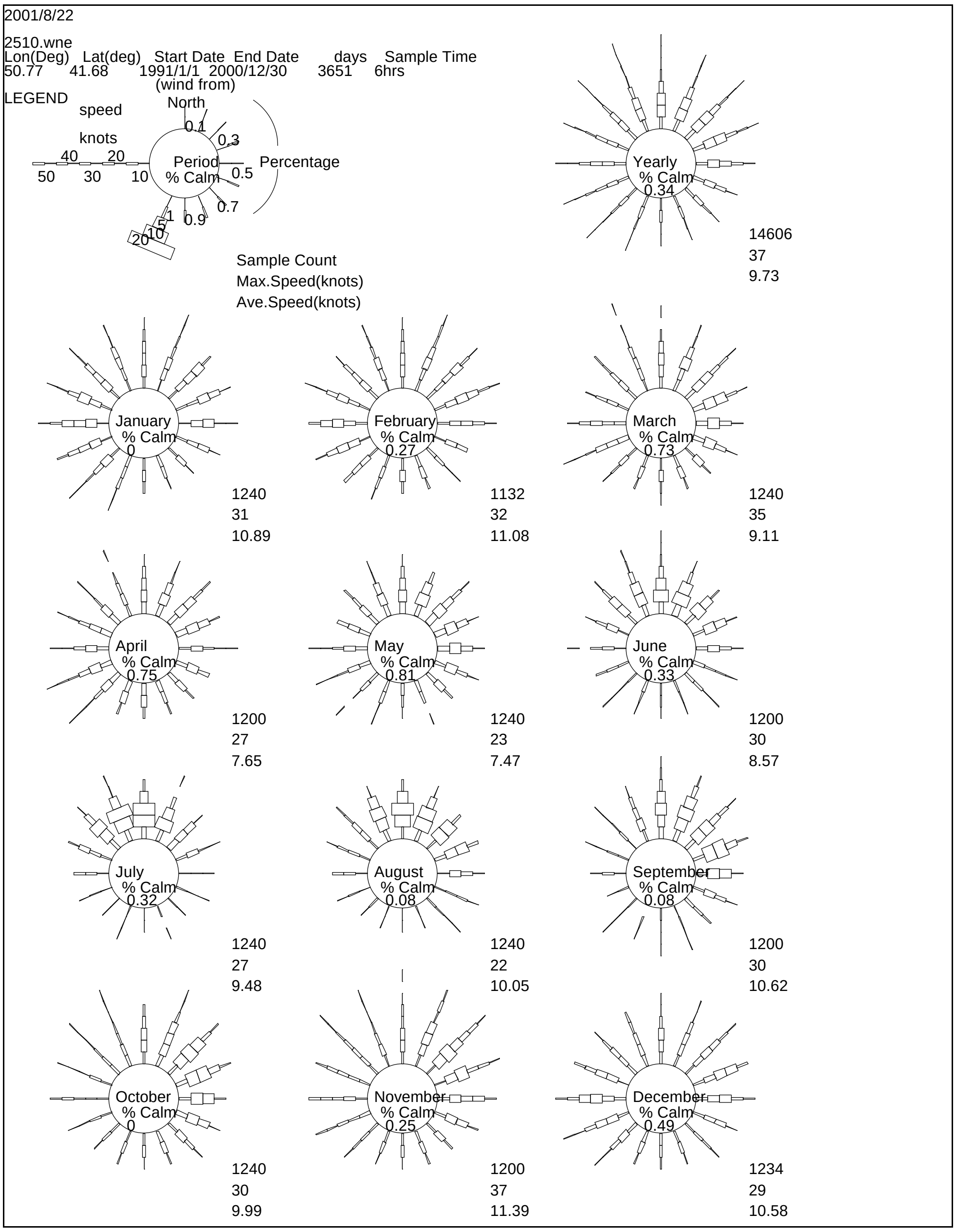

Figure 8. Wind rose generated from 10 years of NCEP model output at 41.68° N 50.77° E for the years 1991 through 2000.

Through inspection of the NCEP model output, the winter season was chosen to be from December through January, while the summer season was chosen as June through August. Within each season two characteristic two week periods were established based upon the wind climatology during which the hydrodynamic, thermal dispersion, anti-foulant dispersion, and mud and drill cutting simulations were conducted. The first of the two week periods for the winter is from 01 January to 15 January. This period is characterized by strong winds primarily from the northeast. The second of the two week periods for the winter season is from 15 January to 31 January. This period is characterized by strong winds highly varying from the north and south. The first of the two week periods for the summer is from 13 July to 28 July. This period is characterized by light variable winds predominantly from the northern and eastern quadrants. The second of the two week periods established for the summer was from 02 August to 17 August. This period is characterized by strong winds predominantly from the north. Once these periods were established the year 2000 was determined to be a typical year due to its having characteristics similar to those present in the 10 year wind rose plot (Figure 8). All simulations were conducted during this year using NCEP model output as the environmental forcing. Figure 9 presents monthly wind roses for NCEP model output data for the year 2000 from a model grid location at 41.68° N 50.77° E.

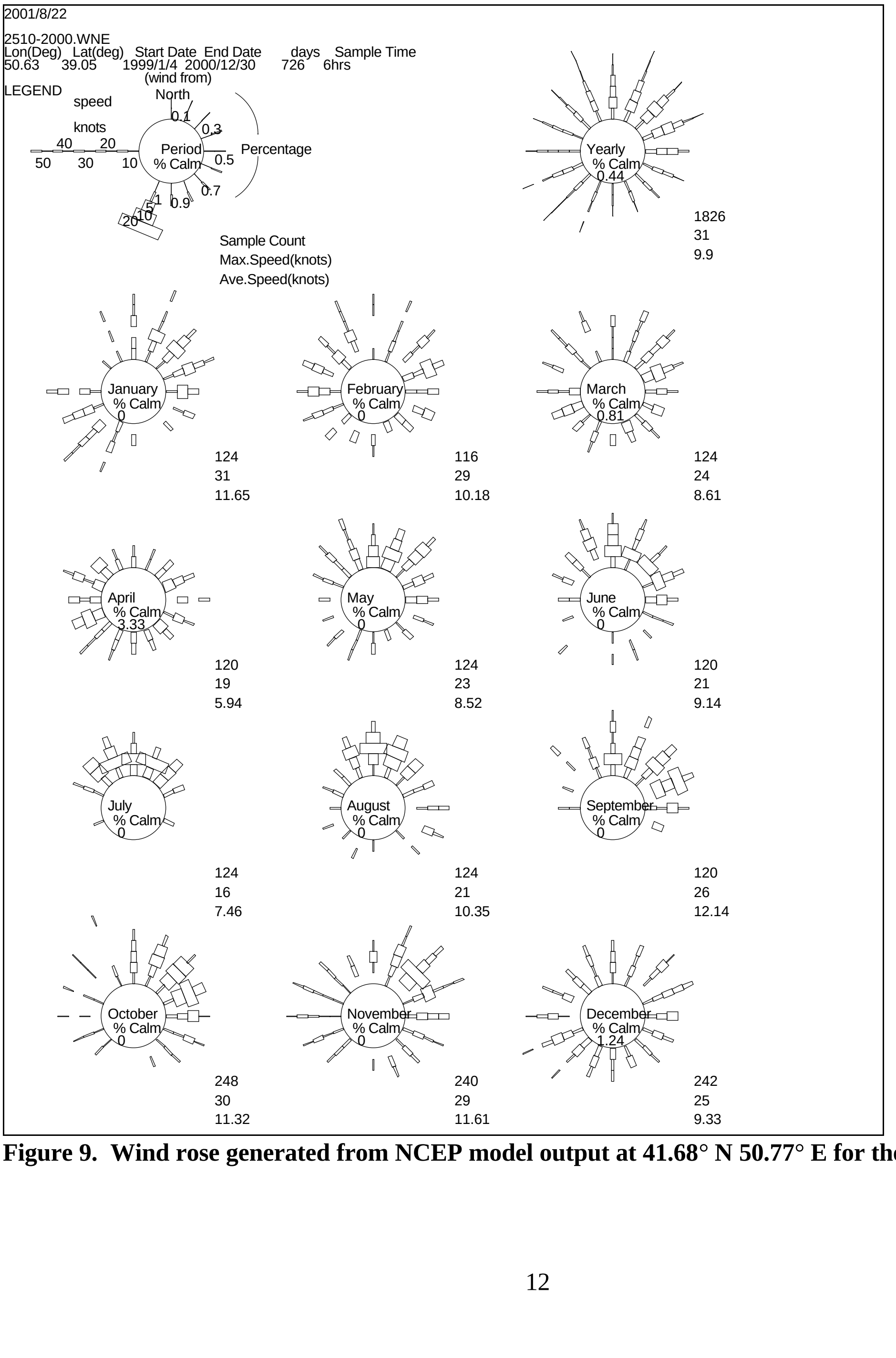

Figure 9. Wind rose generated from NCEP model output at 41.68° N 50.77° E for the year 2000.

3.2 Model Validation

The hydrodynamic model was validated through a comparison to current measurements collected by the Azerbaijan International Operating Company along a proposed pipeline route between Chirag and Sangachal in the Caspian Sea for the winter season from 01 February 2000 to 01 April 2000. Figure 10 shows the location of the data collection points designated KP174, KP145, KP115, KP85, KP65, and KP45. Note no data was available for site KP85 during this period.

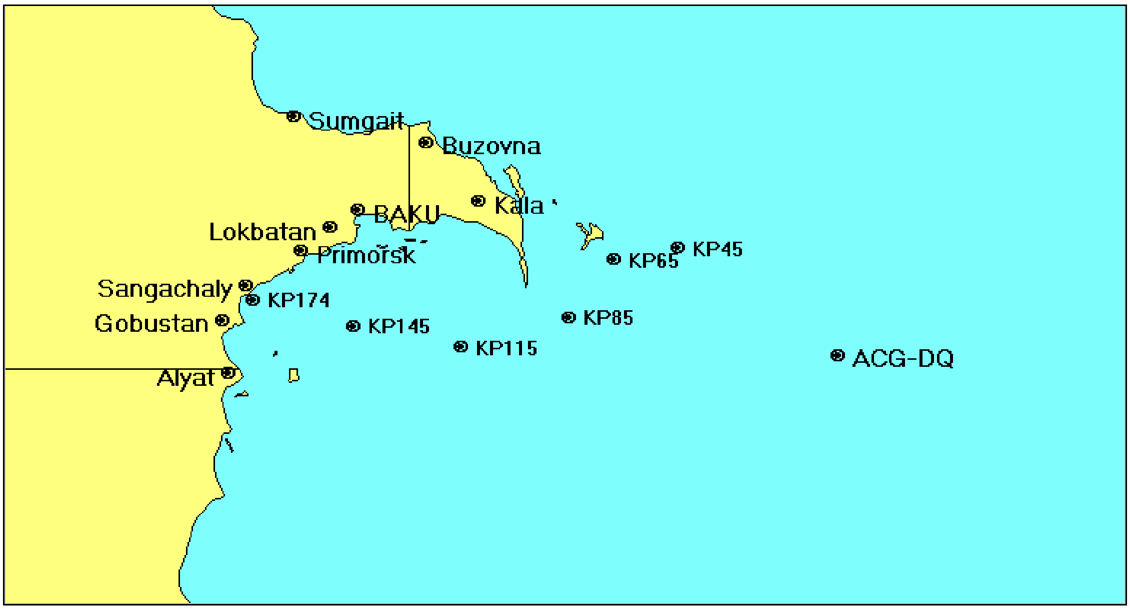

Figure 10. Current measurement data collection sites.

The observational data was prepared for comparison to the model predictions by first applying a bandpass filter with a frequency range of 12 and 0.25 cycles/day. This removed spurious non-weather related events from the data sets which is appropriate since the models only environmental forcing was wind stress. Once the filtering was complete the data was sub-sampled to match the hydrodynamic model output time step of 1 hour. The processed data was then 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 the 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.

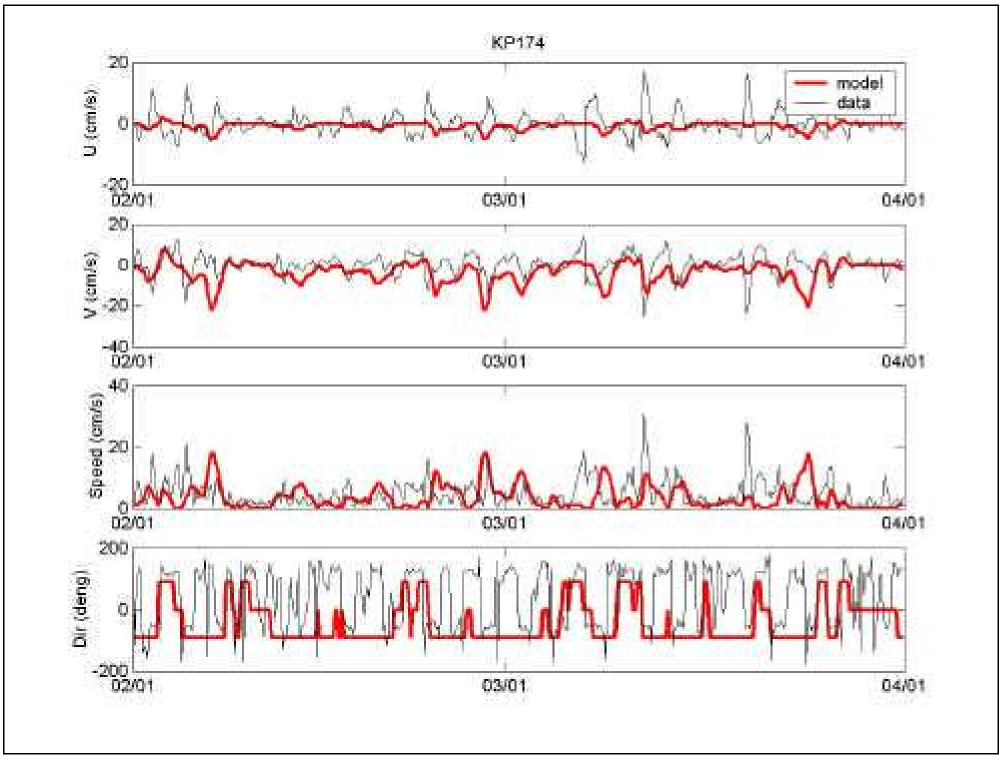

Figure 11. Qualitative model to data comparison at site KP174.

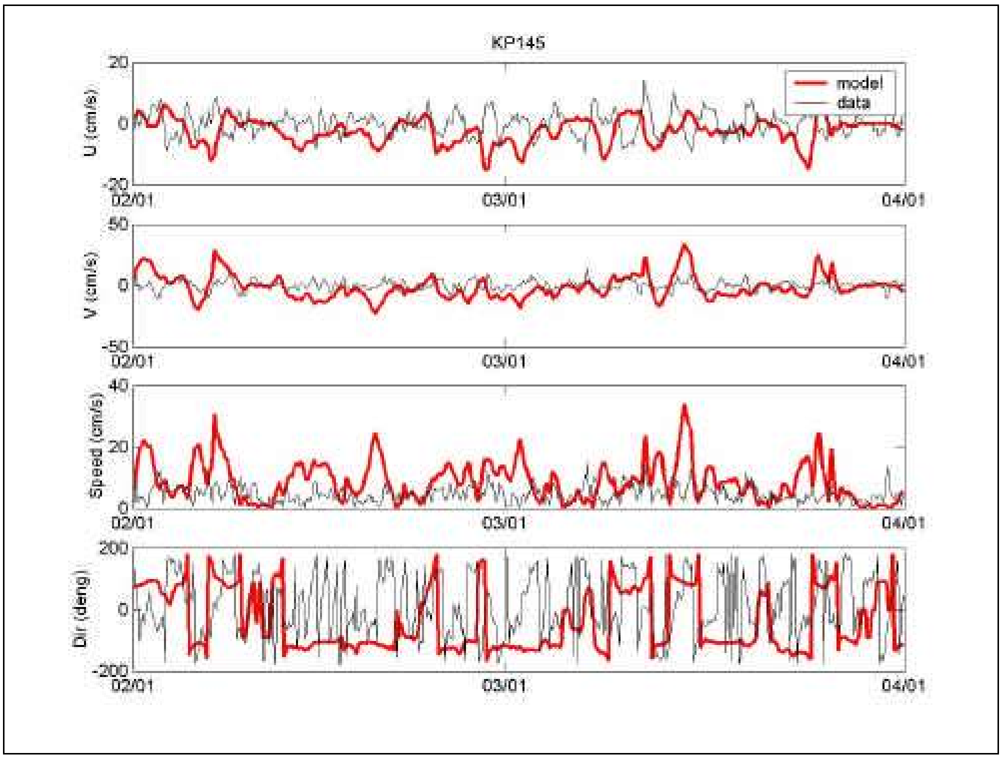

Figure 12. Qualitative model to data comparison at site KP145.

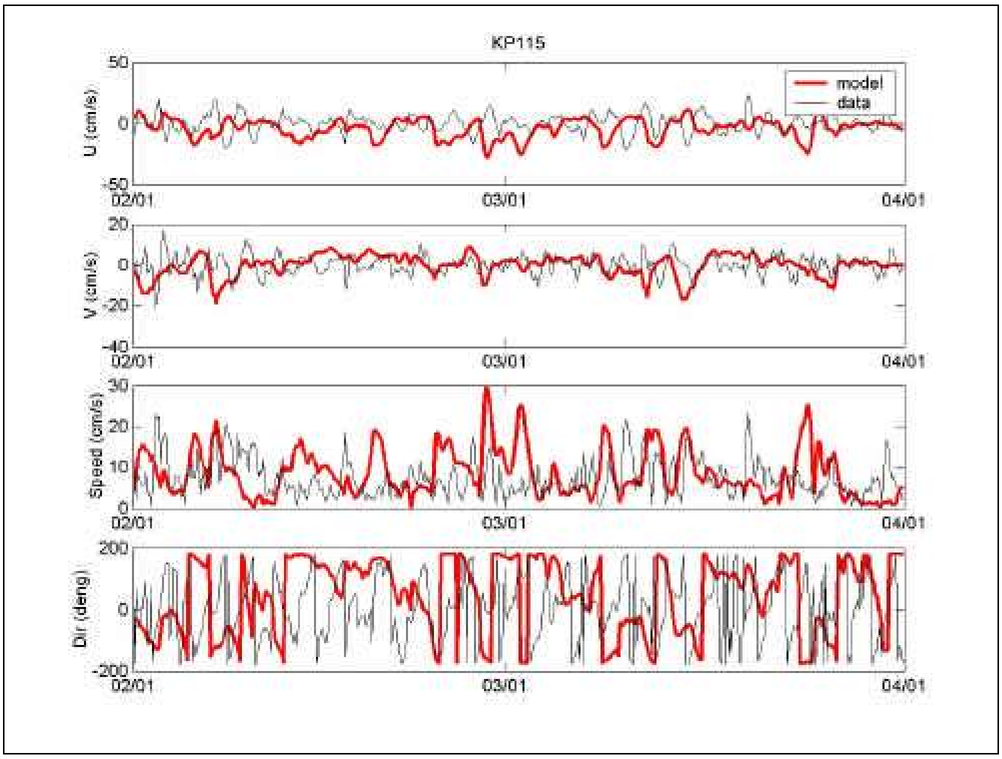

Figure 13. Qualitative model to data comparison at site KP115.

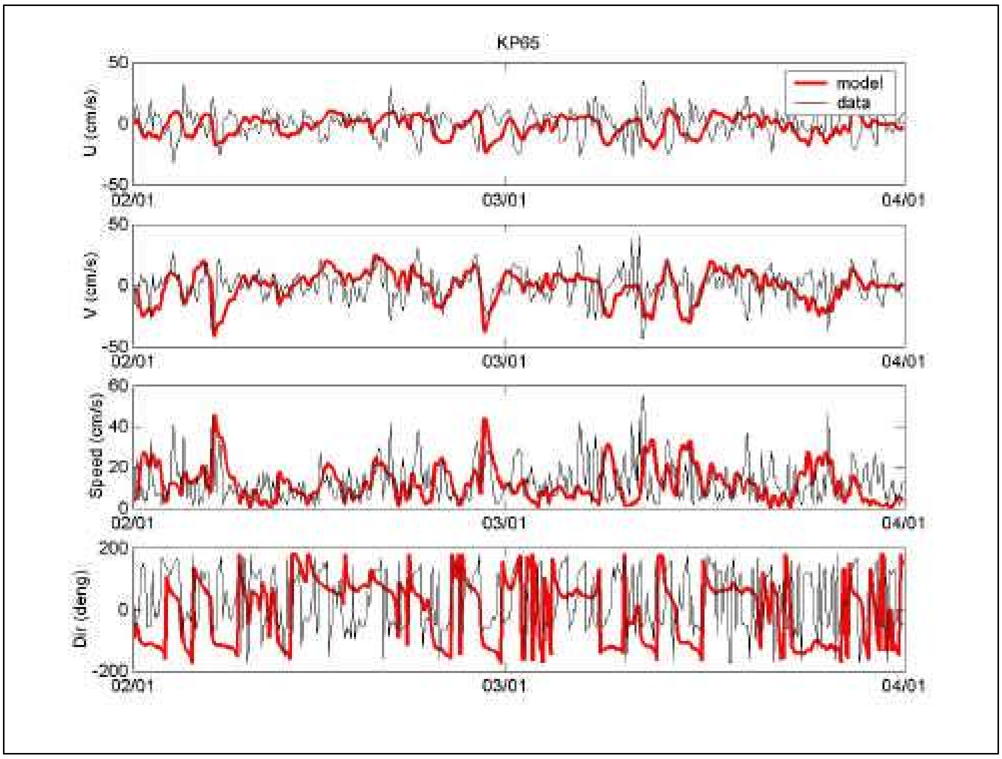

Figure 14. Qualitative model to data comparison at site KP65.

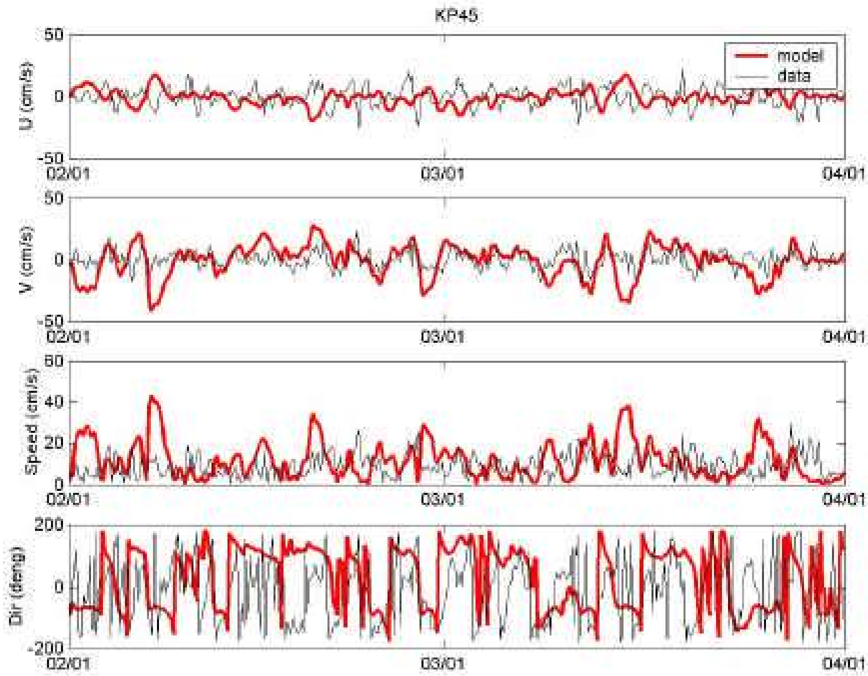

Figure 15. Qualitative model to data comparison at site KP45.

Qualitative comparisons are statistical measures that can be applied to model predictions and field data sets that 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 1) 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 1) 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.

Table 1. Quantitative model to data comparison statistics.

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

3.3 Model Application

The hydrodynamic model was applied to the winter and summer seasons for the year 2000, as described in the previous section. For each season the characteristic seasonal current patterns presented in Figures 3 are reproduced. Figures 16 and 17 present representative current patterns predicted by the hydrodynamic model for the winter and summer seasons, respectively.

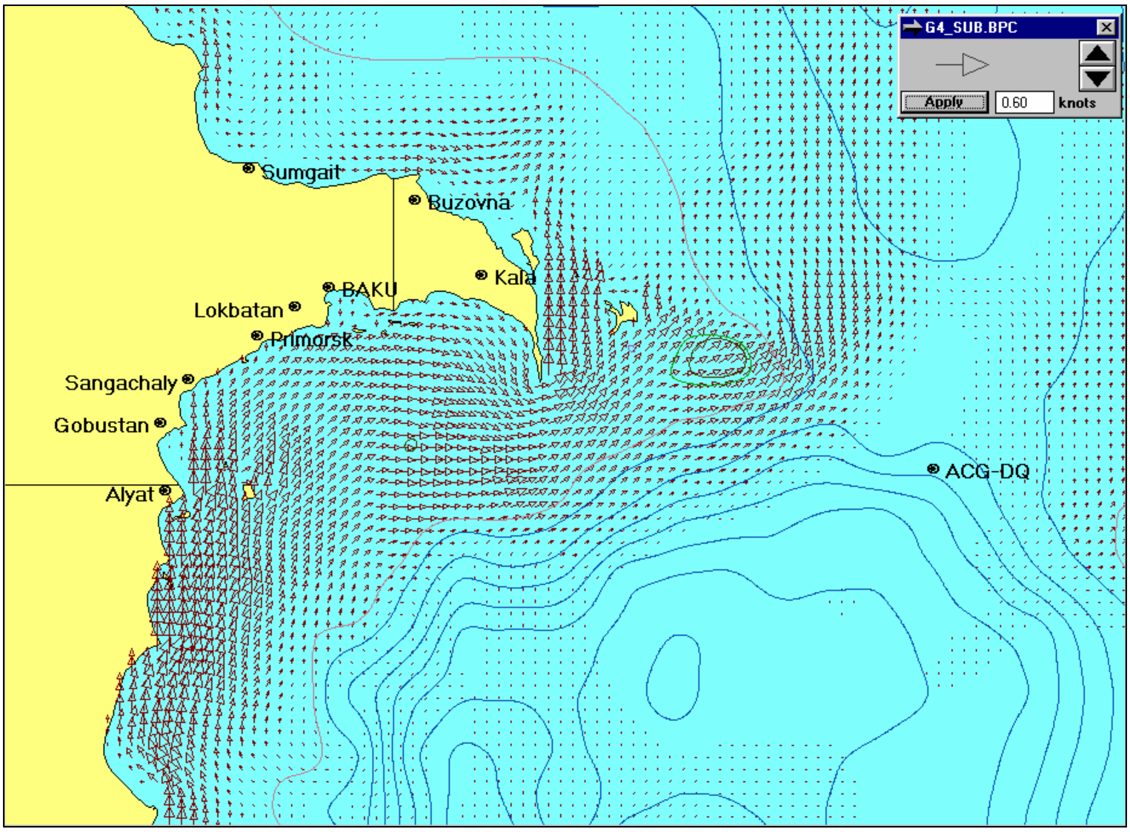

Figure 16. Characteristic hydrodynamic model output for the winter season.

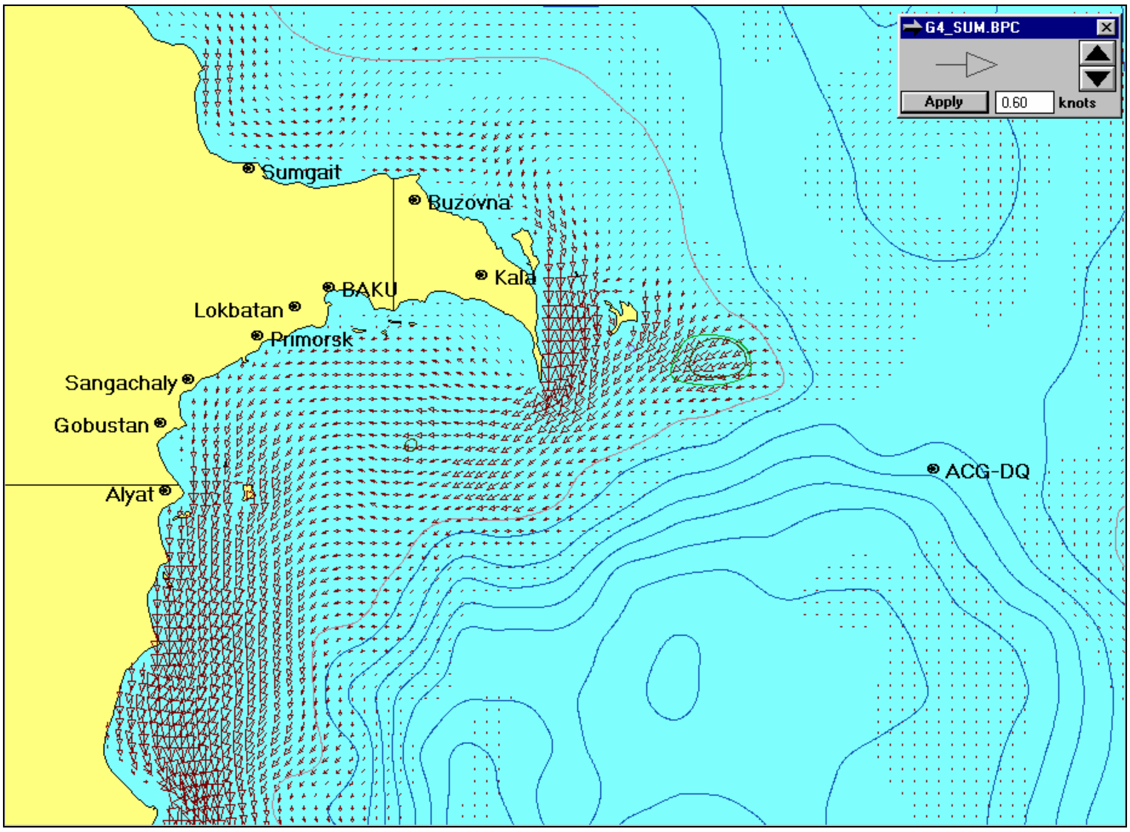

Figure 17. Characteristic hydrodynamic model output for the summer season.

4. Thermal Dispersion Simulations

The simulation of cooling water discharges were performed for the Production Drilling and Quarters Platform and the Compression and Water Platform within the Azeri, Chirag, Gunshali Field (Figure 1) for the winter and summer seasons defined in section 3.2. The cooling water discharge outfalls are to be located within 60 to 200m of each other, which is less than the resolution of the hydrodynamic simulations within the region, thereby allowing the outfalls to be simulated at the same location. A series of simulations were conducted in order to study the thermal dispersion characteristics of the cooling water for various flow rates, release depths, and seasonal conditions. Table 2 summarizes the general conditions for which each simulation was conducted. Note the cooling water discharge rate of 5900 m^3/hr was developed to simulate the combined operation of the Production and Drilling Quarters Platform thermal discharge of 1700 m^3/hr and the 4200 m^3/hr thermal discharge from the Compression and Water Platform.

Table 2. Environmental conditions used for thermal dispersion simulations.

Flow Rate (m^3/hr)	Season	Ambient Temperature (°C)	Discharge Temperature (°C)	Discharge Depth (m)	Discharge Diameter (m)	Discharge Velocity (m/s)	Thermally Stratified
600	Winter	7	22	11	0.4	1.5	No
1700	Winter	7	25	60	0.8	0.9	No
4200	Winter	7	25	60	0.8	2.4	No
5900	Winter	7	25	60	1.2	1.6	No
600	Summer	25	40	11	0.4	1.5	No

1700	Summer	8	25	60	0.8	0.9	Yes
4200	Summer	8	25	60	0.8	2.4	Yes
5900	Summer	8	25	60	1.1	1.6	Yes

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 as having 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 being thermally well mixed with surface to bottom gradients no greater than 1°C. Table 3 presents the vertical structure of temperature used for the cooling water thermal dispersion simulations.

Table 3. 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
150	6.5	7
200	6.8	7

Initial simulations showed the plume response time, the time to steady state, to be less than the variational time scale of the hydrodynamics. This allows the simulations to be conducted in a parametric manner under constant current conditions. These current conditions were chosen as the average and maximum currents during the four simulation periods (Table 4), in order to bound the plume's dynamic response. Note that the average current, in the region, is very small compared to the discharge velocity for all discharge configurations. This results in the thermal plume traveling only under the influence of its own momentum and buoyancy with no appreciable advection due to the current for these periods.

Table 4. Thermal dispersion simulation average and maximum current conditions.

Date	Average Current (cm/s)	Average Direction (quadrant)	Maximum Current (cm/s)	Direction of Maximum Current
01 Jan - 15 Jan	0.18	N	3.1	SSW
15 Jan - 31 Jan	0.14	WNW	10.3	NNE
13 Jul - 28 Jul	0.07	SE	1.0	N
02 Aug - 17 Aug	0.65	EES	4.1	SSE

Further parametric variation addressed the orientation of the outfall relative to the sea surface (horizontal or vertical) and to the ambient current direction (inline or perpendicular). Table 5 presents a complete listing of all thermal dispersion simulations, parameter variations and primary results. The primary results refer to the depth below the surface of the centerline of the thermal plume at 0.5 - 1.0 °C ΔT above ambient (Plume Depth), the maximum horizontal distance the 0.5 - 1.0 °C ΔT above ambient contour travels from the outfall (Plume Travel), and the overall diameter of the 0.5 - 1.0 °C ΔT above ambient contour (Plume Diameter). The nomenclature for the scenario names includes the season, current condition, discharge orientation and flow rate. For example scenario WAV_42 refers to the winter season under average current conditions with a vertical discharge orientation with a flow rate of 4200 m^3/hr. Note that no simulation was conducted for the combined operation (5900 m^3/hr) with the outfall in a perpendicular position due to the horizontal travel distance always being less than 10m. Since the exact distance of the outfalls relative to one another is still unknown, conservative estimates can be established such that the combined operation of the outfalls can be considered separately if the separation distance is greater than the horizontal plume travel distance, and combined if it is less.

Table 5. Thermal dispersion simulations.

Scenario Name	Date	Flow Rate (m^3/hr)	Port Orientation (sea surface)	Port Orientation (current)	Plume Depth (m)	Plume Travel (m)	Plume Diameter (m)
wav_42	Winter	4200	vertical	N/A	14.72	4.72	9.44
wah_42	Winter	4200	horizontal	N/A	16.89	52.30	13.78
wav_17	Winter	1700	vertical	N/A	14.82	4.61	9.22
wah_17	Winter	1700	horizontal	N/A	15.46	28.21	10.92
wah_59	Winter	5900	horizontal	N/A	16.79	46.43	13.00
wmv_42	01 Jan - 15 Jan	4200	vertical	N/A	16.75	25.00	13.16
wmh_42	01 Jan - 15 Jan	4200	horizontal	inline	20.92	89.36	21.84
wmp_42	01 Jan - 15 Jan	4200	horizontal	perpendicular	20.75	68.35	21.04
wmv_17	01 Jan - 15 Jan	1700	vertical	N/A	18.18	48.55	16.36
wmh_17	01 Jan - 15 Jan	1700	horizontal	inline	20.35	81.29	20.32
wmp_17	01 Jan - 15 Jan	1700	horizontal	perpendicular	20.10	67.68	19.86
wmh_59	01 Jan - 15 Jan	5900	horizontal	inline	19.92	77.36	19.84
wmp_59	01 Jan - 15 Jan	5900	horizontal	perpendicular	19.51	58.36	18.56
wmv2_42	15 Jan - 31 Jan	4200	vertical	N/A	15.09	8.60	9.78
wmh2_42	15 Jan - 31 Jan	4200	horizontal	inline	17.73	59.85	15.46
wmp2_42	15 Jan - 31 Jan	4200	horizontal	perpendicular	17.12	52.79	14.24
wmv2_17	15 Jan - 31 Jan	1700	vertical	N/A	14.94	11.75	9.88
wmh2_17	15 Jan - 31 Jan	1700	horizontal	inline	16.38	37.31	12.26
wmp2_17	15 Jan - 31 Jan	1700	horizontal	perpendicular	16.02	29.80	11.52
wmh2_59	15 Jan - 31 Jan	5900	horizontal	inline	17.43	52.67	14.28
wmp2_59	15 Jan - 31 Jan	5900	horizontal	perpendicular	16.96	46.66	13.32
sav_42	Summer	4200	vertical	N/A	41.99	1.92	3.84
sah_42	Summer	4200	horizontal	N/A	44.31	39.62	8.62
sav_17	Summer	1700	vertical	N/A	41.96	1.89	3.78
sah_17	Summer	1700	vertical	N/A	42.88	21.75	5.76
sah_59	Summer	5900	horizontal	N/A	43.95	35.43	7.90
smv_42	13 Jul - 28 Jul	4200	vertical	N/A	42.00	2.11	3.86
smh_42	13 Jul - 28 Jul	4200	horizontal	inline	44.64	40.39	8.98
smp_42	13 Jul - 28 Jul	4200	horizontal	perpendicular	44.47	39.47	8.64
smv_17	13 Jul - 28 Jul	1700	vertical	N/A	41.91	2.32	3.82
smh_17	13 Jul - 28 Jul	1700	horizontal	inline	43.12	22.59	6.00
smp_17	13 Jul - 28 Jul	1700	horizontal	perpendicular	42.89	21.65	5.78
smh_59	13 Jul - 28 Jul	5900	horizontal	inline	44.08	36.15	8.16
smp_59	13 Jul - 28 Jul	5900	horizontal	perpendicular	44.10	35.25	7.92
smv2_42	02 Aug - 17 Aug	4200	vertical	N/A	41.97	2.78	3.94
smh2_42	02 Aug - 17 Aug	4200	horizontal	inline	44.96	43.62	9.92
smp2_42	02 Aug - 17 Aug	4200	horizontal	perpendicular	44.58	39.56	9.16
smv2_17	02 Aug - 17 Aug	1700	vertical	N/A	42.06	4.05	4.12
smh2_17	02 Aug - 17 Aug	1700	horizontal	inline	43.35	26.13	6.90
smp2_17	02 Aug - 17 Aug	1700	horizontal	perpendicular	43.23	21.79	6.24
smh2_59	02 Aug - 17 Aug	5900	horizontal	inline	44.57	38.53	8.88
smp2_59	02 Aug - 17 Aug	5900	horizontal	perpendicular	44.10	35.16	8.20
wav_6	Winter	600	vertical	N/A	3.8	0.8	1.5
wah_6	Winter	600	horizontal	N/A	5.0	18.7	4.0
wmh_6	01 Jan - 15 Jan	600	horizontal	inline	5.6	26.8	5.2
wmp_6	01 Jan - 15 Jan	600	horizontal	perpendicular	6.0	20.8	5.8
wmh2_6	15 Jan - 31 Jan	600	horizontal	inline	5.3	20.5	4.4
wmp2_6	15 Jan - 31 Jan	600	horizontal	perpendicular	5.1	18.6	4.1
sav_6	Summer	600	vertical	N/A	3.8	0.8	1.5
sah_6	Summer	600	horizontal	N/A	4.6	14.6	3.2
smh_6	13 Jul - 28 Jul	600	horizontal	inline	4.7	14.9	3.3
smp_6	13 Jul - 28 Jul	600	horizontal	perpendicular	4.6	14.5	3.2
smh2_6	02 Aug - 17 Aug	600	horizontal	inline	4.8	16.2	3.6
smp2_6	02 Aug - 17 Aug	600	horizontal	perpendicular	4.7	14.5	3.3

The thermal dispersion simulations conducted during the summer season for the flow rates of 1700, 4200 and 5900 m^3/hr at a discharge depth of 60 m showed the thermal plume to travel approximately 20 m upwards and halting at the major thermocline. The horizontal distance each plume traveled from the outfall location for these scenarios varied depending upon the outfall orientation, the discharge velocity and current condition. For the simulations conducted at the 1700 m^3/hr flow rate with a vertical discharge orientation the average horizontal displacement was 2.7 m with a maximum of 4.1 m occurring during the 02 August – 17 August time period while the for a horizontal discharge orientation the average horizontal displacement was 22.8 m with a maximum of 26.1 occurring during the same time period. For the simulations conducted at the 4200 m^3/hr flow rate with a vertical discharge orientation the average horizontal displacement was 2.3 m with a maximum of 2.8 m occurring during the 02 August – 17 August time period while for a horizontal orientation the average displacement was 40.5 m with a maximum of 43.6 m occurring during the same time period. For the simulations conducted at the 5900 m^3/hr flow rate for a horizontal discharge orientation the average horizontal displacement was 36.1 m with a maximum of 38.5 m occurring during the 02 August – 17 August period. The maximum plume diameter also proved to be sensitive to the outfall orientation and the discharge velocity. For the simulations conducted at the 1700 m^3/hr flow rate with a vertical discharge orientation the average maximum plume diameter was 3.9 m with a maximum of 4.1 m occurring during the 02 August – 17 August time period while the for a horizontal discharge orientation the average maximum plume diameter was 6.1 m with a maximum of 6.9 m occurring during the same time period. For the simulations conducted at the 4200 m^3/hr flow rate with a vertical discharge orientation the average maximum plume diameter was 3.9 m with a maximum of 3.9 m occurring during the 02 August – 17 August time period while for a horizontal orientation the average maximum plume diameter was 9.1 m with a maximum of 9.9 m occurring during the same time period. For the simulations conducted at the 5900 m^3/hr flow rate for a horizontal discharge orientation the average maximum plume diameter was 8.2 m with a maximum of 8.9 m occurring during the 02 August – 17 August period. Figures 18 and 19 depict the thermal plume structure as a function of depth from the surface, the thermal structure at the centerline as a function of depth from the surface and the centerline horizontal path for typical plumes with a discharge release depth of 60 m during the summer season in average current conditions for vertically and horizontally oriented discharges, respectively. Note for the vertical discharge orientation the plume rises and spreads solely due to its buoyancy and thermal dispersion while for the horizontal discharge orientation the plume rises due to its buoyancy but is advected downstream due to its own momentum. Figures presenting the results for each summer scenario with a discharge release depth of 60 m are contained in Appendix A.

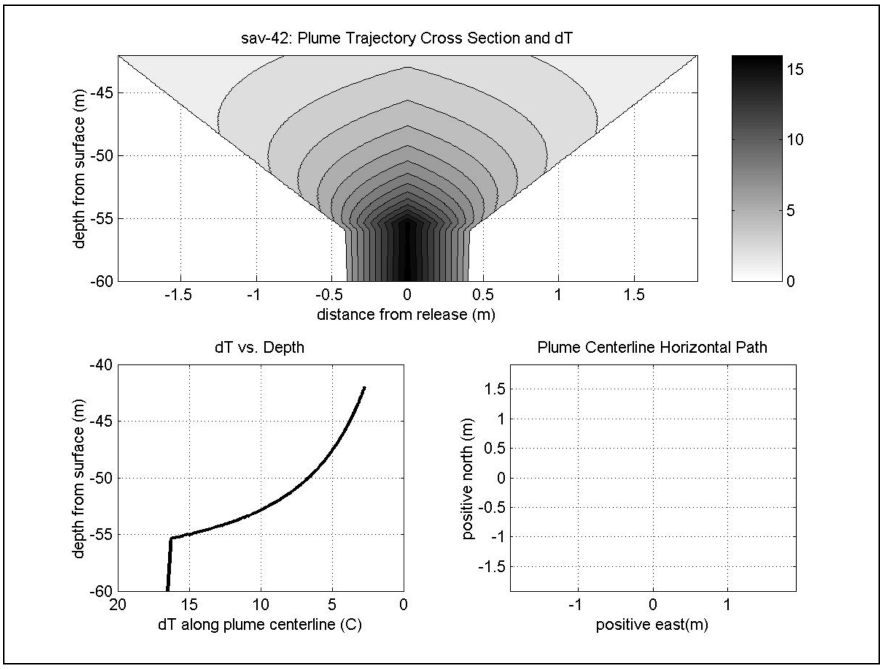

Figure 18. Characteristic thermal plume structure during the summer for a vertical discharge orientation.

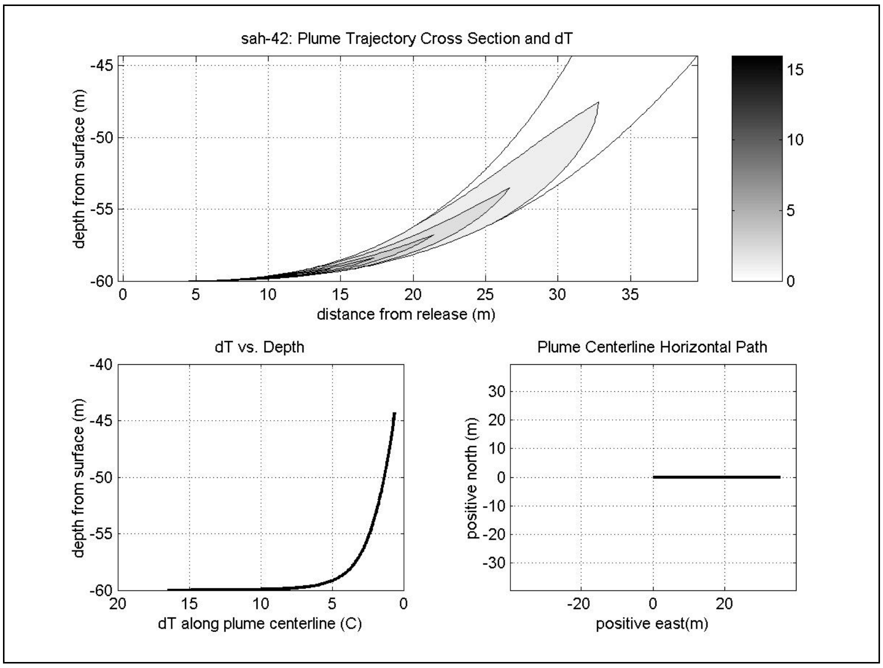

Figure 19. Characteristic thermal plume structure during the summer for a horizontal discharge orientation.

The thermal dispersion simulations conducted during the winter season for the flow rates of 1700, 4200 and 5900 m^3/hr at a discharge depth of 60 m showed the thermal plume to travel on average approximately 43 m upwards with a maximum vertical ascent of 45.3 m for a vertically oriented discharge. The horizontal distance each plume traveled from the outfall location for these scenarios varied depending upon the outfall orientation, the discharge velocity and current condition. For the simulations conducted at the 1700 m^3/hr flow rate with a vertical discharge orientation the average horizontal displacement was 21.6 m with a maximum of 48.6 m occurring during the 01 January - 15 January time period while for a horizontal discharge orientation the average horizontal displacement was 48.9 m with a maximum of 81.3 occurring during the same time period. For the simulations conducted at the 4200 m^3/hr flow rate with a vertical discharge orientation the average horizontal displacement was 12.8 m with a maximum of 25.0 m occurring during the 01 January - 15 January time period while for a horizontal orientation the average displacement was 64.5 m with a maximum of 89.4 m occurring during the same time period. For the simulations conducted at the 5900 m^3/hr flow rate for a horizontal discharge orientation the average horizontal displacement was 56.3 m with a maximum of 77.4 m occurring during the 01 January - 15 January period. The maximum plume diameter also proved to be sensitive to the outfall orientation and the discharge velocity. For the simulations conducted at the 1700 m^3/hr flow rate with a vertical discharge orientation the average maximum plume diameter was 11.8 m with a maximum of 16.4 m occurring during the 01 January - 15 January time period while the for a horizontal discharge orientation the average maximum plume diameter was 14.9 m with a maximum of 20.3 m occurring during the same time period. For the simulations conducted at the 4200 m^3/hr flow rate with a vertical discharge orientation the average maximum plume diameter was 10.8 m with a maximum of 13.2 m occurring during the 01 January - 15 January time period while for a horizontal orientation the average maximum plume diameter was 17.3 m with a maximum of 21.8 m occurring during the same time period. For the simulations conducted at the 5900 m^3/hr flow rate for a horizontal discharge orientation the average maximum plume diameter was 15.8 m with a maximum of 19.8 m occurring during the 01 January - 15 January period. Figures 20 and 21 depict the thermal plume structure as a function of depth from the surface, the thermal structure at the centerline as a function of depth from the surface and the centerline horizontal path for typical plumes with a discharge release depth of 60 m during the winter season in average current conditions for vertically and horizontally oriented discharges, respectively. Note for the vertical discharge orientation the plume rises and spreads solely due to its buoyancy and thermal dispersion while for the horizontal discharge orientation the plume rises due to its buoyancy but is advected downstream due to its own momentum. Figures presenting the results for each summer scenario with a discharge release depth of 60 m are contained in Appendix A.

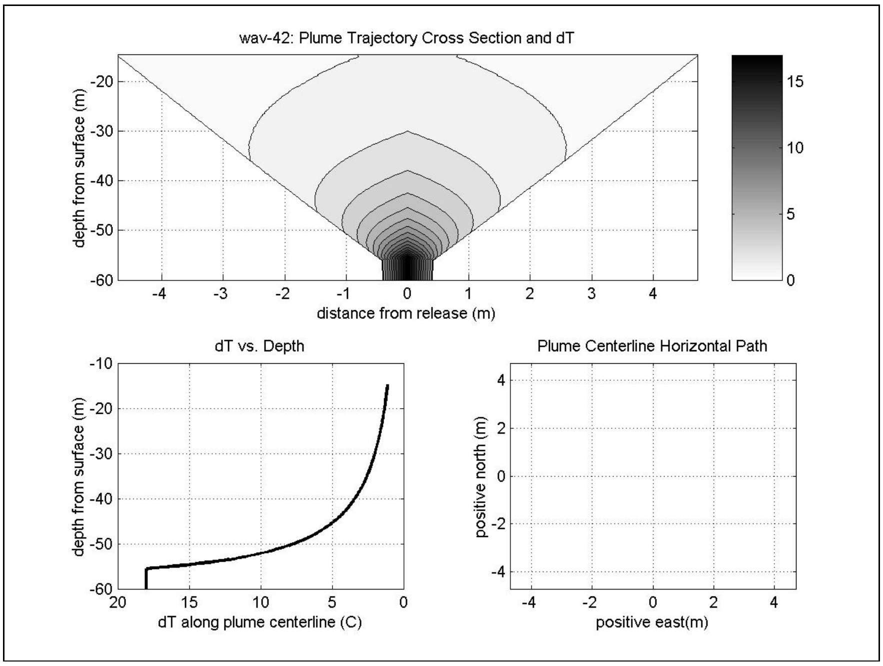

Figure 20. Characteristic thermal plume structure during the winter for a vertical discharge orientation.

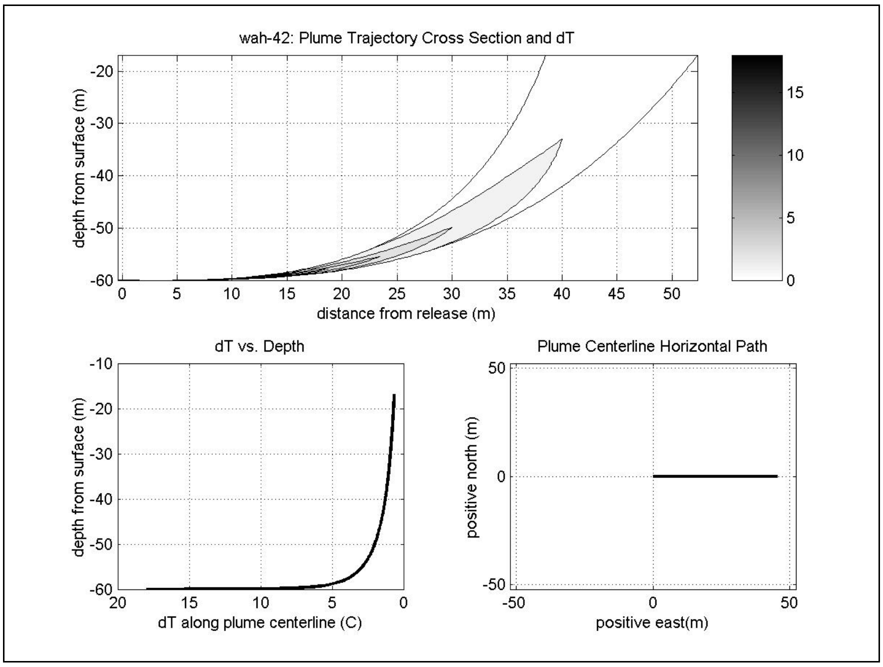

Figure 21. Characteristic thermal plume structure during the winter for a horizontal discharge orientation.

The thermal dispersion simulations conducted during the summer season for the flow rate of 600 m^3/hr at a discharge depth of 11 m showed the thermal plume to travel on average approximately 6 m upwards with a maximum vertical ascent 7.2 m for a vertically oriented discharge. The maximum horizontal displacement of the plume was 0.8 m for a vertically oriented discharge and 16.2 m for a horizontally oriented discharge during the 02 August - 17 August period with an average displacement of 14.9 m for all scenarios with a horizontally oriented discharge. The maximum plume diameter was 1.5 m for a vertically oriented discharge and 3.6 m for a horizontally oriented discharge during the 02 August - 17 August period with an average diameter of 3.3 for all scenarios with a horizontally oriented discharge. Figures 22 and 23 depict the thermal plume structure as a function of depth from the surface, the thermal structure of at the centerline as a function of depth from the surface and the centerline horizontal path for typical plume with a discharge release depth of 11 m during the summer season in average current conditions for vertically and horizontally oriented discharges, respectively. Note the relatively high thermal gradient (~4 °C) at the centerline for the plume due to a vertically oriented discharge once the plume has stop ascending. However, this gradient reduces dramatically to approximately 1 °C within less than a meter from the centerline. Figures presenting the results for each summer scenario with a discharge release depth of 11 m are contained in Appendix A.

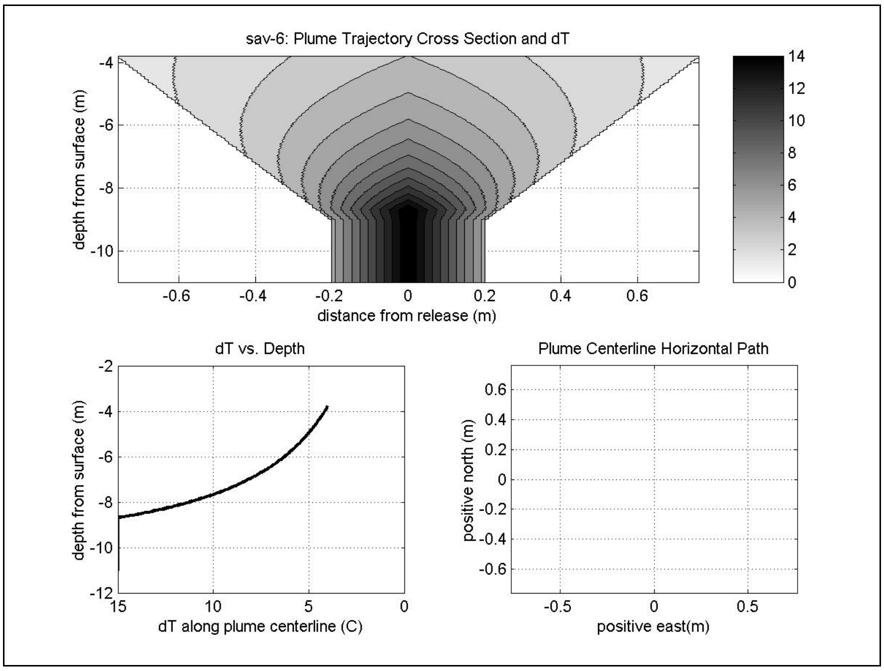

Figure 22. Characteristic thermal plume structure during the summer for a 600 m^3/hr flow rate and a horizontal discharge orientation.

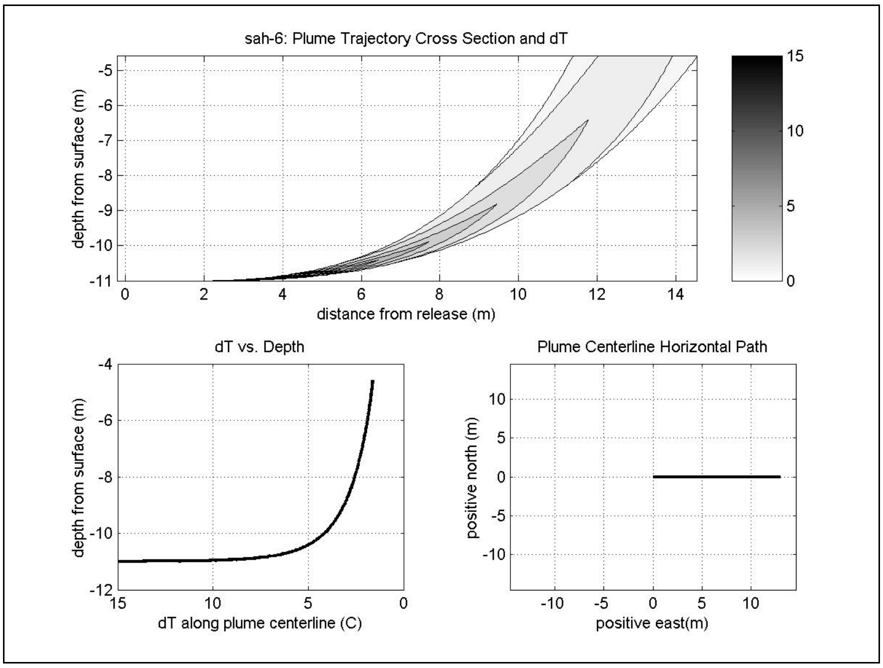

Figure 23. Characteristic thermal plume structure during the summer for a 600 m^3/hr flow rate and a horizontal discharge orientation.

The thermal dispersion simulations conducted during the winter season for the flow rate of 600 m^3/hr at a discharge depth of 11 m showed the thermal plume to travel on average approximately 6 m upwards with a maximum vertical ascent of 7.2 m for a vertically oriented discharge. The maximum horizontal displacement of the plume was 0.8 m for a vertically oriented discharge and 26.8 m for a horizontally oriented discharge during the 01 January - 15 January period with an average displacement of 21.1 m for all scenarios with a horizontally oriented discharge. The maximum plume diameter was 1.5 m for a vertically oriented discharge and 5.8 m for a horizontally oriented discharge during the 01 January - 15 January period with an average diameter of 4.7 m for all scenarios with a horizontally oriented discharge. Figures 24 and 25 depict the thermal plume structure as a function of depth from the surface, the thermal structure of at the centerline as a function of depth from the surface and the centerline horizontal path for typical plume with a discharge release depth of 11 m during the summer season in average current conditions for vertically and horizontally oriented discharges, respectively. Note the thermal gradient of approximately 2 °C at the centerline of the plume due to a horizontally oriented discharge once the plume has stopped ascending. However, this gradient reduces dramatically to approximately 1 °C within less than a meter from the centerline. Figures presenting the results for each winter scenario with a discharge release depth of 11 m are contained in Appendix A.

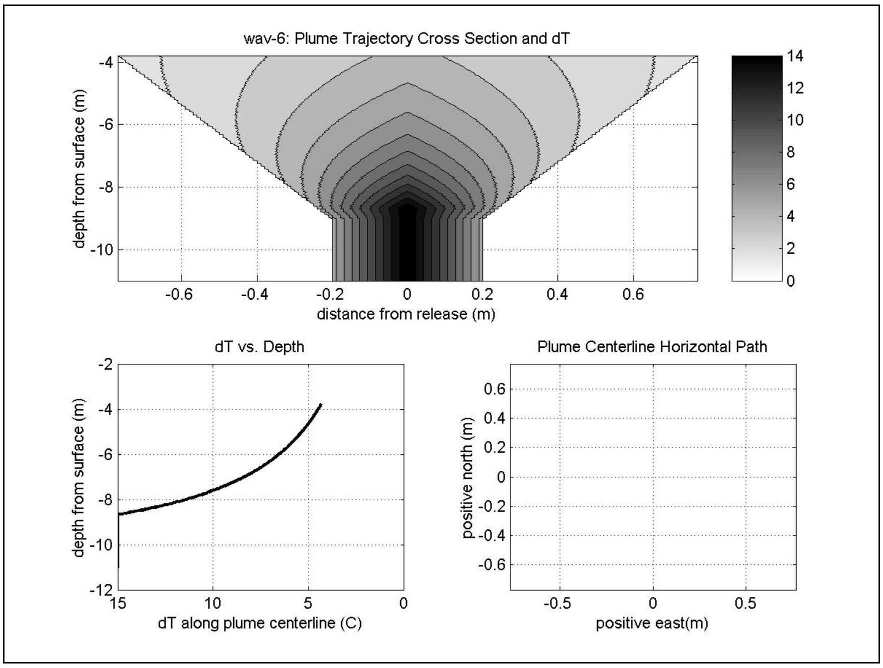

Figure 24. Characteristic thermal plume structure during the winter for a 600 m^3/hr flow rate and a horizontal discharge orientation.

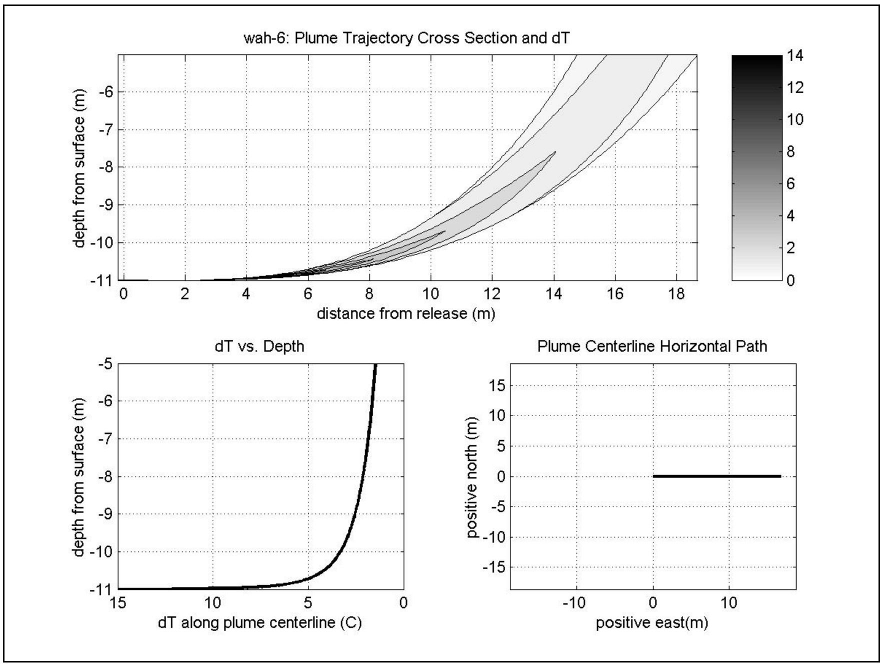

Figure 25. Characteristic thermal plume structure during the winter for a 600 m^3/hr flow rate and a horizontal discharge orientation.

5. Antifoulant Simulations

A series of simulations were conducted for the release of cooling water antifoulant from PDQ and CWP platforms within the ACG Field. As noted earlier, the locations of the outfalls relative to one another are the same in terms of the spatial resolution of the model. Therefore as a conservative estimator, simulations were conducted for the individual operation and combined operation of the outfalls from both locations. Table 6 presents the conditions for each simulation and pertinent results. Note that the release depth for each scenario is different than the caisson depth. The release depth was chosen as the average cooling water plume depth as presented in Table 5. This is a very conservative estimate that assumes that the antifoulant released with the cooling water is completely dissolved and travels with the plume and only begins to dissipate after the cooling water plume has stopped its vertical ascent. Also since no data is available regarding the general dispersion rate for the waters off the coast of Baku conservative estimates of 1.0 m^2/s and 0.00001 m^2/s are used for the horizontal and vertical dispersion respectively. Hence all the results reported are worst-case scenarios in terms of chemical concentration. The nomenclature for the scenario names is "platform-season-chemical-concentration reference". For example the scenario PDQ-W1-CL2 refers to a simulation conducted for the PDQ platform during the winter season from Jan 1-15 for chlorine at a concentration of 2000 ppb. The platform designation of "COM" refers to simultaneous or combined operation of the PDQ discharge of 1700 m^3/hr and the 4200 m^3/hr discharge from the CWP.

Table 6. Antifoulant dispersion simulations.

Scenario	Platform	Season	Flow Rate (m^3/hr)	Antifoulant Chemical	Release Concentration (ppb)	Caisson Depth (m)	Release Depth (m)	Maximum Concentration (ppb)	Plume Depth Range (m)
PDQ-W1-CU	PDQ	JAN 1-15	1700	Copper	1	60	17.5	0.0008	15-22
PDQ-W1-CL1	PDQ	JAN 1-15	1700	Chlorine	10	60	17.5	0.007	14-22
PDQ-W1-CL2	PDQ	JAN 1-15	1700	Chlorine	2000	60	17.5	1.4	15-22
CWP-W1-CU	CWP	JAN 1-15	4200	Copper	1	60	17.5	0.002	11-22
CWP-W1-CL1	CWP	JAN 1-15	4200	Chlorine	10	60	17.5	0.02	11-22
CWP-W1-CL2	CWP	JAN 1-15	4200	Chlorine	2000	60	17.5	3.8	11-22
COM-W1-CU	COM	JAN 1-15	5900	Copper	2	60	17.5	0.006	11-22
COM-W1-CL1	COM	JAN 1-15	5900	Chlorine	20	60	17.5	0.06	11-22
COM-W1-CL2	COM	JAN 1-15	5900	Chlorine	4000	60	17.5	11.2	11-22
PDQ-W2-CU	PDQ	JAN 15-31	1700	Copper	1	60	17.5	0.0008	14-23
PDQ-W2-CL1	PDQ	JAN 15-31	1700	Chlorine	10	60	17.5	0.006	15-22
PDQ-W2-CL2	PDQ	JAN 15-31	1700	Chlorine	2000	60	17.5	1.2	15-22
CWP-W2-CU	CWP	JAN 15-31	4200	Copper	1	60	17.5	0.001	11-23
CWP-W2-CL1	CWP	JAN 15-31	4200	Chlorine	10	60	17.5	0.01	11-23
CWP-W2-CL2	CWP	JAN 15-31	4200	Chlorine	2000	60	17.5	2.6	11-23
COM-W2-CU	COM	JAN 15-31	5900	Copper	2	60	17.5	0.003	11-23
COM-W2-CL1	COM	JAN 15-31	5900	Chlorine	20	60	17.5	0.04	11-23
COM-W2-CL2	COM	JAN 15-31	5900	Chlorine	4000	60	17.5	7.2	11-23
PDQ-S1-CU	PDQ	JUL 13-28	1700	Copper	1	60	43.4	0.0009	41-49
PDQ-S1-CL1	PDQ	JUL 13-28	1700	Chlorine	10	60	43.4	0.008	41-45
PDQ-S1-CL2	PDQ	JUL 13-28	1700	Chlorine	2000	60	43.4	1.6	41-45
CWP-S1-CU	CWP	JUL 13-28	4200	Copper	1	60	43.4	0.002	37-49
CWP-S1-CL1	CWP	JUL 13-28	4200	Chlorine	10	60	43.4	0.02	37-49

CWP-S1-CL2	CWP	JUL 13-28	4200	Chlorine	2000	60	43.4	4.0	41-49
COM-S1-CU	COM	JUL 13-28	5900	Copper	2	60	43.4	0.006	37-49
COM-S1-CL1	COM	JUL 13-28	5900	Chlorine	20	60	43.4	0.05	37-49
COM-S1-CL2	COM	JUL 13-28	5900	Chlorine	4000	60	43.4	10.0	37-49
PDQ-S2-CU	PDQ	AUG 2-17	1700	Copper	1	60	43.4	0.0008	41-49
PDQ-S2-CL1	PDQ	AUG 2-17	1700	Chlorine	10	60	43.4	0.007	41-45
PDQ-S2-CL2	PDQ	AUG 2-17	1700	Chlorine	2000	60	43.4	1.4	41-45
CWP-S2-CU	CWP	AUG 2-17	4200	Copper	1	60	43.4	0.002	37-49
CWP-S2-CL1	CWP	AUG 2-17	4200	Chlorine	10	60	43.4	0.02	37-49
CWP-S2-CL2	CWP	AUG 2-17	4200	Chlorine	2000	60	43.4	3.4	37-49
COM-S2-CU	COM	AUG 2-17	5900	Copper	2	60	43.4	0.005	37-49
COM-S2-CL1	COM	AUG 2-17	5900	Chlorine	20	60	43.4	0.05	37-49
COM-S2-CL2	COM	AUG 2-17	5900	Chlorine	4000	60	43.4	9.6	37-49

During the 01 January - 15 January period for the 1700 m^3/hr flow rate the 1 ppb release of copper resulted in a maximum water column concentration of 0.0008 ppb while the 10 ppb and 2000 ppb releases of chlorine resulted in maximum water column concentrations of 0.007 and 1.4 ppb, respectively. For the same period the 4200 m^3/hr flow rate release of 1 ppb of copper resulted in a maximum water column concentration of 0.002 ppb while the 10 ppb and 2000 ppb releases of chlorine resulted in maximum water column concentrations of 0.02 and 3.8 ppb, respectively. The combined operations during this period with a flow rate of 5900 m^3/hr resulted in a maximum water column concentration for a 2 ppb release of copper of 0.006 ppb while the 20 and 4000 ppb releases of chlorine resulted in maximum water column concentrations of 0.06 and 11.2 ppb, respectively. Figures 26 and 27 present the maximum water column concentrations one day and seven days after the release of 2000 ppb of chlorine at the 1700 m^3/hr flow rate for this period.

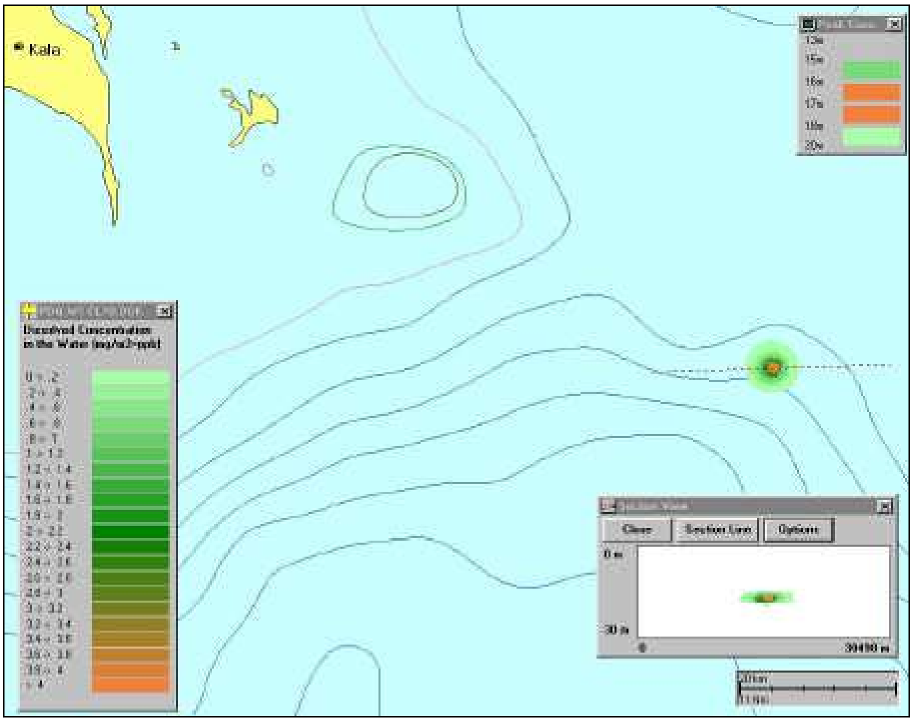

Figure 26. Maximum water column concentration one day after the release of 2000 ppb of chlorine at the 1700 m^3/hr flow rate for the 01 January - 15 January period.

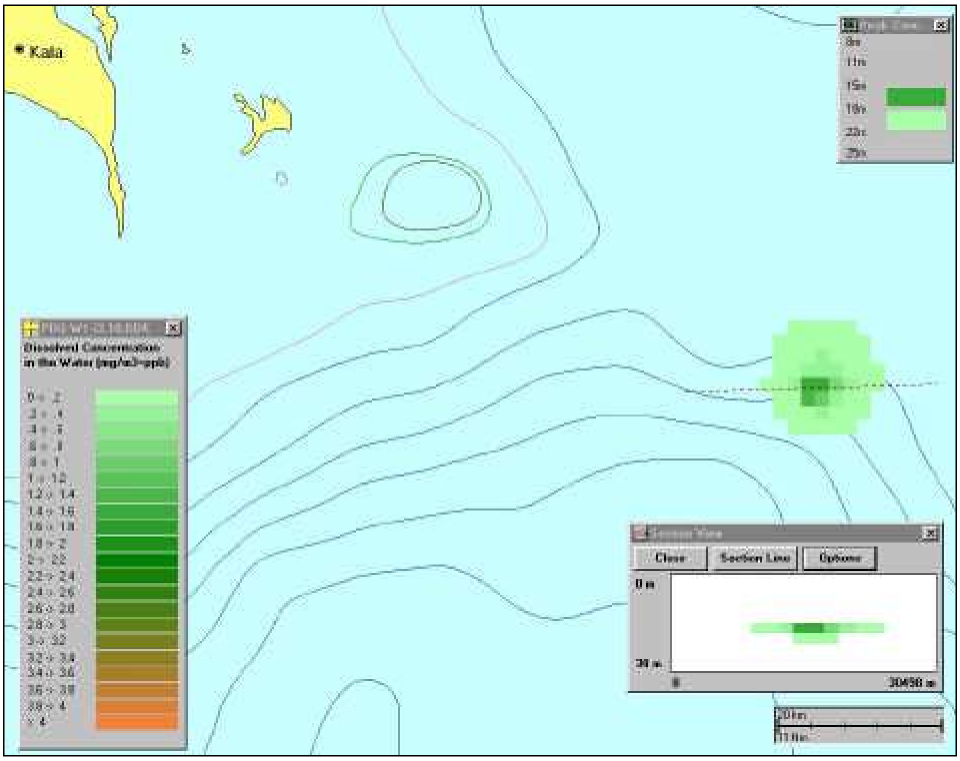

Figure 27. Maximum water column concentration seven days after the release of 2000 ppb of chlorine at the 1700 m^3/hr flow rate for the 01 January - 15 January period.

During the 15 January - 31 January period for the 1700 m^3/hr flow rate the 1 ppb release of copper resulted in a maximum water column concentration of 0.0008 ppb while the 10 ppb and 2000 ppb releases of chlorine resulted in maximum water column concentrations of 0.006 and 1.2 ppb, respectively. For the same period the 4200 m^3/hr flow rate release of 1 ppb of copper resulted in a maximum water column concentration of 0.001 ppb while the 10 ppb and 2000 ppb releases of chlorine resulted in maximum water column concentrations of 0.01 and 2.6 ppb, respectively. The combined operations during this period with a flow rate of 5900 m^3/hr resulted in a maximum water column concentration for a 2 ppb release of copper of 0.003 ppb while the 20 and 4000 ppb releases of chlorine resulted in maximum water column concentrations of 0.04 and 7.2 ppb, respectively. Figures 28 and 29 present the maximum water column concentrations one day and seven days after the release of 2000 ppb of chlorine at the 1700 m^3/hr flow rate for this period.

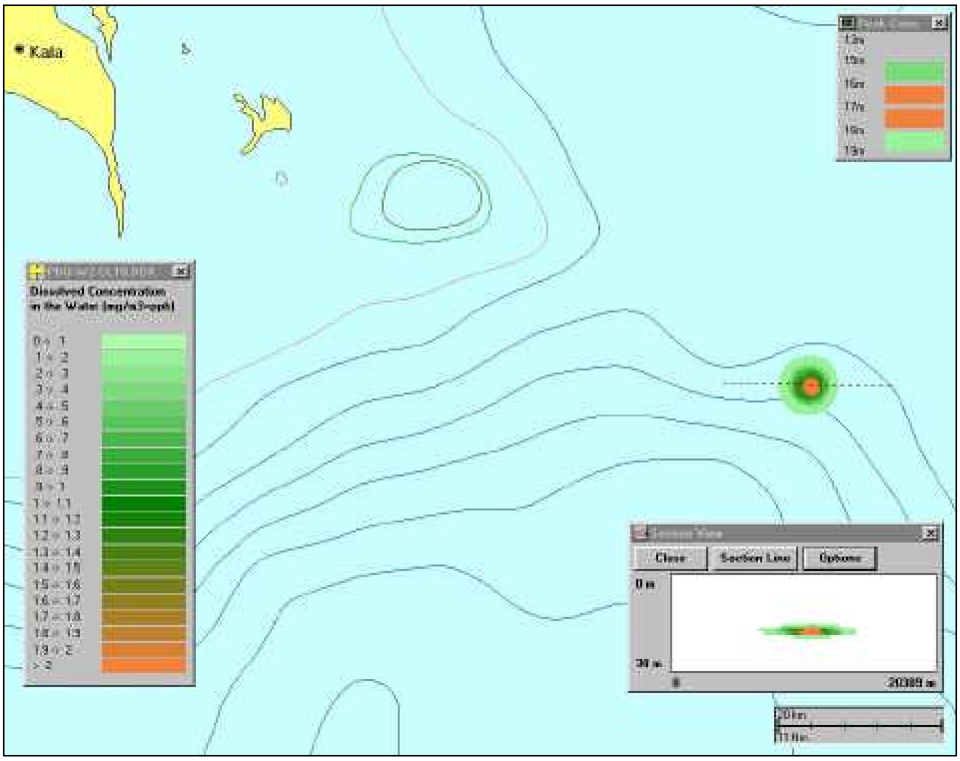

Figure 28. Maximum water column concentration one day after the release of 2000 ppb of chlorine at the 1700 m^3/hr flow rate for the 15 January - 31 January period.

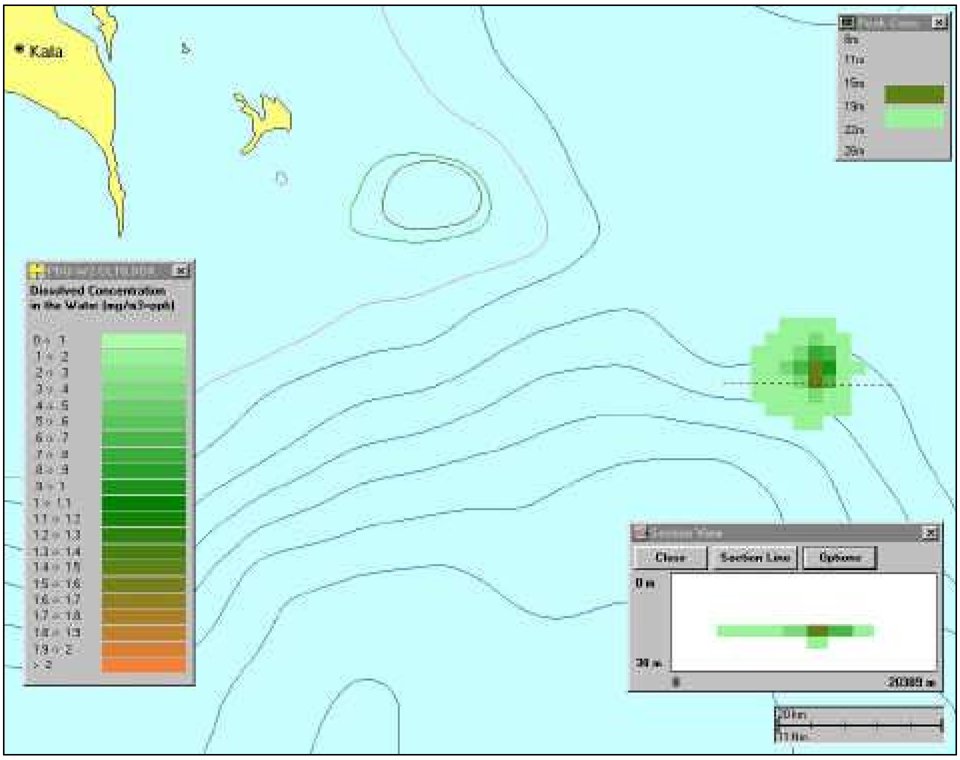

Figure 29. Maximum water column concentration seven days after the release of 2000 ppb of chlorine at the 1700 m^3/hr flow rate for the 15 January - 31 January period.

During the 13 July - 28 July period for the 1700 m^3/hr flow rate the 1 ppb release of copper resulted in a maximum water column concentration of 0.0009 ppb while the 10 ppb and 2000 ppb releases of chlorine resulted in maximum water column concentrations of 0.008 and 1.6 ppb, respectively. For the same period the 4200 m^3/hr flow rate release of 1 ppb of copper resulted in a maximum water column concentration of 0.002 ppb while the 10 ppb and 2000 ppb releases of chlorine resulted in maximum water column concentrations of 0.02 and 4.0 ppb, respectively. The combined operations during this period with a flow rate of 5900 m^3/hr resulted in a maximum water column concentration for a 2 ppb release of copper of 0.006 ppb while the 20 and 4000 ppb releases of chlorine resulted in maximum water column concentrations of 0.05 and 10.0 ppb, respectively. Figures 30 and 31 present the maximum water column concentrations one day and seven days after the release of 2000 ppb of chlorine at the 1700 m^3/hr flow rate for this period.

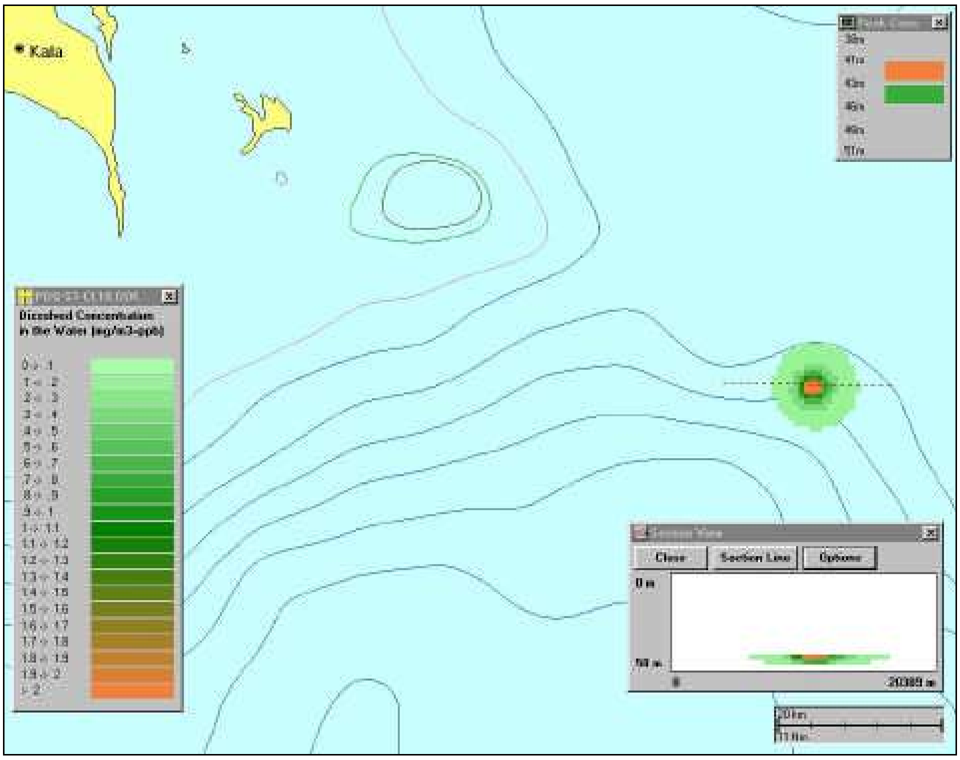

Figure 30. Maximum water column concentration one day after the release of 2000 ppb of chlorine at the 1700 m^3/hr flow rate for the 13 July - 28 July period.

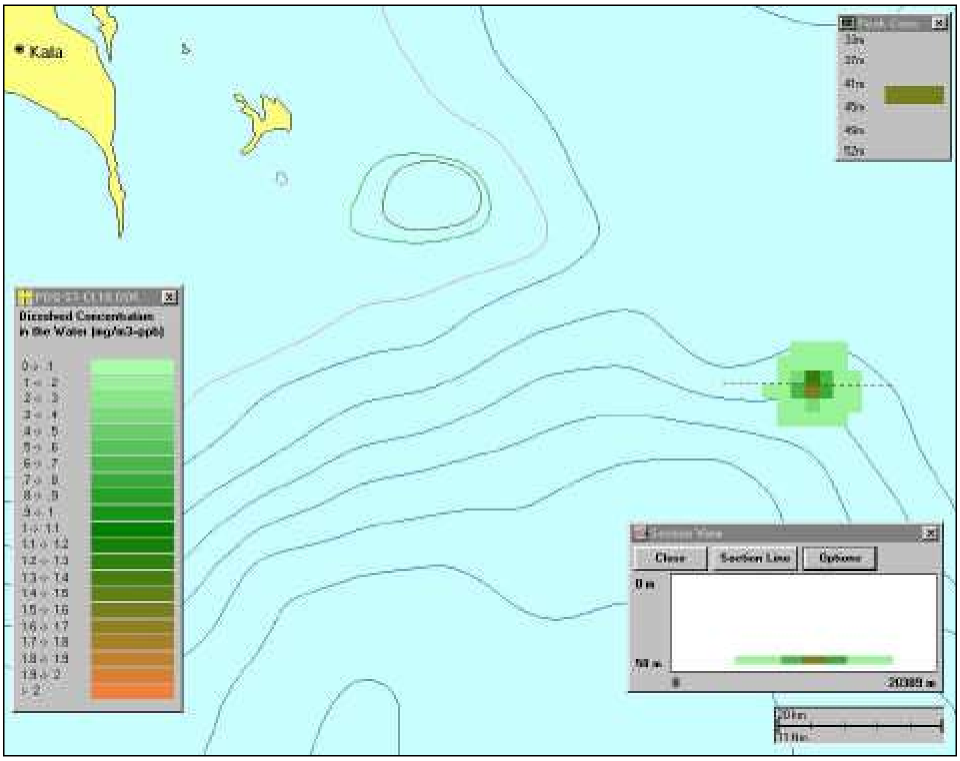

Figure 31. Maximum water column concentration seven days after the release of 2000 ppb of chlorine at the 1700 m^3/hr flow rate for the 13 July - 28 July period.

During the 02 August - 17 August period for the 1700 m^3/hr flow rate the 1 ppb release of copper resulted in a maximum water column concentration of 0.0008 ppb while the 10 ppb and 2000 ppb releases of chlorine resulted in maximum water column concentrations of 0.007 and 1.4 ppb, respectively. For the same period the 4200 m^3/hr flow rate release of 1 ppb of copper resulted in a maximum water column concentration of 0.002 ppb while the 10 ppb and 2000 ppb releases of chlorine resulted in maximum water column concentrations of 0.02 and 3.4 ppb, respectively. The combined operations during this period with a flow rate of 5900 m^3/hr resulted in a maximum water column concentration for a 2 ppb release of copper of 0.005 ppb while the 20 and 4000 ppb releases of chlorine resulted in maximum water column concentrations of 0.05 and 9.6 ppb, respectively. Figures 32 and 33 present the maximum water column concentrations one day and seven days after the release of 2000 ppb of chlorine at the 1700 m^3/hr flow rate for this period.

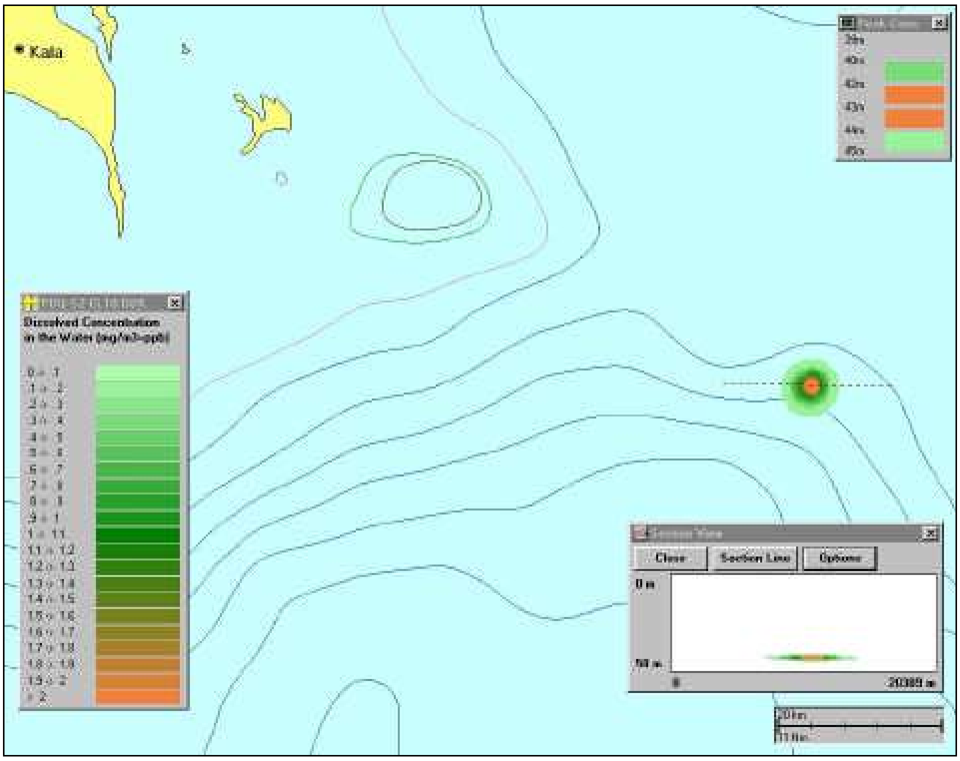

Figure 32. Maximum water column concentration one day after the release of 2000 ppb of chlorine at the 1700 m^3/hr flow rate for the 02 August - 17 August period.

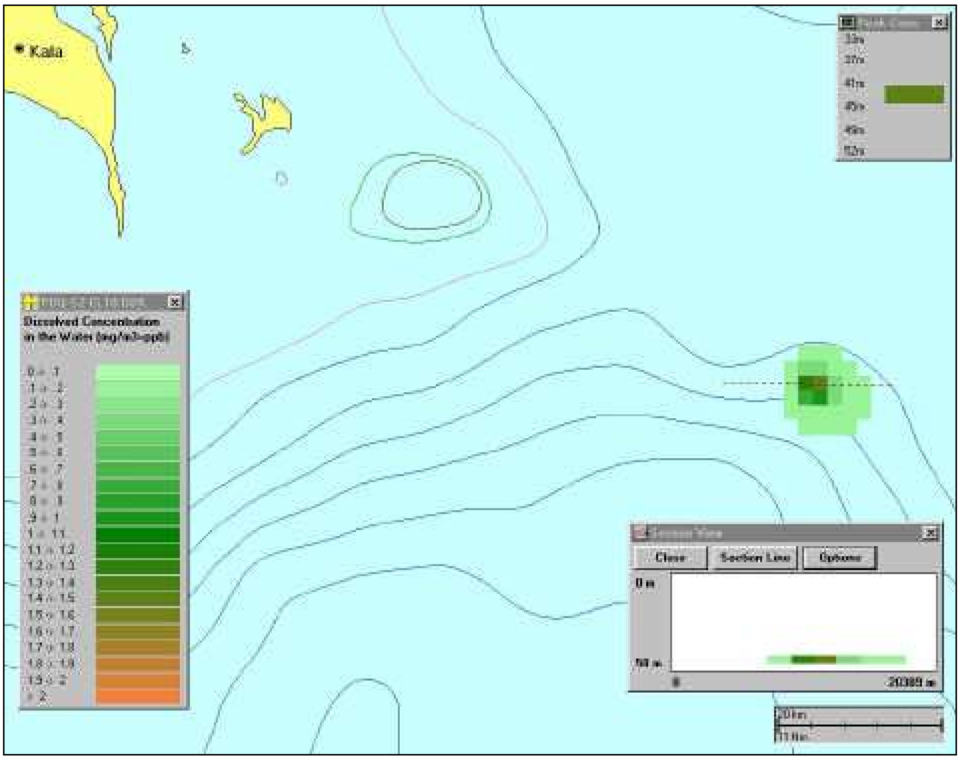

Figure 33. Maximum water column concentration seven days after the release of 2000 ppb of chlorine at the 1700 m^3/hr flow rate for the 02 August - 17 August period.

6. Drill Cuttings and Mud Release Simulations

A series of single and multiple well simulations were conducted for the release of cuttings and mud within the ACG field during the summer and winter periods defined in section 3.2. Table 7 presents the conditions for each simulation set. Grain size distribution and the equivalent fall velocity is presented in Table 8.

Table 7. Cutting and mud release conditions.

Hole Section (inches)	Volume of Cuttings (m^3)	Release Depth (m)	Caisson Diameter (m)	Production Time (hr)	Lubricant
36	538.57	Seafloor	N/A	5	Sea Water
26	276.22	60	0.80	17.5	Water Based Mud
26	276.22	8.3	0.36	17.5	Water Based Mud

Table 8. Cutting and mud release grain size distribution.

Nominal Grain Size (microns)	Specific Gravity	Percentage of Total Mass	Fall Velocity (m/hr)
12500	2.5	85	2582.50
9625	2.5	1.25	2266.13
6750	2.5	1.25	1897.74
3875	2.5	1.25	1437.87
1000	2.5	1.25	730.44
74	3.0	10	11.39

In order to bound the trajectory and eventual bottom thickness contours the simulations were conducted during average and maximum flow events during the summer and winter periods. Table 9 presents a complete listing of all single well release simulations, parameter variations and pertinent results. The nomenclature for the scenario names includes the season, current condition and hole section. for example scenario WM36 refers to the winter season under maximum current conditions for the 36" hole section. The simulations conducted using the 36" hole section were released from the seafloor. This results in all of the material depositing within meters of the hole location, hence only the time to complete settling is reported for these simulations. There is a direct correlation between the distance of the release above the bottom and the complete time to release settling: for example scenario WM36 settles after 5.5 hr of the start of the release with only a 5 hr total cutting time while scenario WM26_A settles after 40 hr of the start of the release with a total cutting time of 17.5 hours. Also note the correlation between the seasonal conditions relative to the maximum travel distance. During the maximum seasonal conditions the smaller materials within the mud cutting mixture are advected further and create a larger deposition footprint. Figure 34 presents a typical mass balance of material released by comparing the time evolution of the total mass released within the water column and the total mass deposited on the seafloor. Note the relationship between the percentage released and the percent deposited. The difference between these two lines is the percentage of the smaller grain size material present in the mixture released. This material will stay in the water column much longer than the larger particles, which settle almost immediately after release, due to their relatively large settling velocities. Appendix C contains mass balance graphs and plan views of the deposition patterns for all single well release scenarios.

Table 9. Single well mud and drill cuttings release simulations.

Scenario	Hole Section (inches)	Release Depth (m)	Season	Start Time	Time to Complete Release Settling (hr)	Maximum Travel Distance (km)
WM36	36	Seafloor	Winter - Max	21 January at 1600 hrs	5.5	N/A
WA36	36	Seafloor	Winter - Avg	09 January at 1200 hrs	5.5	N/A
WM26_A	26	60	Winter - Max	21 January at 1600 hrs	40	3.2
WA26_A	26	60	Winter - Avg	09 January at 1200 hrs	40	0.9
WM26_B	26	8.3	Winter - Max	21 January at 1600 hrs	45	2.9
WA26_B	26	8.3	Winter - Avg	09 January at 1200 hrs	45	0.9
SM36	36	Seafloor	Summer - Max	05 August at 1600 hrs	5.5	N/A
SA36	36	Seafloor	Summer - Avg	22 July at 0000 hrs	5.5	N/A
SM26_A	26	60	Summer - Max	05 August at 1600 hrs	40	1.9
SA26_A	26	60	Summer - Avg	22 July at 0000 hrs	40	0.5
SM26_B	26	8.3	Summer - Max	05 August at 1600 hrs	45	2.3
SA26_B	26	8.3	Summer - Avg	22 July at 0000 hrs	45	0.5

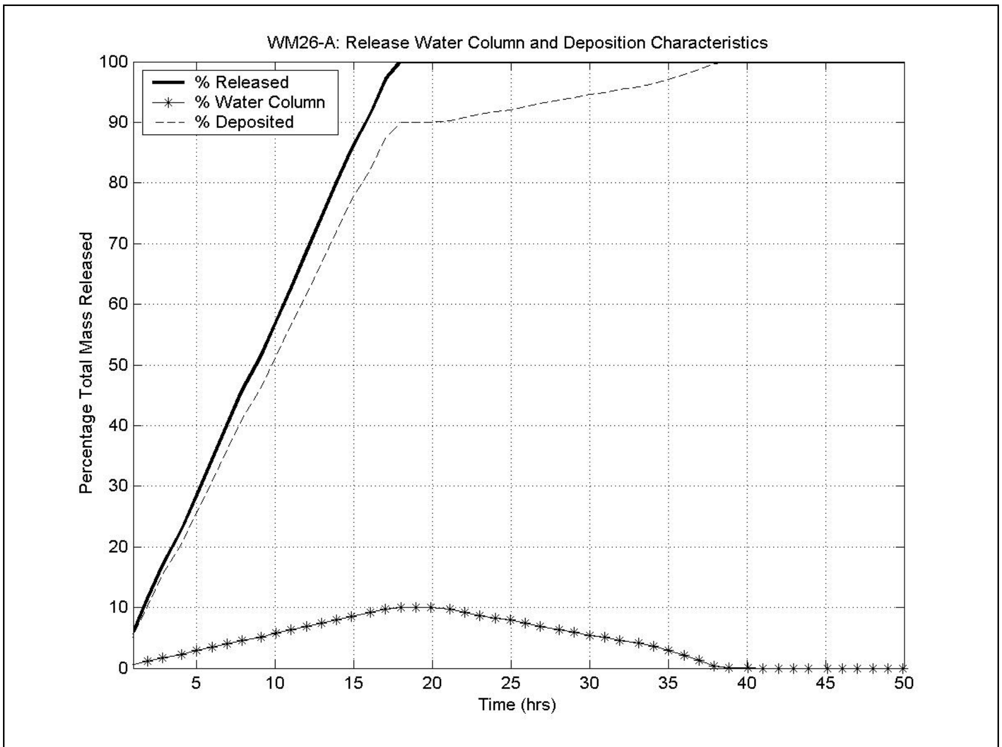

Figure 34. Time dependent mass balance results for scenario WM26-A.

While the single well release scenarios are useful in determining the total particle settling time and the deposition pattern of single wells. Multiple well operations were simulated to determine the deposition pattern for the scenarios are summarized in Table 10.

Table 10. Combined mud and cuttings simulations.

Scenario	Wells	Season	Description
WM9Well	9	Maximum Winter Conditions	36" hole section at seafloor and 26" hole section at 8.3 m water depth
WA9Well	9	Average Winter Conditions	36" hole section at seafloor and 26" hole section at 8.3 m water depth

SM9Well	9	Maximum Summer Conditions	36" hole section at seafloor and 26" hole section at 8.3 m water depth
SA9Well	9	Average Summer Conditions	36" hole section at seafloor and 26" hole section at 8.3 m water depth
WM34Well	34	Maximum Winter Conditions	36" hole section at seafloor and 26" hole section at 60 m water depth
WA34Well	34	Average winter Conditions	36" hole section at seafloor and 26" hole section at 60 m water depth
SM34Well	34	Maximum Summer Conditions	36" hole section at seafloor and 26" hole section at 60 m water depth
SA34Well	34	Average Summer Conditions	36" hole section at seafloor and 26" hole section at 60 m water depth

Figure 35 presents the deposition pattern for the simulation of nine wells during the maximum winter conditions, scenario WM9Well. The deposition pattern for this scenario is elongated to the south-southeast due to current carrying the lighter particle downstream. The region of highest deposition occurs very near to the drill location with maximum deposition thickness on the order of 300000 µm while the elongated deposition region has deposition thickness ranging from 10 to 500 µm.

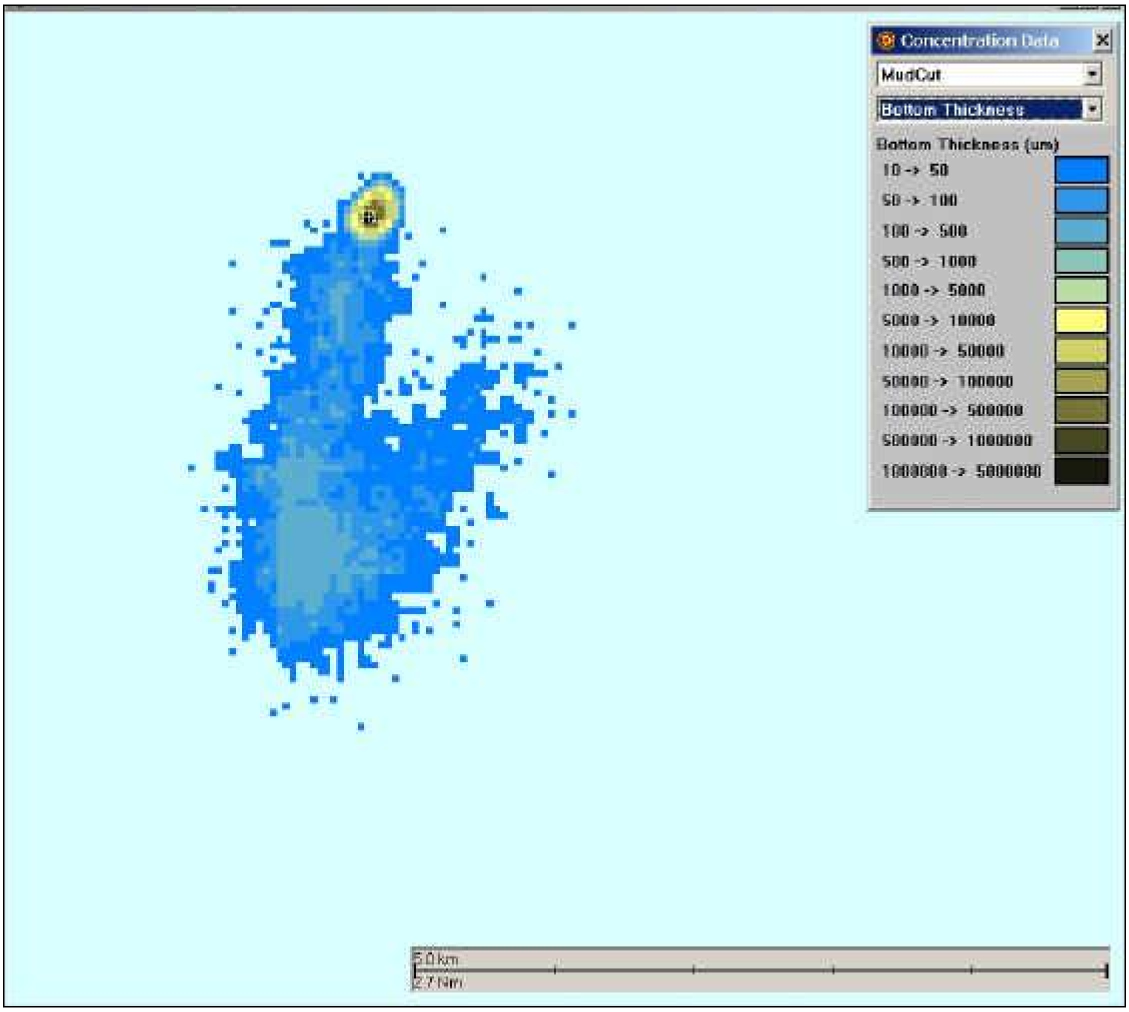

Figure 35. Deposition patterns for the simulation of 9 wells during the maximum winter conditions, scenario WM9Well.

Figure 36 presents the deposition pattern for the simulation of nine wells during the average winter conditions, scenario WA9Well. The deposition pattern for this scenario is offset to the northwest with two separate yet attached regions. The region of highest deposition occurs very near to the drill location with maximum deposition thickness on the order of 560000 µm while a second broader deposition region with thicknesses on the order of 10 to 5000 µm develops to the northwest.

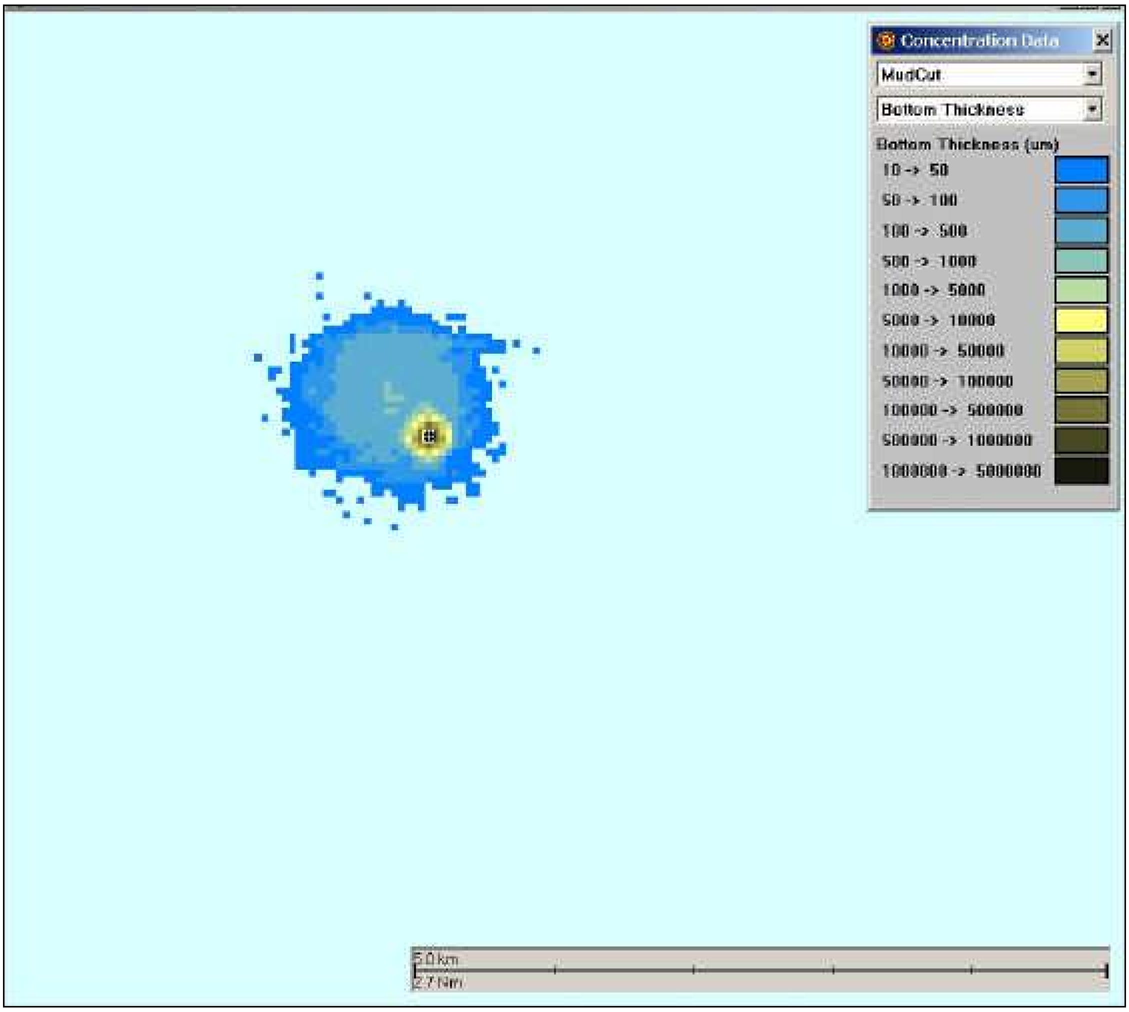

Figure 36. Deposition patterns for the simulation of 9 wells during average winter conditions, scenario WA9Well.

Figure 37 presents the deposition pattern for the simulation of nine wells during the maximum summer conditions, scenario SM9Well. The deposition pattern for this scenario is offset to the southeast with two distinctly separate regions. The region of highest deposition occurs very near to the drill location with maximum deposition thickness on the order of 560000 µm while a second broader deposition region with thicknesses on the order of 10 to 1000 µm develops to the southeast. The development can be attributed to the smaller particle being carried downstream by the current before settling occurs.

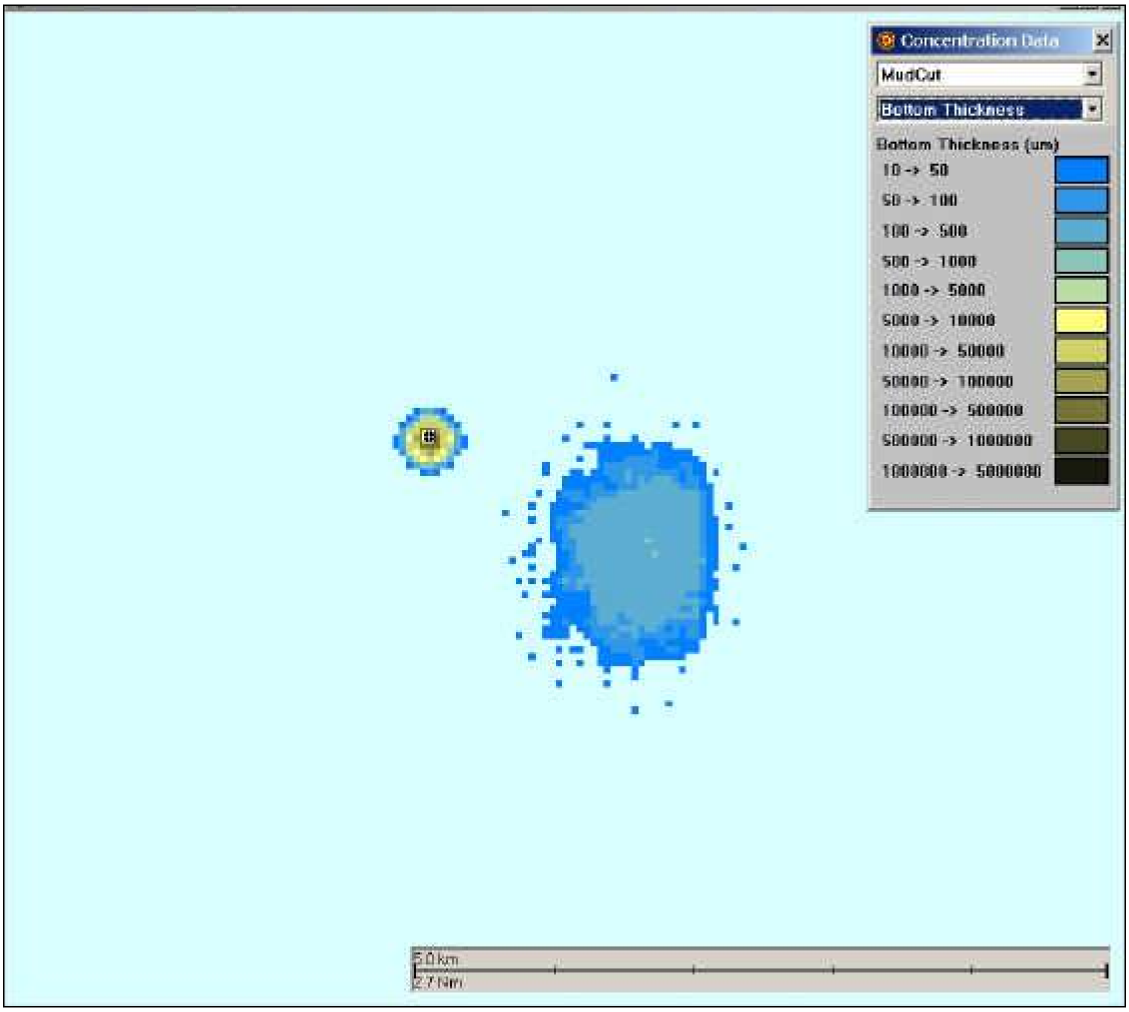

Figure 37. Deposition pattern for the simulation of nine wells during the maximum summer conditions, scenario SM9Well.

Figure 38 presents the deposition pattern for the simulation of nine wells during the average summer conditions, scenario SA9Well. The deposition pattern for this scenario is roughly centered on the release site. The region of highest deposition occurs very near to the drill location with maximum deposition thickness on the order of 600000 µm which reduces to approximately 10 µm on the outer edge.

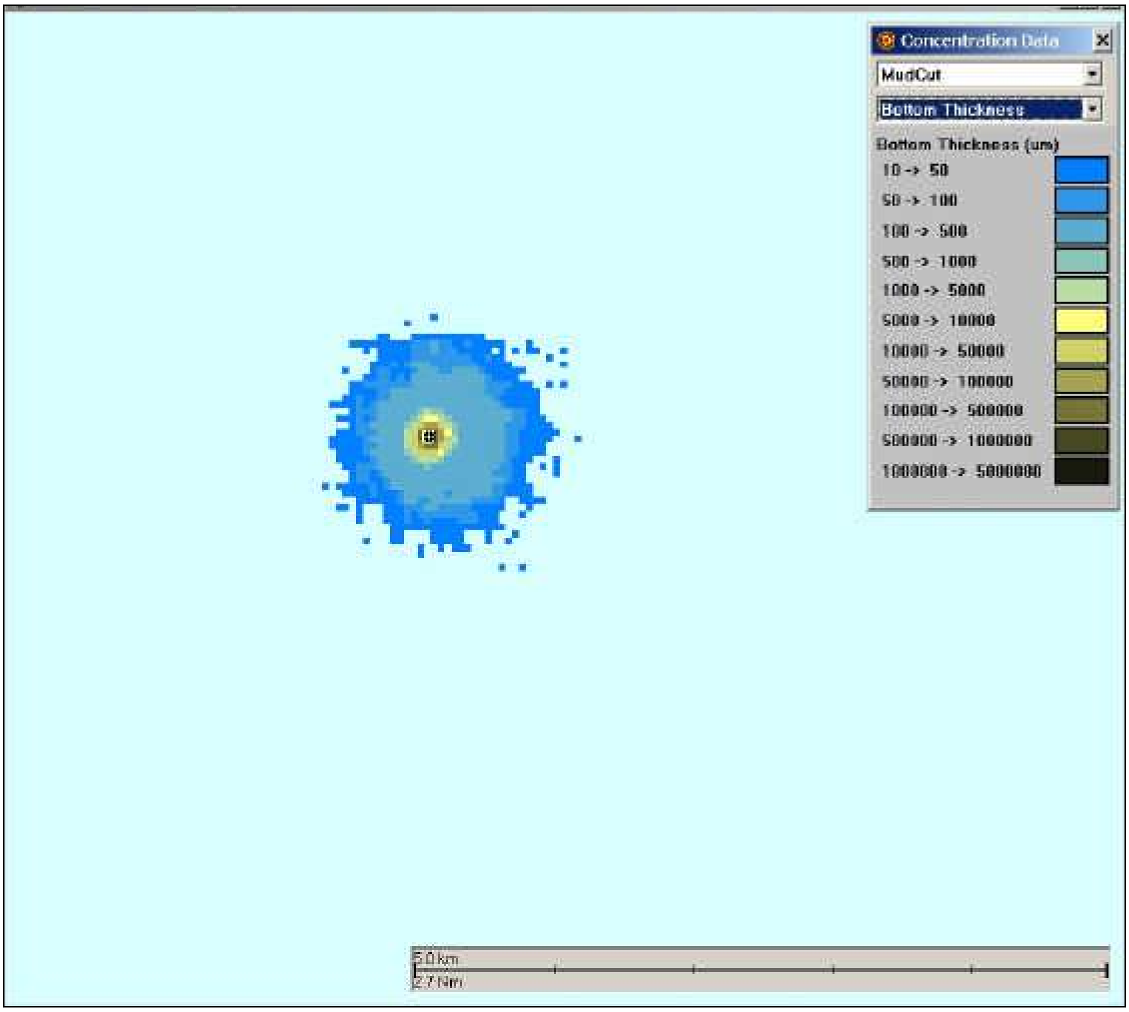

Figure 38. Deposition pattern for the simulation of nine wells during average summer conditions, scenario SA9Well.

Figure 39 presents the deposition pattern for the simulation of 34 wells during the maximum winter conditions, scenario WM34Well. The deposition pattern for this scenario is elongated to the south-southeast due to the current carrying the lighter particles downstream. The region of highest deposition occurs very near the drill location with maximum deposition thickness on the order of 1150000 µm while the elongated deposition region has deposition thickness ranging from 10 to 1000 µm.

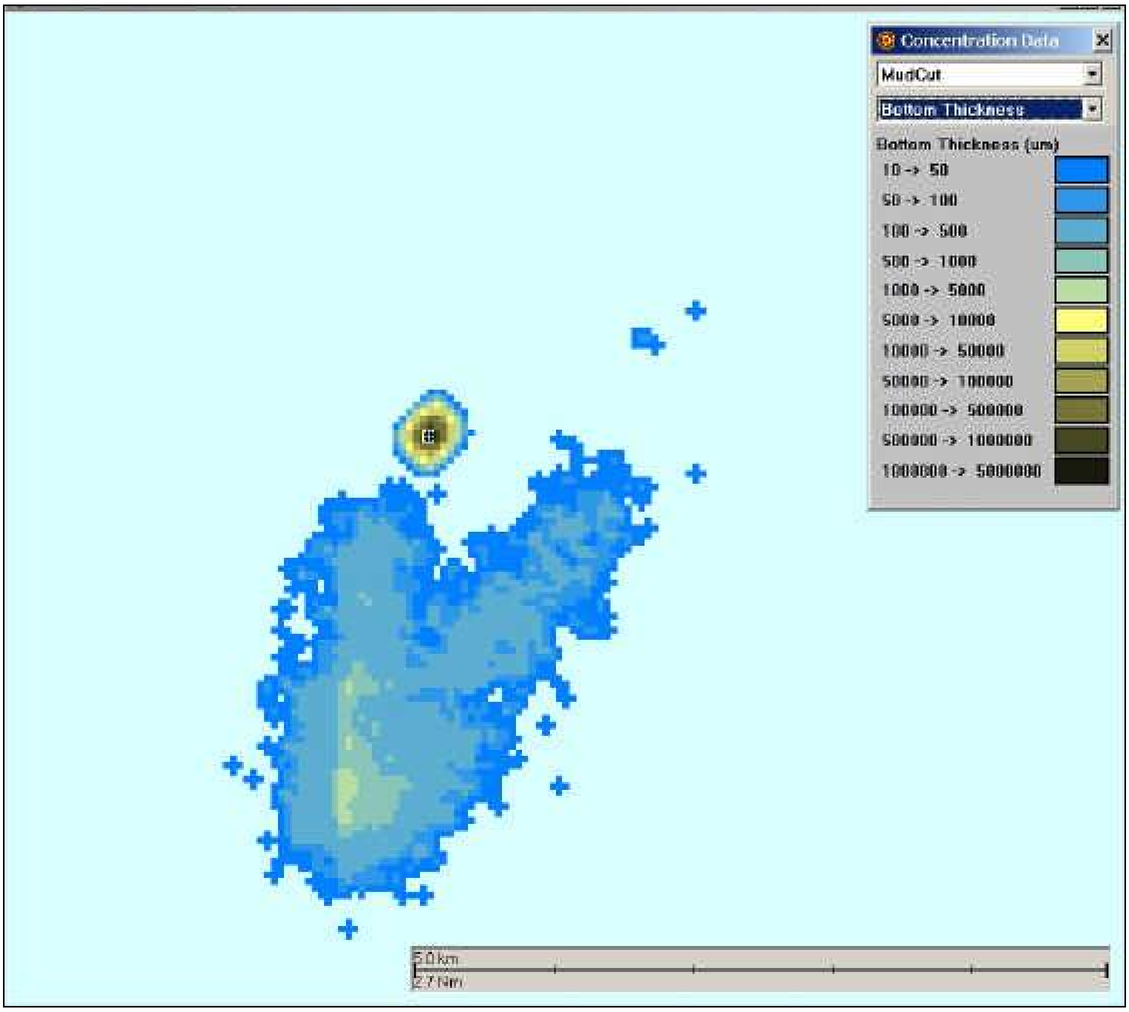

Figure 39. Deposition pattern for the simulation of 34 wells during the maximum winter conditions, scenario WM34Well.

Figure 40 presents the deposition pattern for the simulation of 34 wells during the average winter conditions, scenario WA34Well. The deposition pattern for this scenario is offset to the northwest with two separate yet attached regions. The region of highest deposition occurs very near to the drill location with maximum deposition thickness on the order of 2250000 µm while a second broader deposition region with thicknesses on the order of 10 to 2000 µm develops to the northwest.

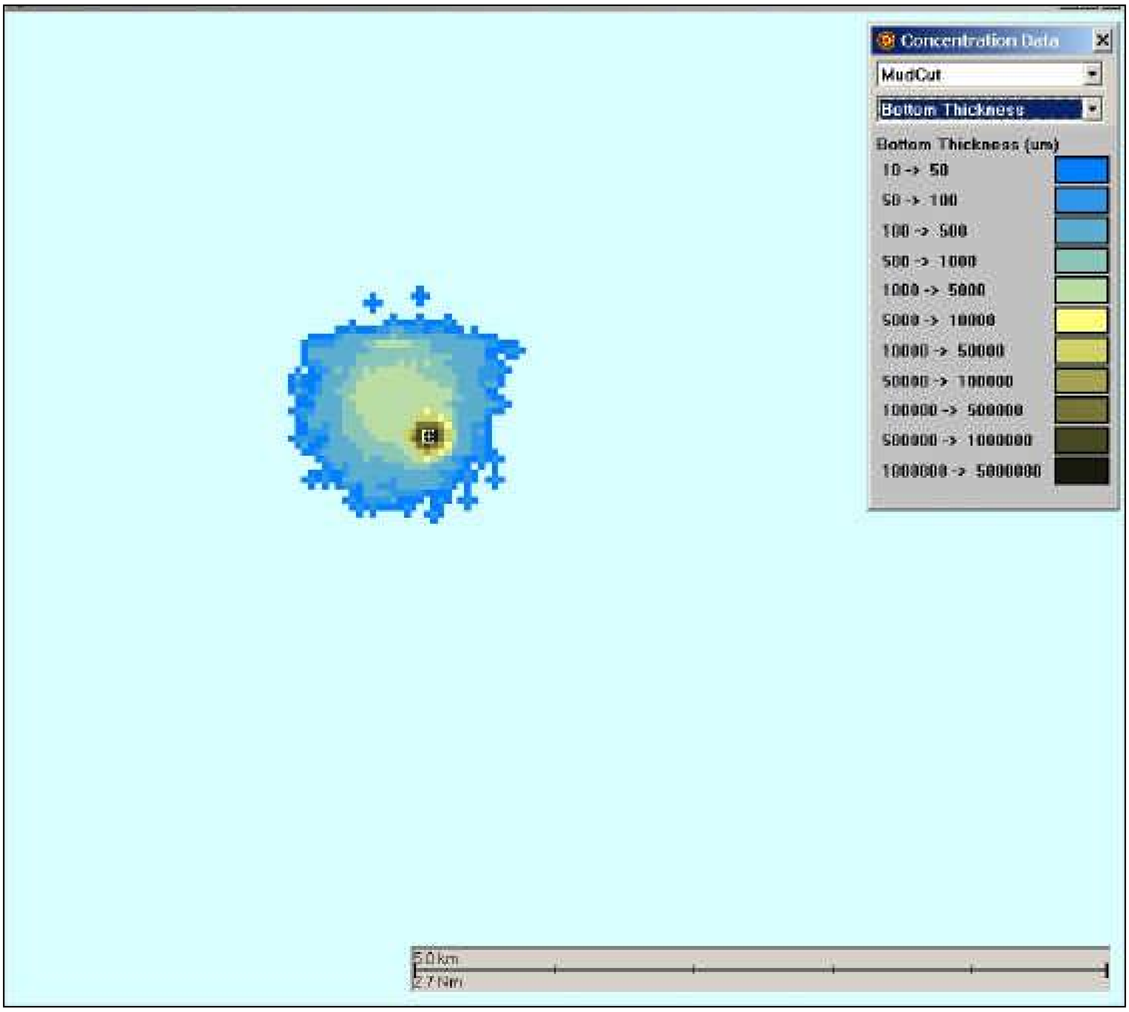

Figure 40. Deposition pattern for the simulation of 34 wells during the average winter conditions, scenario WA34Well.

Figure 41 presents the deposition pattern for the simulation of 34 wells during the maximum summer conditions, scenario SM34Well. The deposition pattern for this scenario is offset to the southeast with two distinctly separate regions. The region of highest deposition occurs very near the drill location with maximum deposition thickness on the order of 2000000 µm while a second broader deposition region with thicknesses on the order of 10 to 2000 µm develops to the southeast. The development can be attributed to the smaller particle being carried downstream by the current before settling occurs.

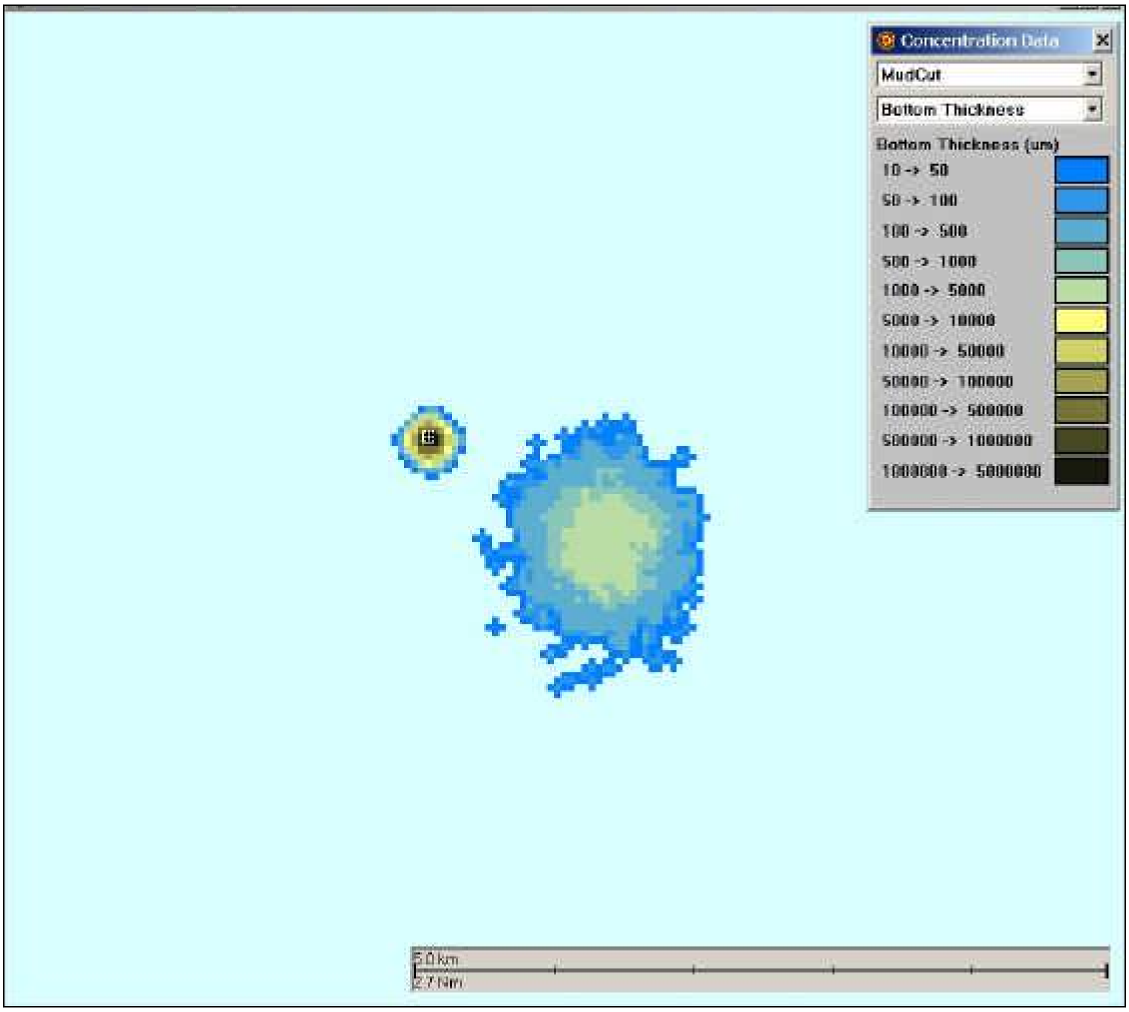

Figure 41. Deposition pattern for the simulation of 34 wells during maximum summer conditions, scenario SM34Well.

Figure 42 presents the deposition pattern for the simulation of 34 wells during the average summer conditions, scenario SA34Well. The deposition pattern for this scenario is roughly centered on the release site. The region of highest deposition occurs very near to the drill location with maximum deposition thickness on the order of 1200000 µm which reduces to approximately 10 µm on the outer edge.

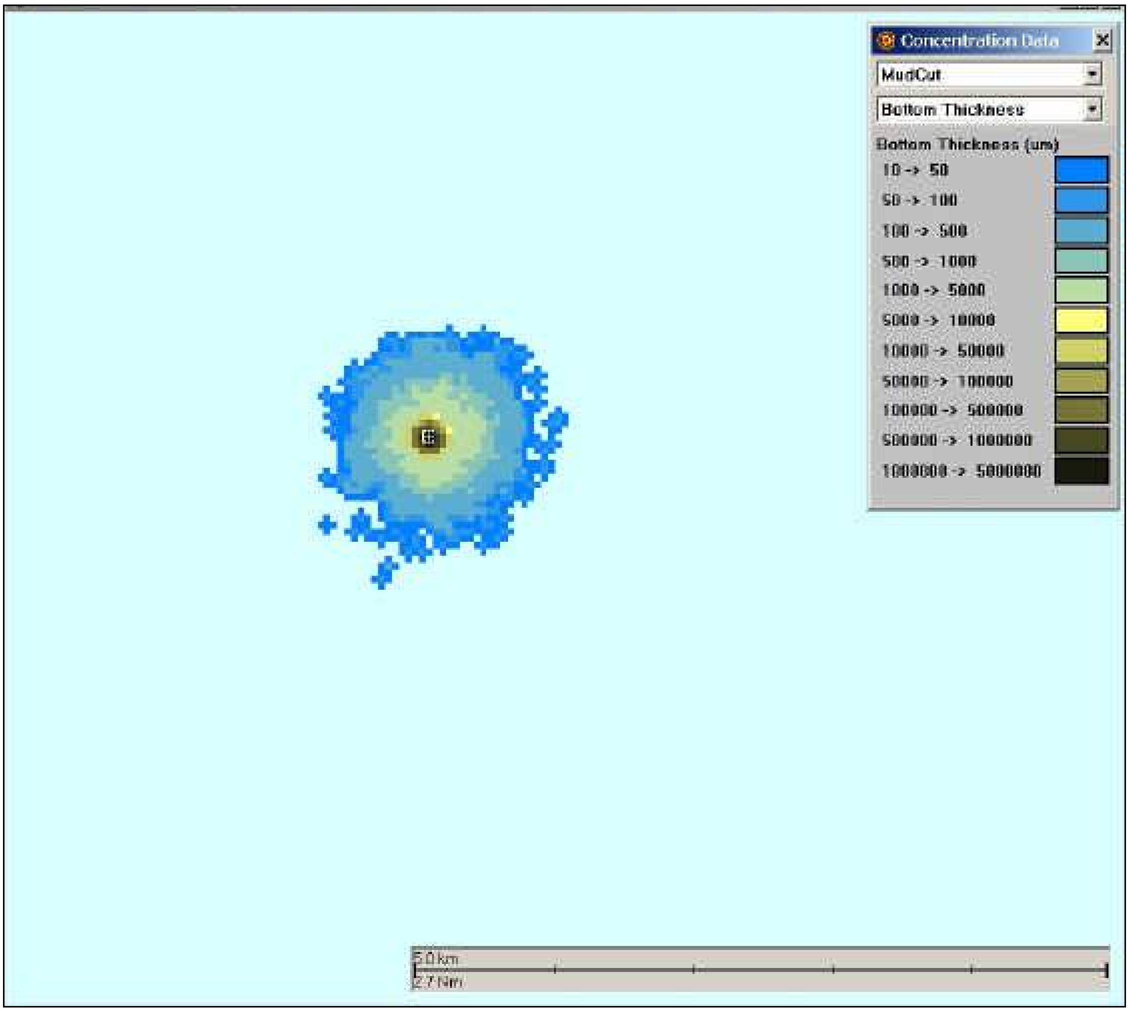

Figure 42. Deposition pattern for each simulation of 34 wells during average summer conditions, scenario SA34Well.

7. Summary

Hydrodynamic simulations were conducted for the Caspian Sea using 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 in the northern Caspian on the order of 20 km and finer resolution in the southern Caspian with resolutions on the order of 5 and 2.5 km in the Baku region. The environmental forcing for the hydrodynamic model consisted of wind data obtained from the numerical atmospheric model: NCEP reanalysis, provided by NOAA-CIRES Climate Diagnostics Center, Boulder Colorado. The hydrodynamic model was validated using current meter data collected by the Azerbaijan International Operating Company along a pipeline route between Chirag and Sangachal Bay within the Caspian Sea (Figure 10) 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 to reproduce the major current trends within the region very well (Figures 11-15) with the model being 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 that can be attributed to local bathymetric or shoreline characteristics not resolved by the computational grid.

Thermal dispersion simulations were conducted for cooling water discharges of 600 m^3/hr, at 11 m depth, and 1700, 4200 and 5900 m^3/hr, at 60 m depth, from the Production Drilling and Quarters Platform and the Compression and Water Platform within the Azeri, Chirag and Gunshali Field during summer and winter. The location of these discharges is expected to be within 60 to 200 m of each other, which is less than the resolution of the hydrodynamic model. Therefore, simultaneous operation of the 1700 and 4200 m^3/hr, Production and Drilling Quarters Platform and the Compression and Water Platform, respectively, were combined to form a single 5900 m^3/hr discharge. A parametric study was conducted to study the seasonal dispersion characteristics of the cooling water for these various flow rates for horizontal and vertical discharge orientations. During the summer the thermal plume, for the 60 m discharges, reaches ambient conditions after traveling approximately 20 m upwards regardless of the discharge orientation. At this depth there exists a strong thermocline in which the upper layer temperature is approximately the same as the original discharge temperature. During the winter the thermal plume, for the 60m discharges, reaches ambient conditions after traveling approximately 40 m upwards, with the vertical discharges traveling slightly further. the greater upward extent of the thermal plume during the winter is due to the much colder vertical well mixed structure of the water column, relative to the summer. The upward extent of the thermal plume for the 600 m^3/hr discharges, released at 11 m depth, at which ambient conditions were achieved was between 4 and 6 m from the surface for both seasons. The horizontal distance the plume traveled away from the discharge and the maximum diameter were directly proportional to the discharge velocity, ambient current conditions and the discharge orientation relative to the current. For example a discharge released inline with the maximum current has a greater horizontal excursion and plume diameter relative to a vertical release under average conditions.

The dispersion of antifoulant, copper and chlorine, contained within the cooling water was simulated for 1700, 4200 and 5900 m^3/hr flow rates. A conservative approach was taken in which the antifoulant material was assumed to be completely dissolved in the cooling water and only begins to disperse after the thermal plume has reached its maximum vertical extent. The maximum concentration of each constituent was directly proportional to the discharge flow rate and the initial release concentration. The maximum concentration of copper ranged from 0.0008 ppb to 0.005 ppb for the 1 ppb release at 1700 m^3/hr and the 2 ppb release at 5900 m^3/hr, respectively. The maximum concentration of chlorine ranged from 0.007 ppb to 11.2 ppb for the 10 ppb release at 1700 m^3/hr and the 4000 ppb release at 5900 m^3/hr, respectively. The dispersion pattern never carried any constituent to the surface but rather showed a vertical spread on the order of 10 m around the release site.

A series of mud and drill cutting simulations were conducted for 9 and 34 wells during average and maximum current conditions for the summer and winter seasons. In general the heavier cuttings settled very near the drill site with lighter particle being carried downstream by the current before settling. The predicted deposition pattern during the average winter conditions is offset to the northwest with two distinct but attached regions with maximum deposition of 560000 and 2250000 μm near the drill site for the 9 and 34 wells, respectively. The predicted deposition pattern during the maximum winter conditions is elongated to the south-southeast with maximum deposition of 300000 and 1150000 μm near the drill site for the 9 and 34 wells, respectively. The predicted deposition pattern during the average summer conditions is roughly centered on the release with maximum deposition of 600000 and 1200000 μm near the drill site for the 9 and 34 wells, respectively. The predicted deposition pattern during the maximum summer conditions is offset to the southeast with two distinct separate regions with maximum deposition of 560000 and 2000000 μm near the drill site for the 9 and 34 wells, respectively.

8. References

ASA (Applied Science Associates, Inc.), *OILMAP Technical and User's Manuals*, Narragansett, RI, 1999.

Brandsma, M. G. and T.C. Sauer, 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, February 7-10, 1983.

Davis, A. M.. 1977: The numerical solutions of the three-dimensional hydrodynamical equations using a B-spline representation of the vertical current profile. *Bottom Turbulence. Proc. 8th liege colloquium on Ocean hydrodynamics.* J. C. J. Nihoul. Ed.. Elsevier. 27-48

Davis, A. M.. 1977: The numerical solutions of the three-dimensional hydrodynamical equations using a B-spline representation of the vertical current profile. *Bottom Turbulence. Proc. 8th liege colloquium on Ocean hydrodynamics.* J. C. J. Nihoul. Ed.. Elsevier. 27-48

Delvigne, G.A.L. and C.E. Sweeney,1988. Natural dispersion of oil. Oil and Chemical Pollution 4: 281-310.

Fay, J.A., "Physical Processes in the Spread of Oil on a Water Surface", in *Proceedings at Joint Conference and Control of Oil Spills*, Washington, D.C., June 15-17, 1971.

French, D., H. Schuttenberg, T. Isaji, 1999. Probabilities of oil exceeding thresholds of concern: examples from an evaluation for Florida Power and Light. In: Proceedings: AMOP 99 Technical Seminar, June 2-4, 1999, Calgary, Alberta, Canada, pp. 243-270.

GEMS, 1998. Quantitative assessment of the dispersion and seabed depositions of drill cutting discharges from Lameroo-1 AC/P16, prepared for Woodside Offshore Petroleum, prepared by Global Environmental Modeling Services, Australia, June 16, 1998.

Gordon. R.. 1982: Wind driven circulation in Narragansett Bay. Ph. D. Thesis. Department of Ocean Engineering, University of Rhode Island, Kingston, RI, 161 pp.

Isaji, T. and M. Spaulding, 1984. Notes and Correspondence. A Model of the Tidally Induced Residual Circulation in the Gulf of Maine and Georges Bank, published in: Journal of Phys. Ocean., June. pp. 1119-1126.

Jirka, Gerhard H., R.L. Doneker and S.W. Hinton, 1996. User's Manual for CORMIX: A hydrodynamic Mixing Zone Model and Decision Support system for Pollutant Discharges into Surface Waters. Cornell University, Ithaca, New York.

Jirka, G.H., 1992. Use of Mixing Zone Models in Estuarine Waste Load Allocation, Part III of Technical Guidance Manual for Performing Waste Load Allocations, Book III: Estuaries. Edited by R.A. Ambrose and J.L. Martin, USEPA, Washington DC, EPA-823-R-92-004, 1992.

King, B, and F. McAllister, 1998. Modeling the dispersion of produced water discharges, APPEA Journal 1998, pp. 681-691.

King, B. and F. McAllister, 1996. The application of MUDMAP for investigating the dispersion of produced water discharges from Harriet A on Australia's Northwest shelf, report to Australian Petroleum Production and Exploration Association, prepared by Australian Institute of Marine Sciences, Townsville, Australia, August 1996.

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 modeling for barged ocean disposal of waste, Environmental Protection Agency Technology Series EPA 660/2-73-029, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Kosarev, A.N., E.A. Yablonskaya, 1994. The Caspian Sea. SPB Academic Publishing, The Hague, 1994.

McCutcheon, S.C., Z. Dongwei and S. Bird, 1990. Model calibration, validation, and use. Chapter 5 in: Technical Guidance Manual for Performing Waste Load Allocations, Book III: Estuaries. Part 2: Application of Estuarine Waste Load Allocation Models. Edited by J.L. Martin, R.B. Ambrose and S.C. McCutcheon. United States Environmental Protection Agency, Office of Water. March 1990.

Spaulding, M. L., T. Isaji, and E. Howlett, 1994. MUDMAP: A model to predict the transport and dispersion of drill muds and production water, Applied Science Associates, Inc, Narragansett, RI.

Spaulding, M. L., 1994. MUDMAP: A numerical model to predict drill fluid and produced water dispersion, Offshore, Houston, Texas, March 1993.

USEPA, 1991B. Technical Support Document for Water Quality Based Toxic Controls. USEPA, Office of Water, Washington, DC, September 1991.

USEPA, 1991A. Assessment and Control of Bioconcentratable Contaminants in Surface Waters. USEPA, Office of Water, Washington, DC, March 1991.

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FINAL REPORT

AZERI, CHIRAG & GUNASHLI
OIL SPILL RISK ASSESSMENT

FOR

BP EXPLORATION (CASPIAN SEA) LTD
BAKU, AZERBAIJAN

Ref: /id 7 May 2002

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FINAL REPORT

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OIL SPILL RISK ASSESSMENT

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BP EXPLORATION (CASPIAN SEA) LTD

BAKU, AZERBAIJAN

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report number	:	3793R/R01PV
project number	:	27527.071

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EXECUTIVE SUMMARY

This oil spill risk assessment report presents a study of the potential accidental oil spills during the lifetime of the ACG Phase 1 project. A number of potential failures that could result in oil spill have been considered:

- Blowout
- Catastrophic pipeline failure
- Minor pipeline leak
- Separator failure on the PDQ platform
- A diesel spill during vessel and platform activities

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.

For a blowout at the ACG field, with the potential for an estimated volume of 200,000m^3 of oil, there is a <1% likelihood of oil beaching on the Aspheron Peninsula in the winter, rising to >10% in the summer. Under worst-case conditions, of an onshore 20 knot wind in the winter, beaching will take place after 48 hours.

A catastrophic pipeline failure of 90,000m^3, either offshore or near shore, has a <1% chance of beaching on the Aspheron Peninsula. Under worst case conditions an offshore spill will beach on the Aspheron Peninsula in 38 hours, a near shore spill in 19 hours.

For a smaller spill volume of 720m^3, arising as a result of a chronic leak from the pipeline, the time to beaching on the Aspheron Peninsula is 48 hours for an offshore leak and 28 hours for a near shore leak. A leak from a separator on the platform, of 140m^3, is considered to behave in a similar manner to an offshore leak from a pipeline and will beach after approximately 48 hours. Modelling of a diesel spill of 100m^3 indicted that the diesel would be fully dispersed after 8 hours.

BP has prepared an overview Oil Spill Contingency Plan (OSCP) for its Azerbaijan Business Unit, which addresses onshore and offshore incidents, incident reporting, oil spill remediation, contractor databases and response resource availability. An ACG Phase 1 project OSCP will be prepared by BP on the basis of this oil spill risk assessment report.

1. INTRODUCTION

This report has been prepared by URS on behalf of BP and is concerned with the risk of oil spill arising as a result of operations during the ACG Phase 1 project. It forms a contribution to the Environmental and Social Impact Assessment (ESIA) for the ACG phase 1 Project, where further detail of the project can be found.

All offshore oil production and export operations carry with them some potential for accidental oil spill. However, oil spills are considered unacceptable by BP, who place considerable emphasis on their prevention. It is BP policy to strive for a zero spill target through the use of 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 ACG Phase 1 ESIA includes a commitment to develop an oil spill response strategy and oil spill contingency plan. This report will make a significant contribution to that process.

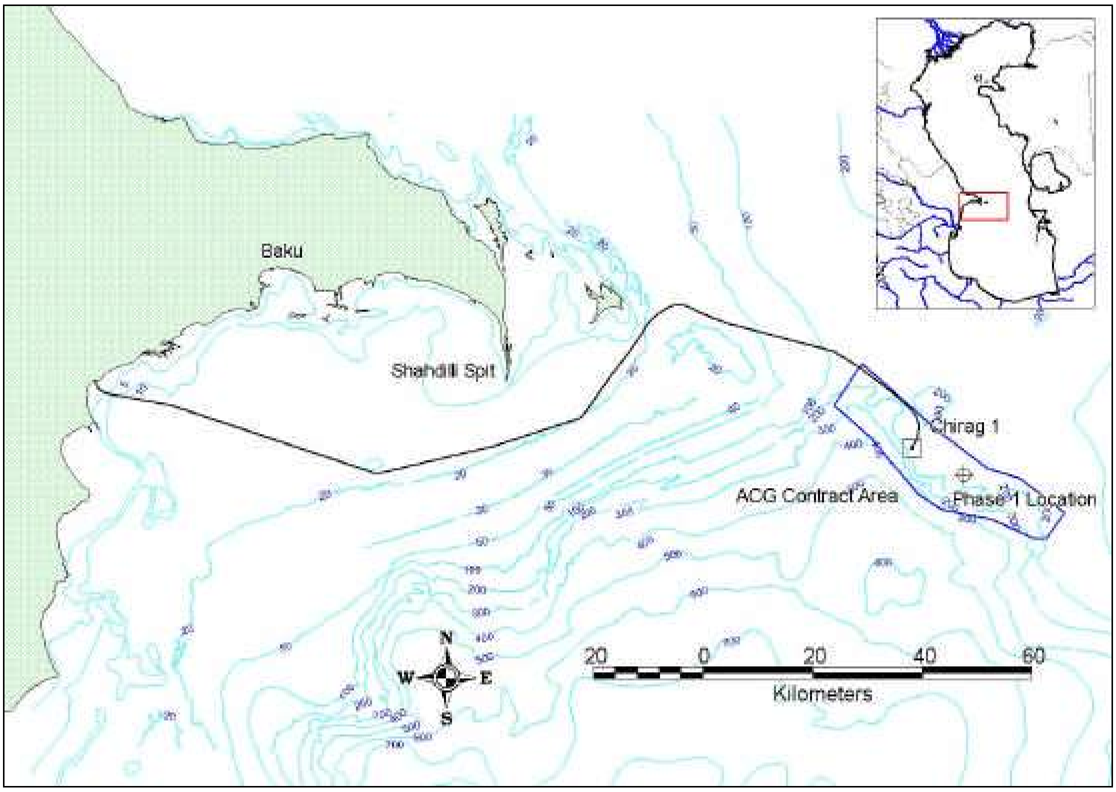
The remaining sections of this report are:

- Section 2, The ACG Phase 1 Project
- Section 3, Oil Spills
- Section 4, Oil Spill Response Strategy
- Section 5, Conclusions

2. THE ACG PHASE 1 PROJECT

Phase 1 facility design will comprise a new Drilling, Production and Quarters platform (PDQ) and Compression and Water Platform (C&WP) offshore, sub sea pipelines for the transport of hydrocarbons to shore and expansion of the existing EOP oil-receiving terminal at Sangachal.

Figure 1: Location of ACG Phase 1 development



The PDQ will consist of oil and gas separation and pumping facilities, drilling facilities and living quarters. The C&WP will provide the facilities to compress associated gas production for reservoir maintenance purposes as well as seawater treatment and water injection pumping equipment required to meet the Phase 1 production expectations. The offshore facilities will be bridge-linked and will be linked by inter-field pipelines to the existing Chirag-1 platform for the transportation of oil to the PDQ and gas to the C&WP. Oil from the PDQ will be exported to the Sangachal terminal facility via a new 30" oil export line. Gas transport from the PDQ will be achieved through conversion of the existing Chirag-1 24” oil pipeline to gas service (although this option is being reconsidered at the time of writing).

The existing EOP Terminal at Sangachal will be expanded to process the additional oil and gas produced. This will include a new oil and gas inlet, two new oil process trains, gas compression and refrigeration package and two additional oil storage tanks and temporary tank storage facilities for produced water.

3. OIL SPILLS

3.1 OVERVIEW

3.1.1 Information Sources

Data on the frequency and consequence of a spill has been derived from a number of sources. These include:

- Historical spill data from oil production operations in 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 these data to the Caspian environment is considered appropriate, as the operations will be run to standards similar to these fields. However it should be recognised that these data have been interpolated from a different geographical region.

- Discussions and workshops held in June and July 2001, involving members of the ACG Phase I design team and environmental specialists from URS when expert option and experience was employed and a consensus achieved concerning frequency and consequence. This process allowed experience gained on the EOP to be imported to the ACG Phase 1 project.

Several scenarios have been considered in this risk assessment:

- Blowout
- Catastrophic pipeline failure
- Minor pipeline leak
- Separator failure on the PDQ platform
- A diesel spill during vessel and platform activities

3.1.2 Modelling Methodology

Oil spill modelling was undertaken by Briggs Marine Environmental Services Ltd. using the Oil Spill Information System (OSIS) model. Scenarios were run for both winter and summer conditions.

Two types of modelling were undertaken:

- Stochastic modelling, where actual statistical wind speed/direction frequency data is 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 is used to obtain 'worst case' shoreline impacts without any oil weathering processes applied and produces the shortest time to shoreline contact under these meteorological conditions.
- Single trajectory modelling is used to predict the weathered state of the oil for each of the stochastic modelling results. The model uses the fastest wind-driven travel speed for oil on the sea to predict the shortest beaching time, termed the 'worst-case scenario'. This represents the shortest allowable response time before the oil reaches a shoreline under 'worst case' conditions. The trajectory model also provides an understanding of the changes in the nature and state of the oil after release to the marine environment.

ACG Crude had not been characterised for use in OSIS at the time that this modelling was undertaken, therefore Iranian Light Crude was used, as it is considered to have a close match for modelling purposes based on API and Specific Gravity:

- Azeri Crude: API 34.5, Specific Gravity 0.85
- Iranian Light: API 33.7, Specific Gravity 0.856

Briggs Marine Environmental Services Ltd has subsequently undertaken a review of the modelling work with the conclusion that Iranian crude was representative of Azeri crude.

The following constants were employed in the modelling work:

- For winter spill runs the air temperature used was 5ºC and the sea temperature was 10ºC;
- For summer spill runs the air temperature used was 35ºC and the sea temperature was 25ºC;
- 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 and using a wind speed at approximately the 90th percentile.
- For spills extending over a long time period a shorter representative modelling time was used. For a spill over 180 days, a spill run lasting 10 days was deemed as representative.

3.1.3 Frequency of Spills

When discussing the frequency of possible oil spills the following terminology has been employed:

- 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.

3.2 BLOWOUTS

3.2.1 Background

An uncontrolled blowout can be defined as any uncontrolled flow of formation fluids from the reservoir to the surface, due to formation pressure exceeding the hydrostatic pressure of the mud or fluid column and failure of secondary blowout prevention measures. Blowout events may occur at the platform or sub sea. Blowouts are extremely remote events, however an uncontrolled blowout would result in a significant release of oil.

3.2.2 Spill Frequency and Volume

The determination of the most likely spill frequency associated with each project activity was accomplished by dividing the number of spills from this activity 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 the proposed project to determine the most likely spill frequency associated with the project. Table 1 presents the most likely blowout frequency (known as the statistically expected value) for the ACG Phase I project lifetime (2001 through 2024). The calculated probability of one or more blowouts >300 tonnes is 4.5% between 2001 and 2024.

Table 1: Statistically Expected Number of Blowouts by Size (l). Phase I Lifetime (2001 through 2024)

Spill Source	Risk Exposure (during project lifetime)[1]	l		
		1-100 tonnes	**100-300 tonnes**	**>300 tonnes**
Blowouts			Spills are either contained and <100 tonnes or uncontrolled resulting in release >300 tonnes	
Development Drilling	48 wells	0.0082		0.0245
Well Completion	48 completions	0.0023		0.0091
Production	860 well-years	0.0042		0.0129
Wireline[2]	860 well-years	0.0031		0.0095
Subtotal – Blowouts		0.0152		0.0465

[1] Risk exposure is the length of time equipment is exposed to during the lifetime of a project.

2 Wire line surveys are included in the production spill statistics, and have not been double-counted in this total.

Table 2: Probability of one or more blowouts by Size (%). Phase I lifetime (2001 through 2024)

Spill Source	%		
	1-100 tonnes	**100-300 tonnes**	**>300 tonnes**
Blowouts			
Development Drilling	0.81	Spills are either contained	2.42
Well Completion	0.28	and <100 tonnes or	0.91
Production	0.42	uncontrolled resulting in	1.28
Wireline[1]	0.31	release >300 tonnes	0.94
Subtotal – Blowouts	1.50	-	4.54

1 Wire line surveys are included in the production spill statistics, and have not been double-counted in this total

If either the Dada Gorgud or the PDQ was to lose control of a well either during drilling or during a well workover, then 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 a 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 given below are based on the assumption that any other 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 worst case modelling, that the time taken for the MODU to suspend drilling operation (7 days), mobilise to the blowout location (5 days) and drill a relief well (30 days) would amount to a total of 42 days. During this time is also assumed 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. However, it is not possible to predict to what extent the flow may be restricted or how much faster drilling and intervention might be achieved and therefore the worst case has been assumed.

Table 3: ACG Phase 1- Blowout Volumes

Parameter	Value/quantity	Notes
Rate of oil flow	30,000 bbls/day	4,770 m^3/ day
Shut-in time	42 Days	Based on 7 days to suspend a rig operating elsewhere in the Caspian (eg Istiglal) then 5 days moving time then 30 days to drill relief well
Volume of Oil (Total) released over 42 days	200,324m^3	

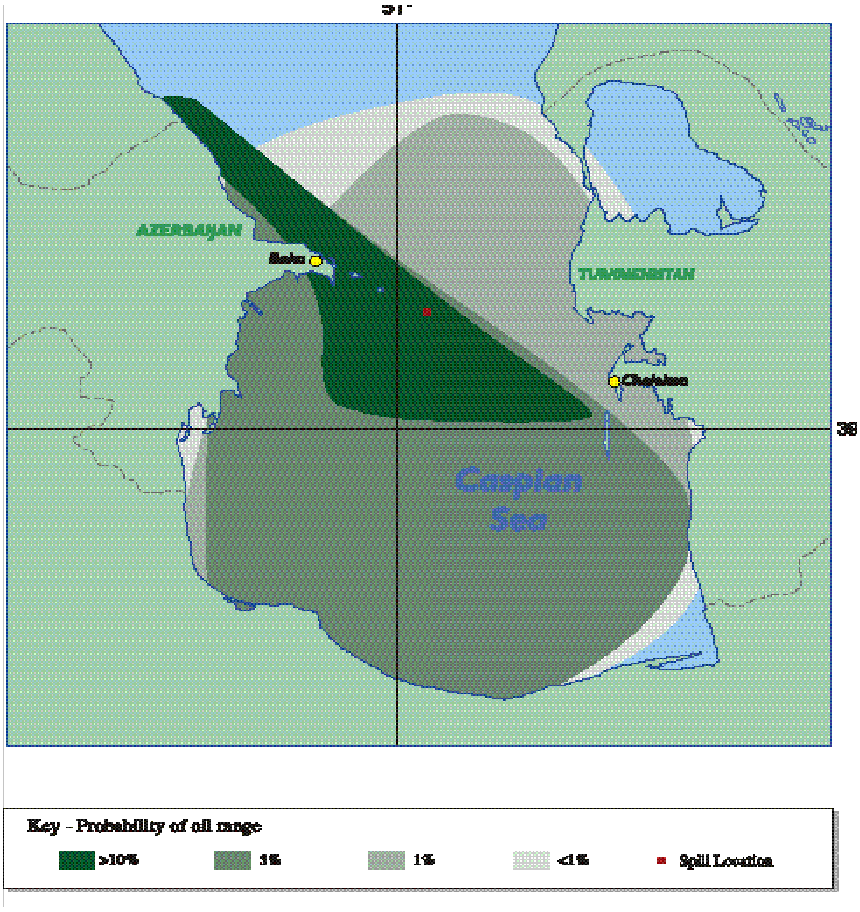
Other blowout or loss of well-control are possible in which the flow from the well is restricted in some way, for example by drilling debris and it is possible under some circumstances to bring the well back under control without the need for an intervention well. Such blowout events (i.e. those quickly controlled by safety valve or blow-out protection equipment) would result in only a minor release of oil (approximately 200 m^3) as they can be controlled within an hour.

3.2.3 Oil Spill Behaviour

3.2.3.1 Stochastic Modelling

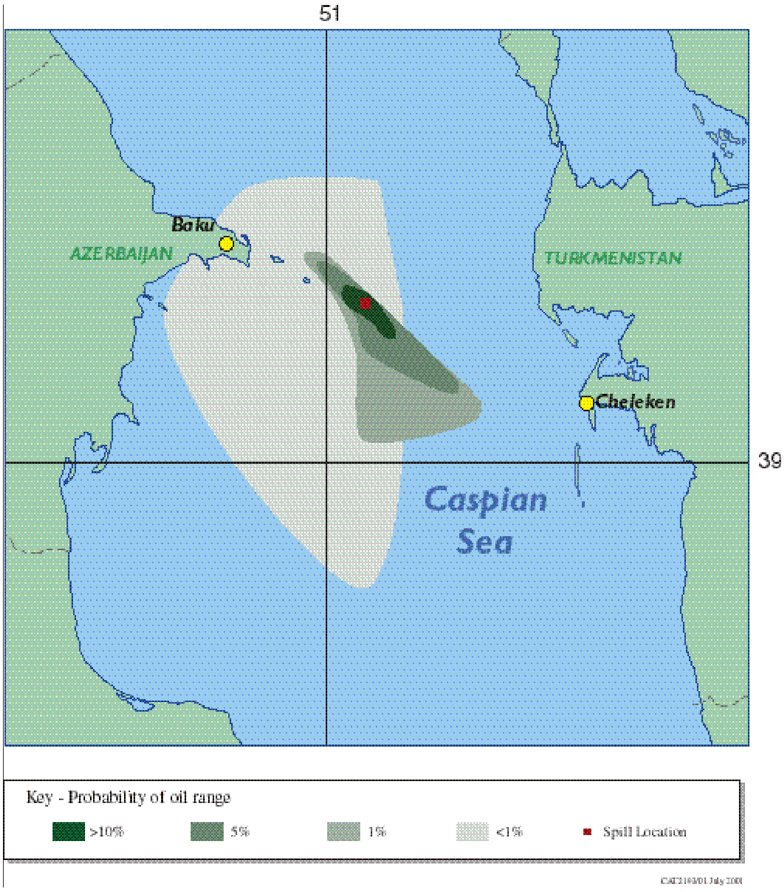
In the winter, stochastic modelling indicates that the oil will be transported predominantly to the south and south east of the field into the Southern Central Caspian Sea area, with the heaviest area of oiling directly to the south east of the release location. There is a <1% probability of oil heading west and reaching the Apsheron Peninsula on the west coast of the Caspian Sea.

Figure 2 Winter Stochastic Modelling of a Blowout



In the summer, stochastic modelling indicates that the oil will be transported predominantly in three broad directions; to the northwest, south and south east of the field into the Southern Central Caspian Sea area, with the heaviest area of oiling also in these directions. There is a >10% probability of oil heading in a north west direction and reaching from the Apsheron Peninsula north towards Makhachkala on the west coast of the Caspian Sea. There is a 5% chance of oil beaching around the coast of the southern Caspian. There is a 1 % probability of oil reaching the Cheleken Peninsula in the east (Turkmenistan).

Figure 3 **Summer Stochastic Modelling of a Blowout**

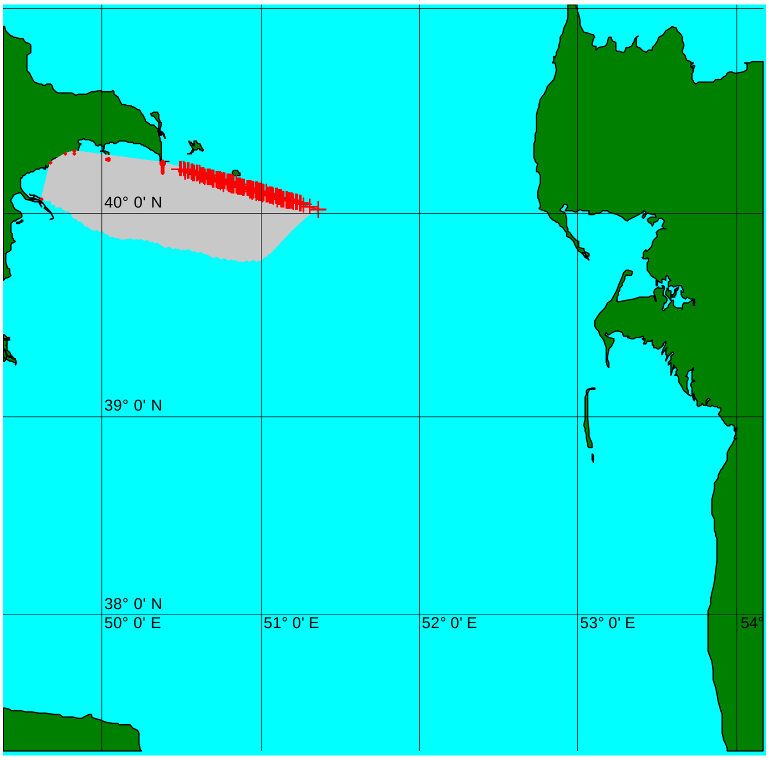


3.2.3.2 Single Trajectory, Worst Case, Modelling of Blowout

Single trajectory modelling of the worst case blowout shows that on release the oil increased in volume due to emulsification before steadily decreasing in volume as the oil dispersed and evaporated. The oil was persistent enough to beach at the point of nearest landfall after 49 hrs. The resultant volumes of emulsified oil after 49 hours were:

- 83032m^3 Evaporated
- 100929m^3 Dispersed
- 77821m^3 Beached

Figure 4: **Well Blowout in worst case conditions**



3.2.4 Blowout Prevention

The reservoirs in the ACG field are normally pressured formations and the wells are all designed so that the wells are monitored and controlled against unplanned influx. 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.

The Blow Out Preventer (BOP) stack provides secondary well control. 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 can close the annulus between the drillpipe 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 oil to be contained and disposed of.

3.3 PIPELINE LEAKS

3.3.1 Background

A number of potential leak scenarios have been identified:

- catastrophic pipeline failure; and
- minor pipeline leak.

The size of spill produced by a leak will depend on the rate of leak and the time taken for detection. Therefore, a minor leak may lead to a large spill if undetected for a long period.

3.3.2 Catastrophic pipeline failure

The worst case for a pipeline leak would be a catastrophic failure of the pipeline resulting in the complete loss of pipeline inventory. 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, the pipeline is on two major gradients as it dips down from the platform and then steadily rises again as the pipeline heads towards the shore. This means that there is a low point at some distance from the platform. For oil 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 oil in the pipeline to be discharged.

Continued production following a catastrophic pipeline failure would of course mean that oil was being forced down the line to the rupture but this effect is offset by the fact that downstream of the rupture there would be relatively less pressure and the oil 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. It is estimated that a pressure drop in the major export pipeline (30”) will be detected within an hour followed by production shut-in. This is not an accurate figure and is taken as a best estimate.

There is no leak detection system associated with the pipeline other than pressure drop and the obvious point that the terminal would cease to receive oil. Thus it is simply estimated that the time to detect a pressure drop, confirm the extent of the pressure drop and subsequently cease export from the installation would be approximately one hour. In the case of a catastrophic failure, it is unlikely that it would take longer than an hour and thus this figure has been assumed in order to quantify the worst case. In fact the amount of oil that would be discharged through one hour's continued production following a catastrophic pipeline failure would amount to approximately 3441 m^3 or a little over 4% of the total worst case volume[1]. Thus, for the purpose of modelling, the exact time to detect a leak is of low significance since in all likelihood the increased oil 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 inventory of the pipeline and one hour production.

3.3.3 Minor pipeline leak (pinhole 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 with online pressure leak detection systems. Furthermore, such leaks may not lead to a surface sheen. This type of spill may continue unnoticed until observed during an intelligent pig survey, Remote Operated Vehicle survey or by a diver performing inspection or maintenance operations. Furthermore, given the depth of water in which the pipeline is located, it is highly likely that any leaked oil will move up through the water column, before 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 oil as it moves through the water column and thus such leaks can be very difficult to detect.

It has been assumed that a leak of $1m^3$/hour would not be detected by pressure drop and thus detection would rely on a visual sighting of the oil. It is highly likely that the oil will be carried some distance from the pipeline by water currents as it rises up through the water column. Since the leaked oil may thus emerge on the sea surface outside of normal platform helicopter flights and supply boat routings, an arbitrary figure of 30 days has been taken as a worst case for the length of time it will take for the leak to be detected.

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[1] The volume of $3441m^3$ is equivalent to one hour of production based on a daily maximum production of 520,000 bbls/day, when solution gas is removed this falls to 505,000 bbls/day, equivalent to $3345m^3$/hour. If this latter figure where used, the difference in volume of the total spill volume would amount to some $96m^3$. The majority of the spill volume, 85,746 m^3, is due to the pipeline inventory. The difference of $96m^3$ would be equivalent to 0.1% of the total spill volume. This is considered to be too small to affect the results of the OSIS modelling reported at Annex A.

3.3.4 Spill Frequency and Volume

Table 4 provides the statistically expected number of pipeline spills for the lifetime of the ACG Phase 1 Project. As indicated in Table 5 the probability of a pipeline spill is unlikely. Table 6 provides realistic estimates of spilled volumes for the ACG Phase 1 project.

Table 4: Statistically Expected Number of pipeline spills by Size (l). Phase I Lifetime (2001 through 2024)

Spill Source, Pipeline Spills	Risk Exposure	l		
		1-100 tonnes	**100-300 tonnes**	**>300 tonnes**
Corrosion and Fittings	4000 km-years	0.072	-	0.056
Pipe Damage/Anchors	4000 km-years	0.022	-	0.016

Table 5: Probability of one or more pipeline spills by Size (%). Phase I Lifetime (2001 through 2024)

Spill Source, Pipeline Spills	%		
	1-100 tonnes	**100-300 tonnes**	**>300 tonnes**
Corrosion and Fittings	6.95	-	5.45
Pipe Damage/Anchors	2.18	-	1.59

Table 6: ACG Phase 1– Catastrophic and Minor Pipeline Failure

Scale of Leak	Parameter	Value/quantity	Notes
Catastrophic	**Production rate (ACG and EOP)**	3,441m^3/hour.	
	Pipeline inventory (30”)	85,746 m^3	Released at above rate.
	Shut in time	1 Hour	
	Total Volume	89,197 m^3	Inventory plus the pipeline flow for 1 hour.
Minor (pin-hole)	**Leak rate**	1 m^3/hour	Note this has been assumed as not detectable by pressure drops.
	Shut in time	30 days	
	Total Volume	720 m^3	30 days at 1m^3/hour

Causes of a minor leak may be erosion, corrosion or minor damage from, for example a dragged anchor. Hole sizes associated with minor leaks are between 0.25 – 0.5 mm resulting in spill release rates between 0.02 – 0.09 m^3/hr. Assuming a worst case scenario of a 30 days period between a leak commencing and being detected, leak volumes would amount to 720 m^3.

3.3.5 Oil Spill Behaviour

3.3.5.1 Overview

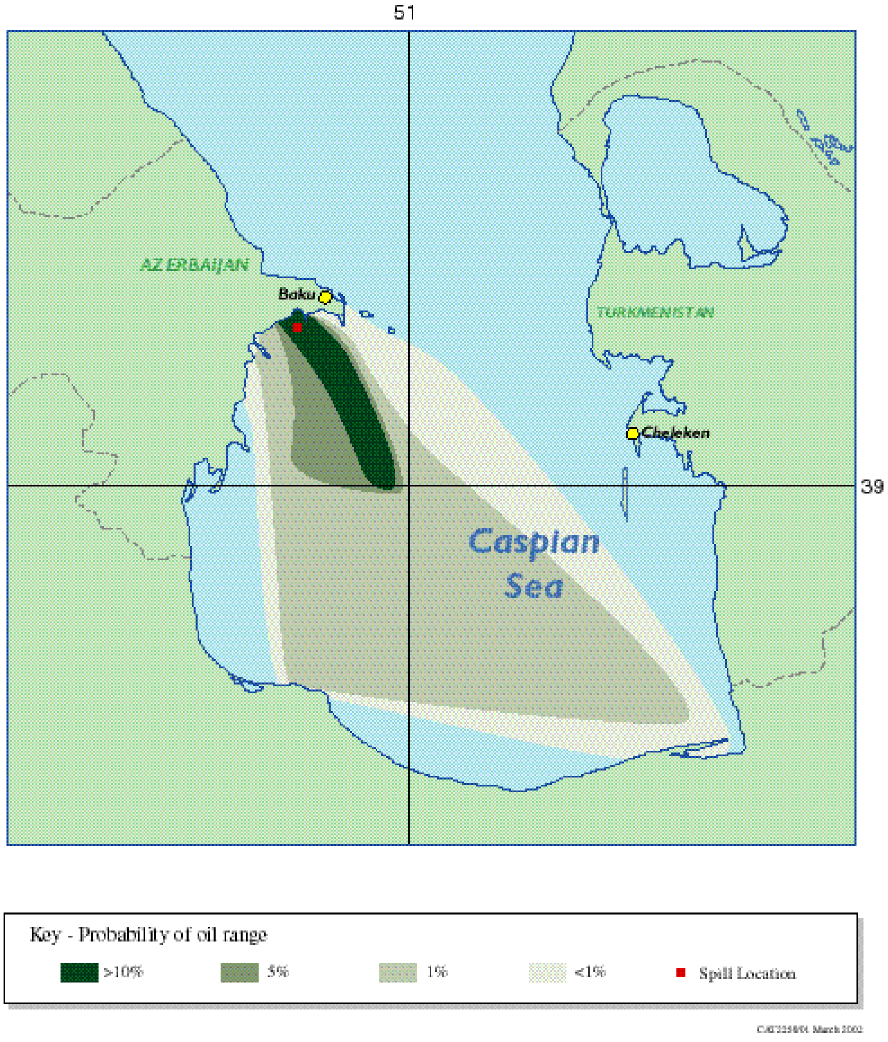
Several scenarios have been modelled, in each of winter and summer, in order to present a better understanding of the consequences of a possible oil spill from the pipeline:

- Offshore catastrophic pipeline spill (89,197 m^3)
- Near-shore catastrophic pipeline spill (89,197 m^3)
- Offshore minor pipeline leak (720 m^3)
- Near-shore minor pipeline leak (720 m^3)

3.3.5.2 Offshore Catastrophic Pipeline Spill –Stochastic Modelling

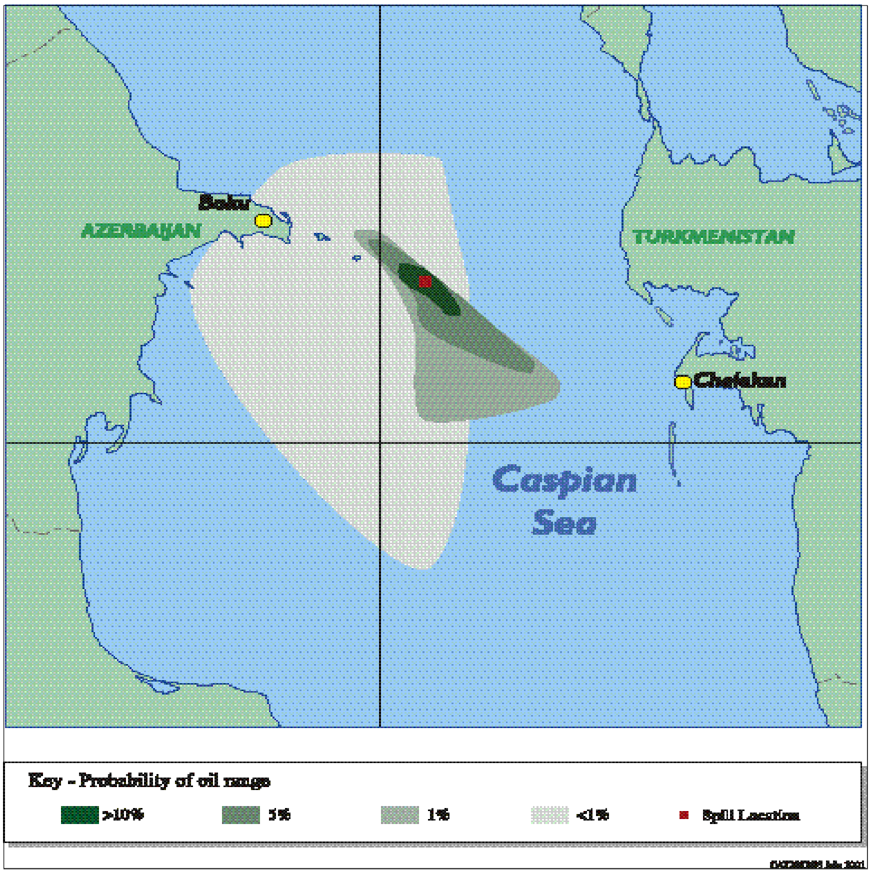
In the winter, modelling indicates that the oil will be transported predominantly to the south east and north west of the field into the Central and Southern Caspian Sea areas, with the heaviest area of oiling directly to the south east and north west of the release location. There is a <1% probability of oil beaching from the Apsheron Peninsula in the West to the Khazar Island (Iran) in the Southwest.

Figure 5 Stochastic Modelling of an Offshore Catastrophic Winter Pipeline Spill



In the summer, modelling indicates that the oil will be transported predominantly to the south east of the field into the Southern Caspian Sea area, with the heaviest area of oiling directly to the south and south east of the release location. There is a <1% probability of oil reaching the Apsheron Peninsula in the West.

Figure 6 Stochastic Modelling of an Offshore Catastrophic Summer Pipeline Spill



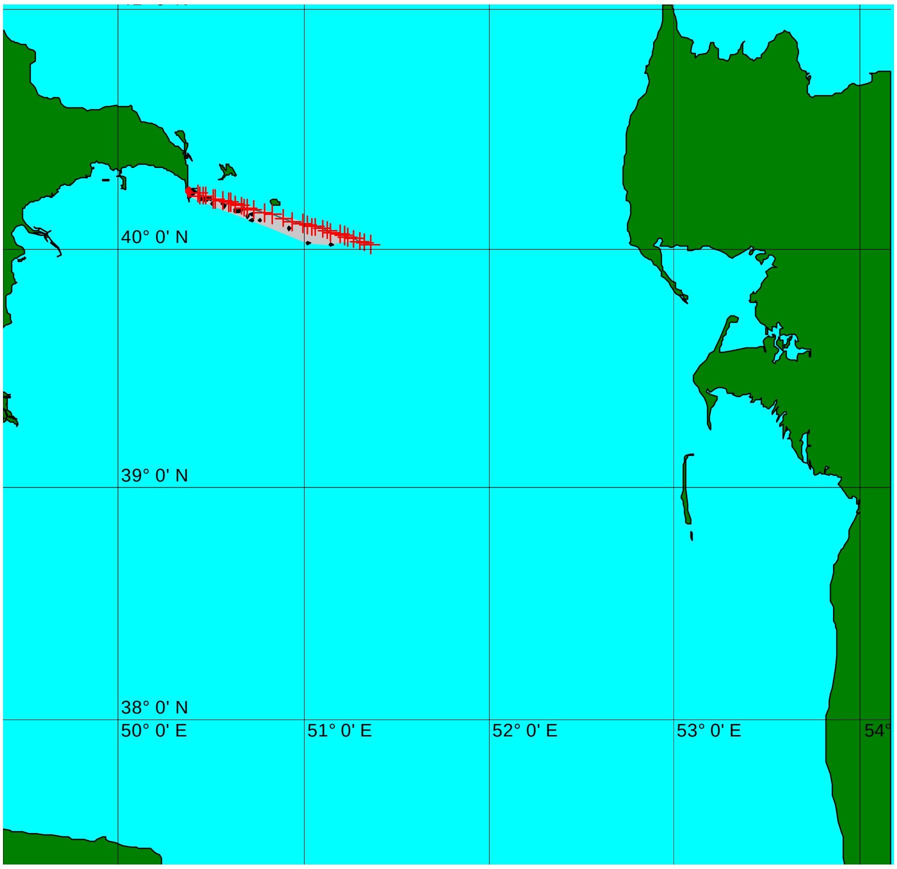
3.3.5.3 Offshore Catastrophic Pipeline Spill -Single Trajectory, Worst Case Modelling

Upon release the oil increased in volume due to emulsification before steadily decreasing in volume as the oil dispersed and evaporated. The oil was persistent enough to beach at the point of nearest landfall after 38 hrs.

The resultant volumes of emulsified oil were:

- 23458m^3 Evaporated
- 13409m^3 Dispersed
- 264288m^3 Beached

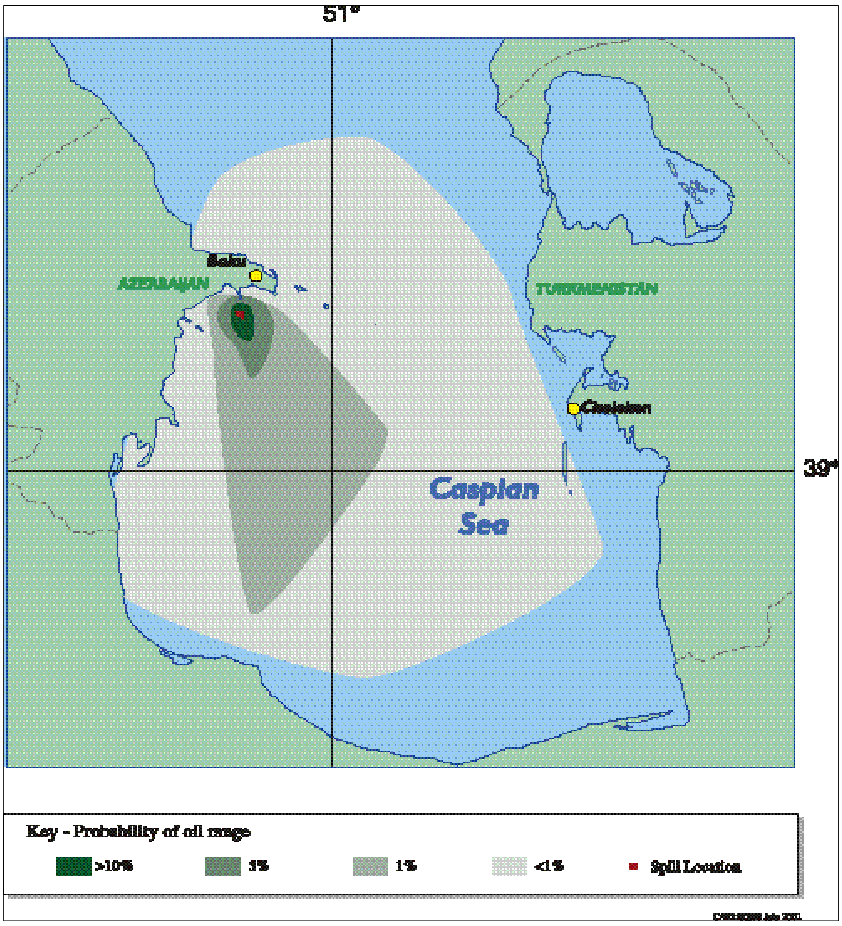
Figure 7: Offshore Catastrophic Pipeline Spill in Worst Case Conditions



3.3.5.4 Nearshore Catastrophic Pipeline Spill –Stochastic Modelling

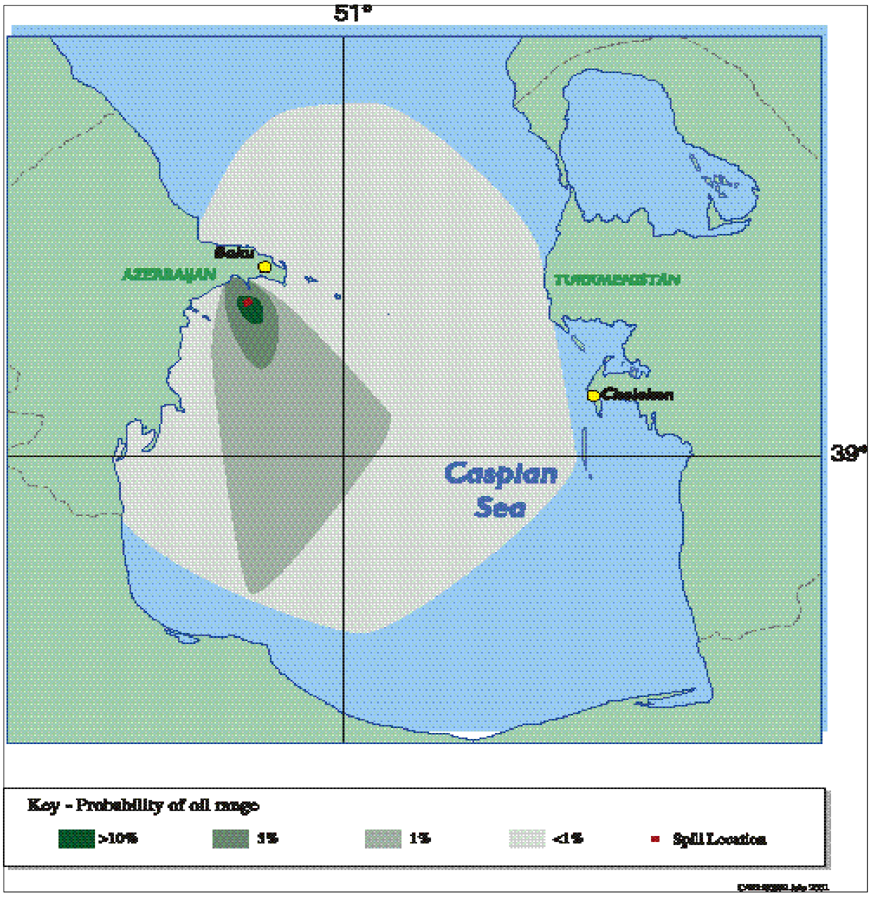
In the winter, modelling indicates that the oil will be transported predominantly to the south of the field into the Southern Caspian Sea area, with the heaviest area of oiling directly to the south and south east of the release location. There is a <1% probability of oil reaching the Apsheron Peninsula in the West, the Cheleken Peninsula in the east and the Khazar Island in the Southwest.

Figure 8 Stochastic Modelling of a Near-shore Catastrophic Winter Pipeline Spill



In the summer, modelling indicates that the oil will be transported predominantly to the south of the field into the Southern Caspian Sea area, with the heaviest area of oiling directly to the south and south east of the release location. There is a <1% probability of oil reaching the Apsheron Peninsula in the West, the Cheleken Peninsula in the east and Astara (Azerbaijan) in the Southwest.

Figure 9 Stochastic Modelling of a Near-shore Catastrophic Summer Pipeline Spill

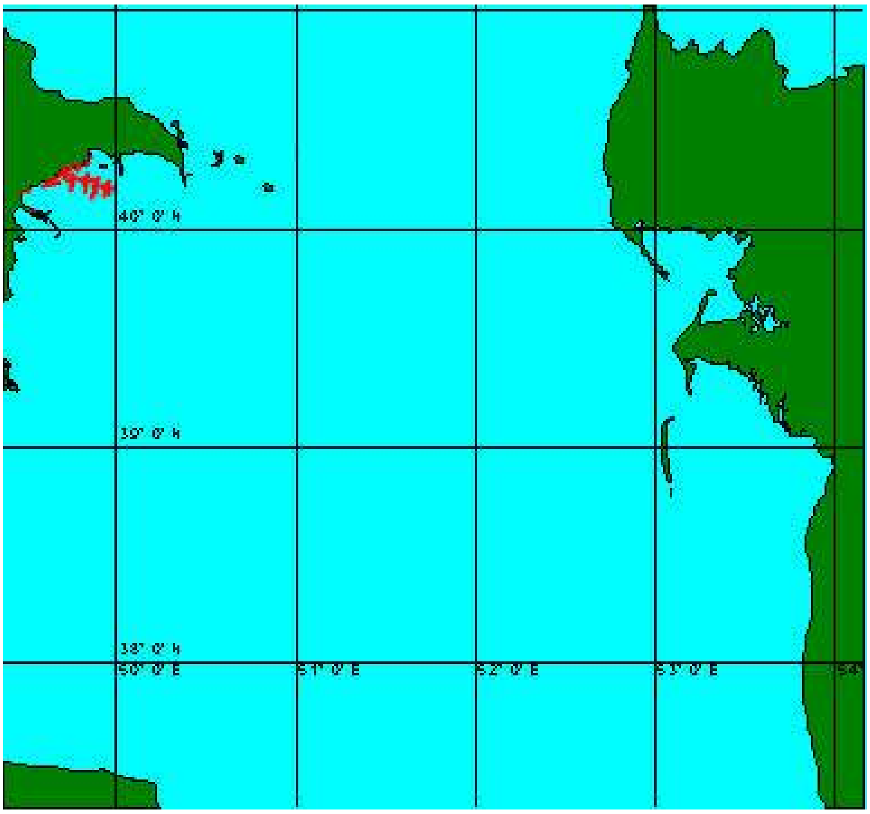


3.3.5.5 Near-shore Catastrophic Pipeline –Single Trajectory, Worst Case Modelling

Upon release the oil increases in volume due to emulsification before steadily decreasing in volume as the oil dispersed and evaporated. The oil was persistent enough to beach at the point of nearest landfall after 19 hrs. The resultant volumes of emulsified were:

- 20470m^3 Evaporated
- 9974m^3 Dispersed
- 294481m^3 Beached

Figure 10: Near-shore Catastrophic Pipeline Spill in Worst Case Conditions



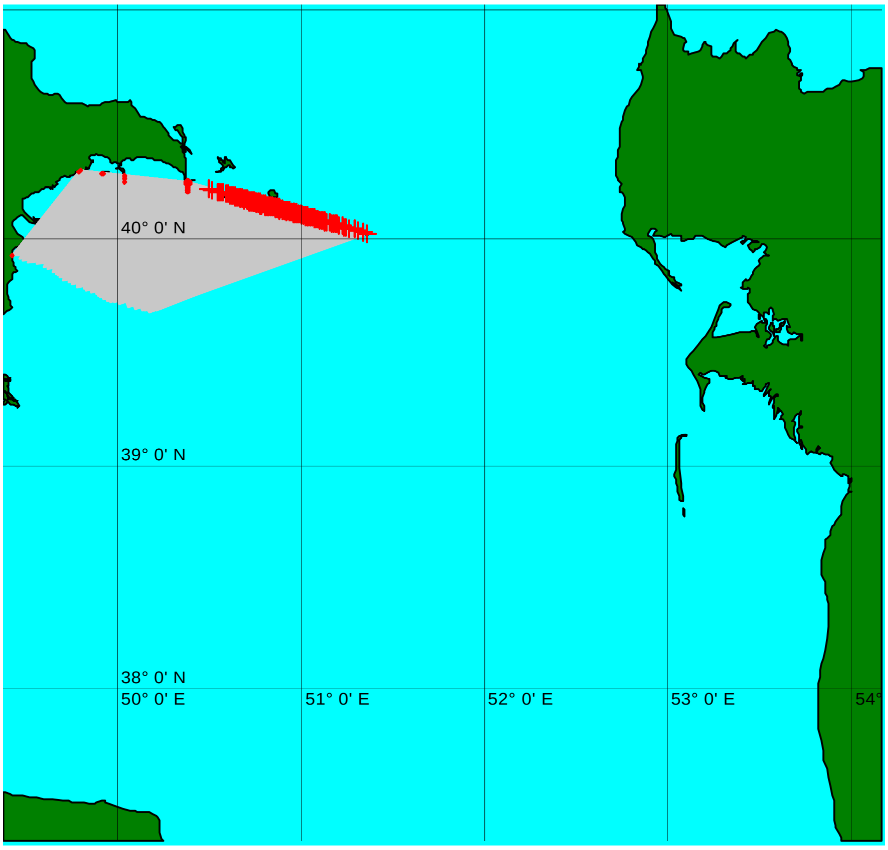
3.3.5.6 Offshore Minor Pipeline Leak –Single Trajectory, Worst Case Modelling

Upon release of $720m^3$ of oil at $1m^3$ per hour for 720 hours the oil increased in volume, due to emulsification, before steadily decreasing in volume as the oil dispersed and evaporated. The oil was persistent enough to beach at the point of nearest landfall after 48 hrs.

The resultant volumes were as follows:

- $321m^3$ Evaporated
- $358m^3$ Dispersed
- $197m^3$ Beached

Figure 11 Offshore Minor Pipeline Leak Worst Case Conditions

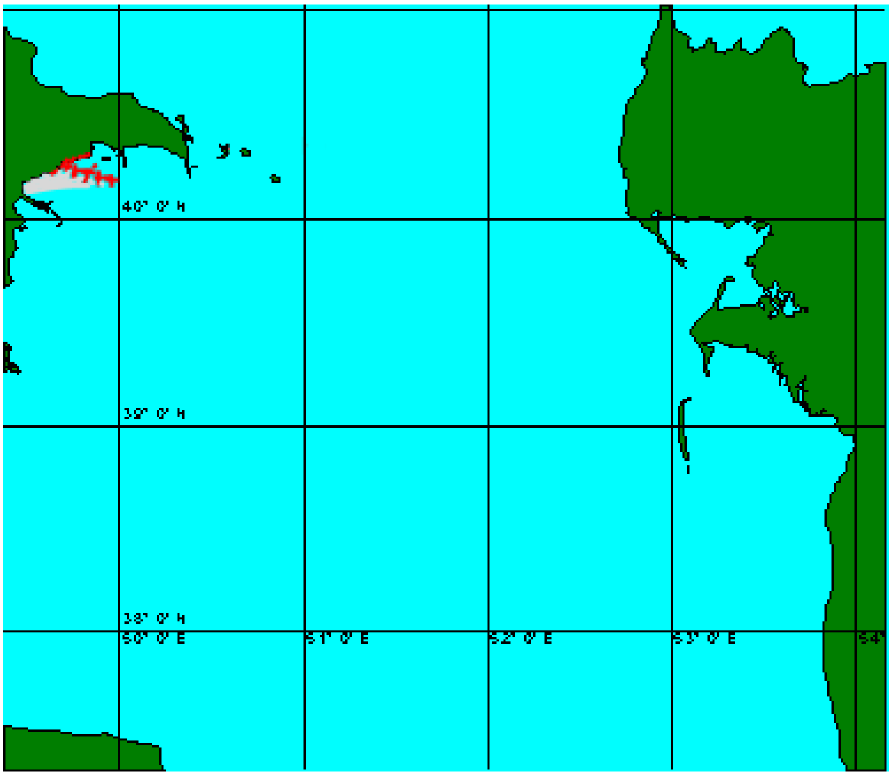


3.3.5.7 Near-shore Minor Pipeline Leak –Single Trajectory, Worst Case Modelling

Upon release of 720m^3 of oil at 1m^3 per hour for 720 hours the oil increased in volume due to emulsification before steadily decreasing in volume as the oil dispersed and evaporated. The oil was persistent enough to beach at the point of nearest landfall after 26 hrs. The resultant volumes after emulsification were:

- 317m^3 Evaporated
- 361m^3 Dispersed
- 205m^3 Beached

Figure 12 Near-shore Minor Pipeline Leak Worst Case Conditions



3.3.6 Prevention of Leaks from Pipelines

3.3.6.1 Overview

Causes of pipeline leak can be divided into:

- Corrosion;
- Impact;
- Minor leaks at joints and valves.

3.3.6.2 Corrosion

Based on generic North Sea frequency data, leaks due to corrosion may occur once every 314-1,429 years depending on pipeline diameter (AME, 1998). Leaks due to corrosion are considered to be remote to extremely remote events.

There are a number of prevention and mitigation measures in place on the ACG Phase 1 pipelines to reduce or remove the probability of leaks from corrosion:

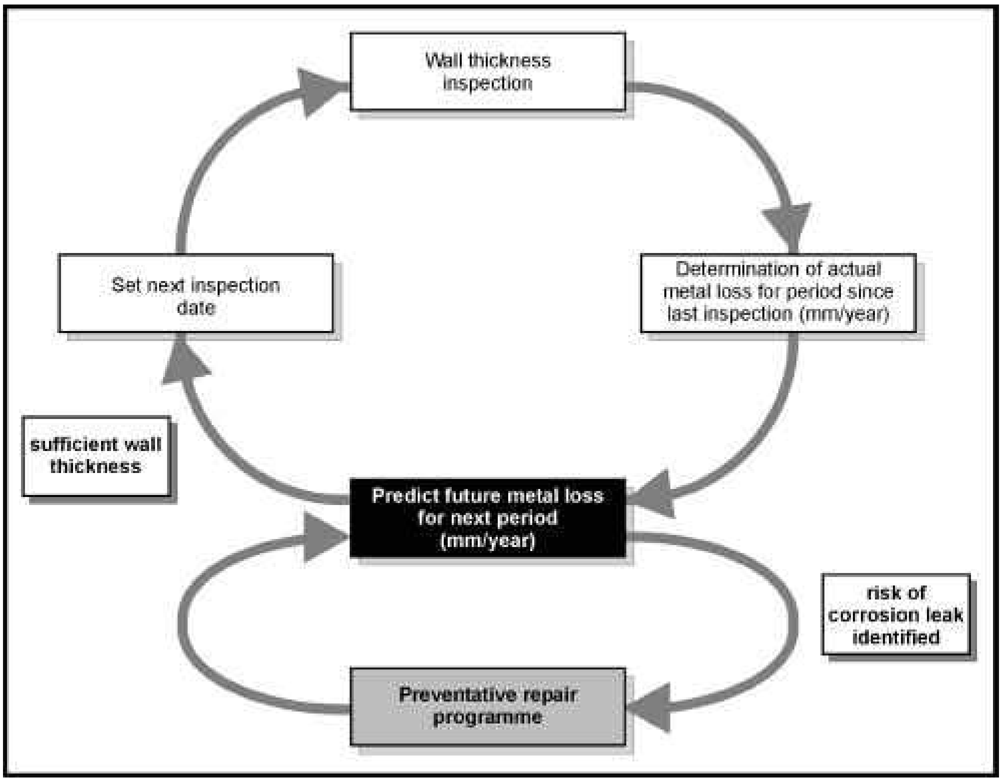
- Use of proven pipeline design and appropriate design codes;
- Inclusion of corrosion allowance along the full length of the pipeline based on worst case anticipated corrosion rates close to the platform;
- The use of corrosion inhibitor in the crude;
- Regular pigging operations to remove water, wax and any other debris;
- Use of an external anti-corrosion coating on the pipeline;
- Use of a cathodic protection system; and
- Regular maintenance driven by an inspection programme.

BP operates a 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 PIMS has been developed for the EOP and will be expanded for the ACG Phase 1 Project. The ACG PIMS includes 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 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 (see Figure 13).

Examples of inspection and monitoring activities that form part of the PIMS process include:

- Internal intelligence pig surveys;
- Corrosion monitoring;
- Side scan sonar surveys; and
- Visual inspection surveys by ROV.

Figure 13: Pipeline corrosion monitoring and mitigation cycle



If the integrity of the pipelines is found to be compromised in any way, remediation measures will be employed. These may include activities such as pipeline free span correction using grout bags or corrosion repairs.

In addition to pipeline integrity tests, the pipelines will require periodic pigging to remove any accumulated wax build up from the crude. There is a high expected wax content in the Azeri crude and as a result, pigging operations will be required to push the wax to reception facilities at the terminal.

The maintenance programme will include any of the following as required:

- span correction;
- corrosion defect repairs;
- reapplication of corrosion coating and cathodic protection anodes; and
- replacement of concretes protection.

3.3.6.3 Impact damage

Impact damage to the pipeline may be caused by a number of events:

- fishing gear impacts;
- anchoring impacts; and
- impact from dropped objects.

At the time of writing there are no operational benthic trawlers in Azerbaijan, therefore there is little risk of impact from fishing gear. North Sea generic pipeline leak frequency data show pipeline leaks from impact damage to be remote to extremely remote events (AME, 1998). The probability of a pipeline incident leading to a loss of containment is greatest per kilometre of pipeline within the 500 m safety zone around the PDQ and C&WP platform. Experience in the Caspian indicates that there is also a greater risk in the near-shore zone. This is due to increased vessel traffic near the pipeline and greater risk of dropped objects in the vicinity of the platforms and by direct vessel impact and anchor dragging in the near-shore zone. The pipeline will be trenched in the nearshore further reducing the likelihood of damage.

Each of the ACG Phase 1 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.

3.3.6.4 Minor Leaks at Joints and Valves

The application of the PIMS to the ACG Phase 1 project pipelines will address leaks from these sources.

3.4 LEAKS FROM OFFSHORE FACILITIES

3.4.1 Overview

Potential spills may be caused by mechanical failure, operational failure or human error. The most common causes of platform spills are:

- Produced water excursions;
- Bunkering operations;
- Hose or plant leaks; and
- Drains and sumps.

3.4.2 Spill Frequency and Volume

Whilst most spills from installations are expected to be small, a risk assessment was undertaken for all potential spill sizes.

The worst-case spill at the platform would be total loss of hydrocarbon inventory, an extremely unlikely event, which would only be caused by catastrophic failure of the platform (e.g. explosion or earthquake). In calculating probability of spills from fixed platforms, oil spill reports submitted to the DTI 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.

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. Spills >50 tonnes are unlikely remote events and are not included in the table. For the Phase I lifetime 2001 through 2024 it has been calculated that there is a probability of 4% on spill larger then 50 tonnes.

Table 7: Statistically Expected Number of spills form offshore facilities by Size (l). Phase I Lifetime (2001 through 2024)

Spill Source	Risk Exposure	l		
		<0.1 tonnes	**<1 tonnes**	**<25 tonnes**
Separator/process Upsets	40 installation years	33	21.05	1.13
Drains/Sumps	40 installation years	21.05	11.76	0.56
Pipe/Hose/Plant failures	40 installation years	10.53	6.35	0.75
Bunkering	40 installation years	7.84	3.74	1.32
All	40 installation-1 years	80	50	4.49

Table 8: Probability of one or more spills from offshore facilities by Size (%). Phase I lifetime (2001 through 2024)

Spill Source	%		
	<0.1 tonnes	**<1 tonnes**	**<25 tonnes**
Separator/process Upsets	100	100	67.59
Drains/Sumps	100	100	43.07
Pipe/Hose/Plant failures	99.99	99.83	52.79
Bunkering	99.99	97.62	73.17
All	100	100	99.88

3.4.2.1 Offshore Separator Leak

The worst-case spill scenario for the offshore platforms is the loss of one of the largest 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 140 m^3 assuming no containment of the spilled oil. In fact the probability of total inventory loss into the sea from a separator is low since much of any oil spilled would be contained within the drain system on the platform. In order to consider the worst case, however, it is assumed that some catastrophic event such as a dropped object would have to occur in order to lose the vessel inventory and in such an event, in all probability would cause further damage to the installation.

3.4.2.2 Loss of Storage Inventory (Diesel)

The loss of diesel in offshore operations is by far the most common type of oil spill. The causes of diesel loss can be due to failure of transfer hose, failure to secure tankage valves or attempts to fill an already full storage tank. Given the rate of transfer of diesel during fuel transfer operations, the amount spilled can often amount to the total storage inventory of one tank. However, since the cause is usually associated with the transfer of fuel into a storage tank, it follows that the most likely worst case is the inventory of one storage tank and not the total inventory of the platform, given that several storage tanks are used, the principal ones being the crane pedestal storage tanks.

Table 9: ACG Phase 1 –Leaks from platforms

Parameter	Value/quantity	Notes
Volume of Oil (Total) Separator Diesel Storage	 140 m^3 100 m^3	 Containment loss of largest separator Diesel volume from tank storage
Loss	Total	Instantaneous release

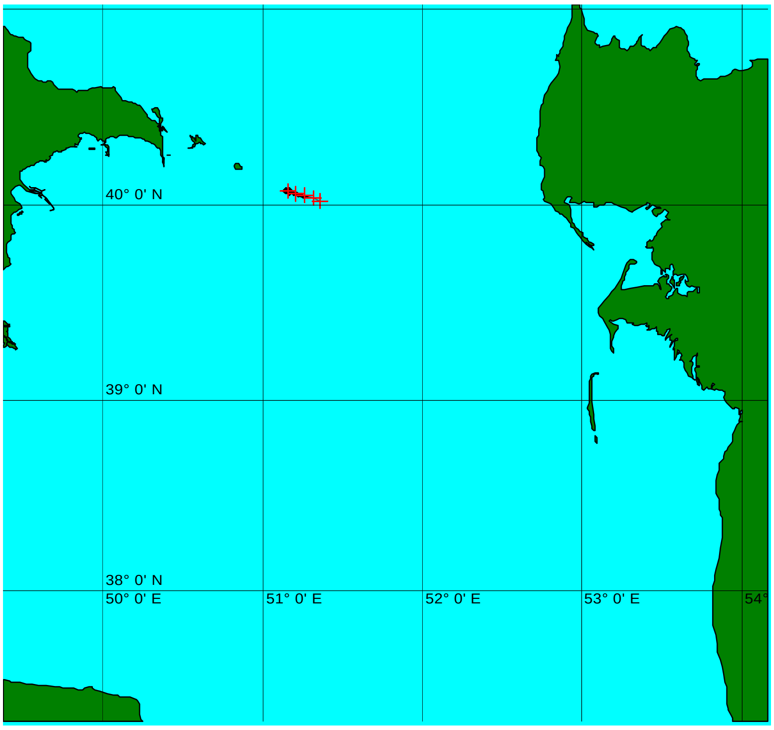
3.4.3 Oil Spill Behaviour

Diesel is non-persistent oil that is rapidly lost from the sea surface. Typically, a diesel spill may be expected to persist for approximately 8 hours after spillage. Small operational spills at the PDQ and C&WP platforms are likely to be diesel spills.

The impact of a diesel spill is expected to be restricted to the vicinity of the release point. Upon release of the worst-case spill of 100m^3, the diesel evaporates quickly. After 8 hours the surface slick at sea is insignificant. No shoreline impacts are expected to arise even from total loss of containment of the diesel inventory. The modelled volumes after 8 hours were:

- 39.54m^3 Evaporated
- 60.46m^3 Dispersed.

Figure 14: Single trajectory, worst case modelling of a 100m^3 diesel spill from the location of the PDQ platform



A spill of 140m^3 crude oil, as a result of a separator failure, from the PDQ platform has not been specifically modelled. However the worst-case conditions for such a spill will be less than the single trajectory, worst case modelling undertaken for the offshore minor pipeline leak. A spill of this size can be expected to reach the shoreline in the order of 48 hours or more and to be less intense than the offshore minor pipeline leak.

3.4.4 Offshore Platform Spill Prevention

The ACG Phase 1 PDQ and C&WP Platforms have been designed to minimise potential leak sources (e.g. by minimising valves, flanges etc.) and to provide secondary containment and processing systems for residual leak sources and spill pathways.

The following are examples of measures employed in the Phase ACG 1 project to reduce the potential for oil spills to sea:

- Produced water management and produced water re-injection system;
- Minimisation of the number of potential leak sources (small bore fittings, flanges etc.) from the hydrocarbon process systems;
- Containment of potential spills of oil, 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.

Taking account of these design measures for the prevention of oil spill, it is considered that the overall probability of a spill from the DPQ and C&WP platforms are unlikely to remote.

3.5 VESSEL OPERATIONS

3.5.1 Overview

Potential oil spills from supply and other vessels arise as a result of:

- Upsets in bilge treatment systems;
- Storage tank failure for lubricating oils, fuel oil (diesel), oil based muds, base oil and chemicals;

- Spill during maintenance activities including equipment removal and lubrication;
- Refuelling and cargo loading operations; and
- Damage sustained during a collision, grounding or fire.

The most frequently reported spills from vessel traffic are those spills associated with upsets in bilge treatment systems and are usually small (< 1 tonne). Worst case spill volumes for accidental spills resulting from grounding, collision or explosion from supply and support vessels will be the total volume of the bunker and any cargo onboard at the time (most likely to be diesel or base oil). The worst-case spill volume is therefore considered to be 100 m^3 of diesel.

3.5.2 Spill Frequency and Volume

Table 8 provides the statistically expected number of vessel collision spills for the lifetime of ACG Phase 1, 2001 to 2024. As indicated in Table 9 the probability that a vessel collision may cause a spill is most unlikely.

The probability of incidents relating to supply and support vessels will be higher during pipelay and jacket installation operations when there may be up to a maximum of three tugs and a barge or pipelay vessel in the wider area at any one time. Vessel numbers during post-installation operations will be one standby vessel (on site at DPQ and C&WP platform all year round) and seven supply vessels per week (each trip duration approximately 10 hours).

Table 10: Statistically expected number of vessel collision spills by Size (l). Phase I Lifetime (2001 through 2024)

Spill Source	**Risk Exposure**	l		
		1-100 tonnes	**100-300 tonnes**	**>300 tonnes**
Vessel Collision/ Impact Damage	40 installation-years	-	-	5.4×10^{-5}

Table 11: Probability of one or more vessel collision spills by Size (%). Phase I Lifetime (2001 through 2024)

Spill Source	**%**		
	1-100 tonnes	**100-300 tonnes**	**>300 tonnes**
Vessel Collision/Impact Damage	-	-	5.4×10^{-3}

3.5.2.1 Oil Spill Behaviour

A worst-case spill volume of $100m^3$ diesel has been modelled above and as having been released from the location of the PDQ platform. This modelling is applicable to a spill from a vessel.

3.5.3 Vessel Spill Prevention

A number of measures will be implemented to reduce the risk of oil spills from supply and standby vessels including, but not limited to:

- Selection of vessels that comply with IMO 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 burmed 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; and
- 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.

OIL SPILL CONTINGENCY PLANNING

3.6 OVERVIEW

This oil spill risk assessment report has shown that accidental oil spills may beach in Azerbaijan and elsewhere in the Caspian Sea. 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.

3.7 OIL SPILL CONTINGENCY PLANNING

An Oil Spill Contingency Plan (OSCP) is the key tool for mitigating impacts resulting from an accidental oil spill. 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 pollution on the environment.

BP's response to an accidental release of oil is to first notify the relevant contacts of the occurrence of the incident and to categorise the size of the oil spill:

- Tier 1 (Minor Event) 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 operational spill sizes.

- Tier 2 (Major Event) incidents are larger spills, which require additional local resources and manpower.

- Tier 3 (Crisis) incidents are very large, possibly ongoing, spills, which may require additional resources from outside Azerbaijan.

Where practical actions are predefined for these three categories. This system of categorisation is internationally recognised as the most pragmatic approach, avoiding excessive costs and seeking shared resources for large, infrequent, accidental events. Using this system, the level of response will be dependant on a number of factors including:

- Quantity of oil spilled;

- Spill location;
- Nature of the oil; and
- Proximity to sensitive resources.

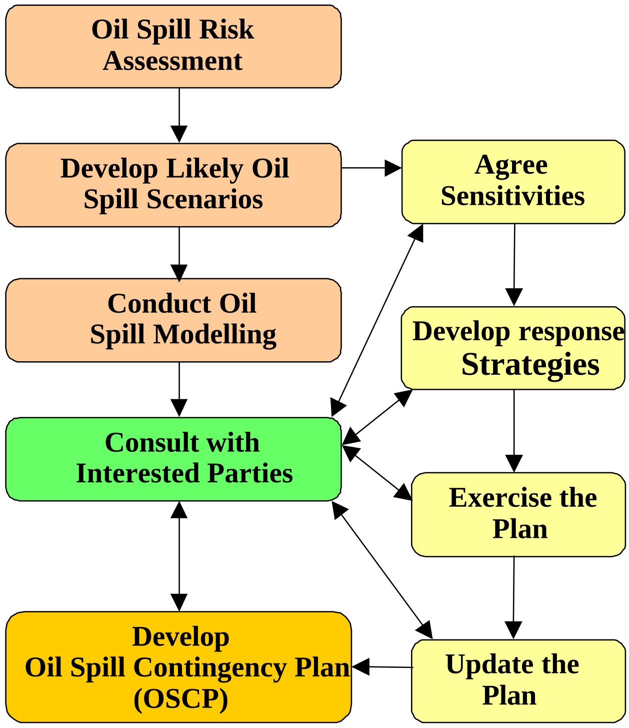
BP has prepared an overview OSCP for all the Azerbaijan Business Unit, which addresses:

- Onshore and offshore incidents;
- Incident reporting;
- Oil spill remediation;
- Contractor databases; and
- Response resource availability.

In addition, the Company will expand the OSCP to include the ACG phase 1 project based on this oil spill risk assessment report. The plan will include an assessment of the adequacy of available response equipment and mobilisation effort required for the spill scenarios identified in this oil spill risk assessment report. 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 oil spill.

The OSCP will also be produced in a form compatible with the current Azerbaijan Business Unit 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 (helicopter companies, spotter planes, dispersant spraying companies etc), together with pertinent contact details for local authorities, NGOs and other interested bodies for responses to the different tier events. This will allow direction and guidance in responding to an oil spill.

Figure 15: Summary of the OSCP process



4. CONCLUSIONS

Several oil spill scenarios have been considered and their frequency and volume estimated using both generic oil industry data, experience of operations in the Caspian Sea and detailed knowledge of the facilities as designed. The scenarios are:

- Blowout, 200,324m^3
- Offshore catastrophic pipeline Leak, 89,197 m^3
- Near-shore catastrophic pipeline Leak, 89,197 m^3
- Offshore minor pipeline leak, 720m^3
- Near-shore minor pipeline leak, 720m^3
- Platform leak due to separator failure, 140 m^3
- Diesel leak from both, platform and vessel, 100 m^3

BP have designed out or reduced the likelihood of oil spills, where practicable. Where the risk remains BP's procedures will further reduce the likelihood of spills. If a spill does occur, despite these activities, the following table summarises the results of stochastic and single trajectory worst case modelling that takes account of winter and summer conditions where appropriate.

Table 12: Summary of Oil Spill Modelling Results

Spill	Volume (m^3)	Probability of beaching on Aspheron Peninsula	Time at beach on Aspheron Peninsula (winter worst case)
Blowout (winter)	200,234	<1%	48hrs
Blowout (summer)	200,234	>10%	-
Catastrophic offshore pipeline failure (winter)	89,197	<1%	38hrs
Catastrophic offshore pipeline failure (summer)	89,197	<1%	-
Catastrophic near-shore pipeline failure (winter)	89,197	<1%	19hrs
Catastrophic near-shore pipeline failure (summer)	89,197	<1%	-
Offshore minor pipeline leak (winter)	720	-	48hrs
Near-shore minor pipeline leak (winter)	720	-	28hrs
Platform leak due to separator failure	140	-	Considered similar to "Offshore minor pipeline leak (winter)", ie 48hrs

Diesel leak from both platform and vessel	100		Does not beach, fully dispersed after 8hrs

BP has prepared an OSCP for the Azerbaijan Business Unit, which will be expanded to take account of the ACG Phase 1 project. on the basis of this oil spill risk assessment report.

Weathering and Dispersibility of Azeri Crude oil

A report produced for Dames & Moore Group

August 2001

Title	Weathering and dispersibility of Azeri crude oil
Customer	Dames & Moore Group
Customer reference	27527-072-AEA
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File reference	EPLB ED28075
Report number	AEAT/R/ENV/0739/A
Report status	Issue 1

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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 crude oil. This study provides an understanding of changes in the physical properties of the oil that would occur in the event of a surface spill and gives an indication of the fate of any spilled oil. 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 crude oil, and enable them to be added to the oil database of the OSIS oil spill simulation model.

The Azeri crude oil exhibited unusual weathering behaviour, which will have a significant influence on the selected spill response strategy. The Azeri crude is a light oil, yet forms viscous emulsions at low temperatures.

Laboratory investigations on the Azeri crude oil suggest that it will rapidly lose approximately 20% by volume from the sea surface by evaporation within the first few hours at sea. After one to two days approximately 32% by volume will eventually be lost. However, this loss in volume will be more than counterbalanced by the increase in volume as a result of water-in-oil emulsion formation. The oil is expected to form a stable emulsion to a maximum water content of 82%, significantly increasing the volume of the residual oil and its viscosity.

The fresh Azeri crude is a light oil, although the viscosity is significantly higher at 6^{o}C than 27^{o}C. At 6^{o}C, the viscosity of the fresh crude is 310 mPas compared to 30 mPas at 27^{o}C. This difference becomes more apparent as the Azeri crude evaporates. When the oil has weathered for the first few hours (i.e. after 20% evaporative loss), the viscosity increases to 430 mPas at 6^{o}C and only 110 mPas at 27^{o}C. This difference is further emphasised after 1-2 days weathering (32% evaporative loss), where the viscosity increases to 16,500 mPas at 6^{o}C and to 510 mPas at 27^{o}C. Azeri crude forms a stable emulsion that is considerably more viscous at a lower temperatures. For example, at 6^{o}C, the emulsion viscosity ranges from 10,500 mPas to 31,200 mPas, and at 27^{o}C, the emulsion viscosity is lower, ranging from 2,900 mPas to 5,800 mPas. The high viscosity of the crude, particularly at low temperatures, indicates that a spill may persist for 10 days at high wind speeds and several weeks at low wind speeds.

The dispersibility of the fresh, weathered and emulsified crude was investigated with Finasol OSR51 dispersant. The results indicate that the dispersant tested would be effective on a spill of fresh Azeri crude oil at 6^{o}C and 27^{o}C. However once the oil becomes weathered and emulsified Finasol OSR51 is not effective.

Using the OSIS model to analyse the time window for dispersibility provides further information on the time available for dispersant application under different conditions. The analysis indicates that at low temperatures, when Azeri crude is most viscous, the fresh crude is only likely to be ‘dispersible’ with Finasol OSR51 for less than one hour in all wind conditions. At low temperatures and high wind speeds the crude will rapidly weather and emulsify to a state at which it is not dispersible with Finasol OSR51, however at lower wind

speeds (2-5 m/s) this process of weathering and emulsification is far slower. As a result, at low wind speeds there may be an extended time window when Azeri may be 'possibly dispersible' , which extends the time window by an additional few days. At higher temperatures, time window analysis indicates that Finasol OSR51 is likely to be effective for less than one hour at high wind speeds (10-20 m/s), although this increases to 9-55 hours at low wind speeds of 2-5 m/s.

In summary, the laboratory studies indicate that a spill of the Azeri crude will form stable viscous emulsions that may persist for a number of days at sea. Treatment of the crude with dispersant is only likely to effective in the very early stages of a spill and would not be effective in cold conditions, so dispersants should not be considered the primary response method. If dispersant use is considered as part of the contingency plan, then it is essential for dispersant stocks to be accessible within a few hours.

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 crude oil 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 crude oil 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 oil
- Undertake dispersibility testing on both fresh crude 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 crude oil:

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 crude oil 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 crude oil 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 oil can produce oils similar to those occurring at sea as a result of weathering. During experimental spills of crude oil 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 crude oil 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^{o}C and 250^{o}C distillation crude oil residues using this emulsification method. These emulsions were used to assess the dispersibility of the crude oil 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 ($\dot{g}$) 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^{o}C	16^{o}C	27^{o}C		
Fresh crude	x	x	x	x	
175^{o}C distillation residue	x		x	x	
175^{o}C distillation residue 6^{o}C emulsion	x				x
175^{o}C distillation residue 27^{o}C emulsion			x		x
250^{o}C distillation residue	x		x	x	
250^{o}C distillation residue 6^{o}C emulsion	x				x
250^{o}C distillation residue 28^{o}C emulsion			x		x
Gas stripping residue				x	

4.2 DISPERSIBILITY TESTING

The dispersibility (i.e. dispersant effectiveness) of the crude oil and emulsions was measured against a commercial dispersant using the Warren Spring Laboratory LR 448 protocol. It should be noted that only one dispersant formulation was available for testing at the time of this study. Additional studies on further dispersants may be carried out in the future.

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:

$$\% \text{ Dispersibility} = \frac{\text{Mass of Oil Dispersed into Water}}{\text{Mass of Oil Used in Test}} \times 100$$

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 Crude oil

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 Crude Oil Results

The results of the weathering and dispersibility studies on the crude oil 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 crude oil 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 Oil Resulting from Gas Stripping and Distillation

Product	Weight Loss %	Volume Loss %
175^{o}C distillation residue	17%	20%
250^{o}C distillation residue	29%	32%
Gas stripped residue	16%	18%

The results indicate that the Azeri crude oil is likely to lose 20% by volume within the first few hours of a spill and a total of 32% by volume probably within 24-48 hours.

Table 5. Crude Oil Distillation Characteristics

Vapour Temperature ^{o}C	Fraction Evaporated % weight
100	5
145	11
175	15
200	19
224	23
250	28

5.1.2 Emulsification

Maximum water content emulsions were prepared with the 175°C and 250°C distillation residues at 6°C and 27°C. All the emulsions prepared were stable, with water contents ranging from 71-82%, allowing further analysis to be undertaken. The properties of the emulsion produced are indicated in Table 6. The 175°C residue emulsion is representative of 24-48 hours at sea and 250°C residue emulsion is representative of 24-48 hours at sea.

Table 6. Properties of the Emulsions

Emulsion	Formation Temperature °C	Water Content % w/w	Colour	Flow Property
175°C distillation residue emulsion	6	79	Light Brown	Mobile
250°C distillation residue emulsion	6	71	Light/Dark Brown	Fairly Mobile
175°C distillation residue emulsion	27	82	Light Brown	Mobile
250°C distillation residue emulsion	27	79	Light Brown	Mobile

5.1.3 Physical Properties

The results of the different physical property measurements undertaken on the various products are indicated in Table 7. As would be expected, the viscosities of the crude and of the distillation residues are influenced by temperature such that lower viscosities occur at higher temperatures. The viscosity of Azeri is significantly higher at 6°C than 27°C. This is particularly apparent as the Azeri crude evaporates. At 6°C, the viscosity of the fresh crude is 310 mPas compared to 30 mPas at 27°C. After 17% evaporative loss, the viscosity increases to 430 mPas at 6°C and only 110 mPas at 27°C. This difference is further emphasised after 29% evaporative loss, where the viscosity increases to 16,500 mPas at 6°C and 510 mPas at 27°C.

The emulsions formed with the residues reflect the differences in the viscosity of the residues. At 6°C, the emulsion viscosity ranges from 10,500 mPas to 31,200 mPas, incorporating 71-79% water. At 27°C, the emulsion viscosity is lower, ranging from 2,900 mPas to 5,800 mPas, incorporating 79-82% water.

Table 7. Results of Physical Measurements Undertaken on Azeri Crude oil

Product	Viscosity mPa s at 10 s^{-1}			Density	Water Content % w/w
	6°C	16°C	27°C		

Fresh crude	310	90	30	850.6	-
175^{o}C distillation residue	430	-	110	881.5	-
175^{o}C distillation residue 6^{o}C emulsion	10,500	-	-	-	79
175^{o}C distillation residue 27^{o}C emulsion	-	-	2,900	-	82
250^{o}C distillation residue	16,500	-	510	892.8	-
250^{o}C distillation residue 6^{o}C emulsion	31,200	-	-	-	-
250^{o}C distillation residue 27^{o}C emulsion	-	-	5,800	-	71
Gas stripping residue	-	-	-	875.2	79

5.2 DERIVATION OF OSIS CONSTANTS

The OSIS v3 constants specific for the Azeri crude oil 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 Crude Oil

Constant	Value
Density, rho	850.63
Distillation, ec1	134.39
Distillation, ec2	119.53
Density change, ec3	88.04
Viscosity, a	4.48
Viscosity, b	23.34
Gas stripping, gs1	8.32
Gas stripping, gs2	15.01
Water visc	0.01
Vis exp	11.82
Max water	0.82
Asp	0
Pour	0
Waxy	0

5.3 DISPERSIBILITY TESTING

Dispersibility testing was undertaken on:

- Fresh crude oil at 6^{o}C and 27^{o}C
- 175^{o}C residue emulsion(representative of 1-2 hours at sea) formed at 6^{o}C and 27^{o}C
- 250^{o}C residue emulsion (representative of 24-48 hours at sea) formed at 6^{o}C and 27^{o}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 Crude

Oil	Dispersibility (%) with Finasol OSR51	
	6°C	27°C
Fresh Crude	17	32
175°C Residue Emulsion	13	13
250°C Residue Emulsion	4	8

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 all the dispersants tested would be effective on a spill of fresh Azeri crude oil at 6°C and 27°C. However once the oil becomes weathered and emulsified Finasol OSR51 is not effective. This is not unexpected as at both temperatures, 6°C and 27°C, the Azeri crude forms stable emulsions of relatively high viscosity, ranging from 2,900 to 31,200 mPas.

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 crude oil was predicted at various sea conditions at 6°C and 27°C. The results are shown graphically in Figures 1-16.

5.4.1 Winter Conditions (6°C)

Figures 1-3 show 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.

Viscosity Changes
Figure 1 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 both a more rapid uptake of water and a faster loss by evaporation. 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	1,000
Slight	5	5,500
Moderate	10	12,500
Rough	15	15,000
Very Rough	20	18,000

The maximum viscosity measured in the laboratory (31,200 mPas) is likely to be reached within 24-48 hours.

Water Content Changes
Figure 2 indicates the change in water content over time at a temperature of 6^{o}C. The modelling predicts that there will be a gradual increase in the water content of spilled oil as a result of emulsification in calm conditions (wind speeds of 2 m/s). This increase in water content will be more rapid in wind speeds of 5 m/s and much more rapid at higher wind speeds of 10-20 m/s, where emulsification will occur more quickly.

Flash Point Changes
Figure 3 indicates the change in flash point over time at a temperature of 6^{o}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 4-8 indicate the mass balance of oil occurring during the different scenarios modelled at a temperature of 6^{o}C.

During calm conditions (Figure 4), the volume of oil on the sea surface steadily declines over time. A proportion of the oil is lost through evaporation, however natural dispersion is the main route of removal of oil from the sea surface although this is limited by the emulsification of the oil. In the absence of a dispersant response, the surface slick from a 1000 tonne spill would persist for up to several weeks.

In slightly higher wind speeds of 5 m/s (Figure 5), there is a slow increase in oil volume in the first 72 hours due to the emulsification of the oil (to 3,200 m^3), which is not apparent at the lower wind speed of 2 m/s (Figure 4). Evaporation of the light oil fraction and natural dispersion results in a steady decrease in surface volume. However more than 50% of the emulsified oil (approx. 1,600 m^3) can be expected to remain on the sea surface up to 11 days.

In rougher conditions, (wind speeds of 10-20 m/s as shown in Figures 6-8) there will be an initial rapid increase in the quantity of material on the sea surface as a result of the oil emulsifying (to approximately 5,000 m^3). However, the volume of surface oil will then steadily decrease through evaporation and natural dispersion. This rate of reduction can be expected to be slightly more rapid in higher wind speeds. The surface slick from a 1000 tonnes spill is predicted to persist for up to 9-14 days.

A spill of Azeri crude would persist for long periods of time at sea at low temperature (6°C). This is due to the high viscosity of the oil and its emulsions at low temperatures, which in turn has the effect of reducing the rate of natural dispersion. The persistence of the oil on the sea surface will be 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 1. Changes in viscosity of Azeri Crude with different wind speeds (6°C)

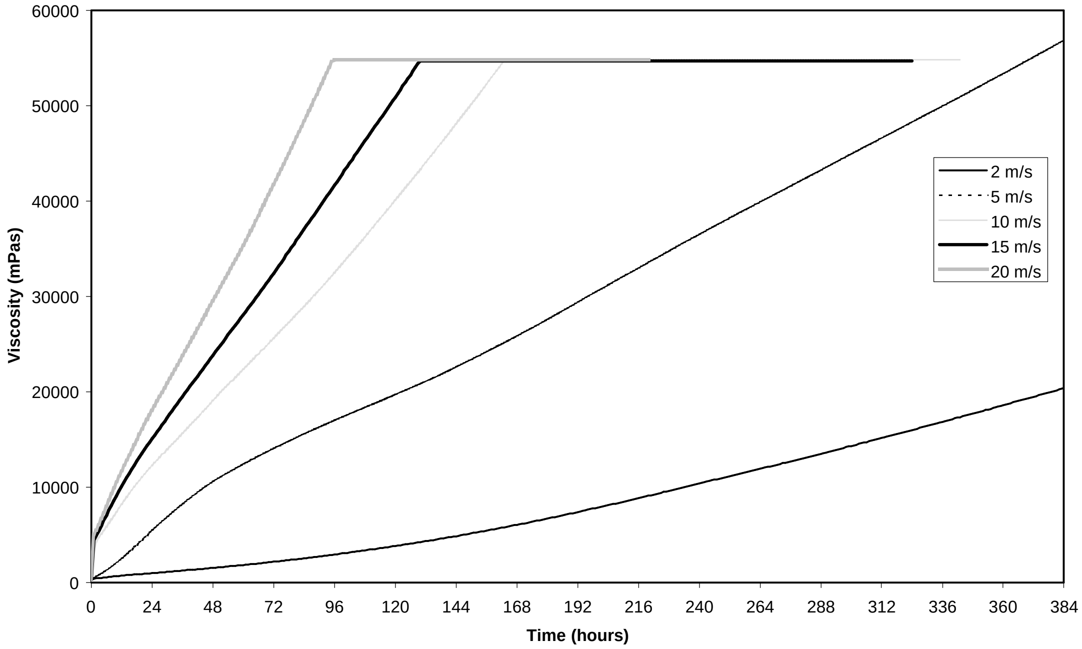


Figure 2. Changes in water content of Azeri Crude with different wind speeds (6°C)

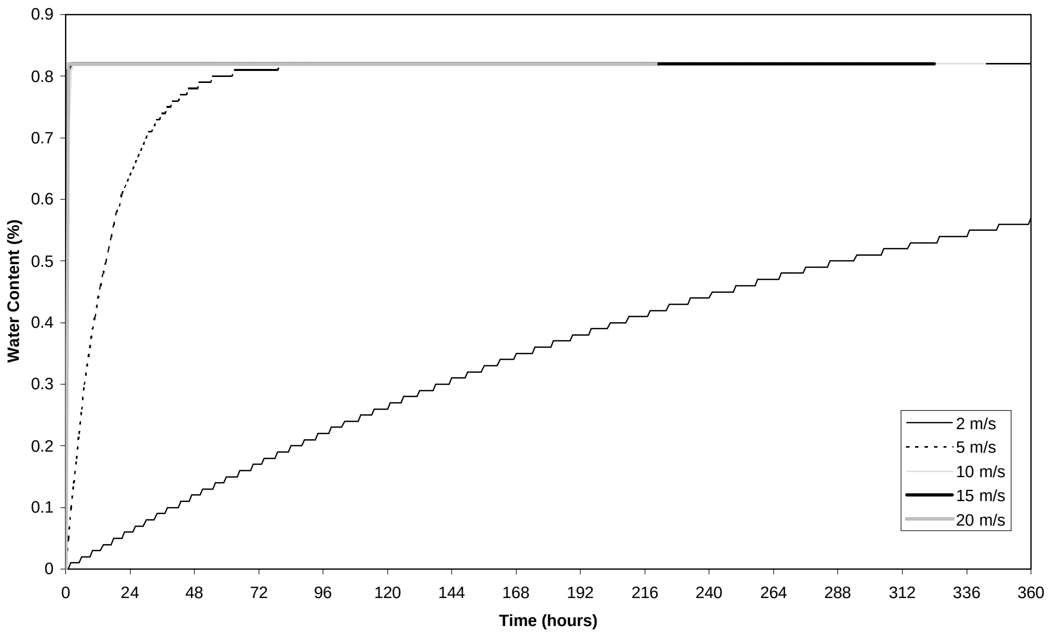


Figure 3. Changes in flash point of Azeri Crude at different wind speeds (6°C)

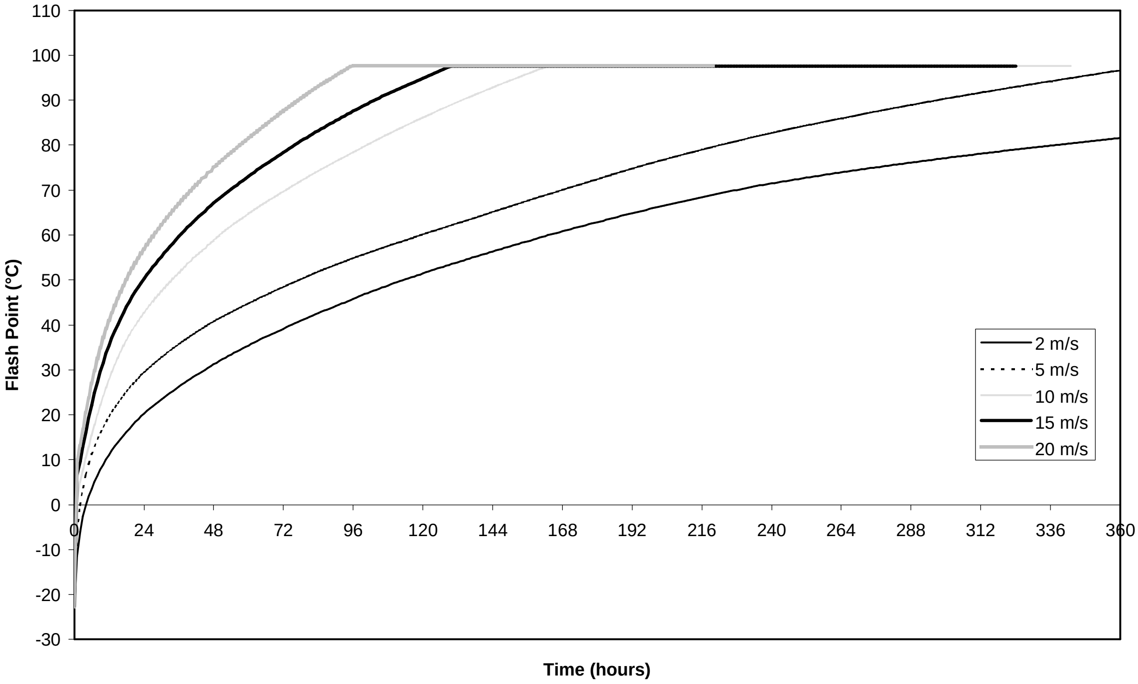


Figure 4. Mass Balance of Azeri Crude at 2 m/s (6°C)

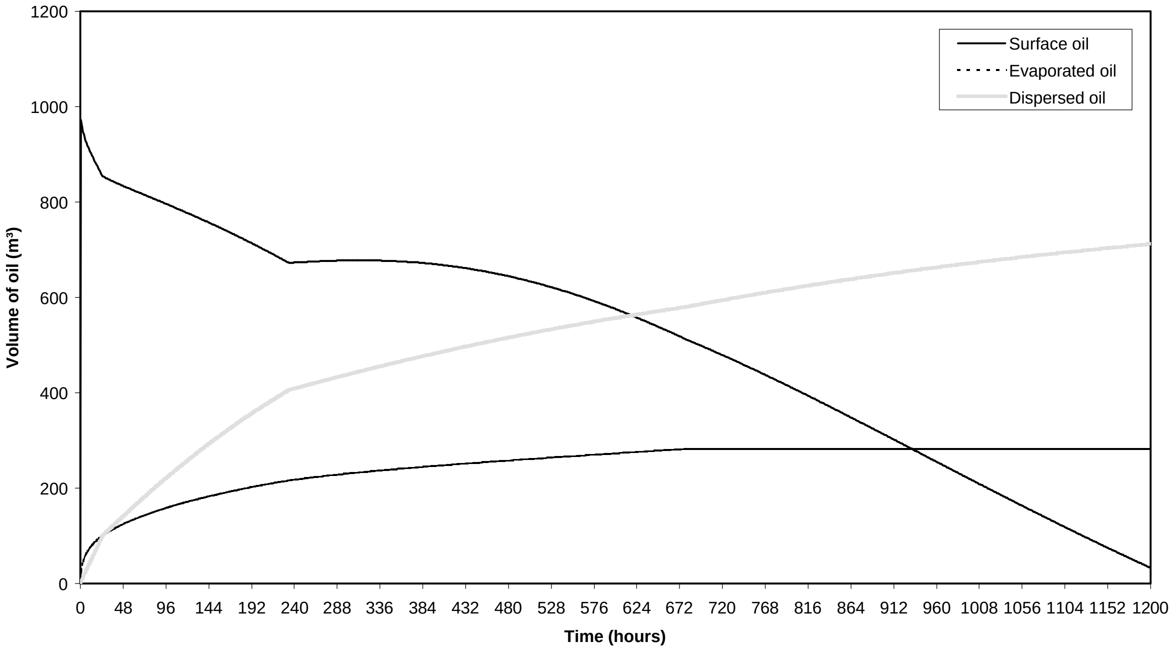


Figure 5. Mass Balance of Azeri Crude at 5 m/s (6°C)

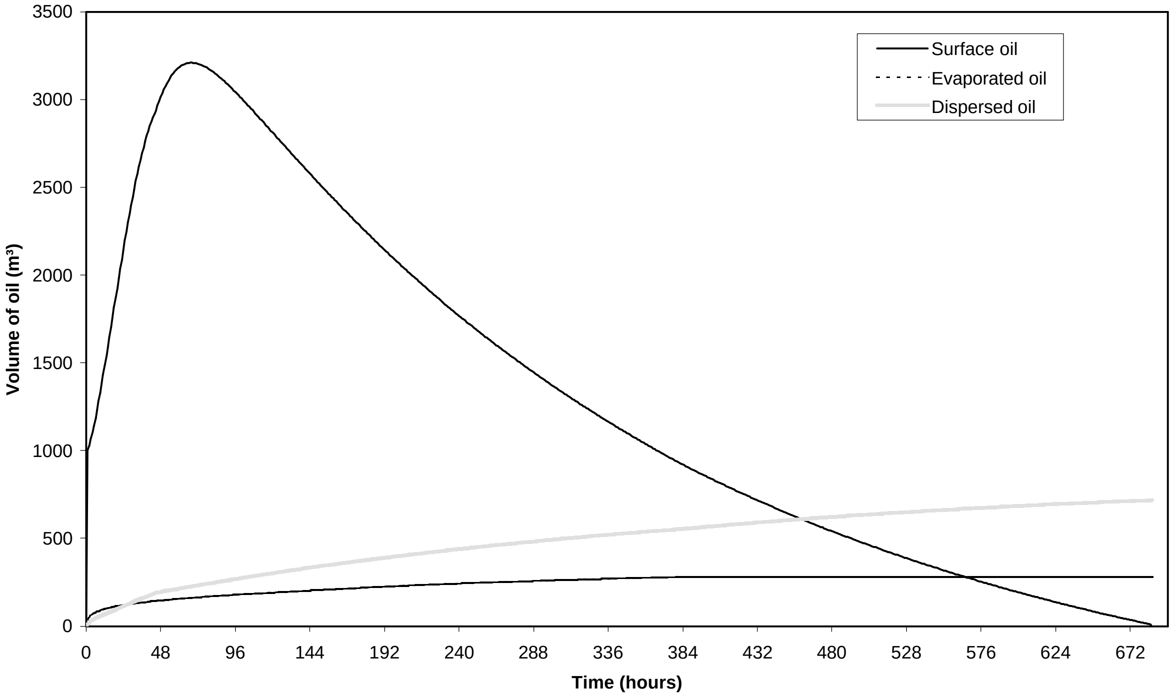


Figure 6. Mass Balance of Azeri Crude at 10 m/s (6°C)

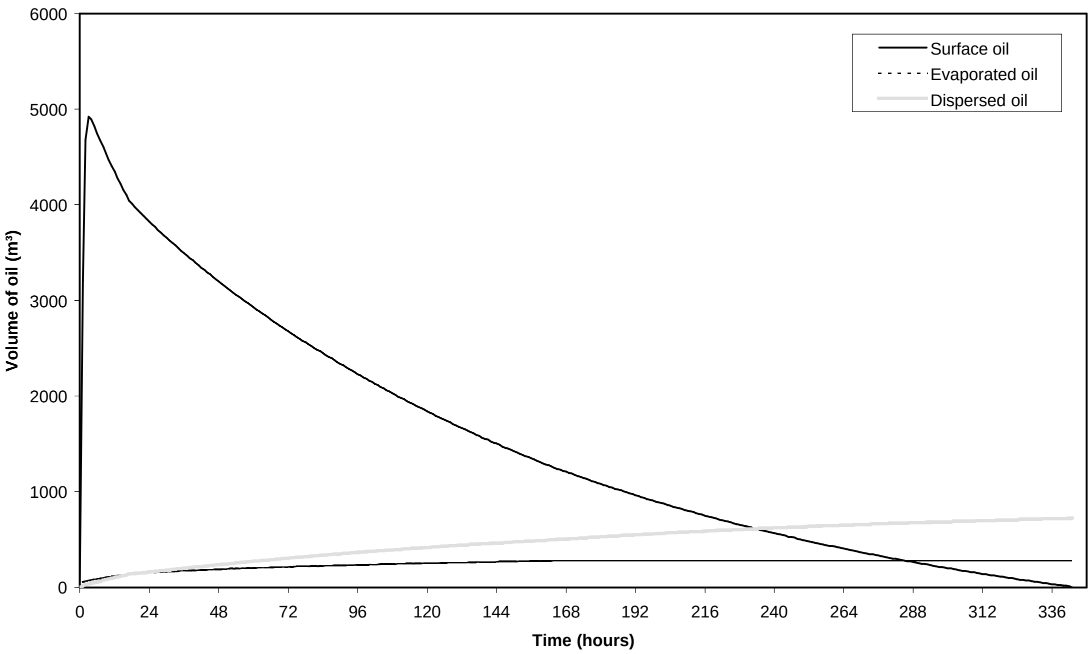


Figure 7. Mass Balance of Azeri Crude at 15 m/s (6°C)

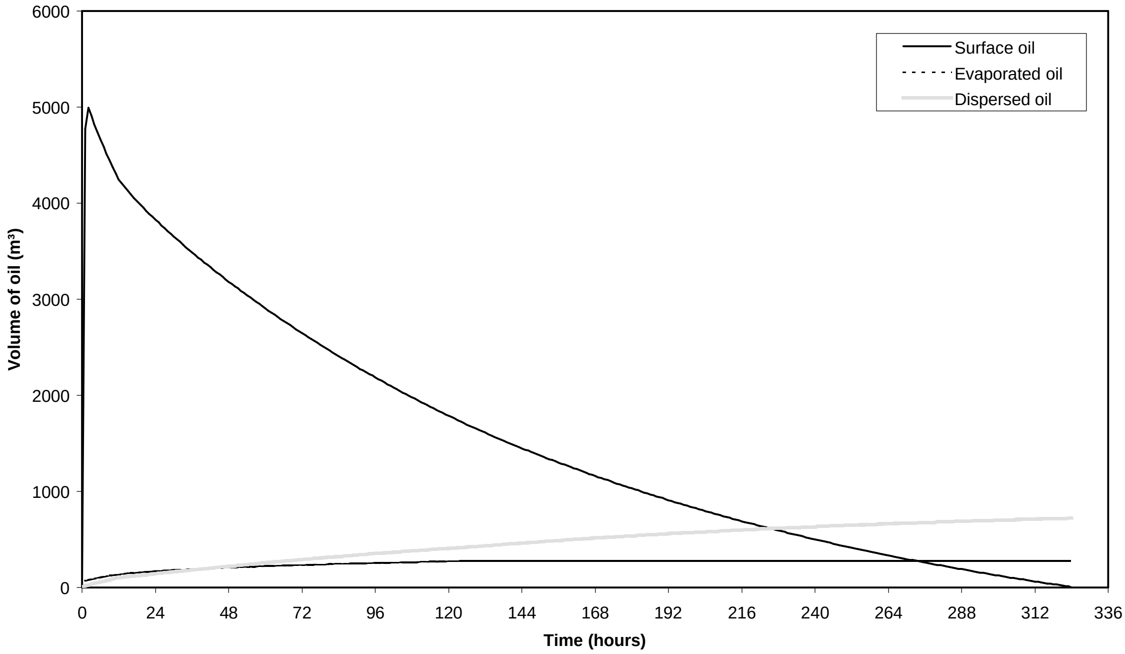
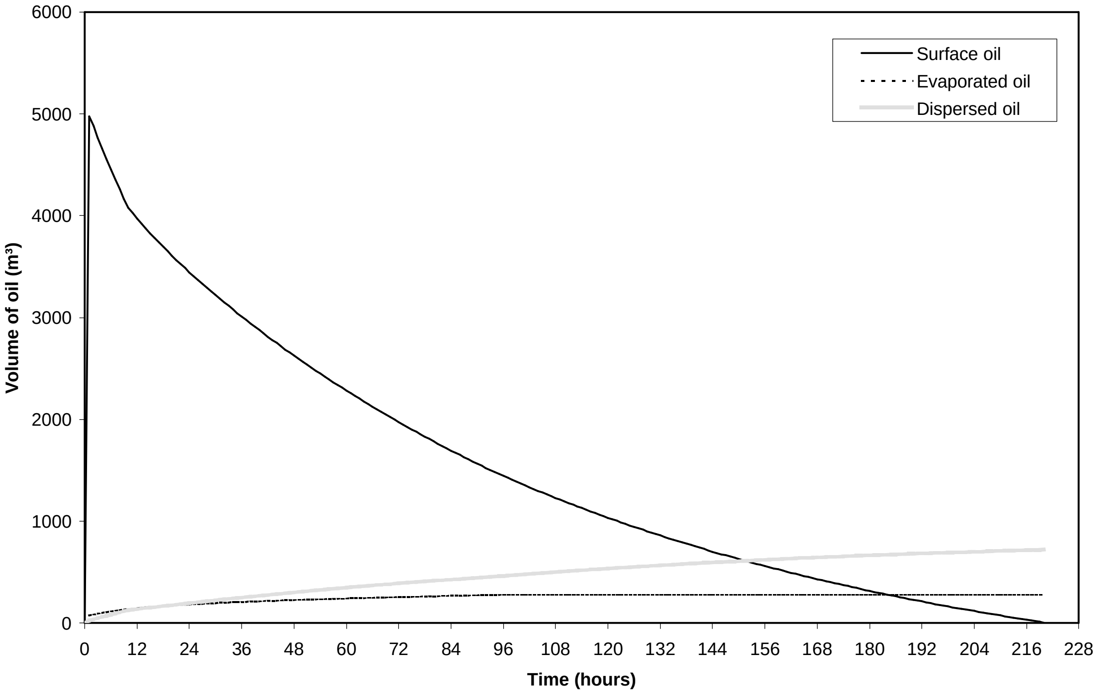


Figure 8. Mass Balance of Azeri Crude at 20 m/s (6°C)



5.4.1 Summer Conditions (27^{o}C)

Figures 9-11 show the changes in oil properties over the time period of the spill in different wind conditions. Figures 12-16 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^{o}C. The rate of increase in viscosity becomes more rapid with increasing wind speed (associated with rougher sea conditions) reflecting both a more rapid uptake of water and a faster loss by evaporation. 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 11. Predicted Viscosity after 24 hours at sea

Sea State	Wind Speed m/s	Viscosity prediction mPas
Calm	2	170
Slight	5	960
Moderate	10	2,100
Rough	15	2,700
Very Rough	20	3,300

The maximum viscosity measured in the laboratory (5,800 mPas) is likely to be reached within 24-48 hours.

Water Content Changes
Figure 10 indicates the change in water content over time at a temperature of 27^{o}C. The modelling predicts that there will be a gradual increase in the water content of spilled oil as a result of emulsification in calm conditions (wind speeds of 2 m/s). This increase in water content will be more rapid in wind speeds of 5 m/s and much more rapid at higher wind speeds of 10-20 m/s, where emulsification will occur more quickly.

Flash Point Changes
Figure 11 indicates the change in flash point over time at a temperature of 27^{o}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 12-16 indicate the mass balance of oil occurring during the different scenarios modelled at a temperature of 27^{o}C.

During calm conditions (Figure 12), the volume of oil on the sea surface steadily declines over time. A proportion of the oil is lost through evaporation, however natural dispersion is the main route of removal of oil from the sea surface although this is limited by the emulsification of the oil. In the absence of a dispersant response, the surface slick from a 1000 tonne spill would persist for up to 22 days.

In slightly higher wind speeds of 5 m/s (Figure 13), there is a slow increase in oil volume in the first 48 hours due to the emulsification of the oil (to 2,500 m^3), which is not apparent at the lower wind speed of 2 m/s (Figure 12). Evaporation of the light oil fraction and natural dispersion results in a steady decrease in surface volume. However more than 50% of the emulsified oil (approx. 1,250 m^3) can be expected to remain on the sea surface for up to 6 days.

In rougher conditions, (wind speeds of 10-20 m/s as shown in Figures 14-16) there will be an initial rapid increase in the quantity of material on the sea surface as a result of the oil emulsifying (to approximately 4,600 m^3). However, the volume of surface oil will then steadily decrease through evaporation and natural dispersion. This rate of reduction can be expected to be slightly more rapid in higher wind speeds. In the absence of a dispersant response the surface slick from a 1000 tonnes spill is predicted to persist for up to 5-7 days.

At 27°C, Azeri crude is far less persistent than observed at 6°C. This is because Azeri is considerably less viscous at 27°C than at 6°C. The reduced viscosity of the oil and its emulsions at higher temperatures has the effect of increasing the rate of natural dispersion.

Figure 9. Changes in viscosity of Azeri Crude with different wind speeds (27°C)

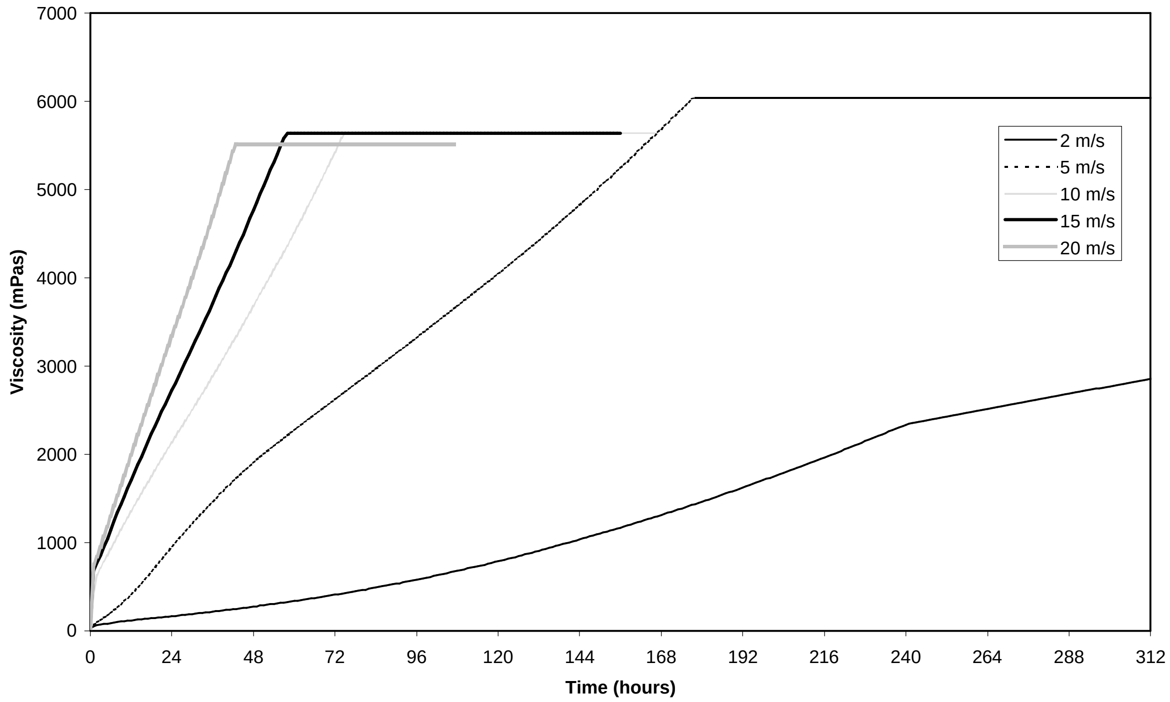


Figure 10. Changes in water content of Azeri Crude with different wind speeds (27°C)

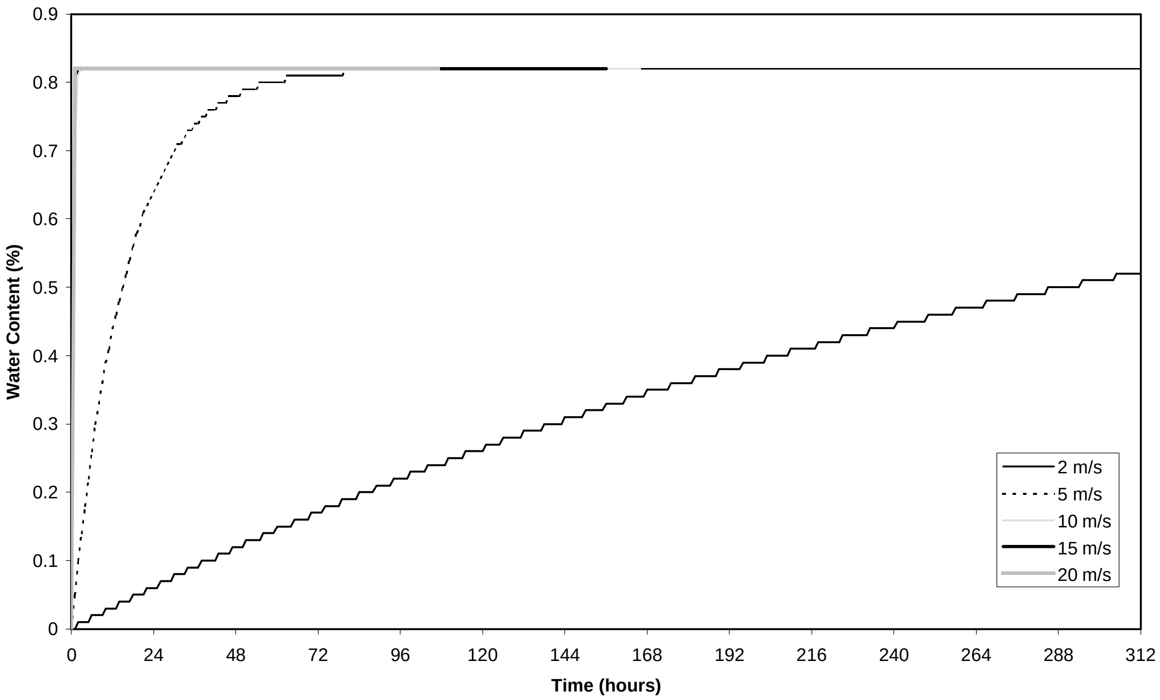


Figure 11. Changes in flash point of Azeri Crude at different wind speeds (27°C)

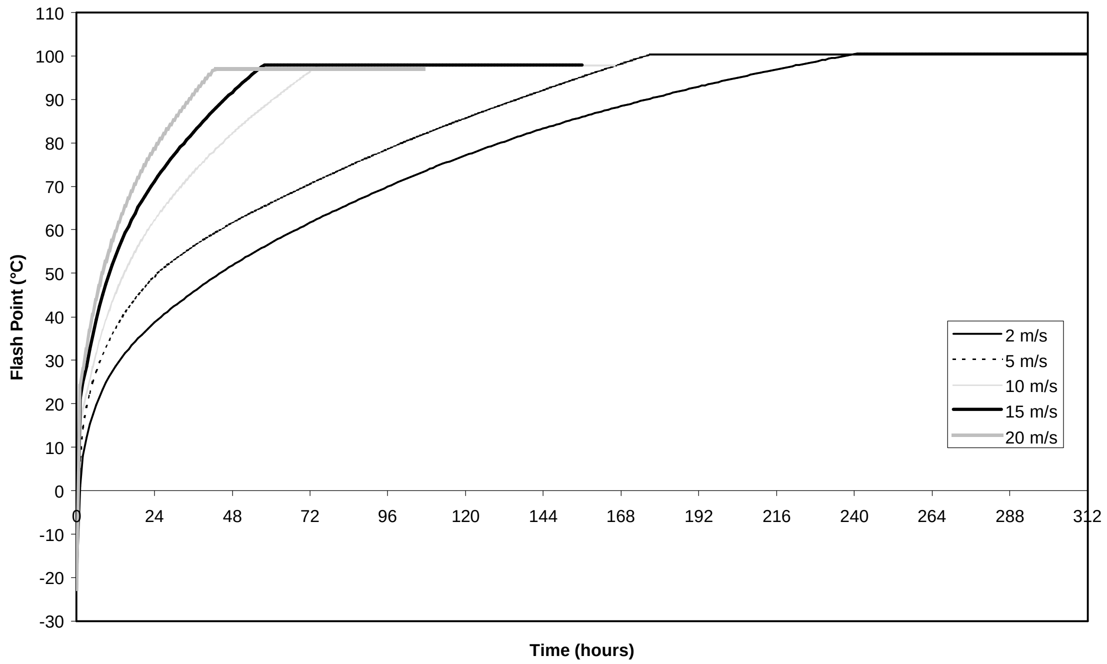


Figure 12. Mass Balance of Azeri Crude at 2 m/s (27°C)

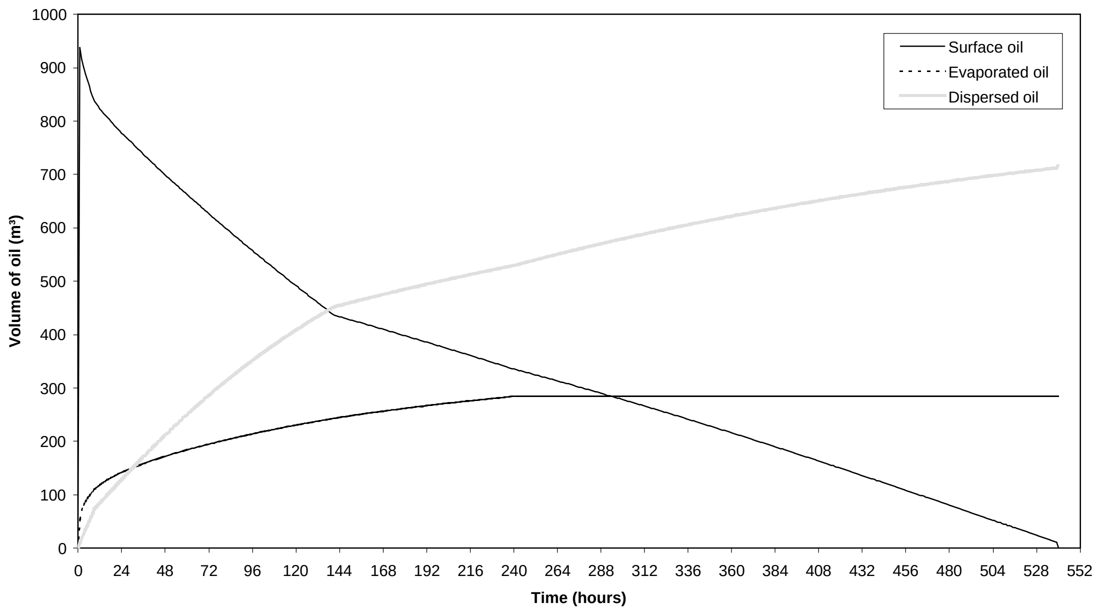


Figure 13. Mass Balance of Azeri Crude at 5 m/s (27°C)

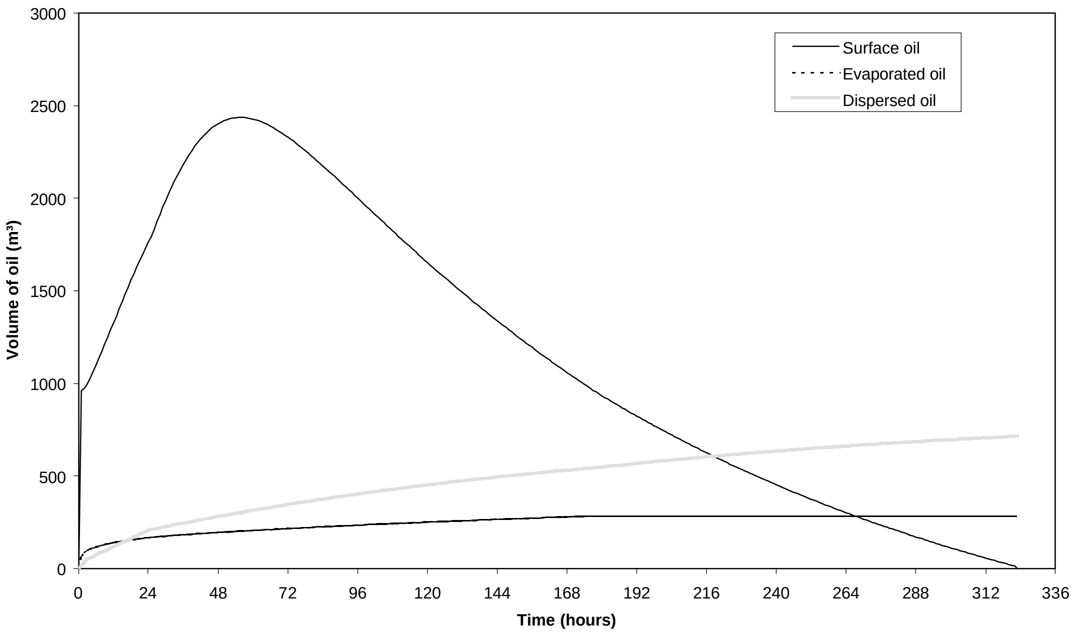


Figure 14. Mass Balance of Azeri Crude at 10 m/s (27°C)

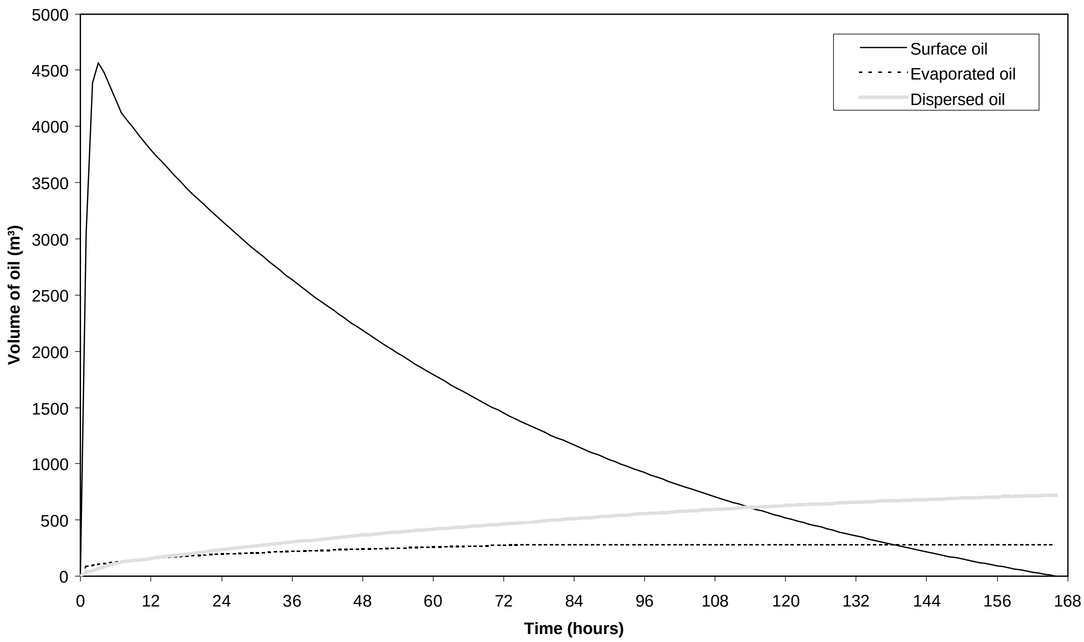


Figure 15. Mass Balance of Azeri Crude at 15 m/s (27°C)

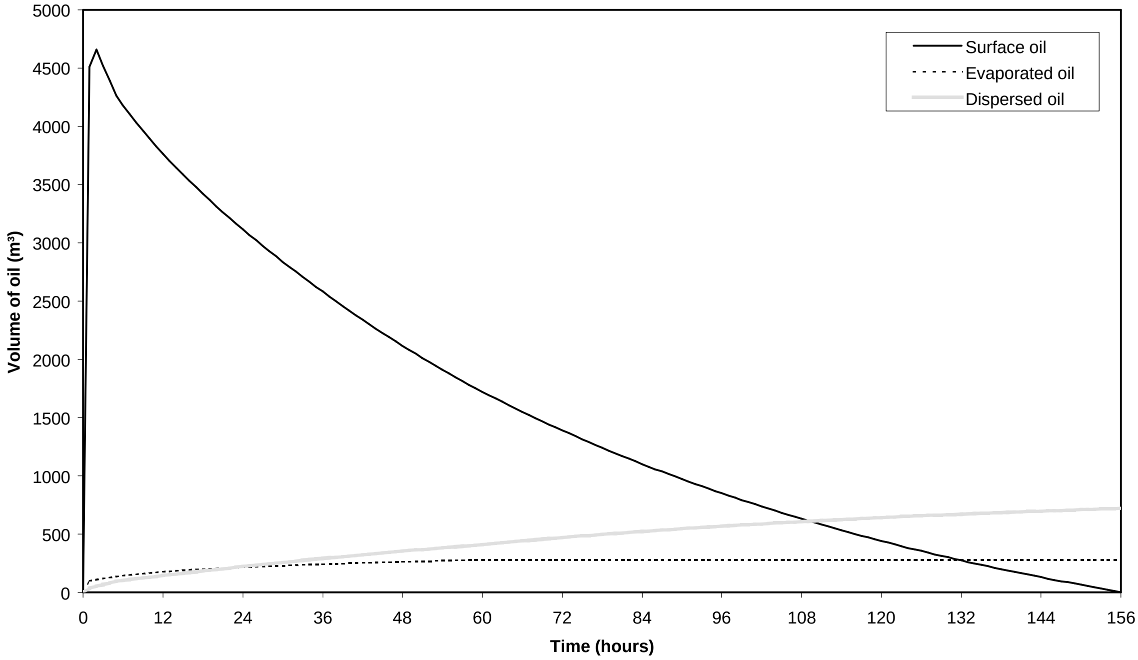
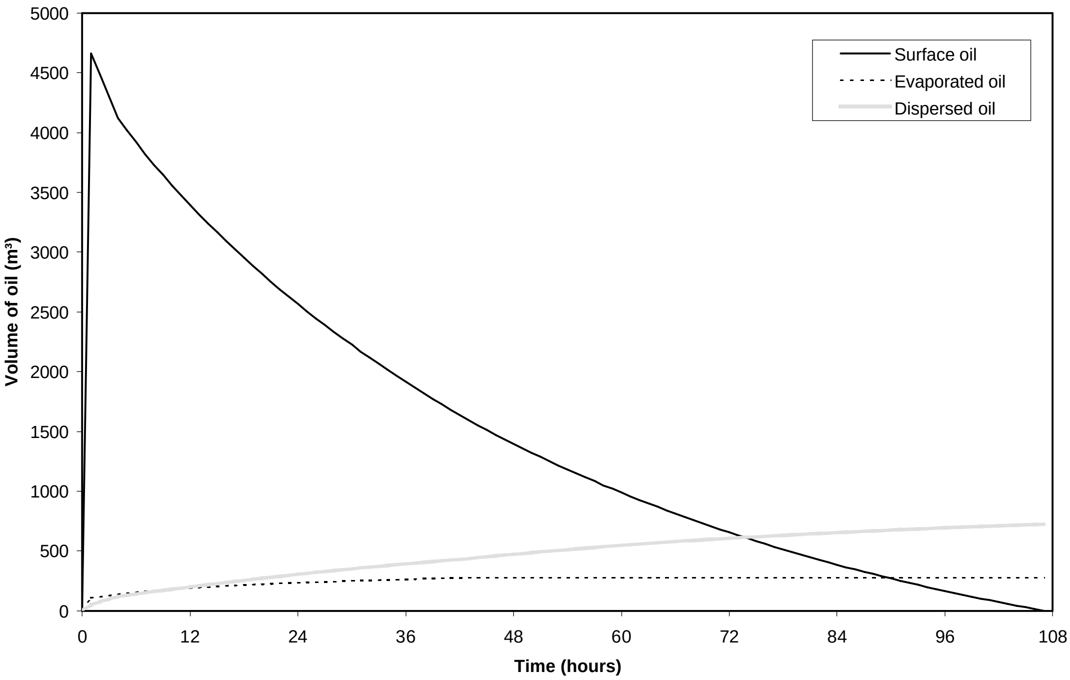


Figure 16. Mass Balance of Azeri Crude at 20 m/s (27°C)



5.4.3 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 11 consists of the dispersant time window constants as derived for OSIS V3.

Table 11. Dispersant Time Window Constants for Azeri Crude oil

Dispersants	Max Readily Dispersible	Dispersible	Reduced Dispersibility
Finasol OSR51	0	310	2900

Tables 12 and 13 indicates the time window for dispersant use at 6°C and 27°C for a range of wind speeds. These tables shows 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).

Time Window for dispersant use at 6°C

The dispersant efficiency tests indicated that the dispersant (Finasol OSR51) was only effective at dispersing fresh Azeri crude. Therefore at low temperatures, when Azeri is most viscous, the fresh crude is only likely to be dispersible for less than one hour in all wind conditions. This is indicated in the first column labelled ‘Dispersant Spraying Effective’.

The column labelled ‘Dispersant Spraying Possibly Effective’ indicates the time period when dispersants may be effective. This describes the period between the viscosity of the crude when it was measured as dispersible in the laboratory and the viscosity of the crude when it was measured as not dispersible. This suggests that Azeri may remain dispersible for a few days at low wind speeds (2-5 m/s), although in higher wind speeds the crude will rapidly weather and emulsify to a state at which it is not dispersible with OSR51.

The final column labelled ‘Dispersant Spraying Not Effective’ describes the time period when the crude reaches a viscosity where it is not dispersible.

Table 12. Time Window for Dispersant Use for Azeri Crude at 6°C with OSR51

Wind Speed (m/s)	Dispersant Spraying Effective (hours)	Dispersant Spraying possibly Effective (hours)	Dispersant Spraying may not be Effective (hours)
2	<1	1-95	>95
5	<1	1-14	>14
10	<1	-	>1
15	<1	-	>1
20	<1	-	>1

Time Window for dispersant use at 27°C

In warmer conditions, the dispersant efficiency tests indicated that the dispersant (Finasol OSR51) was only effective at dispersing fresh Azeri crude. Therefore the time window analysis indicates that OSR51 is only likely to be effective for short time period (less than one hour) at high wind speeds (10-20 m/s). However in low wind speeds of 2-5 m/s, the time window when OSR51 is effective increases to 9-55 hours.

The table indicates the intermediate phase, where dispersant spraying is possibly effective. This suggests that Azeri may still be amenable to dispersants, potentially extending the dispersant time window so that dispersants may still be an option in higher wind speeds for 1-2 days following a spill.

Table 13. Time Window for Dispersant Use for Azeri Crude 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	<55	55-319	>319
5	<9	9-82	>82
10	<1	1-36	>36
15	<1	1-26	>26

20	<1	1-20	>20

7 Conclusions

Laboratory investigations on the Azeri crude oil suggest that it will rapidly lose approximately 20% by volume from the sea surface by evaporation within the first few hours at sea. After one to two days approximately 32% by volume will eventually be lost. However, this loss in volume will be more than counterbalanced by the increase in volume as a result of water-in-oil emulsion formation. The oil is expected to form a stable emulsion to a maximum water content of 82%, significantly increasing the volume of the residual oil and its viscosity.

The fresh Azeri crude is a light oil, although the viscosity is significantly higher at 6^{o}C than 27^{o}C. At 6^{o}C, the viscosity of the fresh crude is 310 mPas compared to 30 mPas at 27^{o}C. This difference becomes more apparent as the Azeri crude evaporates. When the oil has weathered for the first few hours (i.e. after 20% evaporative loss), the viscosity increases to 430 mPas at 6^{o}C and only 110 mPas at 27^{o}C. This difference is further emphasised after 1-2 days weathering (32% evaporative loss), where the viscosity increases to 16,500 mPas at 6^{o}C and to 510 mPas at 27^{o}C. Azeri crude forms a stable emulsion that is considerably more viscous at a lower temperatures. For example, at 6^{o}C, the emulsion viscosity ranges from 10,500 mPas to 31,200 mPas, and at 27^{o}C, the emulsion viscosity is lower, ranging from 2,900 mPas to 5,800 mPas. The high viscosity of the crude, particularly at low temperatures, indicates that a spill may persist for 10 days at high wind speeds and several weeks at low wind speeds.

The dispersibility of the fresh, weathered and emulsified crude was investigated with Finasol OSR51 dispersant. The results indicate that the dispersant tested would be effective on a spill of fresh Azeri crude oil at 6^{o}C and 27^{o}C. However once the oil becomes weathered and emulsified Finasol OSR51 is not effective.

Using the OSIS model to analyse the time window for dispersibility provides further information on the time available for dispersant application under different conditions. The analysis indicates that at low temperatures, when Azeri crude is most viscous, the fresh crude is only likely to be 'dispersible' with Finasol OSR51 for less than one hour in all wind conditions. At low temperatures and high wind speeds the crude will rapidly weather and emulsify to a state at which it is not dispersible with Finasol OSR51, however at lower wind speeds (2-5 m/s) this process of weathering and emulsification is far slower. As a result, at low wind speeds there may be an extended time window when Azeri may be 'possibly dispersible' , which extends the time window by an additional few days. At higher temperatures, time window analysis indicates that Finasol OSR51 is likely to be effective for less than one hour at high wind speeds (10-20 m/s), although this increases to 9-55 hours at low wind speeds of 2-5 m/s.

In summary, the laboratory studies indicate that a spill of the Azeri crude will form stable viscous emulsions that may persist for a number of days at sea. Treatment of the crude with dispersant is only likely to effective in the very early stages of a spill and would not be effective in cold conditions, so dispersants should not be considered the primary response method. If dispersant use is considered as part of the contingency plan, then it is essential for dispersant stocks to be accessible within a few hours.

8 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 Crude Oils 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

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ACG Crude Release

OSIS Modelling Results Report

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Contents

Abstract

Briggs Marine Environmental Services have undertaken single trajectory and stochastic modelling using the OSIS Oil Spill Information System to determine the fate and trajectory of ACG crude in worst case conditions and using identified spill scenarios and actual statistical wind speed/direction frequency data.

The modelling shows that a large spill of ACG Crude from the ACG Platform, Pipeline nearshore and offshore locations has a low to extremely low probability of oil impacting the shoreline around the Caspian. The shortest beaching times for large crude releases from the platform, pipeline nearshore and pipeline offshore locations are 49 hours, 19 hours and 38 hours respectively. This allows sufficient time to mobilise marine and shoreline response resources.

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.

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 order to predict the fate, trajectory and probable impact of a number of spill scenarios from the ACG Platform and pipeline single trajectory and stochastic modelling have been applied using the OSIS Oil Spill Information System.

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 modelling investigates the shortest beaching time, excluding prevailing weather conditions, to deduce the worst case scenario.

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 which 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

Methodology
Using oil spill scenarios determined by URS Corporation, single trajectory and stochastic modelling have been applied using the OSIS Oil Spill Information System.

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 modelling investigates the shortest beaching time, excluding prevailing weather conditions, to deduce the worst case scenario.

For the purposes of modelling, only crude oils that have been characterised for use in the OSIS model appear in the model database. ACG Crude had not been characterised for use in OSIS at the time that this modelling was undertaken, therefore Iranian Light Crude was used as a match for modelling purposes based on API and Specific Gravity.

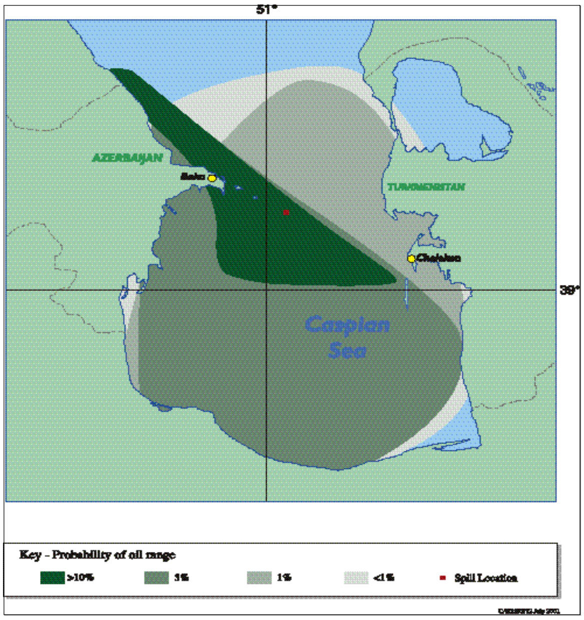
Constants
1. For winter spill runs the air temperature used was 5^0C and the sea temperature was 10^0C;
2. For summer spill runs the air temperature used was 35^0C and the sea temperature was 25^0C;
3. A worst case scenario for single trajectory would be in winter conditions using a 20 knot onshore wind, this has been calculated by examining the annual wind data and using a wind speed at approximately the 90^{th} percentile.
4. For spills extending over a long time period for the purpose of modelling a shorter representative modelling time was used. For a spill over 180 days, a spill run lasting 10 days was deemed as representative and therefore was used for modelling.

3 Results

<u>Scenario 1: Spills from ACG Platform</u>
Release Location: 4433190N, 9530085E (UTM)

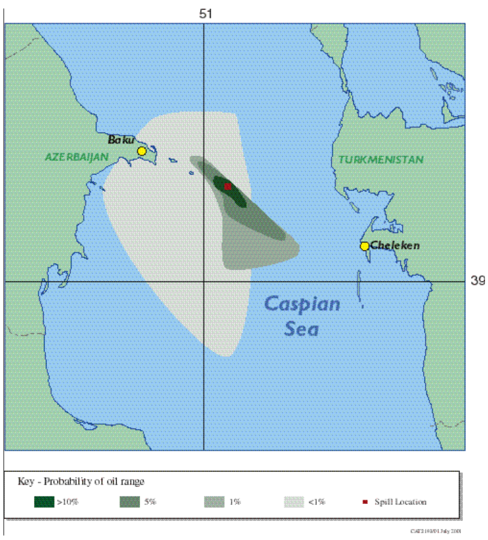
Stochastic modelling has been carried out for a spill of 200,324.04 m^3 of ACG Crude (Iranian Light Crude) released over 42 days (1008 hours) in winter and summer conditions. Single trajectory modelling has also been carried out for the same release representing the worst case scenario and a single trajectory model run has been carried out for a spill of 100m^3 of Diesel from the ACG Platform storage tank.

Figure 1a: 200,324.04m^3 ACG (Iranian Light) Crude (198.7 m^3 per hour for 1008 hours resulting from a Well Blow Out) in Winter conditions



Results
The prevailing Metocean Data indicates that the oil will be transported predominantly to the north west, south and south east of the field into the Southern Central Caspian Sea area, with the heaviest area of oiling also in these directions.
There is a > 10% probability of oil heading north west and reaching from the Apsheron Peninsula north towards Makhachkala on the west coast of the Caspian Sea. There is a 5% chance of oil beaching around the coast of the southern Caspian. There is a 1 % probability of oil reaching the Cheleken Peninsula in the east.

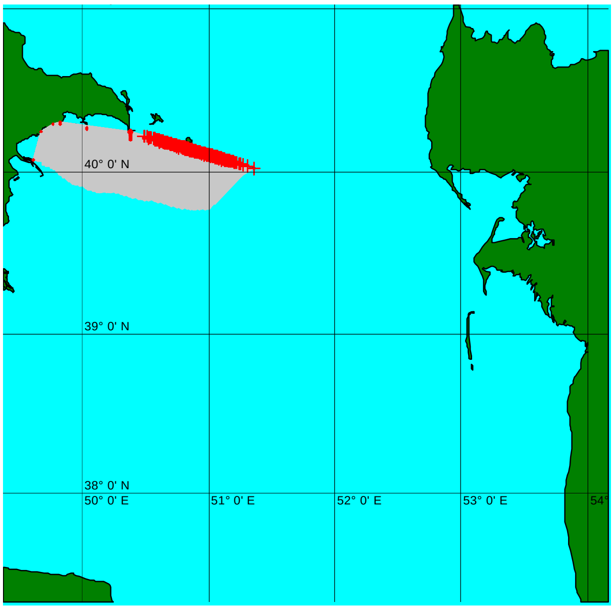
Figure 1b: 200,324.04m^3 ACG (Iranian Light) Crude (198.7 m^3 per hour for 1008 hours resulting from a Well Blow Out) in Summer conditions



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 east of the release location.

There is a <1% probability of oil heading west and reaching the Apsheron Peninsula on the west coast of the Caspian Sea.

Figure 1c: 200,324.04m^3 ACG (Iranian Light) Crude (198.7 m^3 per hour for 1008 hours resulting from a Well Blow Out) in Worst case conditions

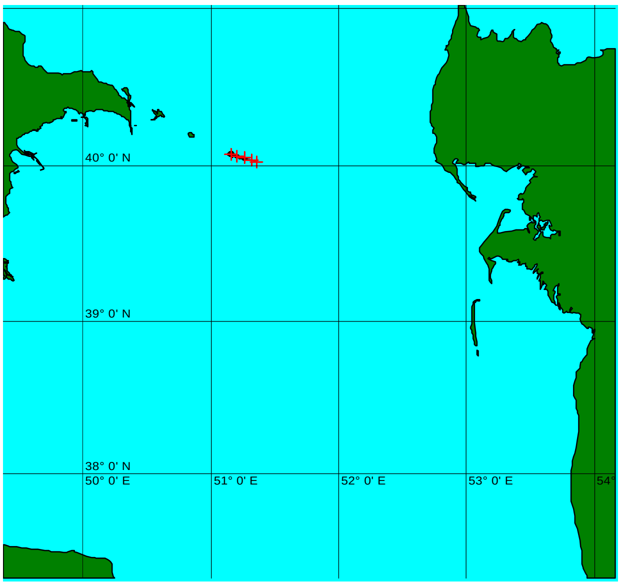


Results

Upon release the oil increased in volume due to emulsification before steadily decreasing in volume as the oil dispersed and evaporated. The oil was persistent enough to beach at the point of nearest landfall after 49 hrs. The resultant volumes were as follows:

83032m^3 Evaporated
100929m^3 Dispersed
77821m^3 Beached

Figure 1d: 100m^3 Diesel (Instantaneous release from loss of Diesel storage tank) in Worst case conditions



Results

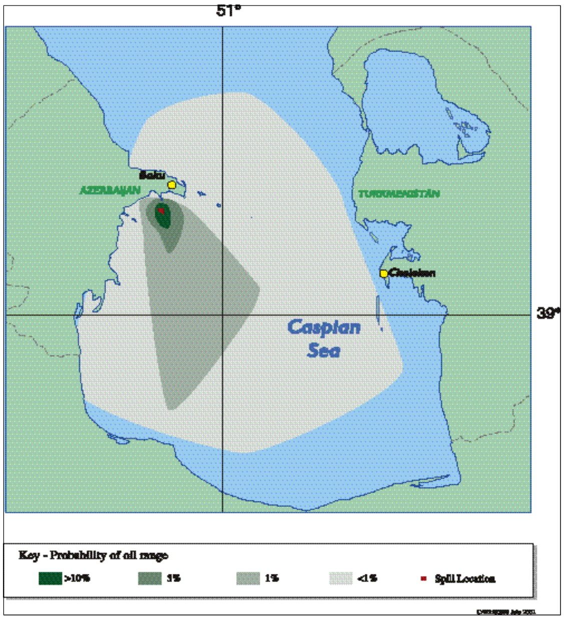
Upon release the diesel evaporated quickly. After 8 hours the surface slick at sea became insignificant The resultant volumes were as follows:

39.54m^3 Evaporated
60.46m^3 Dispersed.

Scenario 2: Nearshore Spills from ACG Pipeline
Release Location: UTM 9371500E, 4449800N

Stochastic modelling has been carried out for a spill of 89, 197 m^3 of ACG Crude (Iranian Light Crude) released over 26 hours in winter and summer conditions. Single trajectory modelling has also been carried out for the same release representing a worst case scenario and a single trajectory model run has been carried out for a spill of 720m^3 of crude released over 720 hours from the ACG pipeline nearshore location.

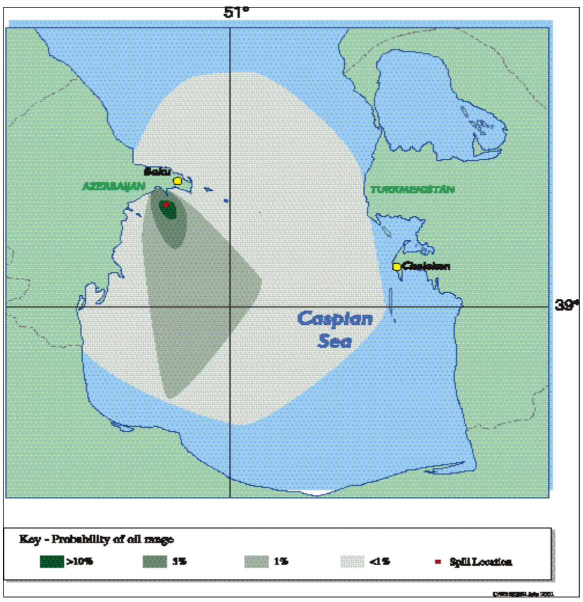
Figure 2a: 89,197m^3 ACG (Iranian Light) Crude (3451 m^3 per hour for 26 hours resulting from a pipeline failure) in Winter conditions



Results
The prevailing Metocean Data indicates that the oil will be transported predominantly to the south of the field into the Southern Caspian Sea area, with the heaviest area of oiling directly to the south and south east of the release location.

There is a <1% probability of oil reaching the Apsheron Peninsula in the West, the Cheleken Peninsula in the east and the Khazar Island in the Southwest.

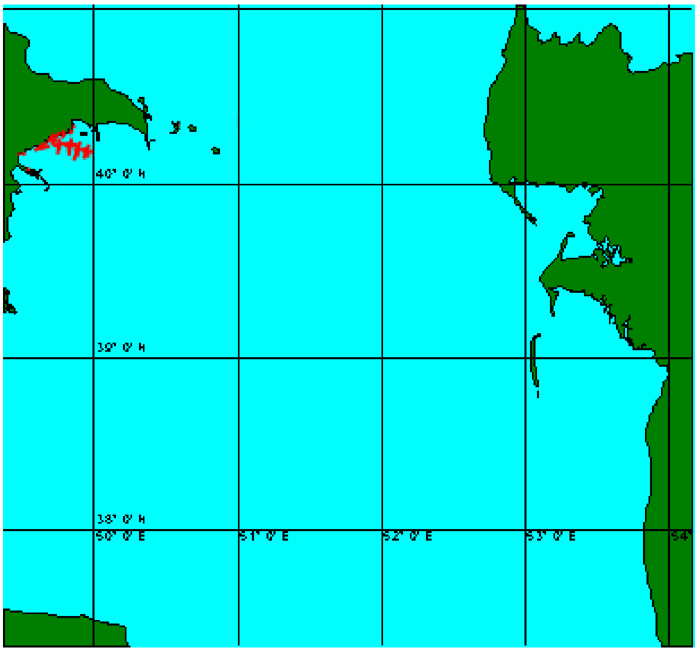
Figure 2b: 89,197m^3 ACG (Iranian Light) Crude (3451 m^3 per hour for 26 hours resulting from a pipeline failure) in Summer conditions



Results
The prevailing Metocean Data indicates that the oil will be transported predominantly to the south of the field into the Southern Caspian Sea area, with the heaviest area of oiling directly to the south and south east of the release location.

There is a <1% probability of oil reaching the Apsheron Peninsula in the West, the Cheleken Peninsula in the east and Astara in the Southwest.

Figure 2c: 89,197m^3 ACG (Iranian Light) Crude (3451 m^3 per hour for 26 hours resulting from a pipeline failure) in Worst Case conditions

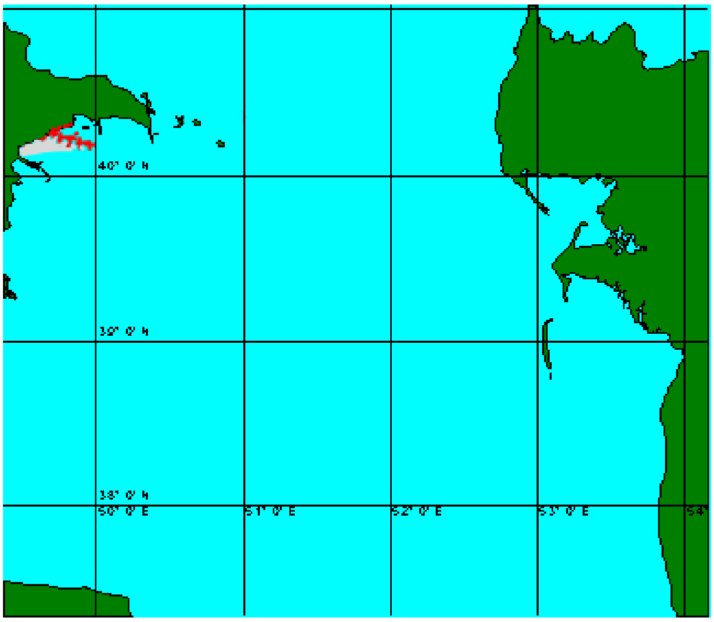


Results

Upon release the oil increased in volume due to emulsification before steadily decreasing in volume as the oil dispersed and evaporated. The oil was persistent enough to beach at the point of nearest landfall after 19 hrs. The resultant volumes were as follows:

20470m^3 Evaporated
9974m^3 Dispersed
294481m^3 Beached

Figure 2d: 720m^3 ACG (Iranian Light) Crude (1 m^3 per hour for 720 hours resulting from a pipeline failure) in Worst Case conditions



Results

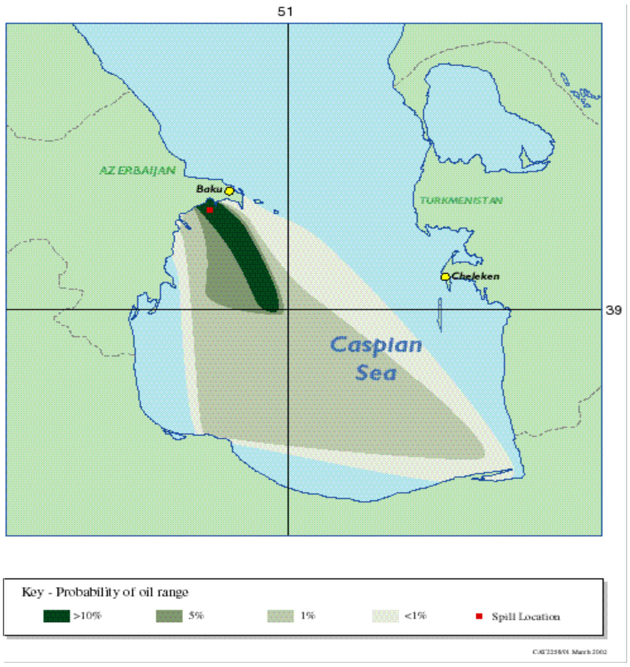
Upon release the oil increased in volume due to emulsification before steadily decreasing in volume as the oil dispersed and evaporated. The oil was persistent enough to beach at the point of nearest landfall after 26 hrs. The resultant volumes were as follows:

317m^3 Evaporated
361m^3 Dispersed
205m^3 Beached

<u>Scenario 3: Offshore Spills from ACG Pipeline</u>
Release Location: 4433190N, 9530085E (UTM)

Stochastic modelling has been carried out for a spill of 89, 197 m^3 of ACG Crude (Iranian Light Crude) release over 26 hours in winter and summer conditions. Single trajectory modelling has also been carried out for the same release representing a worst case scenario, and a single trajectory model run has been carried out for a spill of 720m^3 of crude over 720 hours from the ACG pipeline LP Separator.

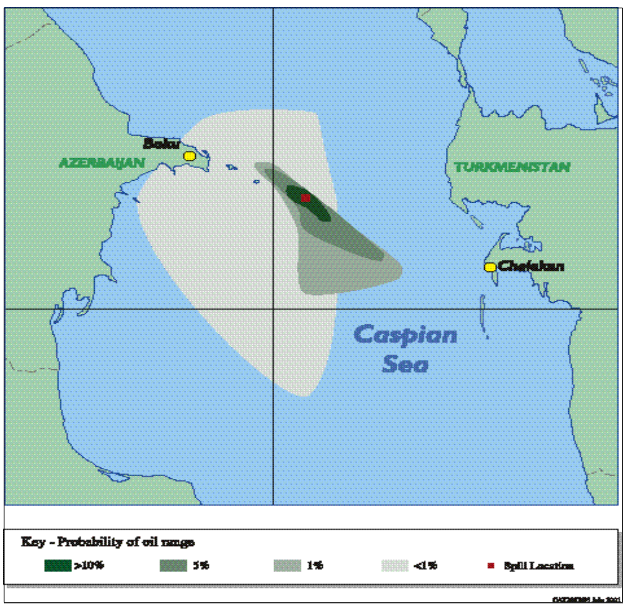
Figure 3a: 89,197m^3 ACG (Iranian Light) Crude (3451 m^3 per hour for 26 hours resulting from a pipeline failure) in Winter conditions



Results
The prevailing Metocean Data indicates that the oil will be transported predominantly to the south east and north west of the field into the Central and Southern Caspian Sea areas, with the heaviest area of oiling directly to the south east and north west of the release location.

There is a <1% probability of oil beaching from the Apsheron Peninsula in the West to the Khazar Island in the Southwest.

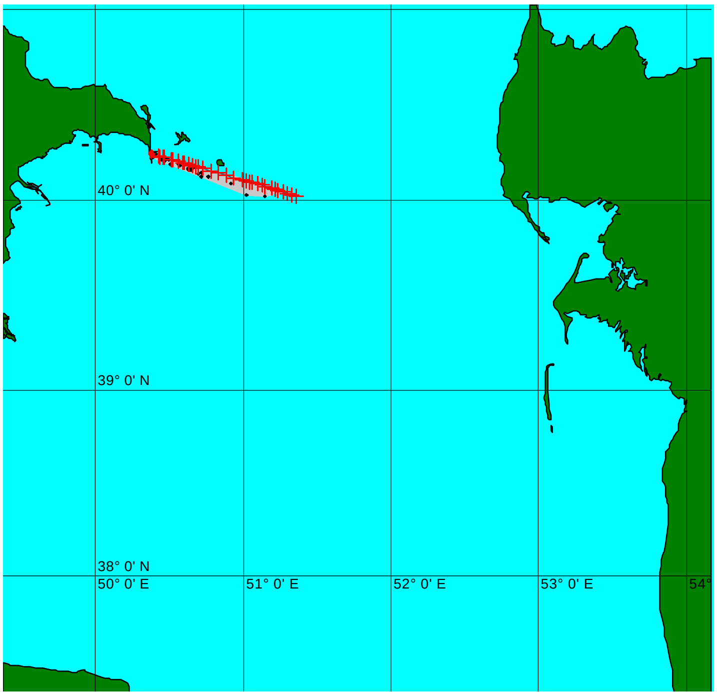
Figure 3b: 89,197m^3 ACG (Iranian Light) Crude (3451 m^3 per hour for 26 hours resulting from a pipeline failure) in Summer conditions



Results
The prevailing Metocean Data indicates that the oil will be transported predominantly to the south east of the field into the Southern Caspian Sea area, with the heaviest area of oiling directly to the south and south east of the release location.

There is a <1% probability of oil reaching the Apsheron Peninsula in the West.

Figure 3c: 89,197m^3 ACG (Iranian Light) Crude (3451 m^3 per hour for 26 hours resulting from a pipeline failure) in Worst Case conditions



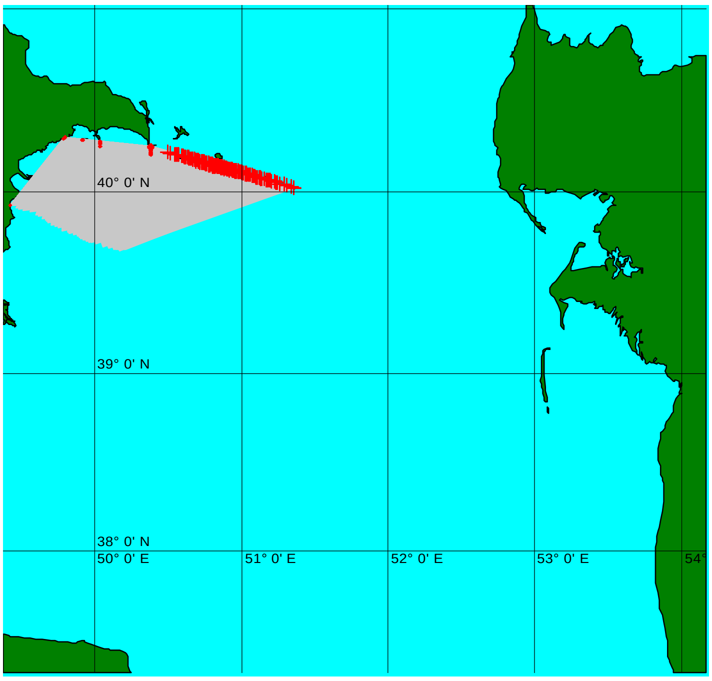
Results

Upon release the oil increased in volume due to emulsification before steadily decreasing in volume as the oil dispersed and evaporated. The oil was persistent enough to beach at the point of nearest landfall after 38 hrs.

The resultant volumes were as follows:

23458m^3 Evaporated
13409m^3 Dispersed
264288m^3 Beached

Figure 3d: 720m^3 ACG (Iranian Light) Crude (1 m^3 per hour for 720 hours resulting from a pipeline failure) in Worst Case conditions

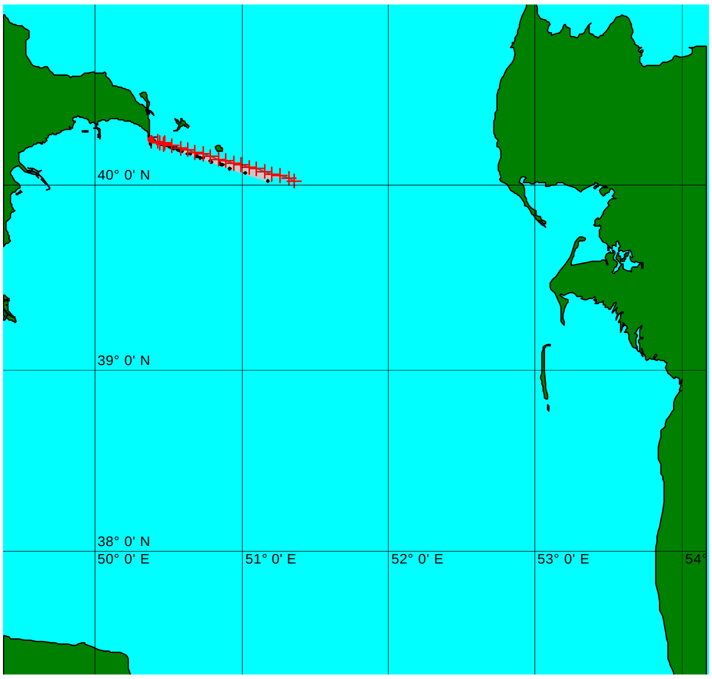


Results

Upon release the oil increased in volume due to emulsification before steadily decreasing in volume as the oil dispersed and evaporated. The oil was persistent enough to beach at the point of nearest landfall after 48 hrs.

The resultant volumes were as follows:

321m^3 Evaporated
358m^3 Dispersed
197m^3 Beached

Figure 3e: 140m^3 ACG (Iranian Light) Crude (Instantaneous Release of Inventory of LP Separator) in Worst Case conditions	
	**Results** Upon release the oil increased in volume due to emulsification before steadily decreasing in volume as the oil dispersed and evaporated. The oil was persistent enough to beach at the point of nearest landfall after 37 hrs. The resultant volumes were as follows: 51m^3 Evaporated 25m^3 Dispersed 315m^3 Beached

4 Discussion

ACG crude has a medium API, suggesting it may have a moderate rate of evaporation. The specific gravity value verifies this illustrating that the crude is medium to light and will therefore evaporate and disperse up on release into the marine environment.

Scenario 1
The modelling results show that the probability of oil beaching even when a large spill has occurred from the ACG Platform is low, <10% probability, and that in worst case conditions, with a constant 20 knot onshore wind towards the nearest coastline 77821m^3 of crude would impact the Apsheron Peninsula after 49 hrs. This allows adequate time to mobilise a marine and shoreline response.

Scenario 2
The modelling results show that the probability of oil beaching even when a large spill has occurred from the ACG Pipeline nearshore location is extremely low, <1% probability, and that in worst case conditions, with a constant 20 knot onshore wind towards the nearest coastline 294481m^3 of crude would beach on the Apsheron Peninsula after 19 hrs. This allows adequate time to mobilise a marine and shoreline response.

Scenario 3
The modelling results show that the probability of oil beaching even when a large spill has occurred from the ACG Pipeline offshore location is extremely low, <1% probability, and that in worst case conditions, with a constant 20 knot onshore wind towards the nearest coastline 264288m^3 of crude would beach on the Apsheron Peninsula beach at the point of nearest landfall after 38 hrs. This allows adequate time to mobilise a marine and shoreline response.

5 Conclusion

The modelling shows that a large spill of ACG Crude from the ACG Platform, Pipeline nearshore and offshore locations show a low to extremely low probability of oil impacting the shoreline around the Caspian. The shortest beaching times for large crude releases from the platform, pipeline nearshore and pipeline offshore locations are 49 hours, 19 hours and 38 hours respectively. This allows sufficient time to mobilise marine and shoreline response resources.

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BP

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

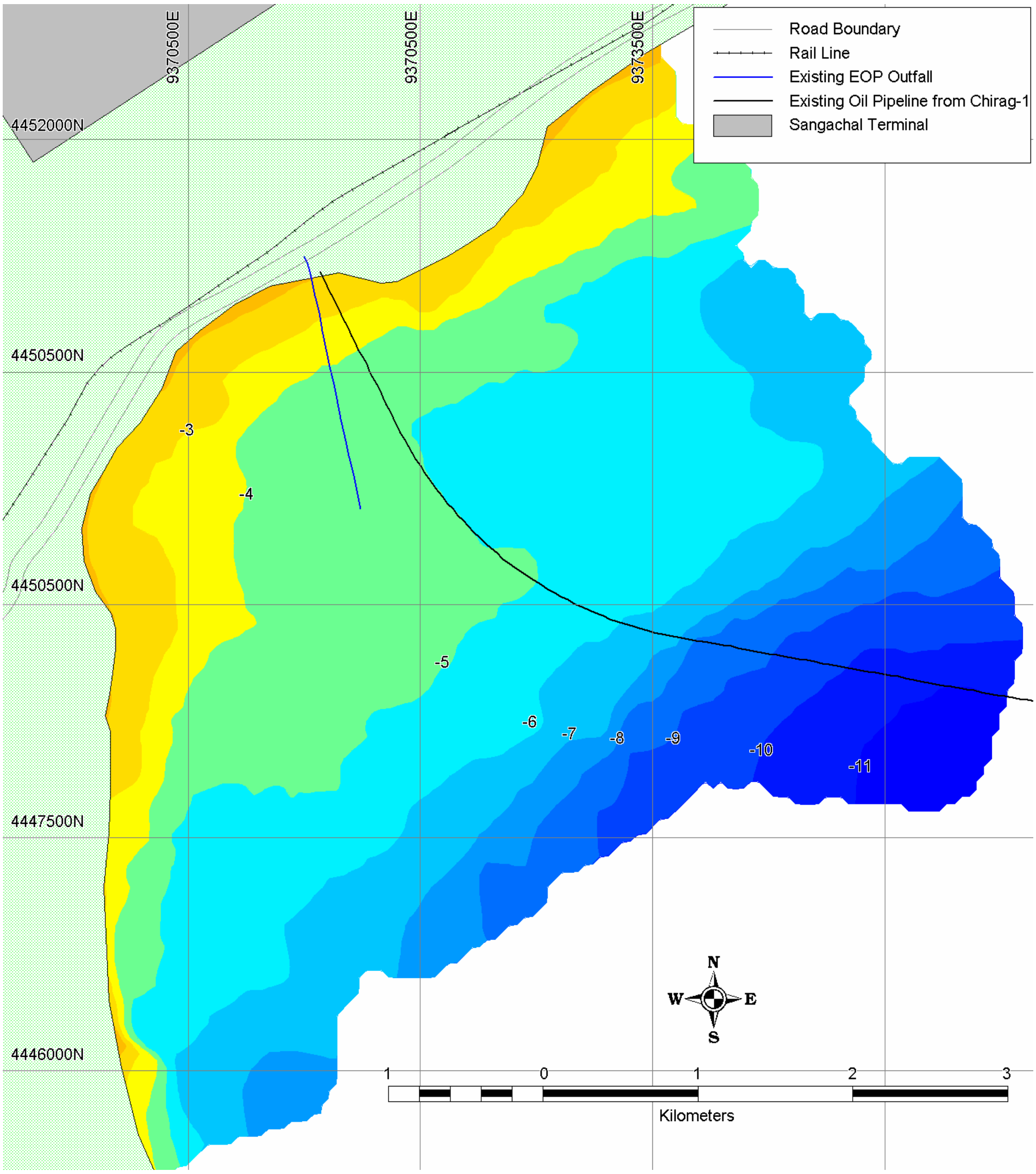
Seagrass and macroalgae were sorted from grab samples taken at 16 stations and either preserved in formalin-seawater (algae and seagrass) or transported live to Belfast (seagrass only). Samples were sorted under a dissecting microscope. All macroalgae samples were made into stained slide preparations 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.

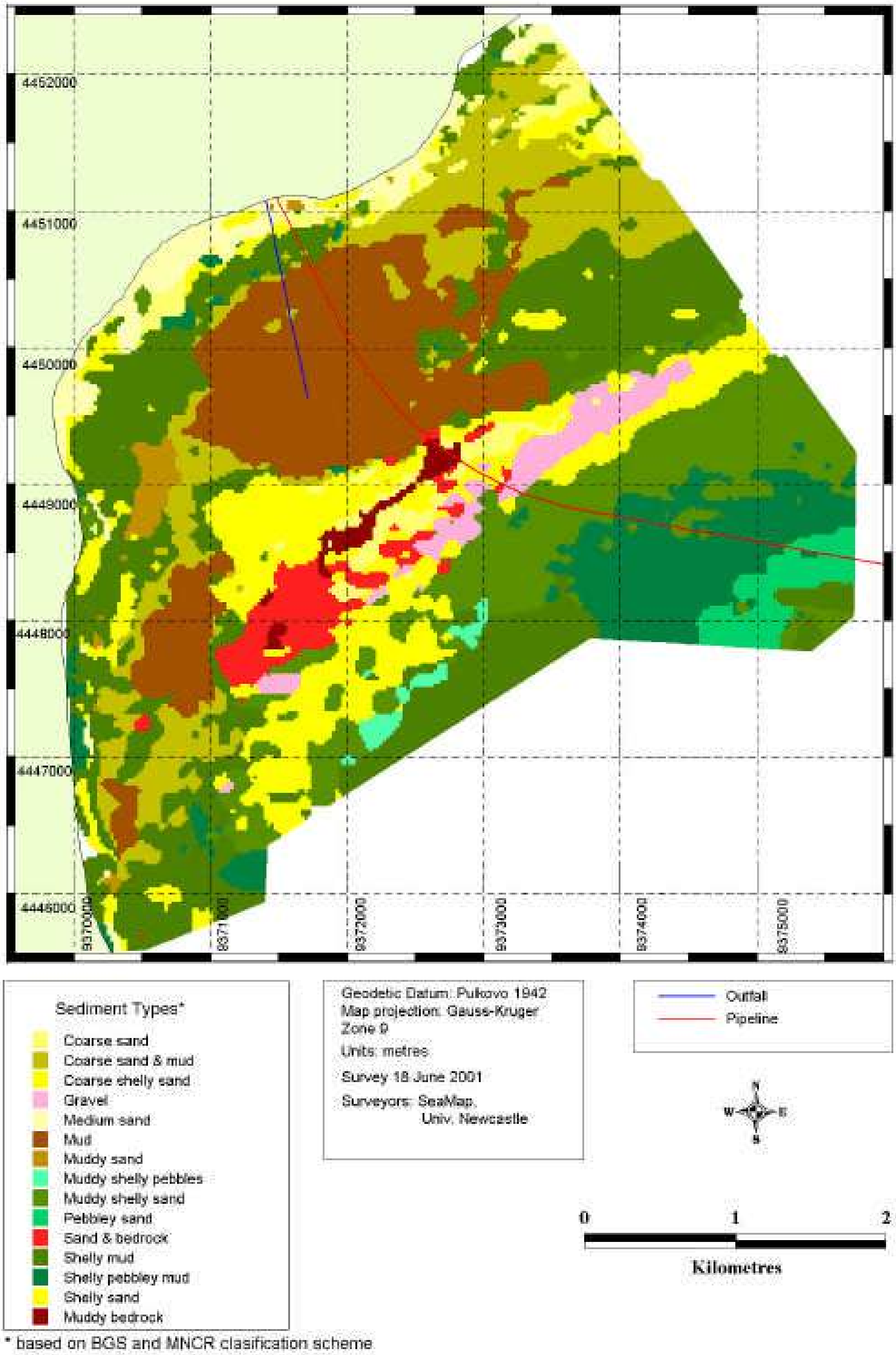
Figure 3.1 Bathymetry of Sangachal Bay (depths in metres)



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.

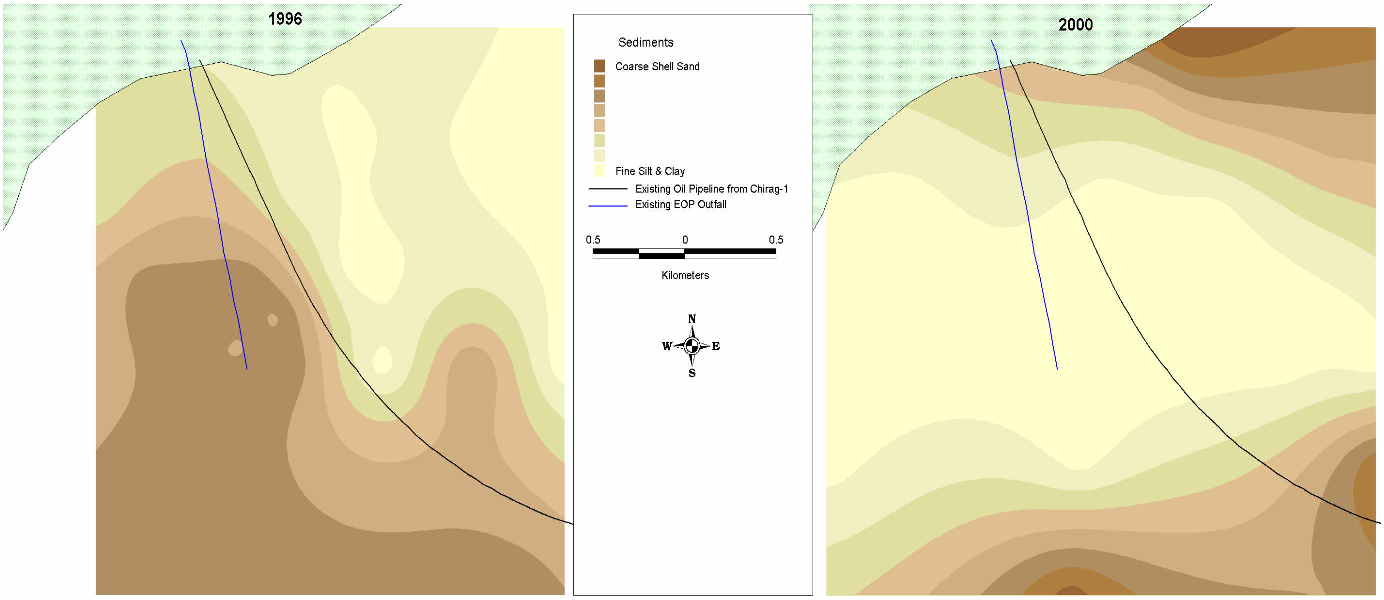
Figure 3.2 Seabed sediment types



* 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.

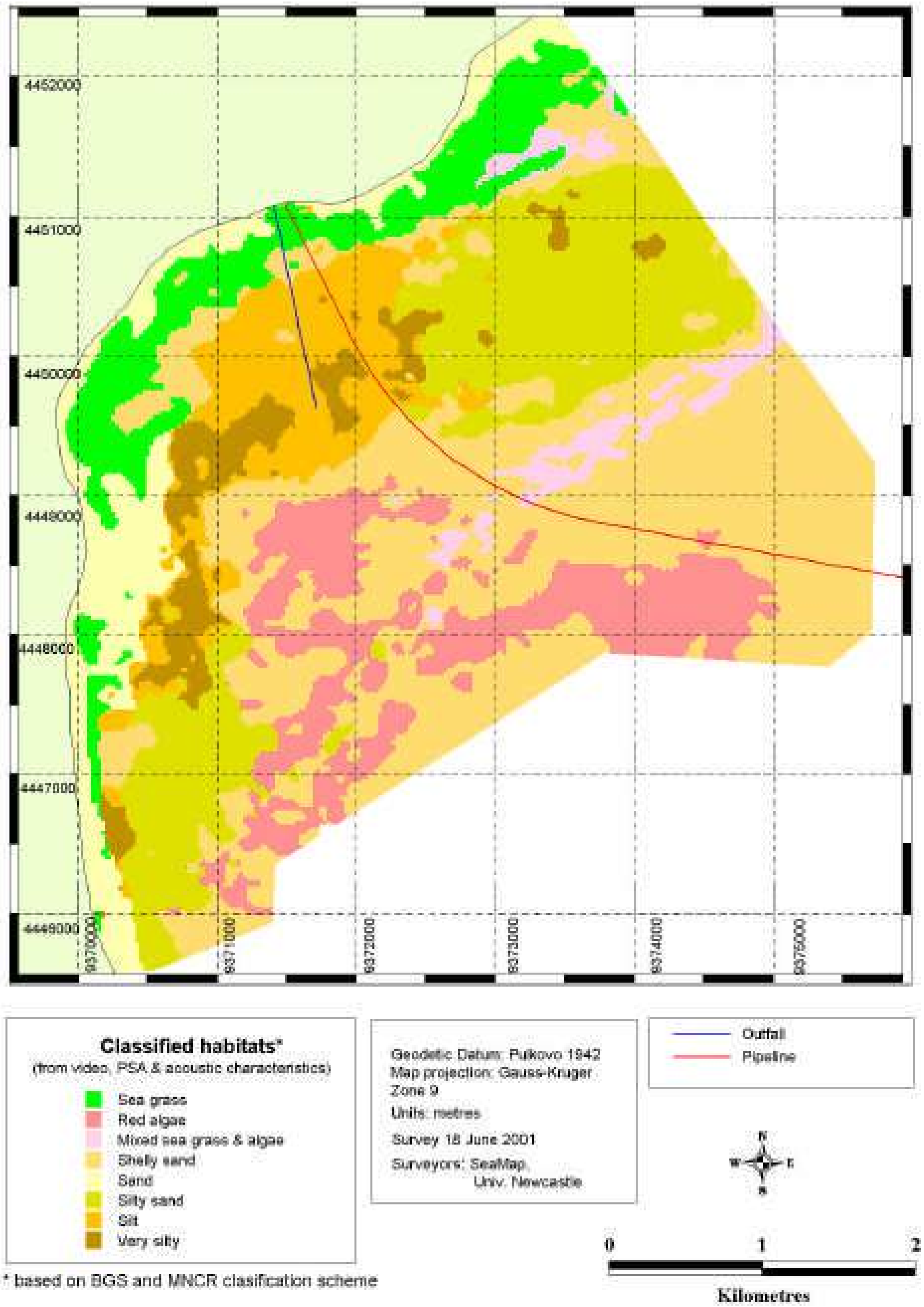
3.3 Marine flora

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.

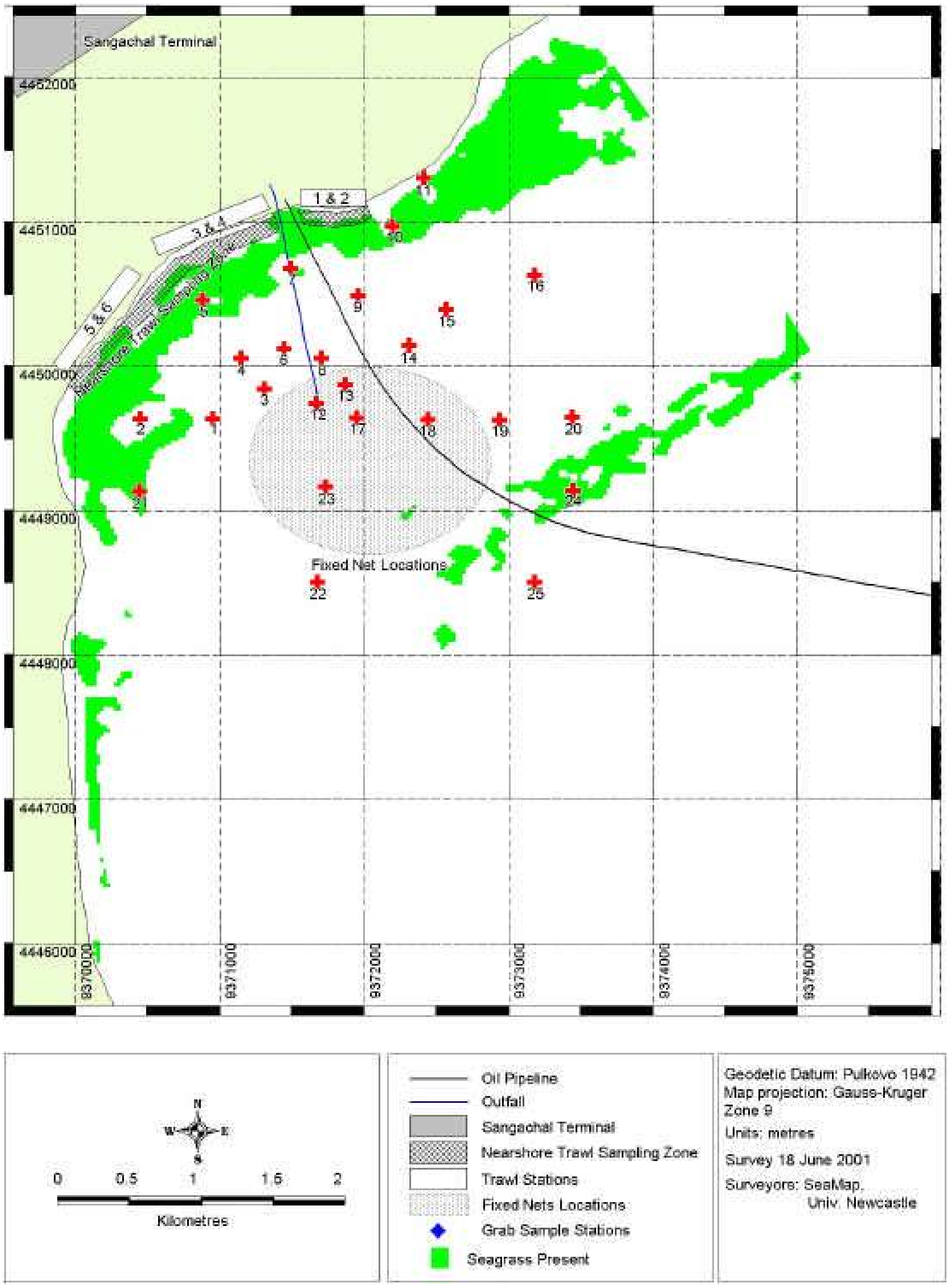
A seabed survey of the Sangachal area was conducted in 2000. Seagrass was observed in grab samples at six stations (10, 13, 15, 19, 21, 22 – Figure 3.5), and five stations coincide with the nearshore seagrass beds delineated in the current seagrass mapping survey (5, 10, 11, 21 and 24). Red algae were 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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FINAL REPORT

NEARSHORE ASSESSMENT OF SANGACHAL BAY

Prepared for:

Azeri, Chirag & Gunashli (ACG) Phase 1 Upstream Development Project
BP

October 2001

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Figures

1.1 BACKGROUND

The development programme for ACG Phase 1 and Shah Deniz Gas Export Stage 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 Phase 1 ACG 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.

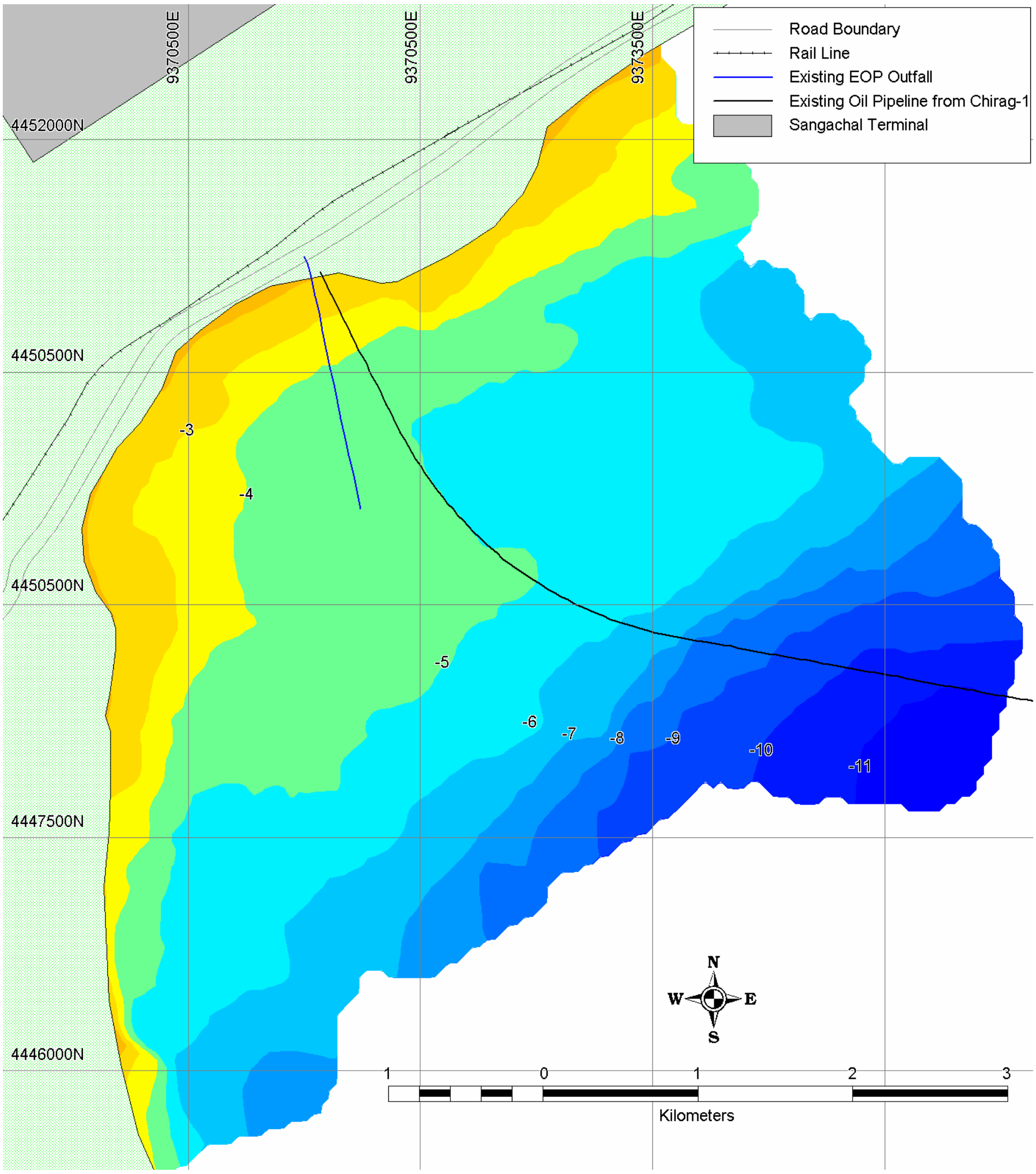
In the Apsheron region as a whole winds greater than 5 ms^{-1} blow approximately 37% of the time and winds greater than 10 ms^{-1}, 18% of the time (ERT, undated). At Alyat, some 15 km south of Sangachal, the average wind speed is 3.6 ms^{-1} and for up to 100 days a year, wind speed exceeds 15 ms^{-1}. 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)

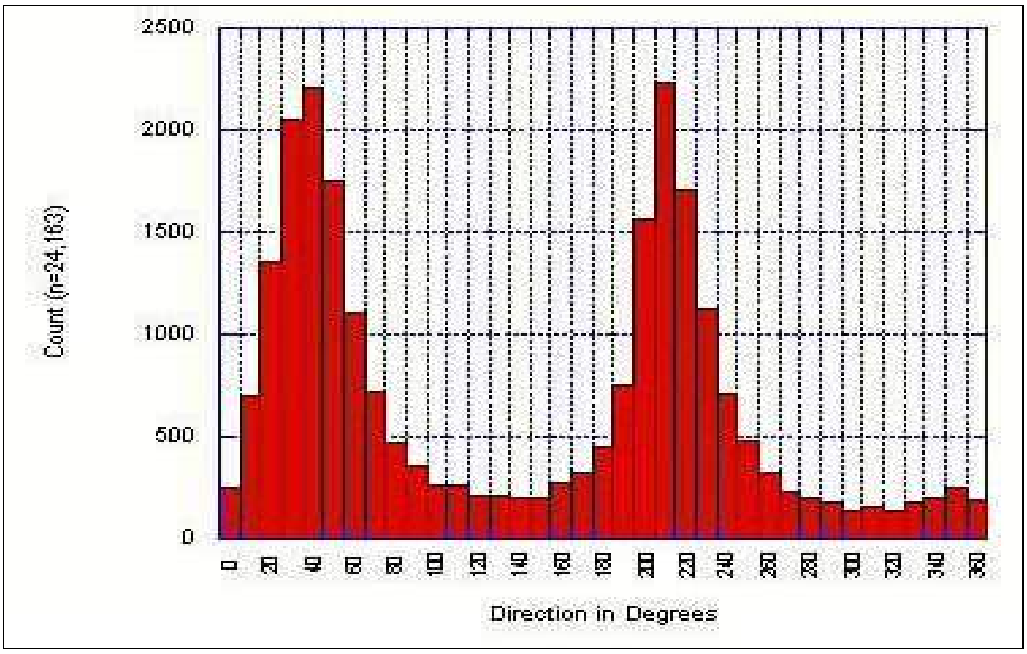


2.2.2 Currents and Water Circulation

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.

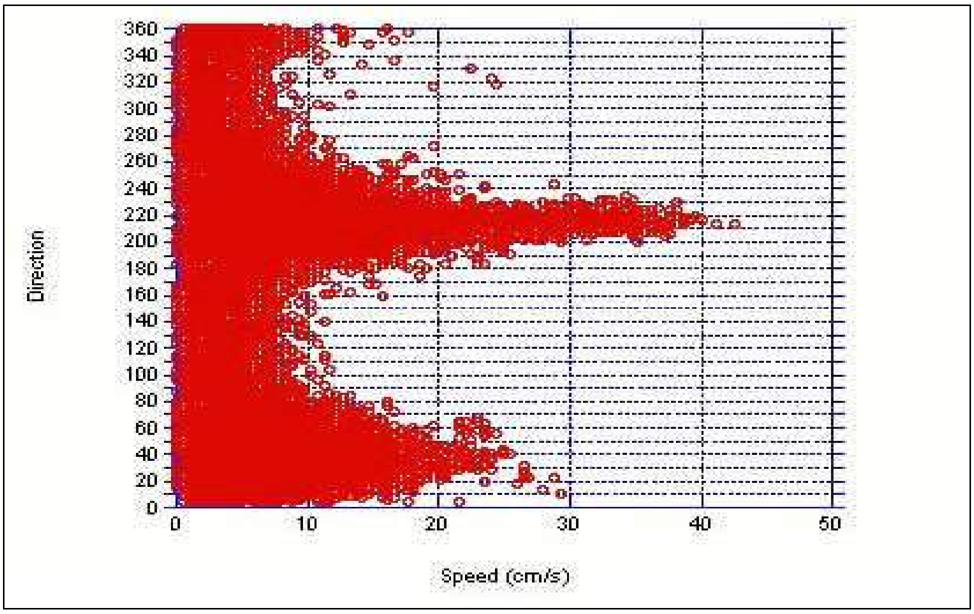
The NeSA BV data showed that the minimum current speed was 0.0 cms^{-1} and the maximum, approximately 42.5 cms^{-1} (Figure 2).

Figure 2 Distribution of current direction over complete NESA by record



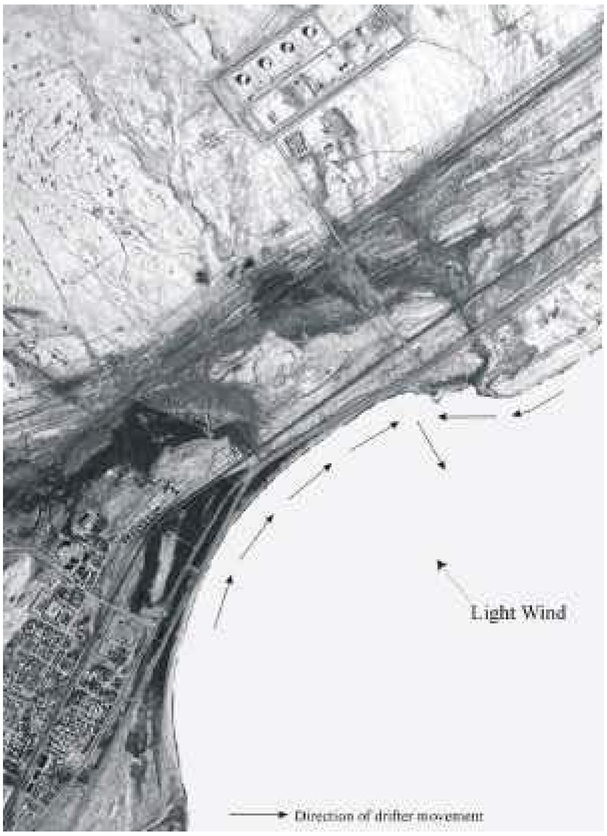
The mean current speed was approximately 7.9 cms^{-1}. Current direction was evenly distributed between flowing in a southwesterly direction and a northeasterly direction; that is, down coast and up coast respectively (Figure 3). Higher current speeds are associated with the southwesterly direction currents.

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.

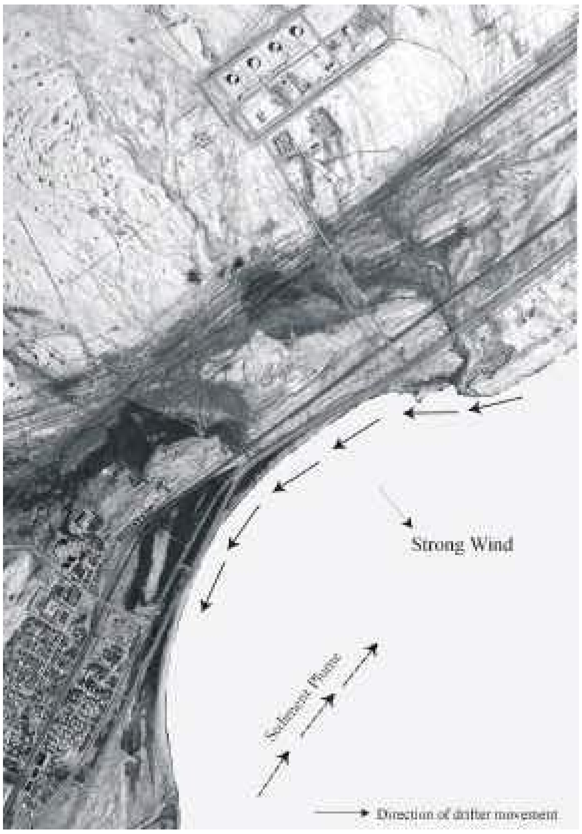
Figure 4 Inferred current direction – light southeast winds



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

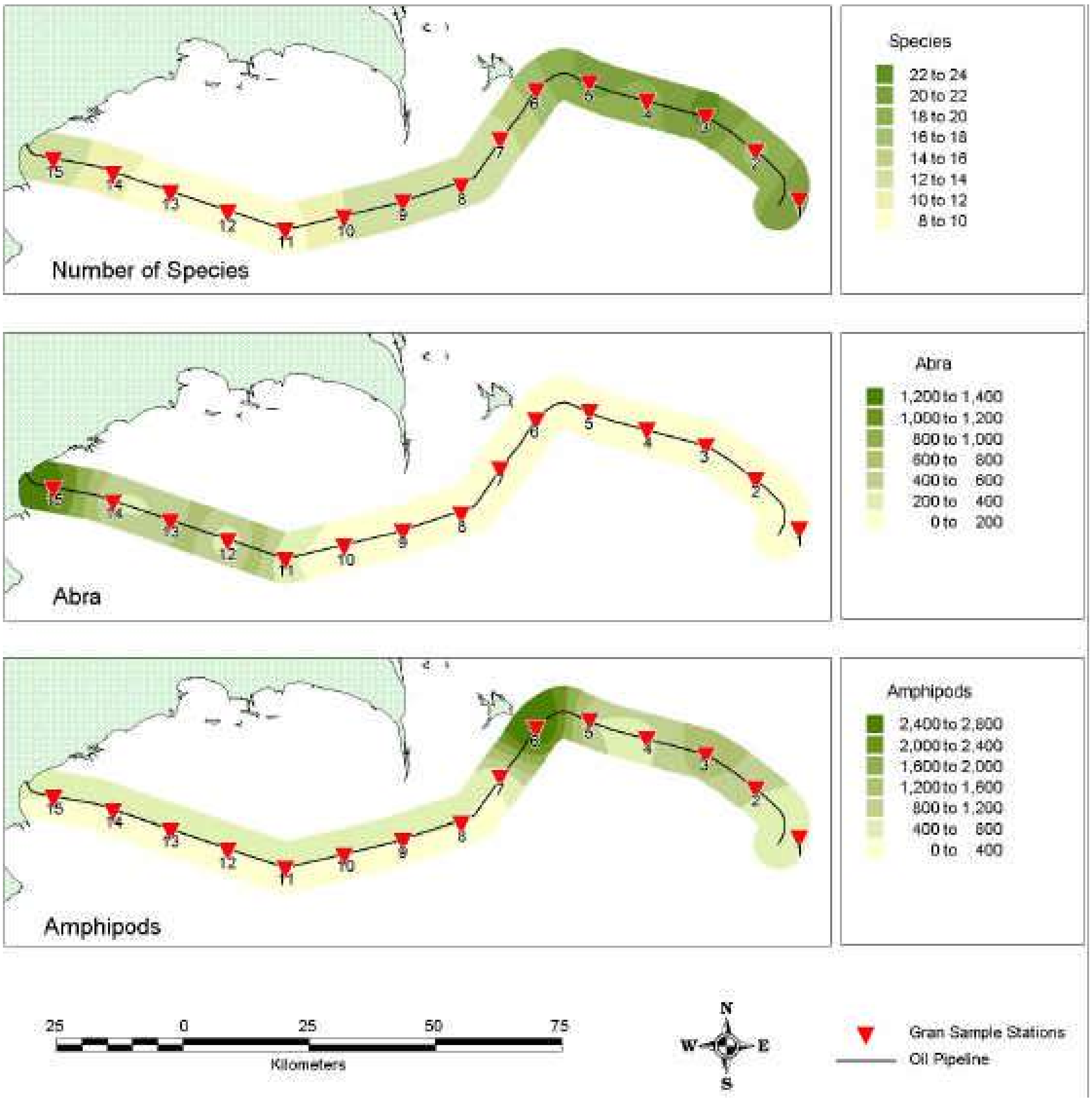
This section provides a general description of the biological communities in the nearshore area of Sangachal Bay based on a survey of part of the pipeline route that was carried out in November 2000 and visual observations during the June 2001 site visit.

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

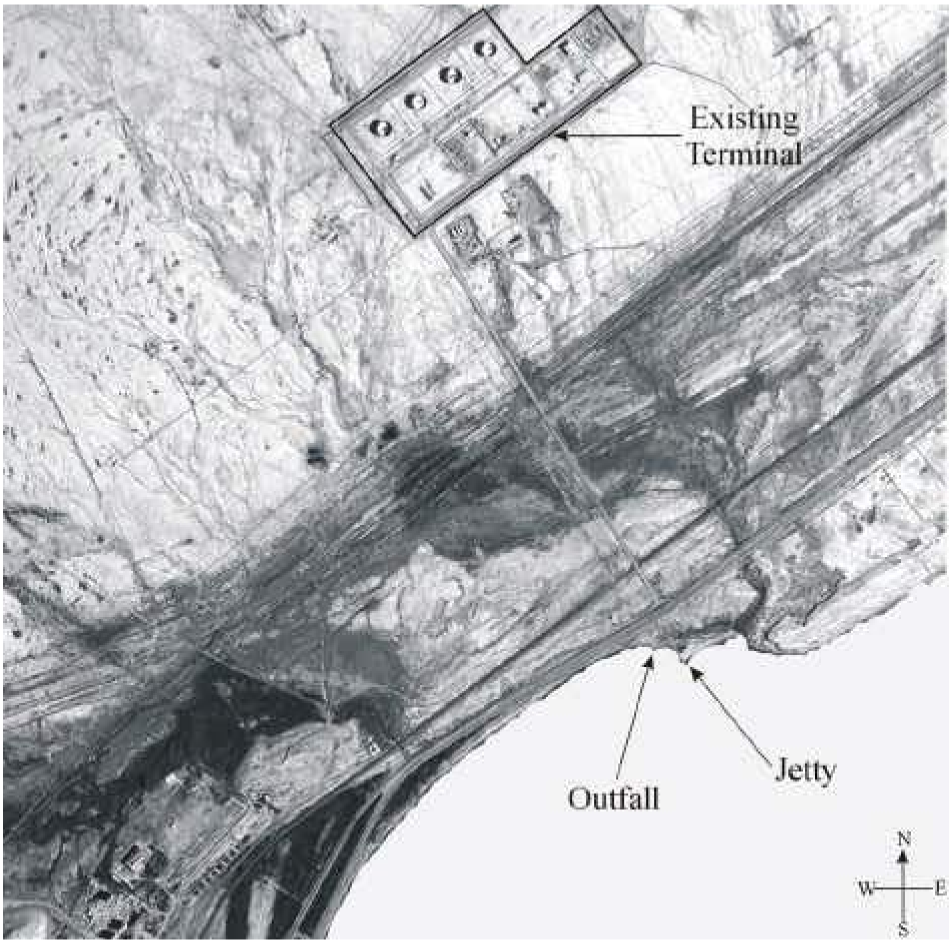
During the June 2001 site visit, seagrass communities were observed from the existing jetty. Also, artisinal fishers were observed collecting small shrimp within a few metres of the shoreline, as well as fishing from the jetty.

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.

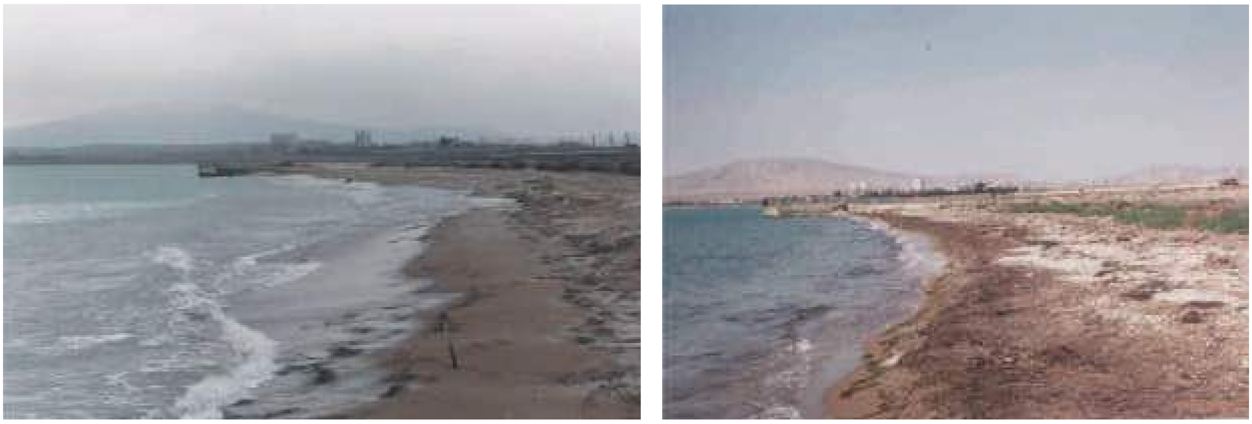
It should be noted that the sea level in Sangachal Bay was higher during the June field investigation than that observable in the January-February 2001 photos (Figures 8-12). The exact cause of this rise is unknown.

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.

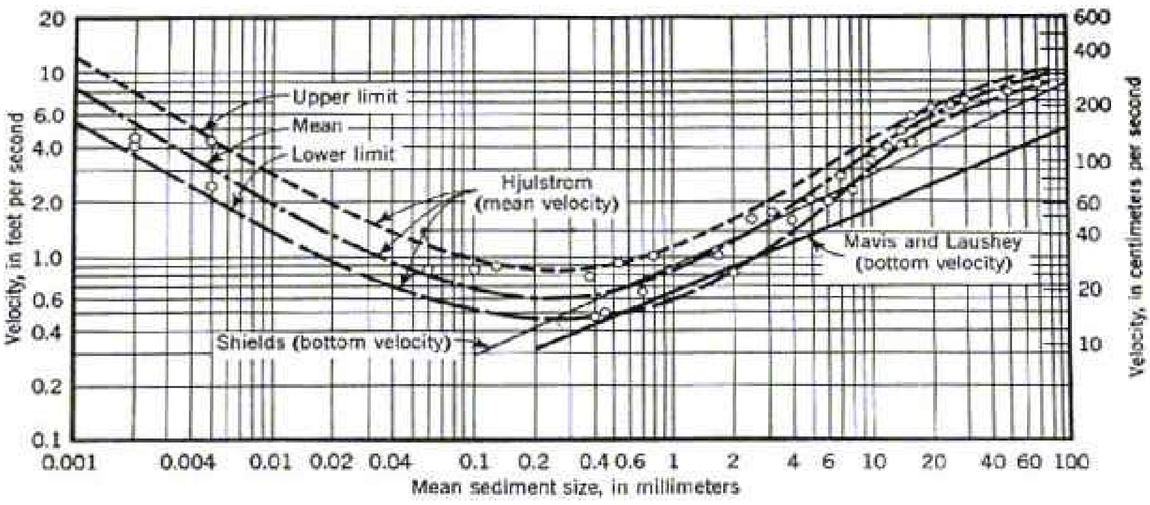
A comparison of evidence from historical photos (January-February 2001) to the results of the June 2001 field investigation into beach profiles and shoreline sediment distribution indicates that considerable change has occurred to the shoreline's configuration over a short period of time. Some of this 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

SAMPLE NUMBER	SOIL VAPOUR (ppm)	DEPTH (m)	DESCRIPTION	COMMENTS
	*	0	Dry, loose, light brown very silty fine SAND,	NVO
TPH, Metals	0 SPT 1 n=10	1.0	increasing density with depth.	
	0	2.0		
	SPT 2 n=12 0	3.0	Dry, medium dense, light brown, very silty CLAY, occasional crystals- probably gypsum ($CaSO_4$)	NVO
TPH, Metals, BTEX, PAH	0 SPT 3 n=16	4.0		
	0	5.0		
	SPT 4 n=53		Dry, very dense, grey-brown, poorly cemented fine SANDSTONE (probably gypsum cement).	NVO
	0	6.0	Dry, very dense, clayey silty, fine to medium SAND, occasional small sandstone nodules and crystals - probably gypsum.	NVO
	0 SPT 5 n=>50	7.0		
			Slightly moist, very dense, brown, silty fine to medium SAND, occasional shell fragments.	NVO
	0	8.0		
	SPT 6 n=>50		Slightly moist, very dense, brown, clayey silty fine SAND, occasional grey-brown clay laminations.	Moisture at 8.5mbgl.
	0	9.0		Perched water standing at 9.1mbgl, (2 June 2001)
	0	10.0		

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	

BOREHOLE CONSTRUCTION	SAMPLE NUMBER	SAMPLE TYPE	SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	DESCRIPTION	COMMENTS
			0		10		Moist, very stiff, grey silty CLAY intercalated with very grey-brown, fine to medium, very dense sand, occasional shell fragments.	NVO
					11.0			
			0 SPT 7 n=67					
					12.0			
	TPH, Metals	☒	0		13.0		Dry, very stiff, grey silty CLAY (intact), occasional thin, fine sand laminations - intact.	NVO
					14.0			
					15.0			
			SPT 8 n=>50		16.0			
					17.0			
			SPT 9 n=>50				Dry, very stiff, grey silty CLAY (intact) with much black organic carbon nodules.	NVO
					18.0			
					19.0			
					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:	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 **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
			0*			
	TPH, Metals		0* SPT 1 n=28		1.0	
			0*		2.0	
			SPT 2 n=13 0*		3.0	
	TPH, Metals, BTEX, PAH		0* SPT 3 n=11		4.0	
			0*		5.0	
			SPT 4 n=44 0*		6.0	
			0* SPT 5 n=44		7.0	
			0*		8.0	
			SPT 6 n=>50 0*		9.0	
			0*		10.0	

DESCRIPTION	COMMENTS
Dry, loose, light brown silt.(MADE GROUND)	NVO
Dry, medium density (non-plastic), light brown, slightly fine sandy clayey SILT.	NVO
Dry, non-plastic, medium dense, brown slightly sandy, very clayey SILT.	
Dry, very dense, grey-brown, poorly cemented fine SANDSTONE (probably gypsum cement).	NVO
Dry, very stiff, light brown silty thinly laminated CLAY, some crystals - probably gypsum.	NVO
Dry, very stiff-dense, light brown very silty fine SAND.	NVO
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
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 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 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: ED	Drawn: DH	Date: 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: **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	Type	Soil Vapour (ppm)	Groundwater	DESCRIPTION	COMMENTS
10.0			0*		CLAY intact, occasional seams of shell fragments.	NVO
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	☒	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
19.0			SPT 10 n=>50	Dry	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.	

Depth scale: 10, 11.0, 12.0, 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 - 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

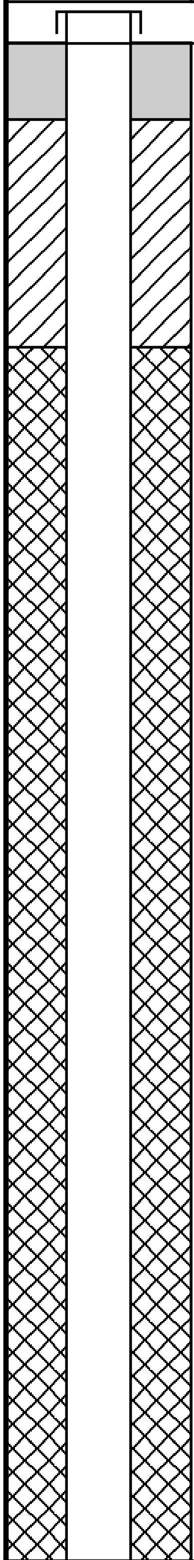
Job Title	Terrestrial Soil and Groundwater Survey
Location	SANGACHAL, AZERBAIJAN
Client	BP

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

BOREHOLE CONSTRUCTION



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	☒	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	☒	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

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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
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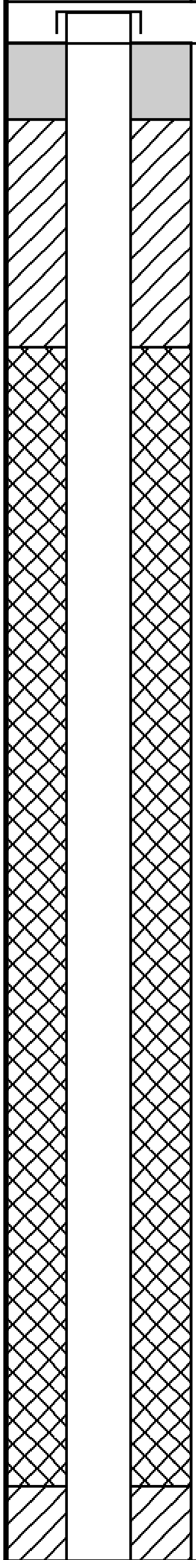
Thorburn Colquhoun

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: **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	SAMPLE TYPE	SOIL VAPOUR (ppm)	GROUNDWATER	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		
					Dry, light brown-greenish brown, silty CLAY (intact) with very fine SAND laminations,	NVO
		0		6.0		
		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

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: **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

SAMPLE NUMBER	SAMPLE TYPE	SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	DESCRIPTION	COMMENTS
		0		10		
				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.	
			Dry	14.0		
TPH, Metals	☒			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 - 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 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	

Depth (m)	Sample Number	Sample Type	Soil Vapour (ppm)	Description	Comments
0				Dry, loose, light brown fine sandy SILT.	NVO
				Dry, very stiff, light brown, slightly fine sandy, very clayey SILT,	NVO
1.0			0 SPT 1 n=24	occasional fine sand laminations, occasional gypsum in powder form.	
2.0	TPH, Metals	Disturbed Sample	0 SPT 2 n=>50	Dry, very stiff, light brown-brown, very silty CLAY, occasional gypsum in powder form and crystals.	NVO SPT Weight bouncing.
3.0			0 SPT 3 n=>50		
4.0			0 SPT 4 n=20	Dry, very stiff to hard, light brown-brown silty CLAY, occasional crystal - probably gypsum, occasional organic carbon,	NVO
5.0	TPH, Metals, BTEX, PAH	Disturbed Sample	0 SPT 5 n=>50	colour darkening with depth, occasional shell fragments,	
6.0			0 SPT 6 n=>50		
7.0			0	becoming lighter in colour.	
8.0			0 SPT 7 n=>50		
8.5				Dry, very stiff, brown to dark brown, very silty CLAY (intact), occasional shell fragments, occasional (iron oxide) staining.	NVO
9.0			0		
10.0			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: **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

SAMPLE NUMBER	SAMPLE TYPE	SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	DESCRIPTION	COMMENTS
TPH, Metals	Disturbed	SPT 8 n=>50	Dry	10.0–11.8	Dry, very stiff to hard, grey to dark grey, slightly silty CLAY (intact), some orange (iron oxide) staining, occasional shell fragments.	NVO
		SPT 9 n=>50				
				11.8	Borehole terminated at 11.8mbgl, well installed at 11.5mbgl..	

Depth scale: 10, 11.0, 12.0, 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 Sample	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 Sample	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

SAMPLE NUMBER	SAMPLE TYPE	SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	DESCRIPTION	COMMENTS
Metals	Disturbed			10.0		
				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
TPH, Metals	Disturbed		Dry	13.0	Dry, very hard, calcium carbonate EVAPORITE	NVO Dry, groundwater not encountered.
				13.5	Borehole terminated at 13.5mbgl.	

Depth scale: 10, 11.0, 12.0, 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 - 9370451.5
4450520.5

LEGEND

- Disturbed Sample
- Undisturbed Sample
- * Headspace Analysis
- † Down Borehole Analysis
- Groundwater Table
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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

TERRESTIAL SOIL AND GROUNDWATER SURVEY

SANGACHAL OIL TERMINAL,
BAKU, AZERBAIJAN

FOR

BP

URS Corporation7
St George's House, 2nd Floor
5 St George's Road
Wimbledon
London   SW19 4DR

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1 EXECUTIVE SUMMARY

1.1 Introduction

The Azerbaijan International Operating Company (AIOC), operated by BP, proposes to begin development of Phase 1 of the Full Field Development of the Azeri, Chirag and Deep Water Gunashli (ACG) contract area located at the Sangachal Terminal. The Phase 1 project will develop the central part of the Azeri reservoir, to the south east of Chirag-1 and will consist of:

- production, drilling and quarters platform (PDQ);
- bridge-linked compression and water platform (C&WP) for gas and water injection to the reservoir;
- 30” sub-sea oil pipeline from the PDQ to shore;
- potential new 30” gas line to shore, or, conversion of the existing 24” sub-sea oil pipeline from Chirag-1 to gas service;
- expansion of the Sangachal Terminal to receive the increased production and export requirements.

URS Dames & Moore was commissioned by BP to complete a baseline assessment of the soil and groundwater conditions beneath the Sangachal Terminal during May/ June 2001. Sangachal Terminal is located 1.5 km west of the Caspian shoreline approximately 40 km south of the Azerbaijan capital of Baku. Current activities at the terminal comprise the reception of oil from Early Oil Project (Chirag 1) totalling some 125,000 bpd with gas export to the local market of around 100 million standard cubic feet per day (MMscfd).

The purpose of this report is to establish the baseline soil and groundwater conditions prior to terminal expansion and upgrade of the facilities for the Phase 1 development.

1.2 Background

The Sangachal region, including the 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. 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.

In addition to the rail and road infrastructure, the area also comprises number of underground and aboveground pipelines (oil, water and gas), as well as a number of poorly abandoned exploration wells.

A previous investigation of the area conducted by Fugro in 1996 indicated the site to be underlain by low permeability estuarine clays to a depth of at least 50m. Regionally, 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.

There does not appear to be any significant groundwater body present in the immediate vicinity of the site. The regional groundwater appears to be present at significant depth (i.e. greater than 50 m below ground level) and is confined by a significant thickness of relatively impermeable clays. From the limited data available it is likely that the associated regional groundwater gradient is towards the Caspian Sea. Samples were taken from the one installed well in order to provide a general indication of the quality of near surface groundwater units in the vicinity of the site – but this is unlikely to be representative of a regional groundwater body.

1.3 Scope of Work

URS' baseline assessment comprised a site walkover and the construction of 6 soil borings, which were completed as groundwater monitoring wells (to depths of approximately 20m), the collection of soil samples from these borings and the collection of 22 surface sediment samples from a variety of locations within a 5Km radius of the site. In addition, to maximise field survey efficiencies the borings and associated samples were subjected to geotechnical testing in order to establish soil properties for construction purposes. Groundwater was detected in only one of the 6 wells installed and a groundwater sample was obtained from this well (URSBH1). The soil and groundwater samples were dispatched to the Caspian Environmental Laboratory, operated by Environment & Resource Technology Ltd.. The samples were transported to the laboratory under full chain of custody for the analysis of a range of determinands including total petroleum hydrocarbons (TPH), polyaromatic hydrocarbons (PAHs), metals total organic carbon (TOC) and particle size analysis.

1.4 Observations and Findings

During the site walkover, 3 areas were identified where visual or olfactory indications of contamination were noted. These were located in the vicinity of a former oil well where ashy soils were observed, stained sediments in a wadi to the south of the site, and ash located between the railway tracks and the coast road.

Analytical results were compared to the Dutch Intervention Values (DIV) adjusted by using site specific soil data collected as part of the baseline assessment (TOC and clay content – PSD results). Where the DIV were not available USEPA Region 9 Preliminary Remedial Goals for Industrial Soils were used as the screening criteria to assess the significance of the results. This procedure is typically referred to as a Tier 1 assessment and is consistent with standard risk assessment practice.

The soil samples obtained from the soil borings were analysed for TPH. PAHs were also analysed for in the near surface samples (less than 0.5mbgl) and metals. None of the samples from the soil borings exceeded the Tier 1 screening criteria. None of the soil samples results for TPH and PAH exceeded the Tier 1 screening criteria. For the metals analyses, barium was reported in the near surface sample from SS3 (0.5mbgl) collected from the wadi to the south of the site; elevated concentrations of copper were reported in the near surface from SS7 located between the railway and the coast road and also in the near-surface sample from SS16 near the former oil well where ashy soils were observed; iron was also reported at concentrations above the screening criteria (100,000 mg/kg) in the near surface samples at the following locations: SS7 and SS15-18 inclusive.

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 was determined. This analysis indicated that SS1, SS2, SS3 and SS4 located at or near the beach and intertidal area 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%.

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 –12 blows per 0.3 m indicating a firm consistency and an inferred cohesion value of 40-75 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/m^3.

Groundwater collected from URSBH1 was analysed for heavy metals and TPH and none of the reported values exceeded the screening criteria. A trace concentration of TPH was detected in the groundwater.

1.5 Conclusions

The principal conclusions from the baseline assessment are as follows:

- Consistent with the finding from the previous investigation, groundwater was not detected in the borings to any significant extent with the exception of a moist layer, which produced a modest amount of groundwater in one well (BHURS1).
- The results of the analysis of groundwater do not indicate a significant impact by potential pollutants. It is likely that any regional groundwater flow takes place towards the Caspian Sea although there is little direct evidence to support this;
- The soils in the vicinity of the site have been slightly impacted in localised areas as a result of past activities and most probably, earlier oil exploration and production activities. Identified contamination was not however, significant and is not considered to have resulted from AIOC activities at the EOP Sangachal terminal.;
- The geotechnical properties of the soils the upper clay unit clay had ‘n’ counts of between 10 –12 blows per 0.3m indicating a firm consistency and an inferred cohesion value of 40-75 kN/m^3. The lower clay unit had ‘n’ counts of between >50 blows per 0.3m indicating a hard consistency and an inferred cohesion value of >200 kN/m^3.

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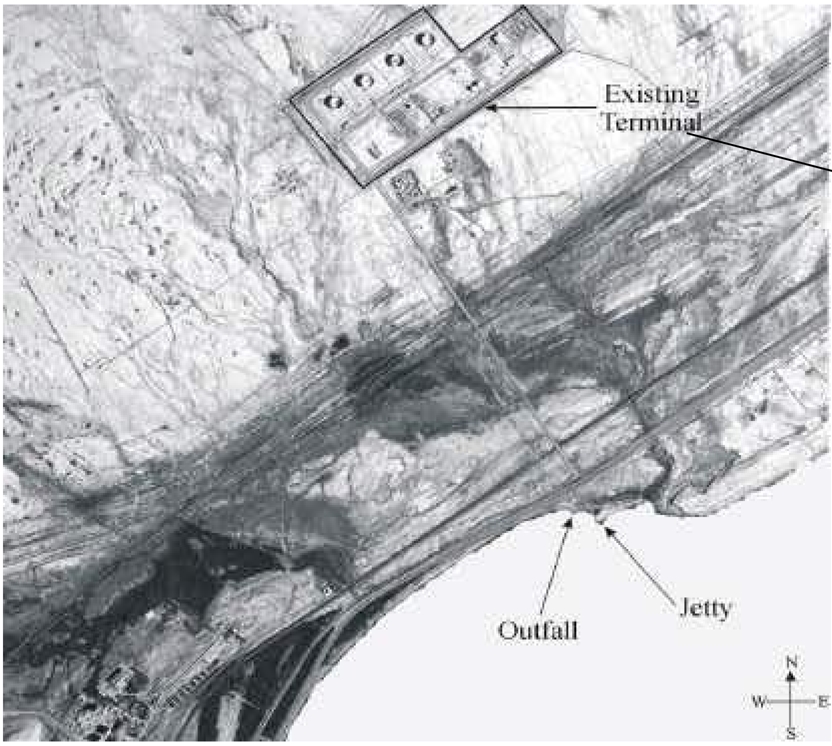
2 TERRESTIAL SOIL & GROUNDWATER SURVEY REPORT

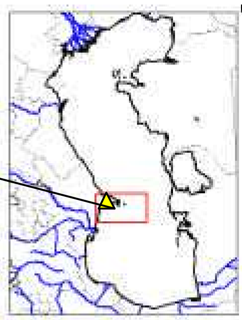
2.1 Introduction

2.1.1 Background

This report presents the findings of an intrusive environmental site assessment conducted in the area of the existing Sangachal Oil Terminal (the site) and the area of proposed expansion. The terminal is located approximately 40km south of Baku, Azerbaijan, as shown on Figure 1. URS Dames & Moore on behalf of BP, undertook the work in accordance with URS' tender submission, Proposal 8.08 - ACG FFD Phase 1 and Shah Deniz Gas Export Stage 1 Upstream Environmental and Socio-economic Impact Assessment (E-00-BPCS-23453).

Figure 1 – Location of existing Sangachal terminal





Location of Sangachal in respect to Azerbaijan and Caspian Sea.

2.2 Objectives

The primary objective of the environmental assessment was to investigate the surface sediments, subsoil and groundwater in order to assess the nature and extent of any potential contamination within a 2.5 km radius of the existing and proposed terminal developments. The findings of this study will be incorporated into the ADG and SD Environmental, Socio-Economic Impact Assessments (ESIAs) as baseline data.

In addition, as part of the technology transfer element of the ESIA projects, URS Dames & Moore trained three local consultants in site investigation and sampling procedures.

2.3 Background

Fugro Environmental Limited conducted an intrusive investigation in 1996, prior to construction of the Early Oil Project (EOP) terminal. These results indicated that the facility is underlain by a series of recent marine low permeability clays, to a depth of at least 50 metres. Laboratory analysis of soil samples indicated concentrations of TPH at <300mg/kg. Groundwater was not encountered during this previous survey although, historic hydrogeological maps of the area indicate the groundwater table to be between 10 and 20m around the terminal site. The estimated direction of groundwater flow was reportedly towards the sea.

An intrusive investigation was recommended to allow for a further evaluation of the potential environmental liabilities and also to determine the hydro-geological setting of the site.

2.4 Structure of Report

The report is presented in the following sections:

- Section 2 describes the scope of works for the site investigation and environmental assessment;
- Section 3 describes the site's environmental setting, including the geological and hydrogeological regime. These have been assessed to provide a review of potential contaminant migration pathways and receptors at the site;
- Section 4 discusses the results of the chemical analysis of the soil and groundwater samples. A review of current relevant soil and groundwater quality criteria is also included in this section, and the analytical results are compared to these criteria to access the significance of the results; and
- Section 5 discusses the conclusions of the investigation.

3 SCOPE OF WORKS

3.1 Preamble

The scope of work developed to meet the objectives of the investigation described in Section 1.2 was divided into the following tasks:

- Task 1: Field Investigation;
- Task 2: Laboratory Analysis;
- Task 3: Tier 1 Qualitative Risk Assessment; and
- Task 4: Data Assessment and Reporting.

The activities undertaken by URS Dames & Moore to accomplish these tasks are detailed in the following sections.

3.2 Task 1: Field Investigation

The field investigation was conducted at the site between 26th May 2001 and 02 June 2001. Site works were conducted and managed by Mr Ed Dennis of URS Dames & Moore in the company of Mr Kevin Richardson of BP, a site engineer from GIBB, Mr Gamlet Mailov of the Geological Committee and Mr. Rovshan Seidbalayev of ASPI.

3.2.1 Drilling of Boreholes

Six boreholes, BHURS1 to BHURS6, were drilled to a maximum depth of 20m below ground level (mbgl) to gain an understanding of the subsurface stratigraphy.

Sampling locations were selected based in relation to the proposed terminal boundaries and to target areas of potential contamination (identified during the initial site walkover) in order to provide characterisation of any potential contaminants present and to provide site coverage. The location of each borehole is shown in Figure 2.

Prior to drilling the investigation locations were checked for underground services using available site plans and discussions with on-site personnel. Where necessary an inspection pit was hand dug to a depth of at least one metre below ground level to further check for underground services and the boreholes were drilled within the inspection pits.

The boreholes were drilled by Tekar, a local drilling contractor, using a continuous flight auger drilling (CFA) rig. This track-mounted diesel-powered rig was used to advance a 200mm external diameter steel auger by rotating to the required depth below ground level. The auger comprises a flighted solid central rod, which displaces the soil by the action of rotation. Disturbed soil samples were brought to the surface by the rotating action of the auger. On completion of drilling, the auger was removed from the hole, allowing the installation of monitoring wells as required.

All downhole boring and drilling equipment was carefully washed prior to and between drilling each borehole using mains potable quality water. No oils, grease or similar type lubricants were used on boring or drilling tools or casing.

3.2.2 Soil Logging & Monitoring

Soils at each borehole location were logged in accordance with BS539, the British Standard for soil descriptions by a qualified geologist from URS Dames & Moore. The borehole logs are provided as Appendix A and provide a detailed record of site observations and all field measurements. During the site works the drilling returns were monitored for ionisable volatile organic compounds (VOCs) as follows:

- Soil samples were taken from the flight auger using a pre-cleaned stainless steel spatula and placed directly into plastic bag which was then sealed; and
- After five minutes a headspace reading was taken using a Photo Ionisation Detector (PID), the results of which were noted on the borehole logs (Appendix A).

3.2.3 Geotechnical Testing

In-situ standard penetration tests (SPTs) were conducted in five of the six boreholes in order to determine the consistency and cohesive nature of the sub soils. Using the CFA drilling rig, a standard split barrel sampler was driven 0.30m into the ground using a hammer. The number of blows 'n' indicated an approximation of the strength of the soils. SPTs were conducted approximately every half metre and at lithological changes and were recorded on the borehole logs (Appendix A).

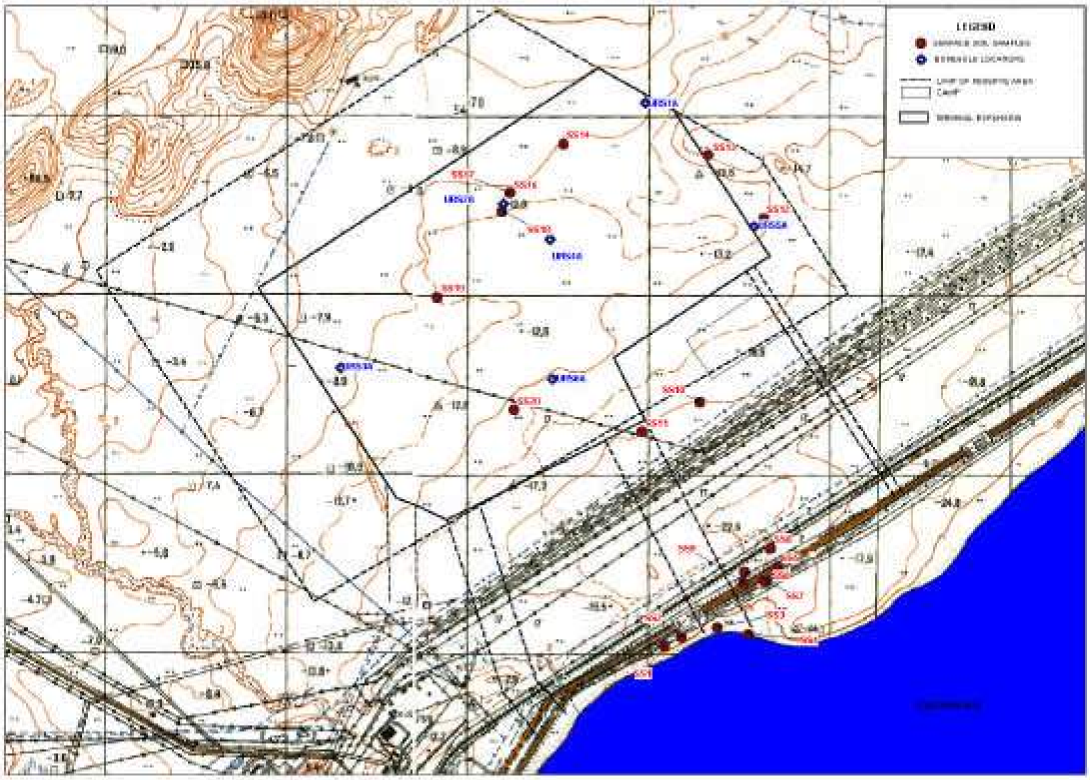
3.2.4 Surface Sediment Sampling Locations

Twenty surface sediment samples were collected within the proposed terminal boundary after a brief walkover of the area. The survey was designed to give broad coverage and to focus on potential areas of concern. The investigation locations are shown in Figure 2 and described in the Table 1 below.

Table 1 – Surface soil sample inventory

Sample ID	Easting	Northing	Comments
SS1_0.05	9371078	4451050	Beach
SS2_0.05	9371171	4451094	Beach
SS3_0.05	9371370	4451151	Beach
SS4_0.05	9371545	4451110	Intertidal Zone
SS5_0.05	9371706	4451487	Wadi
SS6_0.03	9371666	4451589	Wadi- 100m N of SS5 (black staining), beneath Railway Crossing
SS7_0.03	9371522	4451459	150m W of SS6 between coast road and railway - dark grey silty ash
SS8_0.05	9371636	4451407	300m N of Railway, 500m of Terminal road
SS9_0.05	9371520	4451401	West of SS8, adjacent to Terminal Road
SS10_0.05	9371276	4452404	1km N railway, 1km E of Terminal road
SS11_0.05	9370954	4452240	Adjacent to Terminal Road 1km N railway
SS12_0.05	9371628	4453431	100m E BHURS5
SS13_0.05	9371322	4453783	300m N of Terminal bund - in-line with cracking tower
SS14_0.05	9370518	4453843	480m ESE of BHURS2
SS15_0.05	9370221	4453572	Ashy silt 50m NE BHURS2
SS16_0.05	9370221	4453572	Ashy silt 50m NE BHURS2 **(DUPLICATE OF SS15)**
SS17_0.25	9370221	4453572	Ashy silt 50m NE BHURS2 - **0.25m depth**
SS18_0.05	9370175	4453468	Ashy silt 50m SW BHURS2
SS19_0.05	9369815	4452990	700m WSW BHURS2 en route BHURS3
SS20_0.05	9370241	4452363	600m S SS19 level with SW corner Terminal bund

Figure 2 – Sampling and Drilling Locations



3.2.5 Soil & Sediment Sampling

Soil samples from the boreholes and surface sediments were collected for detailed laboratory analysis. All samples were taken using a pre-cleaned stainless steel spatula directly from the surface of the steel hand auger or steel flight auger. All samples were collected in accordance with URS Dames & Moore's Field protocols (based on US EPA) protocols as follows:

- samples were placed directly into pre-cleaned glass vessels with teflon-lined screw-top lids;
- surgical-type gloves were worn for sampling and a fresh pair was used for each sample to minimise cross-contamination of samples;
- sample jars were labelled with a unique sample code which was also included on a Chain of Custody Form in triplicate;
- samples were stored on-site in cooler boxes containing ice packs and were transferred to a refrigerator at 3 - 4°C at the end of each field sampling day;
- samples were finally transferred under Chain of Custody protocols (with custody seals in cool boxes containing ice packs) by carrier to the sub-contractor laboratory.

3.2.6 Monitoring Well Installation

To facilitate the sampling of the groundwater, monitoring wells were installed in each of the six boreholes. The following monitoring well materials were used:

- slotted well screen - 50 mm ID PVC, screw fitting
  slot size 1 mm
  geowrap
- solid well screen - 50 mm ID PVC, screw fitting
- bottom caps - PVC screwcap
- top cap - polypropylene push on cap
- filter pack - 1 to 2 mm rounded graded granular material
- bentonite seal - compactonite (activated bentonite) pellets
- cement grout - cement/sand mix
- protective metal cover with locking screw

Each monitoring well was installed with a slotted casing length forming a screened section. From the top of the screened section, solid casing was installed to ground level. A filter pack was placed around the screen above which a bentonite seal (of at least 0.5 m thickness) was placed up to ground surface. At ground surface the annulus was sealed with cement grout, which was used to secure a protective cover.

3.2.7 Groundwater Sampling

Groundwater samples were collected for detailed laboratory analysis from one well installed by URS in the terminal area, in accordance with URS Dames & Moore's field protocols (based on US EPA) as follows;

- The borehole lid and cap was removed and any observations of odour or organic vapour were made;
- The diameter of the standpipe was recorded in mm. The depth to groundwater relative to the ground surface and the total depth of the well was recorded using a dip meter;
- The volume of the water in the well was calculated from the water column height and stand pipe diameter ($\Pi r^2 h$);
- The newly installed wells were 'developed' in order to settle the gravel pack and cleanse the water bearing strata in the immediate vicinity (of the borehole of debris resulting from the drilling process). Well development was undertaken using disposal bailers, with one bailer dedicated to each well. The bailer was lowered to the full depth of the borehole to allow sorting of the sand pack and removal of fines. Groundwater was removed from each well until it was sediment free and field parameters such as pH had stabilised. Upon completion of development,, the wells were left several days prior to purging and sampling;
- Standing water in the well was 'purged' by removing a minimum of three well volumes using dedicated bailers. This ensured that the groundwater sample collected was representative of the aquifer and was not a 'stagnant' sample;
- All groundwater samples were collected using a dedicated disposable bailer. The bailer was lowered gently into the water column and allowed to fill before being gently raised to the surface. Excessive disturbance of the of the groundwater during sample recovery and transfer to the laboratory bottles was avoided in order to preserve sample integrity;
- samples were placed directly into pre-cleaned glass vessels with teflon-lined screw-top lids;
- surgical-type gloves were worn for sampling and a fresh pair was used for each sample to minimise cross-contamination of samples;
- sample jars were labelled with a unique sample code which was also included on a Chain of Custody Form in triplicate;
- samples were stored on-site in cooler boxes containing ice packs and were transferred to a refrigerator at 3 - 4°C at the end of each field sampling day; and

- samples were finally transferred under Chain of Custody protocols and with custody seals in cool boxes containing ice packs by carrier to the sub-contractor laboratory.

3.3 Task 3: Chemical Analysis

Soil, surface sediment and groundwater samples were dispatched to the Caspian Environment & Resource Technology Environmental Laboratory for analysis of the following analytes:

- Metals (arsenic, barium, cadmium, chromium, copper, lead, iron, mercury and zinc);
- Total Petroleum Hydrocarbons (TPH) – PAH analysis was undertaken on the near surface soil samples from soil borings;
- Total Organic Carbon (TOC) (soils and surface sediments),
- Particle Size Distribution (surface sediments); and
- Salinity (groundwater).

The range of analyses performed on the samples is presented in Table 1. The results of the analyses are presented in Appendix B.

3.4 Task 4: Risk Assessment

A qualitative risk assessment was undertaken at the site forming the first tier of the two-tiered approach to data interpretation in line with the generally accepted risk assessment practice. This risk assessment phase was qualitative, comprising;

- identification of pollutant linkages present at the site and development of a conceptual site model (CSM); and
- a comparison of detected chemical concentrations with suitable generic criteria, where published.

This qualitative evaluation was automatically undertaken upon completion of the site investigation works and allowed conclusions to be reached regarding the need for, and extent of, a quantitative risk assessment.

3.5 Task 5: Reporting and Presentation

This report will include the site investigation results and observations, the analytical results and the lithological records from the soil borings. The risk assessment methodology and are also included.

4 ENVIRONMENTAL SETTING

4.1 Site Location & Description

Sangachal Terminal is located 1.5 km west of the Caspian shoreline approximately 40 km south of the Azerbaijan capital of Baku as shown in Figure 1. Development of the area immediately around the terminal site is limited and comprises railway lines and the main Baku – Alyaty highway. In addition, approximately six poorly abandoned Soviet exploration wells exist to the north and northwest of the terminal area, the closest being 600 m from the terminal boundary.

A number of utility lines and pipelines are also routed along the coast parallel to the highway and railway line as follows:

- Communication – 6
- Gas pipelines – 6
- Oil pipelines – 2
- Condensate pipeline – 1
- Water pipelines – 6
- Overhead high-voltage lines – 5
- Unidentified lines - 3

4.2 Previous Site Investigations

URS Dames & Moore has reviewed the following reports of works conducted at the proposed Sangachal Terminal:

- Environmental Assessment - Sangachal Terminal and Waste Disposal Facilities Chirag 1 Early Oil Development Project Report No. K-2435/031, Fugro Engineering B.V.

4.3 Site Topography

The Sangachal region, including the 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. 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.

4.4 Site conditions

The regional geology is typical of a marine environment with a substantial thickness of marine clays near surface. The subsurface conditions encountered during the site investigation are summarised below:

- Loose silty surface cover with limited vegetation
- Limited Made Ground;
- A stiff clayey-silty sequence; and
- Further stiff to hard marine clays.

4.4.1 Surface Cover

Limited vegetation was noted during the site investigation and the surface soils generally comprised dry, loose, light brown silts and or fine silty sands with limited organic content. These soils have been formed in desert climate conditions with accompanying 150 mm of winter precipitation and high summer temperatures, leading to a high rate of disintegration of organic matter.

Twenty surface sediment samples were collected as shown in Figure 2. The samples indicated that the sediments ranged from beach sands and clays to fine silts.

4.4.2 Made Ground

Made ground (i.e. imported fill material) was generally absent across the site and was encountered only in one borehole, BHURS1, located in the vicinity of a former oil well. This borehole is located to the northwest of the existing terminal. The made ground was encountered to a depth of 0.6 mbgl and comprised dry, loose brown silt.

4.4.3 Geology

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 13mbgl. 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.

The maximum depth drilled during this investigation was 20 mbgl in BHURS1. The base of the Clay units was thus not proven in any of the locations. Detailed descriptions of the geology encountered are provided in the borehole logs (Appendix A).

4.4.4 Site Geotechnical Properties

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 –12 blows per 0.3m indicating a firm consistency and an inferred cohesion value of 40-75 kN/m^3. The lower clay unit had ‘n’ counts of between >50 blows per 0.3m indicating a hard consistency and an inferred cohesion value of >200 kN/m^3. Full field results are presented on the borehole logs (Appendix A).

4.5 Site Hydrology and Hydrogeology

The nearest surface water feature to the site is the Caspian Sea, located 1.5 km to the east of the proposed Sangachal Terminal. Seasonal wadies are located to the north and south of the investigation area and were dry at the time of the site investigation.
No groundwater was encountered in the boreholes during drilling. However, a slightly moist, clayey/silty fine sand unit was encountered at 8.5 m below ground level in borehole BHURS1.

During the sampling event groundwater was encountered in BHURS1 suggesting low permeability with slow ingress of water. Groundwater recovery was recorded as low to moderate, which indicates that the unit is not significantly transmissive or productive. The remaining five boreholes were dry and the presence of groundwater in only one of the wells suggests that any groundwater present near surface beneath the site is not extensive and does not present any significant potential with respect to groundwater resources. The groundwater does not therefore represent a significant pathway by which contaminants may be transported below surface.

Although limited groundwater elevation data was available a general groundwater gradient across the site towards the Caspian Sea may be inferred, broadly similar to the site topography.

4.6 Potential Contaminant Migration Pathways

The principal potential contaminant migration pathways that should be considered given the surrounding land use and the underlying geology are as follows:

- Migration of hydrocarbon or solvent vapours in the unsaturated zone;
- Dust migration from exposed shallow soil during construction;
- Contaminated surface water runoff during storm events into the natural drainage system and the Caspian Sea. The wadies and their surrounds provide a low resistance pathway for the migration of contaminants across the site and ultimately off site; and
- Lateral migration of contamination, above the stiff clays flowing within any permeable Made Ground, or sandy deposits.

4.7 Potential Receptors

The potential on-site receptors that may be exposed to contamination arising from the site via the pathways described in Section 3.6 are:

- Shallow perched groundwater in the more permeable deposits
- On-site workers, especially during intrusive site works.

The potential off-site receptors that may be exposed to contamination arising from the site are:

- The Caspian Sea, via potential discharge from the wadies;
- Off-site workers in neighbouring sites, for example shepherds and fishermen; and
- Ecological receptors.

5 ASSESSMENT OF SOIL AND GROUNDWATER CONTAMINATION

5.1 Introduction

This section describes the results of laboratory analyses of soil, surface sediment and groundwater samples and includes a discussion of field observations. The discussion is structured as follows:

- a discussion of the soil and water assessment criteria, including the legislative background;
- field observations recorded during drilling and groundwater sampling;
- description of the analytical results; and
- a discussion of the results in terms of the assessed extent of contamination and its likely impact on receptors.

5.2 Criteria for Assessment of Soil and Groundwater Contamination

The following section presents a review of the relevant environmental standards and guidelines used for this assessment in order to provide a context for discussion of the results and to enable their significance in terms of potential environmental liability to be evaluated. The assessment criteria have been used to screen soil and groundwater quality results to enable identification of the general condition of the soil and groundwater.

5.2.1 Legislative Background

There is no current soil and groundwater legislation in Azerbaijan, which provides guidance on the risk assessment of soil and groundwater contamination. In the absence of any locally applicable standards, the analytical results of the soil and groundwater baseline assessment have been compared to internationally accepted screening standards. The standards used in this assessment are Dutch Intervention Values (DIV), which have been adjusted in accordance with standard practice for total organic content and clay content of the local soil types encountered. Where a DIV is not available for a particular compound, the USEPA Region 9 reference value for industrial soils has been used.

The DIV were developed in the Netherlands to protect the multi-functionality of soils and are themselves divided into "intervention values" and "target values". For soils, the former are based on human toxicological and ecotoxicological considerations and their exceedence triggers a need for clean up in the Netherlands when applied appropriately, with the *urgency* of remediation being based on a site-specific risk assessment. For groundwater, intervention values are typically based on the soil values and appropriate partitioning relationships. The target value is the ideal clean-up level for soil and groundwater in the Netherlands, although this is typically decided on a case-by-case basis. It is important to note that the DIV have no legal status in Azerbaijan although the application of these criteria for such a purpose is an internationally accepted practice.

5.2.2 Initial Site Assessment Criteria

In line with internationally accepted best practice, a tiered approach to the assessment of contamination has been adopted. In this context an initial tier (Tier 1) risk-based approach has been used to assess the detected levels of soil and groundwater contamination at the proposed Sangachal Terminal Site. The Tier 1 assessment is of a simple nature and has involved the comparison of measured chemical concentrations with the criteria mentioned

above which are considered to be protective of human health and the environment at, and near to, the site.
In accordance with internationally accepted practice, a source-pathway-target approach has been used to assess the potential for a significant risk of significant harm, or, of pollution of surface and groundwaters to exist. The receptors for assessment in regard to significant harm are humans, sensitive ecological receptors and property (including livestock and buildings).

Except for a modest showing in one boring, groundwater was not encountered during the current investigation which suggests therefore that groundwater is not present in significant quantities near surface and therefore has not been subject to analytical assessment other than an assessment of salinity for potential potability assessment. However, it should be noted that this groundwater unit would not produce a sustainable yield for supply purposes.

5.3 Field Observations

The following visual and olfactory observations were made during the site investigation:

- 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. This odour was considered to be a natural odour rather than an indication of potential contamination.

No further evidence of visual or olfactory contamination was noted during the investigation.

5.4 Soil, Surface Sediment and Groundwater Analytical Results

5.4.1 Introduction

The following sections describe the analytical results obtained for the soil, surface sediment and groundwater samples collected during the site investigation. The laboratory test certificates for the investigation are presented in Appendix B. Analytical tests performed are shown in Table 1 and are summarised below:

- Soil Analysis:
  - Total Petroleum Hydrocarbons (TPH) 18 No. samples
  - PAHs where elevated concentrations of TPH were reported 6 No. samples
  - Metals 18 No. samples
- Surface Sediment Analysis:
  - Total Petroleum Hydrocarbons (TPH) 20 No. samples
  - Metals 20 No. samples
  - Total Organic Carbon (TOC) 20 No. samples
  - Carbonate Content 20 No. samples
  - Particle Size Distribution 20 No. samples
- Groundwater Analysis: (samples include duplicate and blank)
  - Total Petroleum Hydrocarbons (TPH) 3 No. samples
  - Metals 3 No. samples
  - Salinity 3 No. samples

5.4.2 Soil Analysis

The results of the analyses performed on soils collected from the soil borings are presented below:

Metals

A total of 18 soil samples were analysed for Arsenic, Barium, Cadmium, Chromium, Copper, Iron, Lead, Mercury, and Zinc. No cadmium was detected and only trace concentrations of the remaining metals were detected with 0 exceedances of their relevant Tier I criteria.

TPH

Trace concentrations of TPH were detected in the eighteen soil samples. The maximum concentration was detected in BHURS1 at 13 m. No TPH concentrations were detected that exceeded the relevant Tier 1 criteria.

PAHs

Although TPH was not detected in any significant concentration, PAHs were analysed in all six of the near surface soil samples collected from the borings. None of the analytical results for PAHs exceeded the relevant Tier 1 criteria.

5.4.3 Surface Soil/Sediment Analysis

The results of the analyses performed on soils collected from surface locations including the beach, wadi systems and other areas of surface staining are presented below:

Metals

A total of 20 surface sediment samples were analysed for Arsenic, Barium, Cadmium, Chromium, Copper, Iron, Lead, Mercury, and Zinc. Trace concentrations of arsenic, barium, chromium, copper, iron, lead and zinc were detected.

An elevated barium concentration of 1,519.20 mg/kg was detected in SS3 at 0.05mbgl located near the mouth of the wadi on the beach. Barium is a constituent of drilling muds and the high concentration may indicate historic contamination.

Elevated concentrations of copper (578.2 mg/kg) and iron (328.45 mg/kg) were detected in SS7 at 0.03mbgl, 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. During sampling it was noted that these sediment samples comprised ashy silts that may relate to a former fire in the vicinity of the former oil well.

Total Petroleum Hydrocarbons (TPH)

During the investigation a total of 20 surface sediment samples were analysed for TPH. Trace concentrations were detected in each sample but the adjusted DIV of 5000mg/kg was not exceeded in any of the samples. The maximum concentrations were detected in SS15 at 0.05 mbgl, SS16 at 0.05 mbgl, and SS17 at 0.25 mbgl at concentrations of 338 mg/kg, 363 mg/kg and 358 mg/kg respectively.

Carbonate Content

The maximum carbonate content of 75.99 % was encountered in SS4 located in the intertidal zone. High percentage concentrations were encountered in SS1, SS2 and SS3, which comprised beach sands. In general a carbonate content of less than 50% was encountered in the silty sands of the remaining surface samples.

Organic Content

A maximum organic content of 6.18% was encountered in SS17, which comprised ashy silt. In general organic content of the samples was below 3%.

Particle Size Distribution

Particle size analysis indicated that the surface samples collected at the beach and intertidal zone, SS1, SS2, SS3 and SS4, comprised well sorted fine to medium sands. The remaining samples comprised moderate to poorly sorted fine to medium silts.

5.4.4 Groundwater Analysis

The presence of groundwater in the 6 wells was monitored during the period of the site works. At the time of sampling, five days after installation, groundwater was encountered only in BHURS1; the remaining boreholes were found to be dry. A duplicate sample and a blank sample disguised as BHOFFSITE and BHONSITE respectively, for QA purposes was also collected from BHURS1. The absence of groundwater in the area of the site was also reported in the previous investigation of the site.

Metals

Trace concentrations of copper, iron, lead and zinc below their respective Tier 1 guidelines were detected in BHURS1. No metals were detected above the method detection limit in the groundwater sample from BHURS1.

Total Petroleum Hydrocarbons (TPH)

Trace concentrations of TPH were detected in two of the three groundwater samples. However, in BHURS1 a maximum concentration of 68.6 μg/l was detected in BHURS1, which is below the relevant assessment criteria of 120 μg/l

Salinity

The salinity analysis results indicate that the three groundwater samples contain greater than 10% total dissolved solids (TDS) and are thus saline.

6 CONCLUSIONS

The principal findings of this baseline assessment are as follows:

- there is no significant groundwater bearing unit within 20 m of the surface beneath the site

- the analyses of soil samples collected from the site do not indicate that there has been a significant impact to soils at the site with respect to activities taking place there;

- the surface sediment samples collected from the vicinity of the site do not show any significant impacts with respect to the activities taking place at the site. However, slight impacts appear to have occurred as a result of former drilling operations and potentially a fire assumed to have taken place near the former oil well;

- the geotechnical properties of the soils beneath the site indicate that the upper clay unit clay had ‘n’ counts of between 10 –12 blows per 0.3m indicating a firm consistency and an inferred cohesion value of 40-75 kN/m^3. The lower clay unit had ‘n’ counts of between >50 blows per 0.3m indicating a hard consistency and an inferred cohesion value of >200 kN/m^3. Full field results are presented on the borehole logs (Appendix A).

7 Limitations of Report

URS Dames & Moore has prepared this report in accordance with generally accepted consulting practices and for the intended purposes as stated in the related contract agreement. No other warranty, expressed or implied, is made as to the professional advice in this report.

The accuracy of the interpretation and conclusions drawn in the report is partly dependent upon the accuracy and reliability of information drawn together from a number of sources. Only limited attempts have been made to independently verify information supplied by others. Field investigations carried out by URS Dames & Moore have been restricted to a level of detail appropriate to the study. It is important therefore that these limitations be clearly recognised when the findings of this study are being interpreted.

The qualitative risk assessment has been carried out using currently available site investigation data, and standard assumptions applicable to the site. Should additional site investigation be undertaken, it may be necessary to revise the risk assessment.

To the best of our knowledge information contained in this report is accurate at the time of issue. Subsurface conditions, including groundwater levels and contaminant concentrations may vary spatially with time. This should be borne in mind if the report is used without further confirmatory testing after a significant delay.

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Appendix A

BOREHOLE LOGS

Appendix B

ANALYTICAL RESULTS

Subject: Trace metal analysis **Analysis Reference:** 1612

8 Overview

Soil and ground water samples were analysed for:

- Arsenic
- Barium
- Iron
- Cadmium
- Chromium
- Zinc
- Copper
- Lead
- Mercury

9 Analytical methods

Pre-weighed samples were digested in nitric acid in a Teflon flask using a "Mars-5" microwave digester. Analysis of the acid extracts for mercury concentrations was completed by cold vapour atomic fluorescence, for arsenic by hydride generator spectroscopy, barium, cadmium, chromium, copper, iron, lead, zinc by atomic absorption spectrometry (AAS).

10 Results

1.1 Trace metal analysis

Sample ID	Concentration expressed as ugg^{-1}								
	Arsenic	**Barium**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Mercury**	**Zinc**
BHURS 1-1.0	8.7	320.9	<2.5	41.4	22.3	24,143	19.7	0.03	53.8
BHURS 1-4.0	17.7	290.6	<2.5	47.6	26.6	26,179	11.8	0.08	68.8
BHURS 1-13.0	24.6	431.0	<2.5	44.4	40.1	29,389	17.7	0.03	73.3
BHURS 1-13.0	16.8	347.5	<2.5	62.4	42.3	35,825	27.2	0.04	93.4
BHURS 2-4.0	19.0	325.8	<2.5	58.5	36.5	33,064	20.0	0.05	86.7
BHURS 2-15.0	13.3	252.5	<2.5	64.0	36.4	38,375	26.9	0.04	90.5
BHURS 3-4.0	9.8	287.5	<2.5	56.2	38.4	32,750	19.8	0.02	87.2
BHURS 3-10.5	11.6	257.5	<2.5	74.9	49.0	44,075	25.0	0.06	99.4
BHURS 3-14.5	10.2	260.0	<2.5	75.2	48.8	33,975	20.8	0.04	98.7
BHURS 4-2.0	14.0	264.3	<2.5	50.0	31.6	30,467	18.8	0.05	77.5
BHURS 4-8.0	10.9	311.2	<2.5	61.5	54.4	32,059	25.8	0.04	97.6
BHURS 4-15.0	13.0	311.1	<2.5	59.0	48.5	36,545	22.1	0.04	86.7
BHURS 5-2.0	10.3	205.0	<2.5	48.7	35.4	28,175	21.8	0.04	76.1
BHURS 5-5.0	11.8	210.0	<2.5	57.9	42.5	34,775	18.6	0.05	87.6
BHURS 5-10.5	10.7	213.2	<2.5	63.3	41.2	32,549	20.3	0.04	89.5
BHURS 6-3.0	11.8	317.5	<2.5	62.4	47.1	36,750	29.4	0.02	104.4
BHURS 6-10.0	10.3	335.0	<2.5	56.5	34.0	44,175	21.0	0.02	81.8
BHURS 6-13.5	5.8	37.7	<2.5	8.8	7.8	7,479	1.9	0.01	14.8
SS 1-0.05	25.3	603.4	<2.5	14.6	11.9	8,053	17.2	0.00	19.0
SS 2-0.05	20.1	575.0	<2.5	13.6	11.9	7,763	17.3	0.01	18.8
SS 3-0.05	19.4	1,519.2	<2.5	15.1	12.5	8,123	33.6	0.01	20.1
SS 4-0.05	15.9	466.7	<2.5	14.3	12.1	6,992	22.5	0.01	18.2
SS 5-0.05	9.7	257.5	<2.5	29.7	21.0	17,250	17.8	0.02	50.9
SS 6-0.05	12.6	301.4	<2.5	60.4	43.6	34,412	25.2	0.04	95.6
SS 7-0.03	12.5	30.0	<2.5	13.8	578.2	328,450	17.4	0.03	141.0
SS 8-0.05	11.2	335.7	<2.5	68.5	44.4	34,314	34.6	0.05	105.4
SS 9-0.02	13.4	338.8	<2.5	60.4	41.2	29,279	17.0	0.03	99.1
SS 10-0.05	12.0	286.7	<2.5	59.6	41.9	34,461	21.0	0.05	92.6
SS 11-0.05	9.3	262.5	<2.5	48.8	31.6	27,125	24.8	0.03	68.3
SS 12-0.05	18.4	386.7	<2.5	48.2	32.0	29,352	20.8	0.04	67.9
SS 13-0.05	15.2	367.5	<2.5	46.2	30.8	27,625	34.7	0.03	69.3
SS 14-0.05	16.4	312.5	<2.5	55.2	35.6	31,775	23.7	0.07	80.2
SS 15-0.05	8.8	130.0	<2.5	25.1	186.2	158,950	21.3	0.06	139.8
SS 16-0.05	10.9	143.5	<2.5	24.7	202.5	154,117	26.5	0.05	141.0
SS 17-0.05	5.8	115.0	<2.5	29.4	136.9	150,075	17.3	0.04	126.5
SS 18-0.05	10.9	382.4	<2.5	43.9	125.5	117,107	26.2	0.05	139.5
SS 19-0.05	13.9	352.5	<2.5	54.6	39.3	34,575	20.0	0.04	88.9
SS 20-0.05	11.9	311.2	<2.5	61.3	44.5	33,235	21.4	0.02	99.2

Subject: Particle Size Analysis **Analysis Reference:** 1612

11 Overview

Soil samples from the Sangachal Terminal Area as part of the ACG Phase 1/Shah Deniz Stage 1 ESIA.

Origin of samples shown in Table 1.

Table 1 Sample ID and description

Sample ID	Sample Depth (m)	Date Sampled
SS 1	0.05	02.06.01
SS 2	0.05	02.06.01
SS 3	0.05	02.06.01
SS 4	0.05	02.06.01
SS 5	0.05	02.06.01
SS 6	0.03	02.06.01
SS 7	0.03	02.06.01
SS 8	0.05	02.06.01
SS 9	0.05	02.06.01
SS 10	0.05	02.06.01
SS 11	0.05	02.06.01
SS 12	0.05	02.06.01
SS 13	0.05	02.06.01
SS 14	0.05	02.06.01
SS 15	0.05	02.06.01
SS 16	0.05	02.06.01
SS 17	0.25	02.06.01
SS 18	0.05	02.06.01
SS 19	0.05	02.06.01
SS 20	0.05	02.06.01

12 Analytical methods

Particle Size Distribution Analysis - undertaken on oven-dried soil. The analysis is divided into two stages:

- Sieve analysis of the sand fraction (all the material retained by a 63 um sieve)
- Pipette analysis of the silt/clay fraction (all the material passing through a 63 um sieve) to determine the percentage of silt (63-3.9 um) and clay (<3.9 um) in each sample. This analysis is carried out if the silt/clay constitutes 5% or more of the total weight of the sample

Carbonate & Organic analysis - the carbonates present in the soil samples are removed by treatment with hydrochloric acid, after this procedure the amount of organic matter present is determined by ashing the sample at 600^0 C. The proportion of carbonate and organics present are determined gravimetrically.

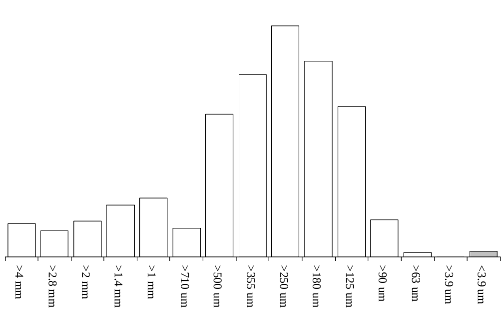
13 Results

13.1 Particle Size analysis result

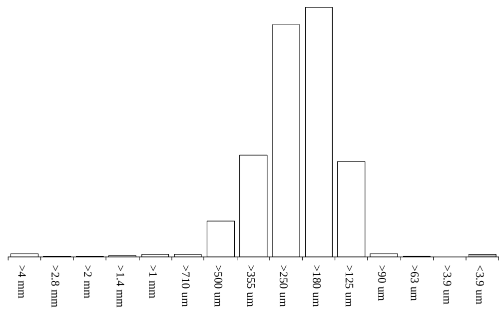
Station Number	Mean diameter	Carbonate	Organic	Silt/Clay	Silt	Clay	Mean diameter	Standard deviation	Skewness	Wentworth scale	Sorting index
	Xµm	%	%	%	%	%	X f	S f	Skq f		
SS1	263	71.10	0.34	0.36	0.02	0.34	1.92	0.74	1.31	Medium sand	Very good
SS2	293	69.19	0.68	0.34	0.02	0.32	1.77	1.30	-1.48	Medium sand	Good
SS3	236	64.73	0.92	0.60	0.07	0.53	2.09	0.84	1.42	Fine sand	Very good
SS4	401	75.99	0.56	0.49	0.03	0.46	1.32	1.40	-0.18	Medium sand	Good
SS5	29	44.83	2.53	52.69	28.16	24.53	5.10	2.42	0.08	Medium silt	Poor
SS6	8	23.35	4.92	83.63	25.18	58.45	7.02	1.96	-0.99	Very fine silt	Moderate
SS7	30	23.24	0.01	64.79	58.15	6.64	5.08	1.74	-0.24	Medium silt	Moderate
SS8	6	28.70	5.57	96.58	35.00	61.58	7.38	1.67	-2.13	Very fine silt	Moderate
SS9	18	30.49	4.12	91.02	88.79	2.22	5.78	1.01	-2.43	Medium silt	Good
SS10	11	26.53	3.95	83.16	36.57	46.59	6.48	2.38	-1.08	Fine silt	Poor
SS11	11	31.33	4.17	85.15	44.66	40.49	6.57	1.92	-0.84	Fine silt	Moderate
SS12	30	32.34	3.21	60.98	29.23	31.75	5.04	3.28	-0.74	Medium silt	Extremely poor
SS13	17	26.86	3.37	71.97	42.29	29.68	5.86	2.22	-0.53	Medium silt	Poor
SS14	10	21.74	3.44	91.42	57.87	33.55	6.61	1.53	-0.33	Fine silt	Moderate
SS15	19	46.21	2.70	77.15	62.41	14.74	5.75	1.62	-0.29	Medium silt	Moderate
SS16	18	45.27	2.79	77.61	61.85	15.76	5.79	1.63	-0.27	Medium silt	Moderate
SS17	15	31.63	6.18	79.94	55.60	24.35	6.07	1.73	-0.22	Fine silt	Moderate
SS18	14	31.52	4.00	75.87	40.39	35.48	6.20	2.05	-0.42	Fine silt	Poor
SS19	14	25.69	4.15	72.92	31.49	41.42	6.16	2.33	-0.55	Fine silt	Poor
SS20	9	24.21	5.04	94.37	46.64	47.73	6.86	1.28	0.88	Fine silt	Good

Particle size histograms, 01/612 URS Dames&Moore

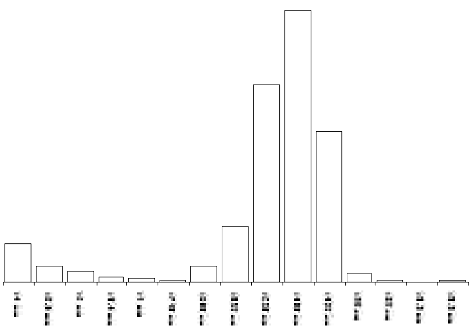
SS 1



SS 4



SS 2



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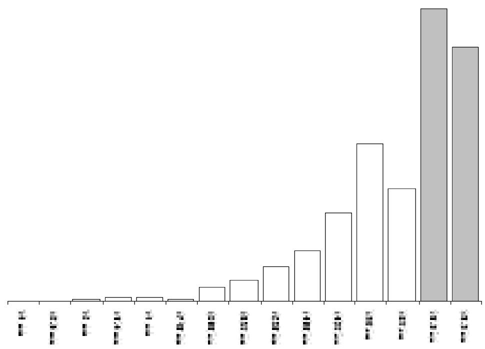

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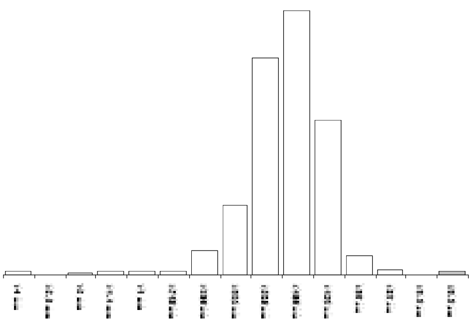

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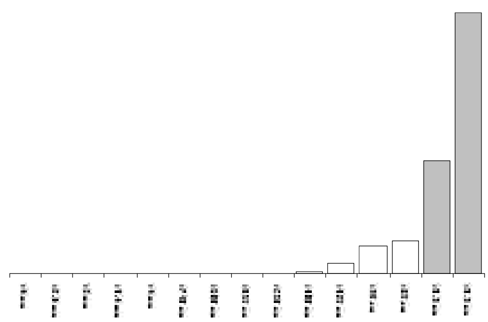

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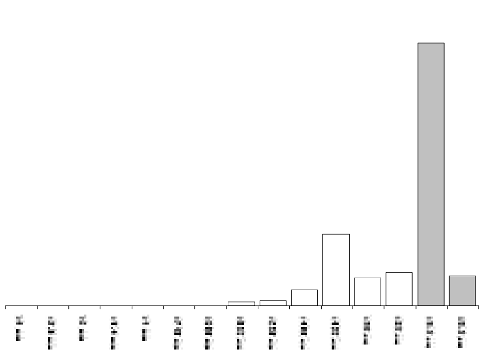

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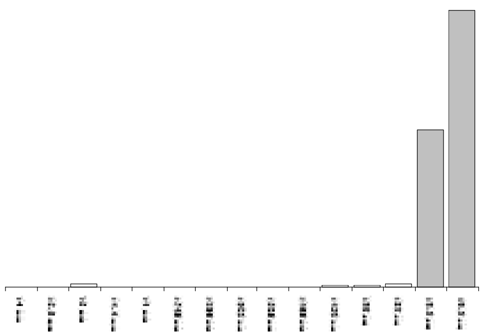

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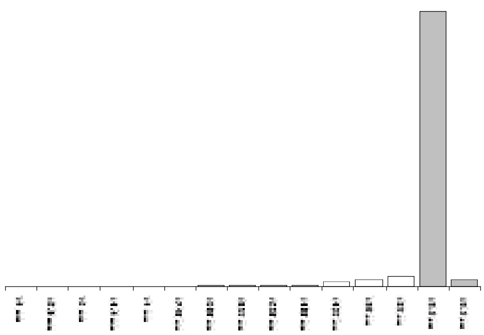

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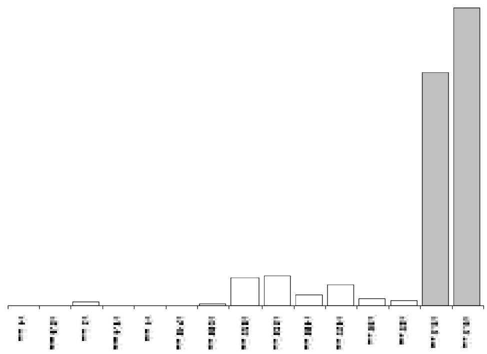

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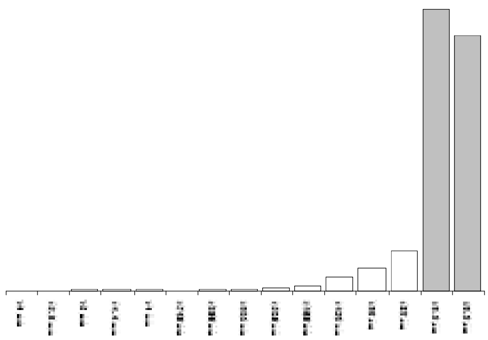

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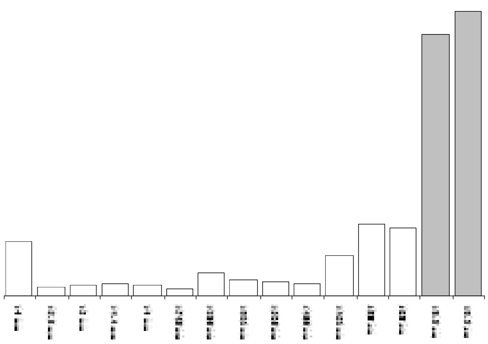

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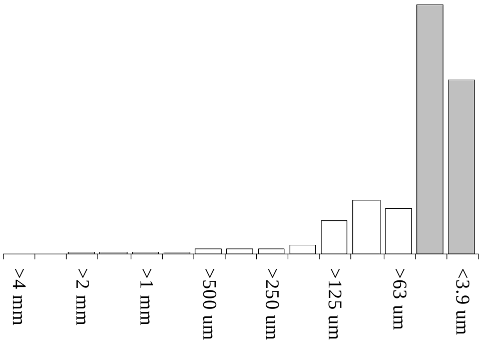

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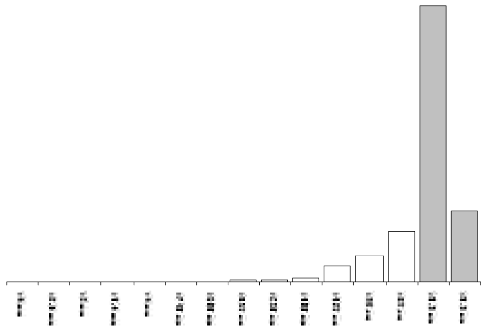

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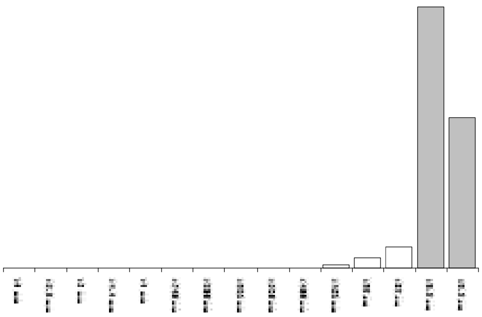

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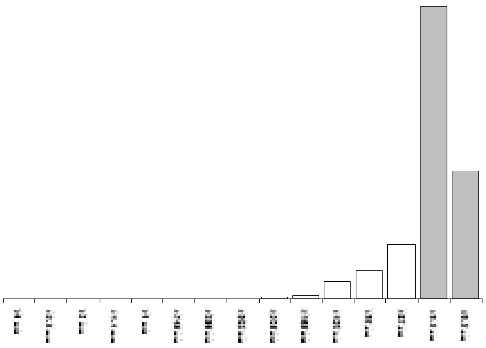

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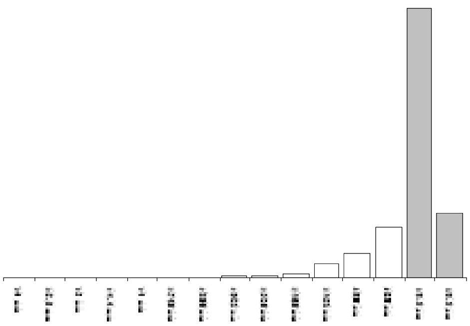

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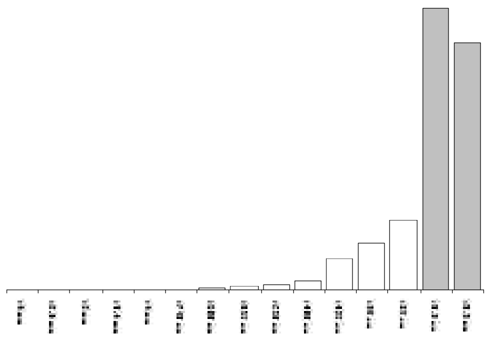

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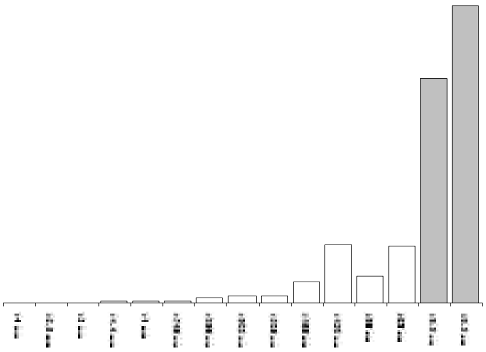

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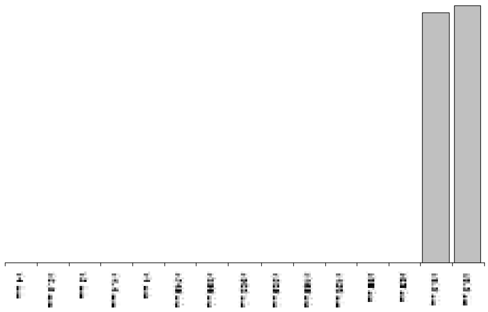


Subject: Hydrocarbon analysis of soils **Analysis Reference:** 1612

14 Overview

Soil and ground water samples were analysed for total hydrocarbon content.

15 Analytical methods

Pre-weighed samples were extracted by dichloromethane using ultrasonic bath. The extracts were further cleaned up by silica gel chromatography. Total hydrocarbons content were determined by gas chromatography with flame ionisation detector.

16 Results

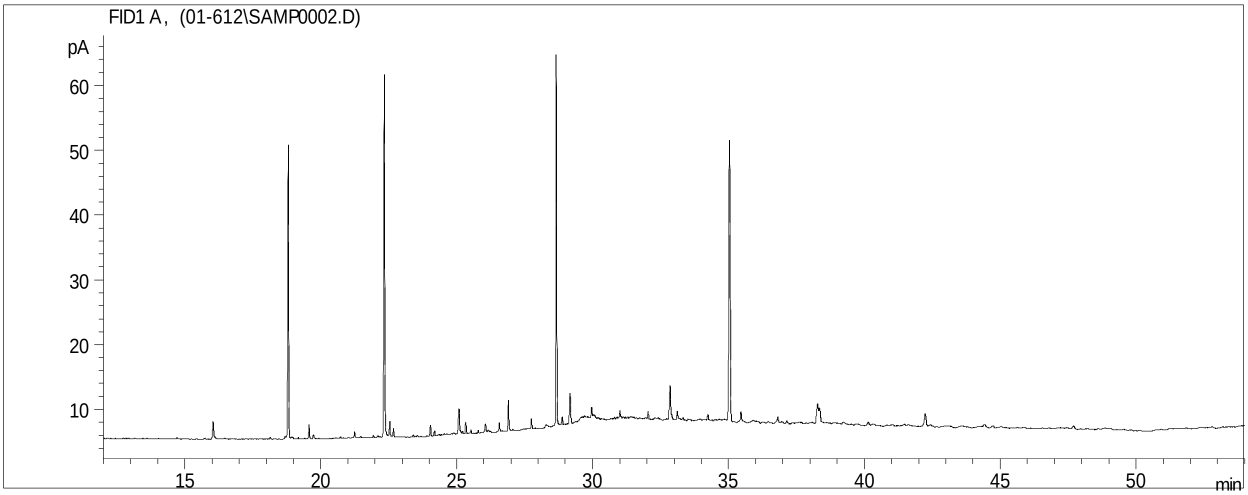
16.1 Total hydrocarbon analysis

No.	Station Identification	Concentration expressed as $\mu g g^{-1}$	
		THC	UCM
1	BHURS 1-1.0	2.1	0.7
2	BHURS 1-4.0	2.0	0.7
3	BHURS 1-13.0	47.1	39.9
4	BHURS 2-1.0	11.3	8.9
5	BHURS 2-4.0	12.8	10.8
6	BHURS 2-15.0	4.5	3.1
7	BHURS 3-4.0	4.9	2.8
8	BHURS 3-10.5	5.7	3.7
9	BHURS 3-14.5	16.5	11.2
10	BHURS 4-2.0	3.0	1.6
11	BHURS 4-8.0	2.6	1.5
12	BHURS 4-15	13.4	10.1
13	BHURS 5-2.0	3.3	1.7
14	BHURS 5-5.0	5.2	2.7
15	BHURS 5-10.5	13.7	9.5
16	BHURS 6-3.0	2.1	1.0
17	BHURS 6-10.0	6.6	3.2
18	BHURS 6-13.5	11.3	7.8
19	SS1 –0.05	51.2	24.5
20	SS2 –0.05	21.4	18.3
21	SS3 –0.05	6.5	5.1
22	SS4 –0.05	22.0	18.3
23	SS5 –0.05	17.6	13.5
24	SS6 –0.03	10.7	8.0
25	SS7 –0.03	9.9	7.3
26	SS8 –0.05	15.4	10.1
27	SS9 –0.05	50.6	39.8
28	SS10 –0.05	6.9	4.8
29	SS11 –0.05	6.8	3.5
30	SS12 –0.05	6.3	4.4
31	SS13 –0.05	2.6	0.5
32	SS14 –0.05	2.3	0.9
33	SS15 –0.05	337.8	303.5
34	SS16 –0.05	363.4	327.2
35	SS17–0.25	357.7	317.7
36	SS18 –0.05	111.6	113.3
37	SS19 –0.05	12.6	8.9
38	SS20 –0.05	12.1	9.4

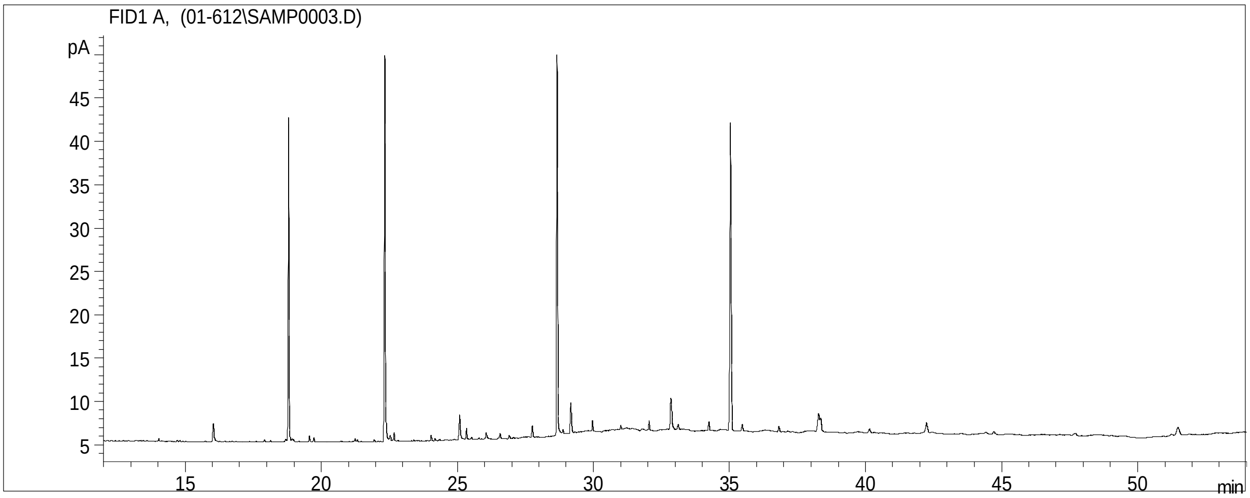
THC[1] –total hydrocarbons, UCM [2] –unresolved complex mixture

GC chromatograms

BHURS 1-10

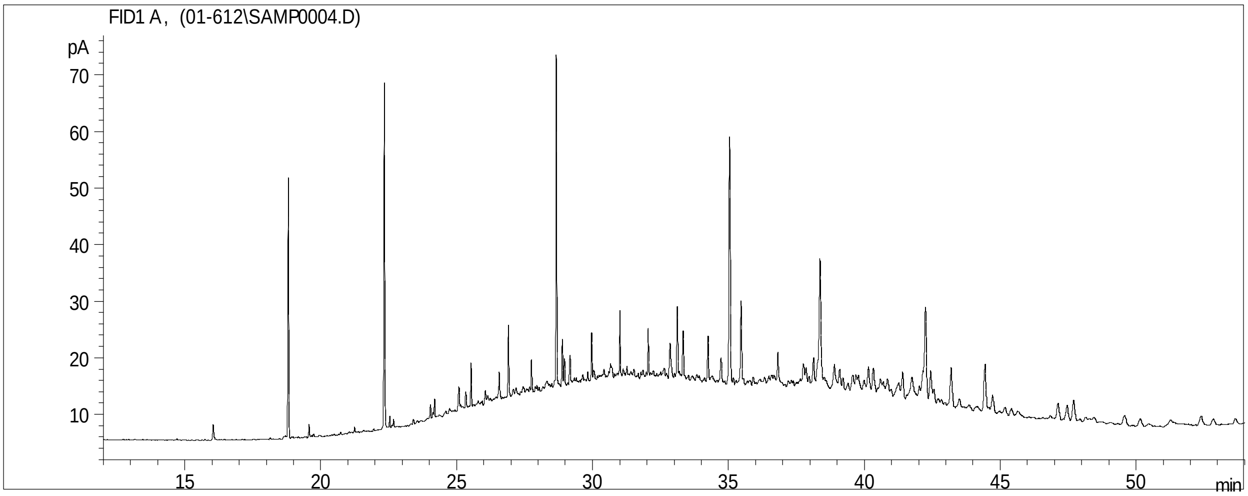


BHURS 1-4.0

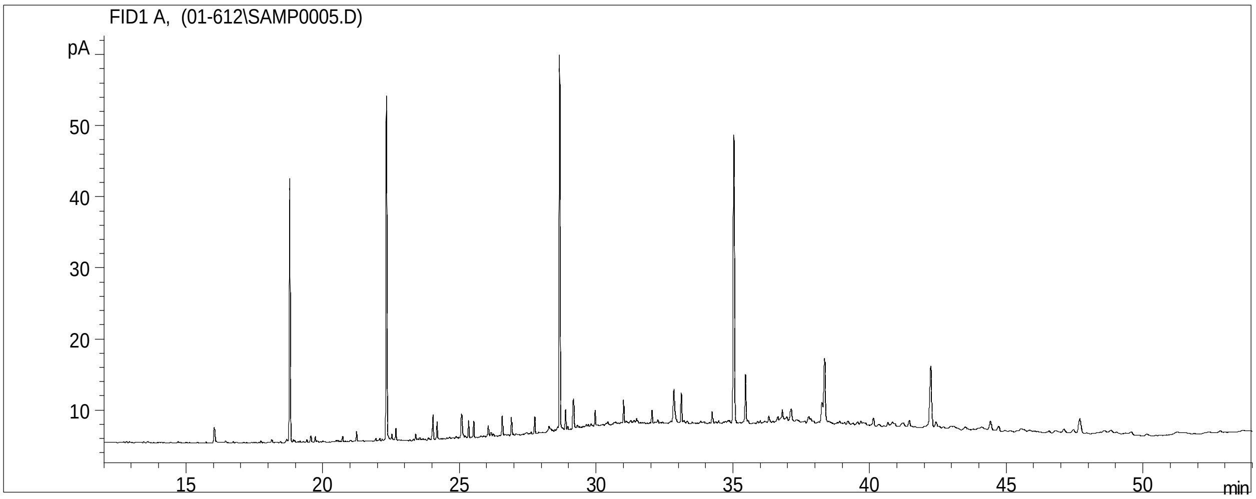


GC chromatograms

BHURS 1-13

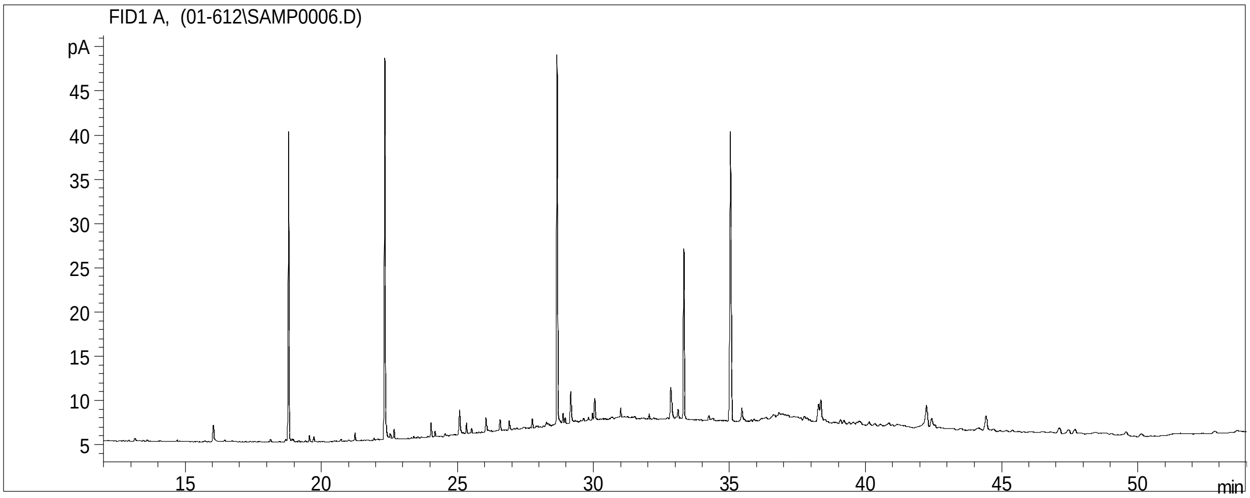


BHURS 1-2.0

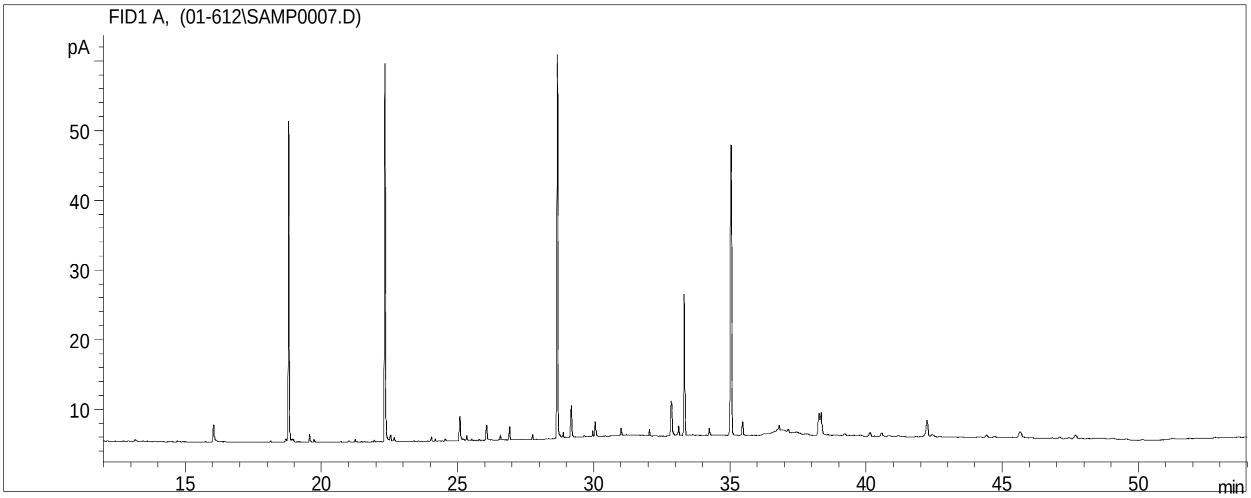


GC chromatograms

BHURS 2-4.0

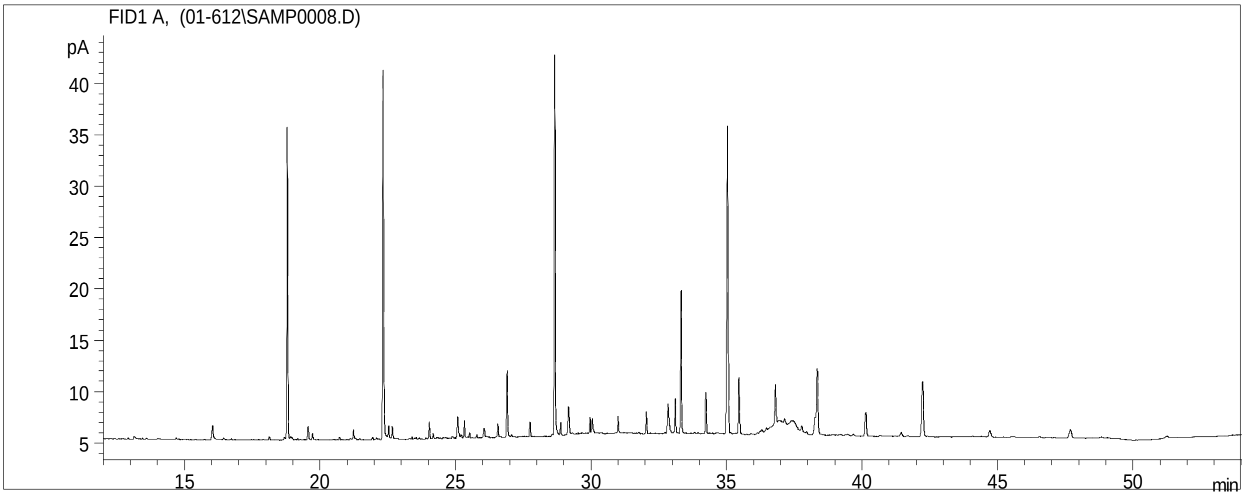


BHURS 2-15.0

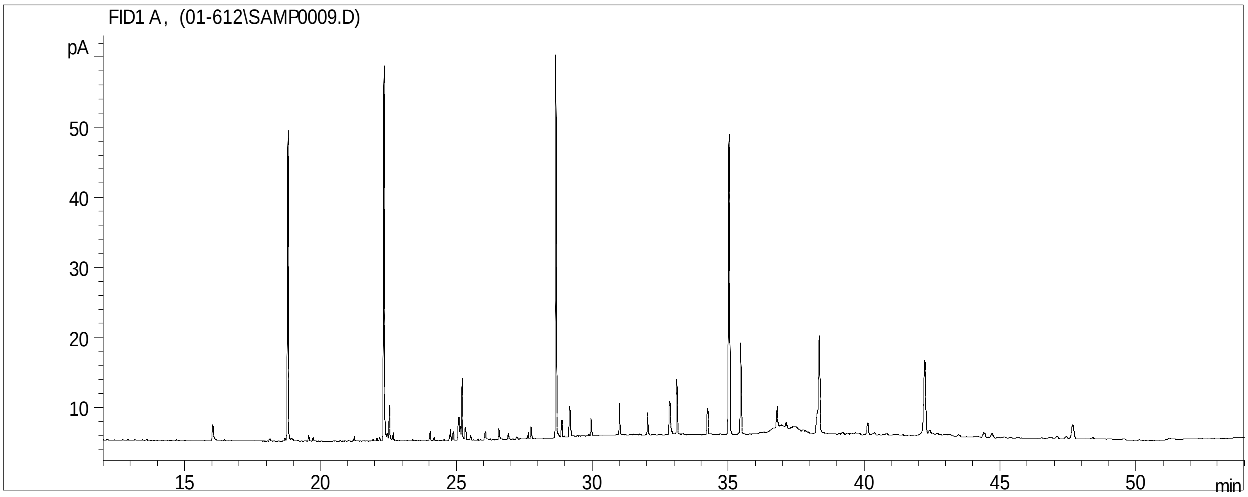


GC chromatograms

BHURS 3-4.0

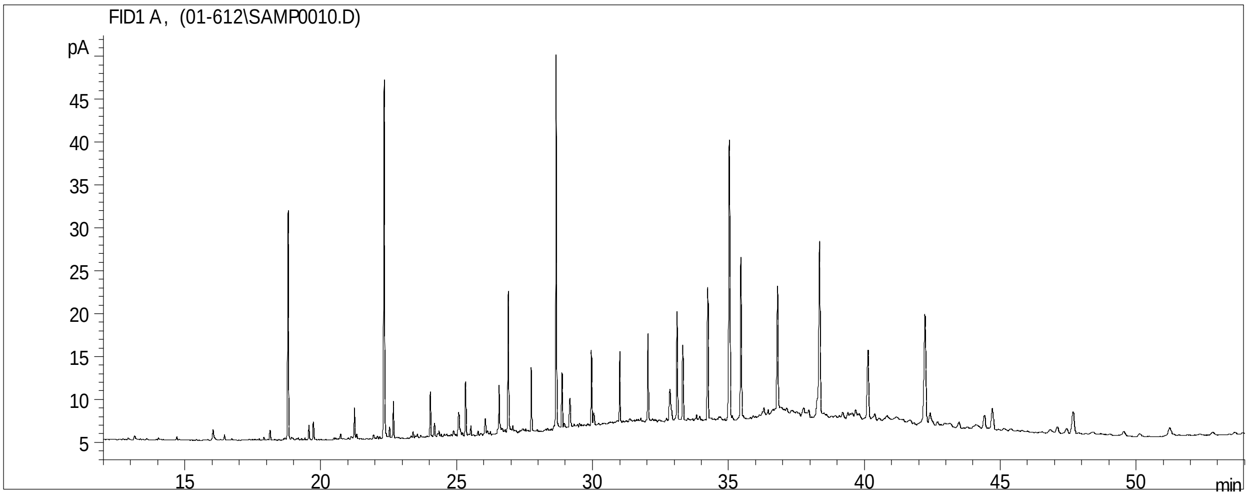


BHURS 3-10.5

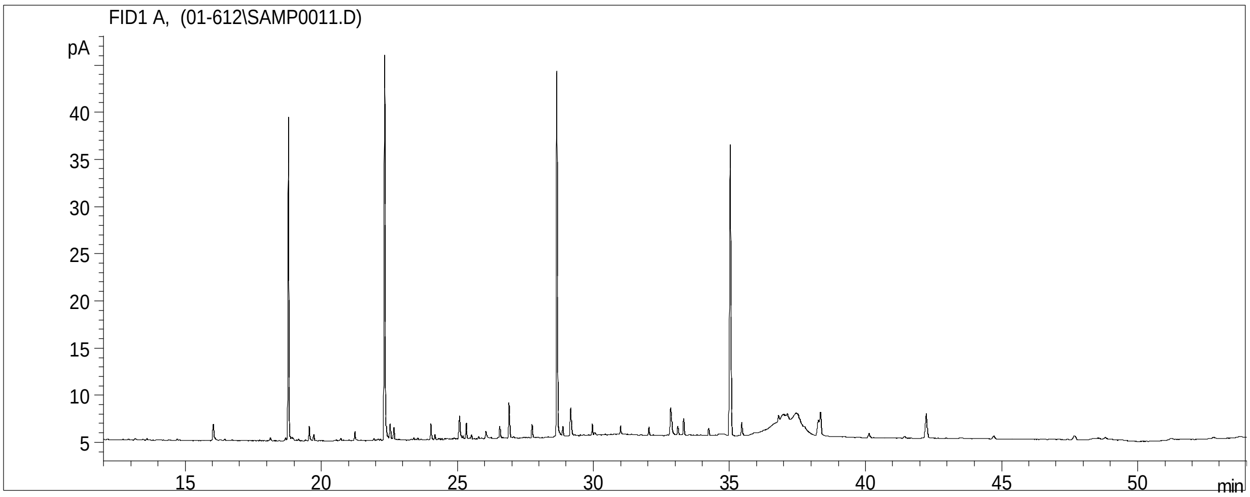


GC chromatograms

BHURS 3-14.5

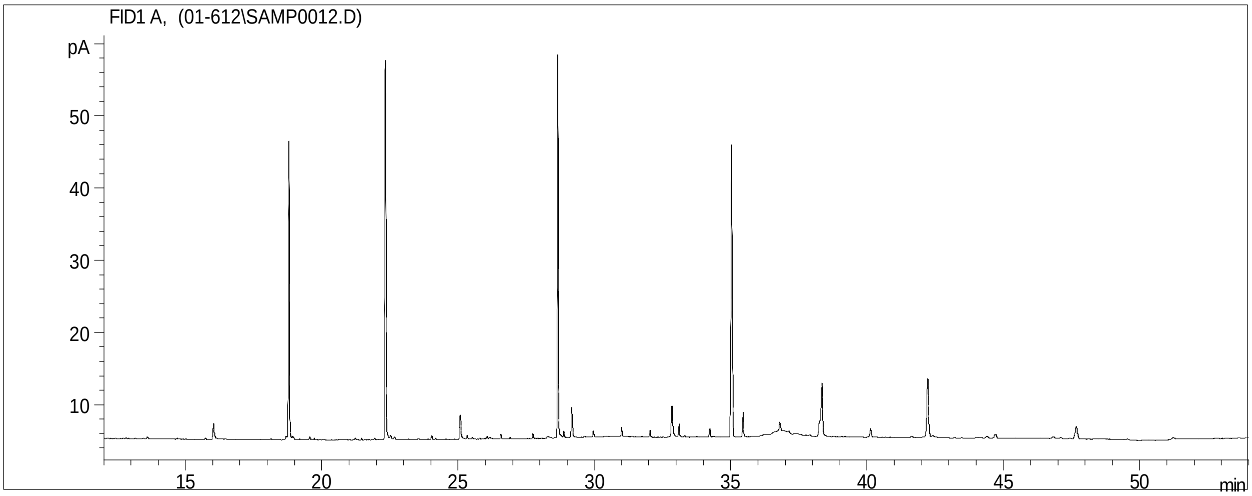


BHURS 4-2.0

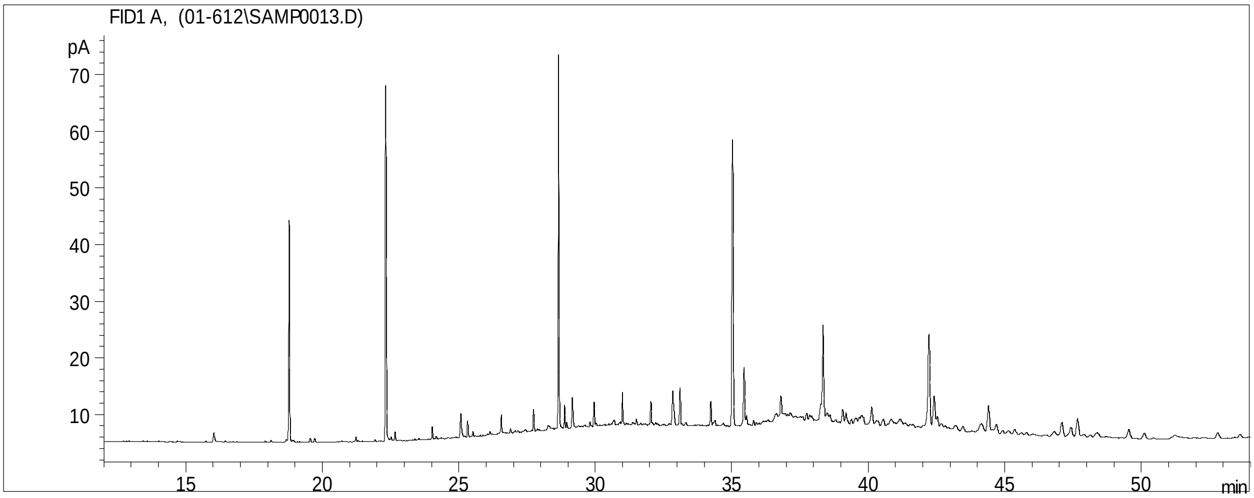


GC chromatograms

BHURS 4-8.0

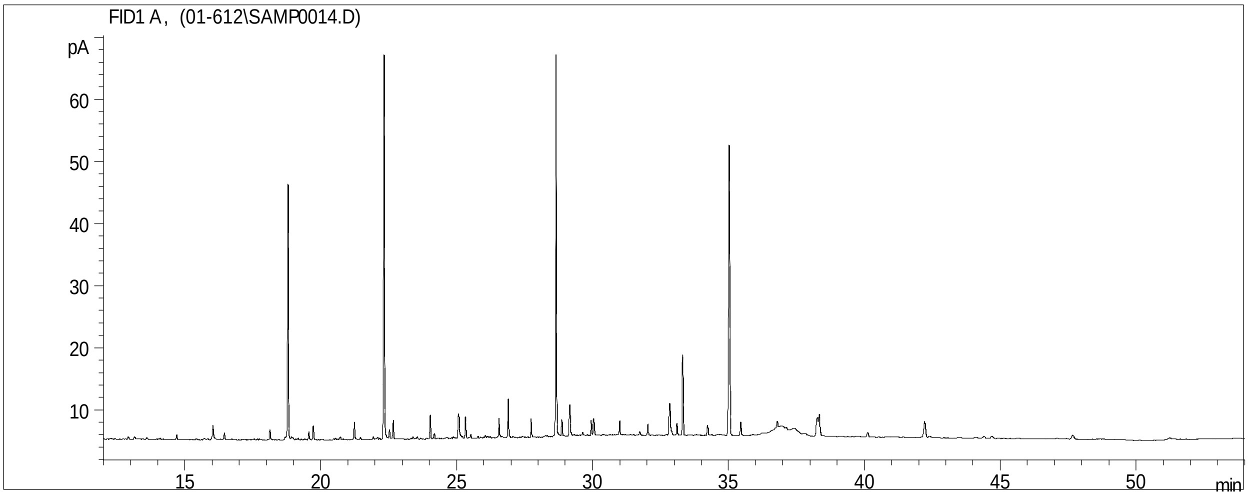


BHURS 4-15

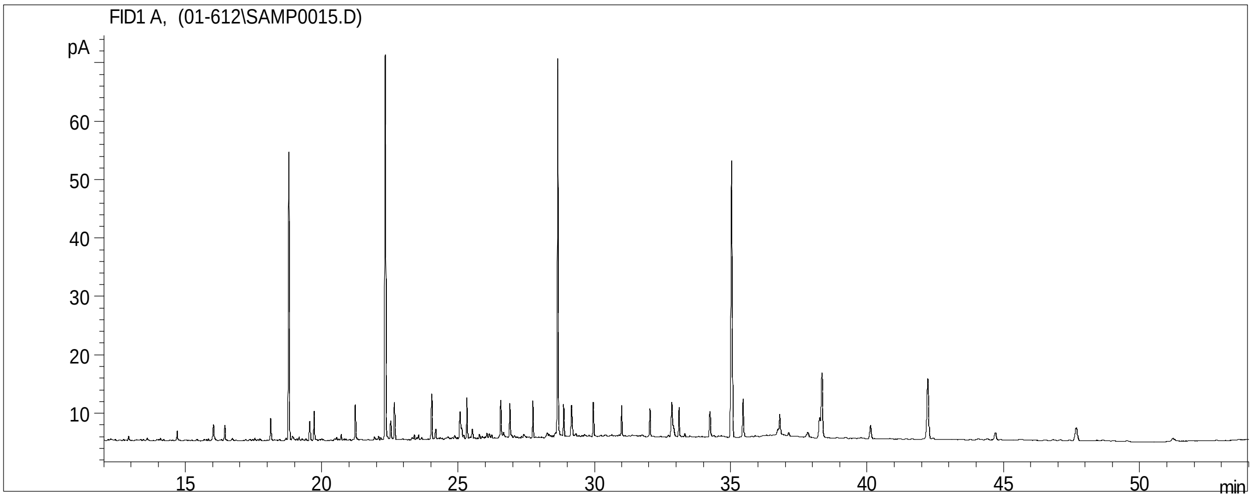


GC chromatograms

BHURS 5-2.0

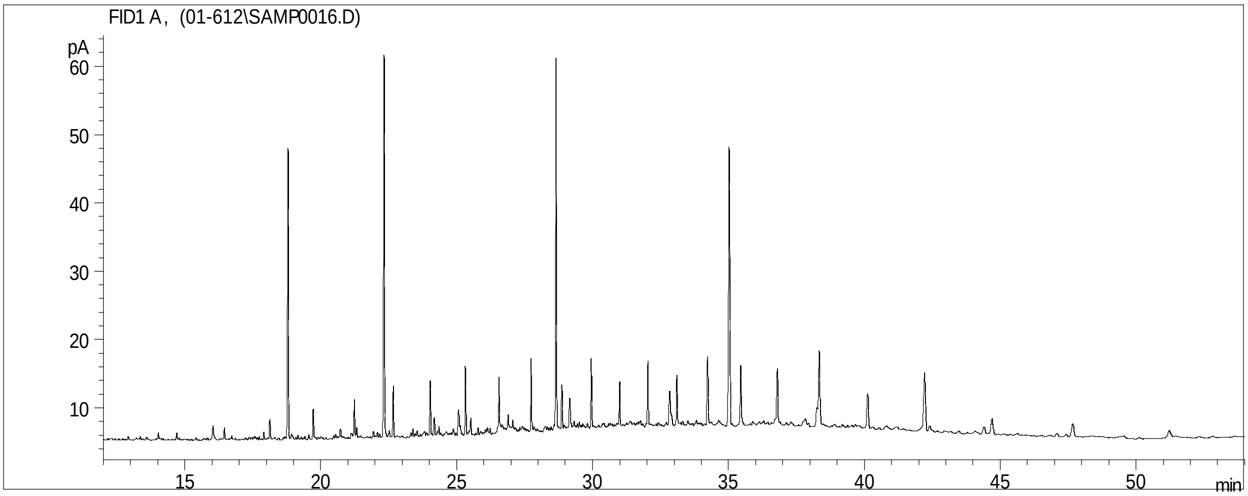


BHURS 5-5.0

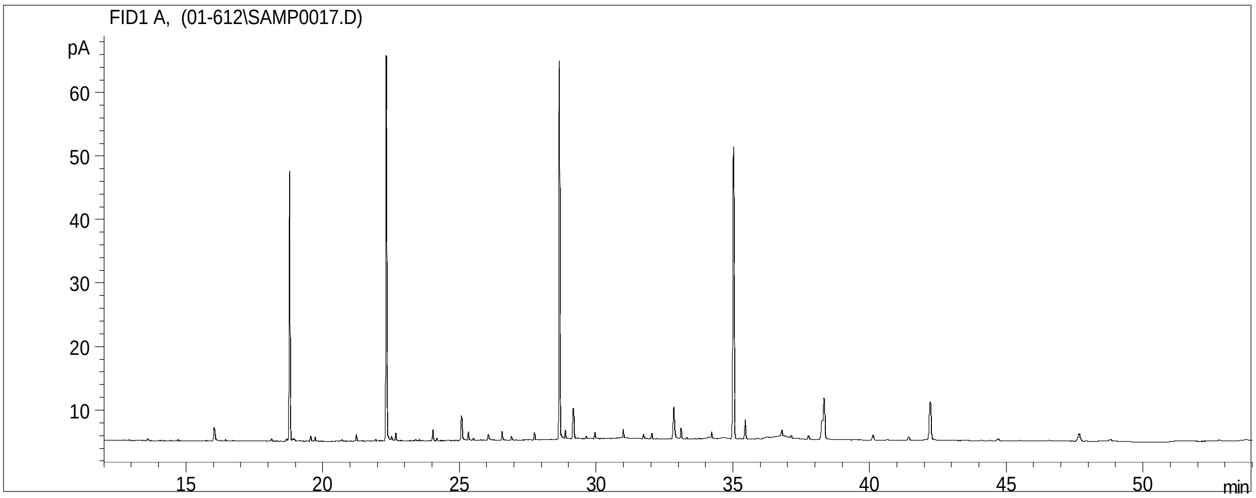


GC chromatograms

BHURS 5-10.5

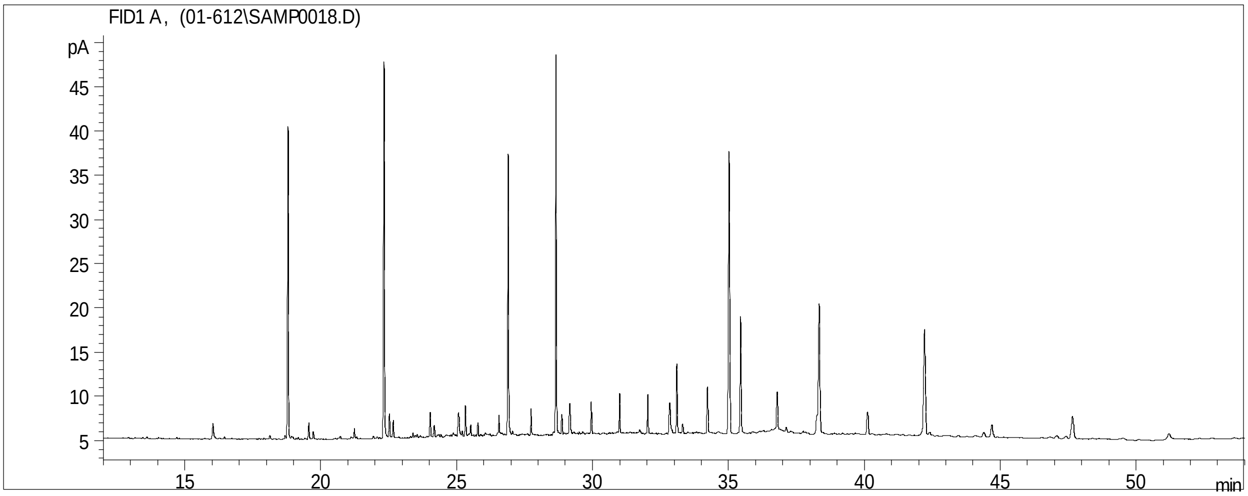


BHURS 6-3.0

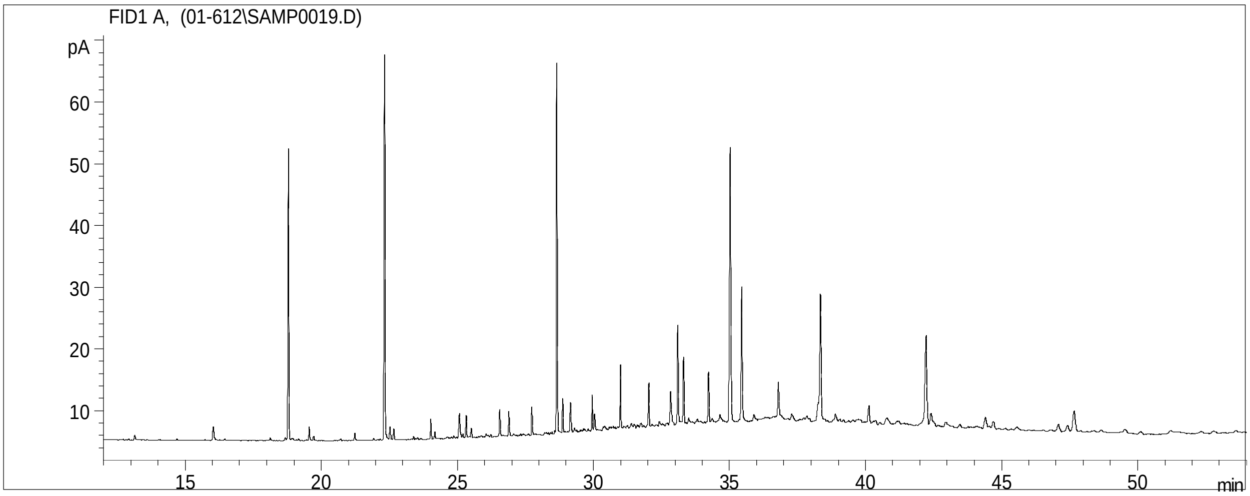


GC chromatograms

BHURS 6-10.0

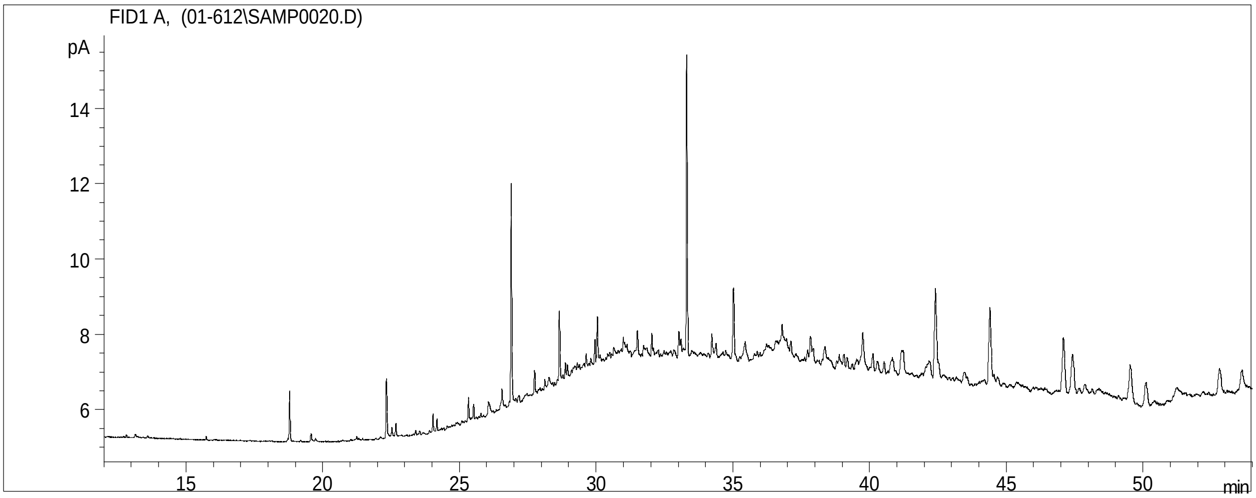


BHURS 6-13.5



GC chromatograms

SS 1-0.05



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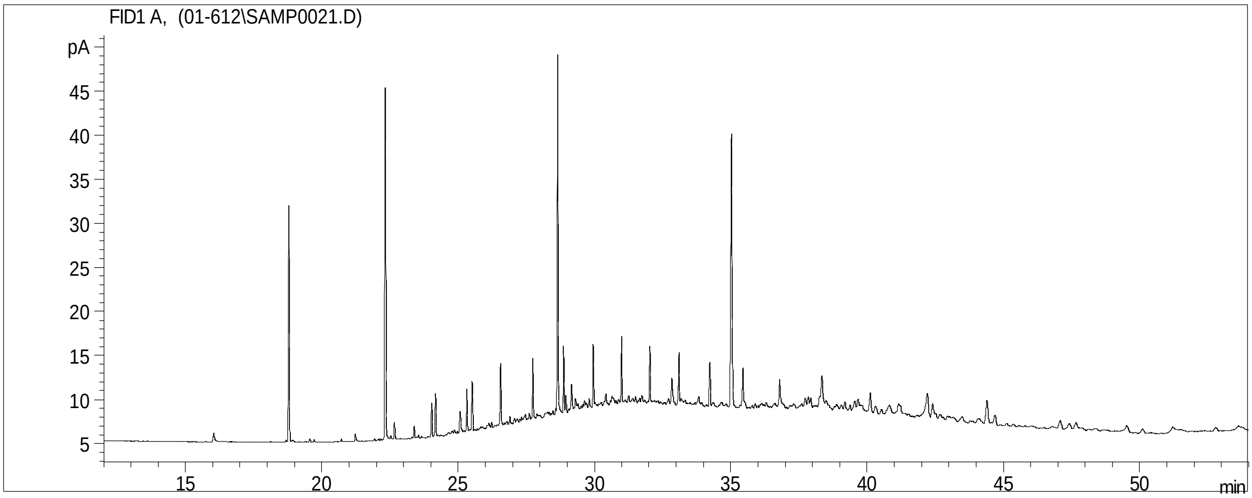
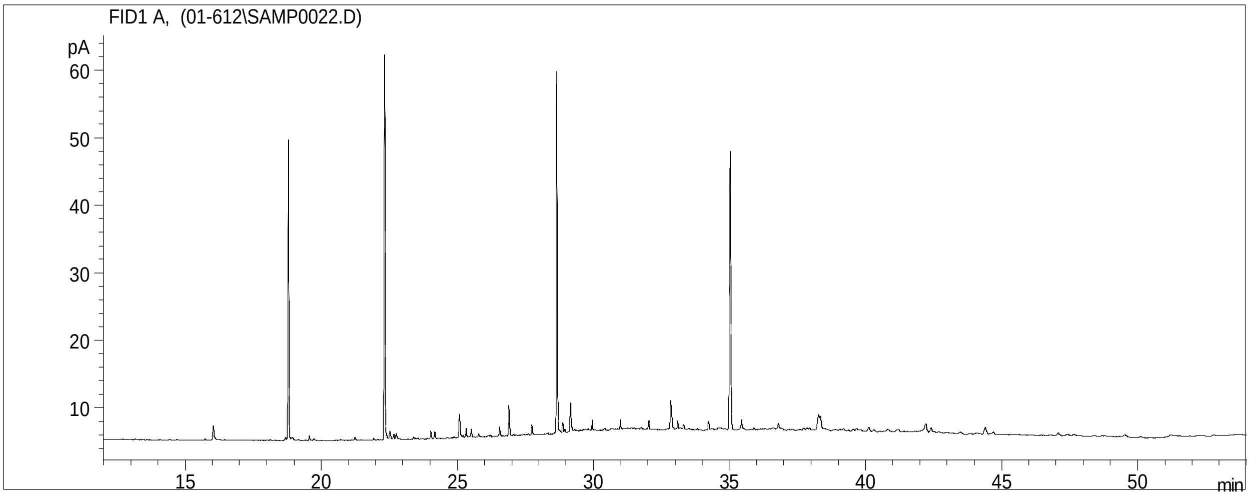


GC chromatograms

SS3



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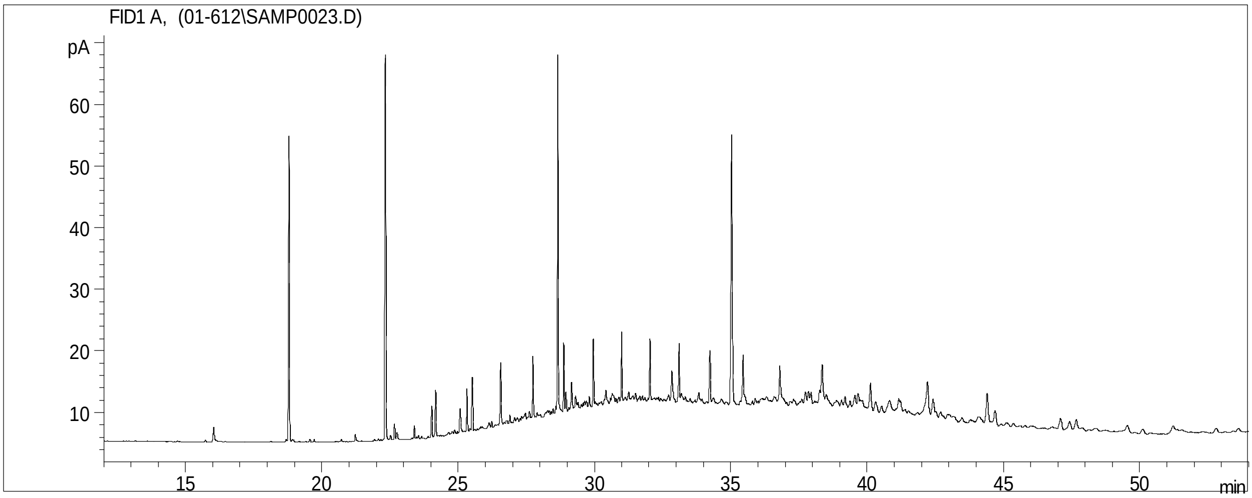

GC chromatograms

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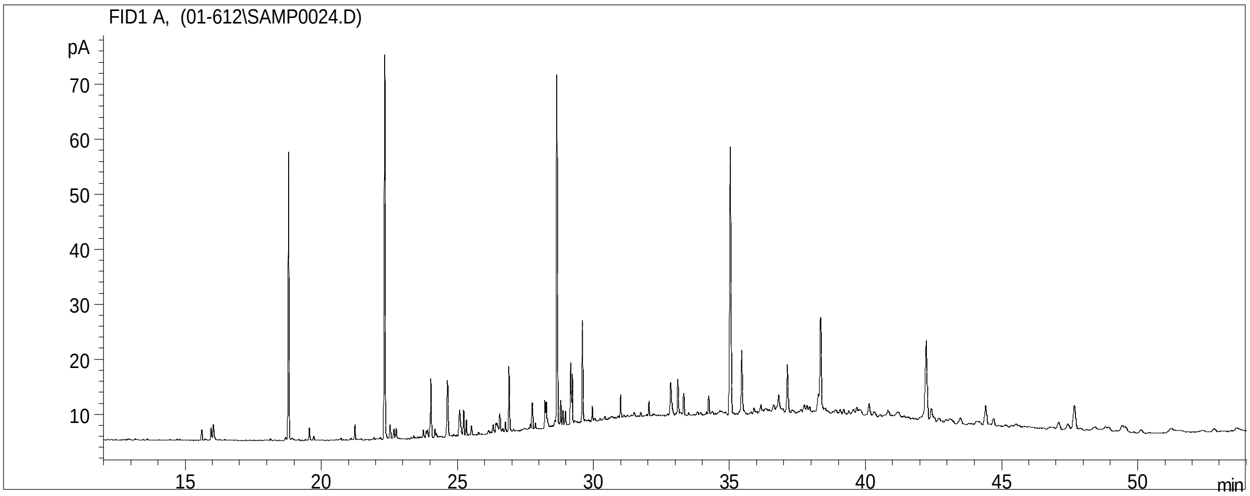

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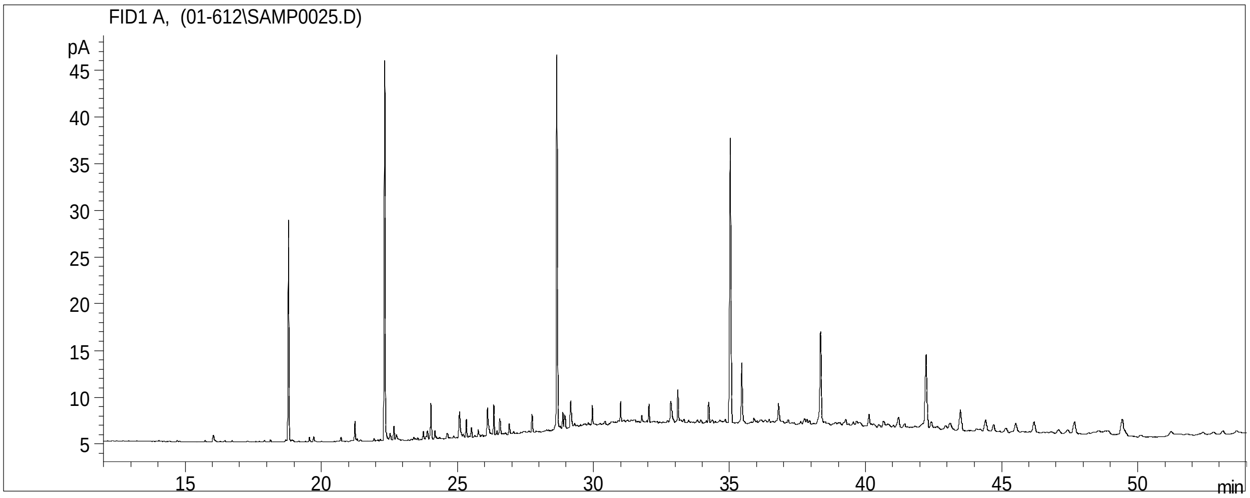

GC chromatograms

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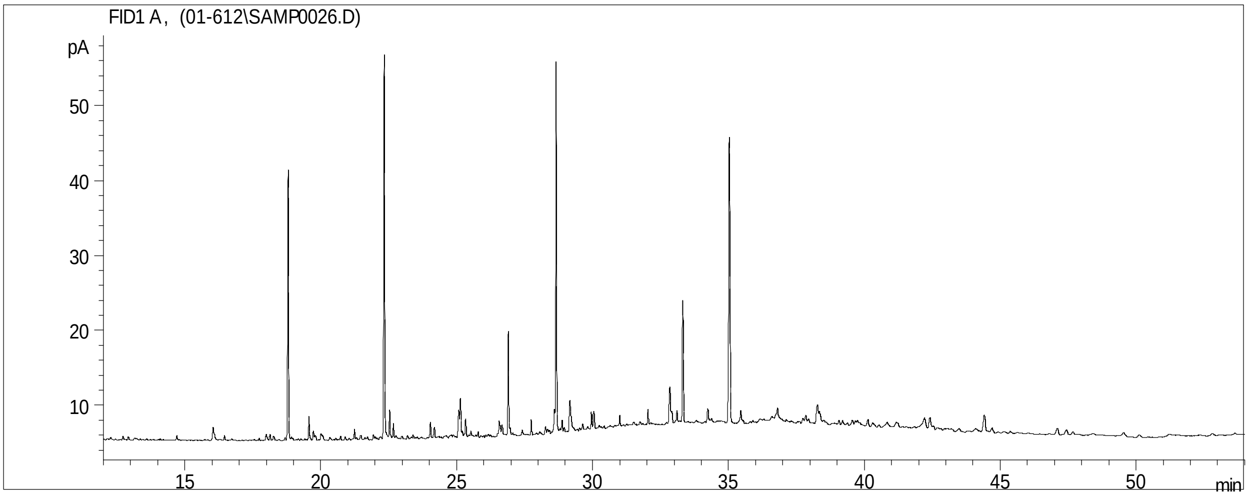

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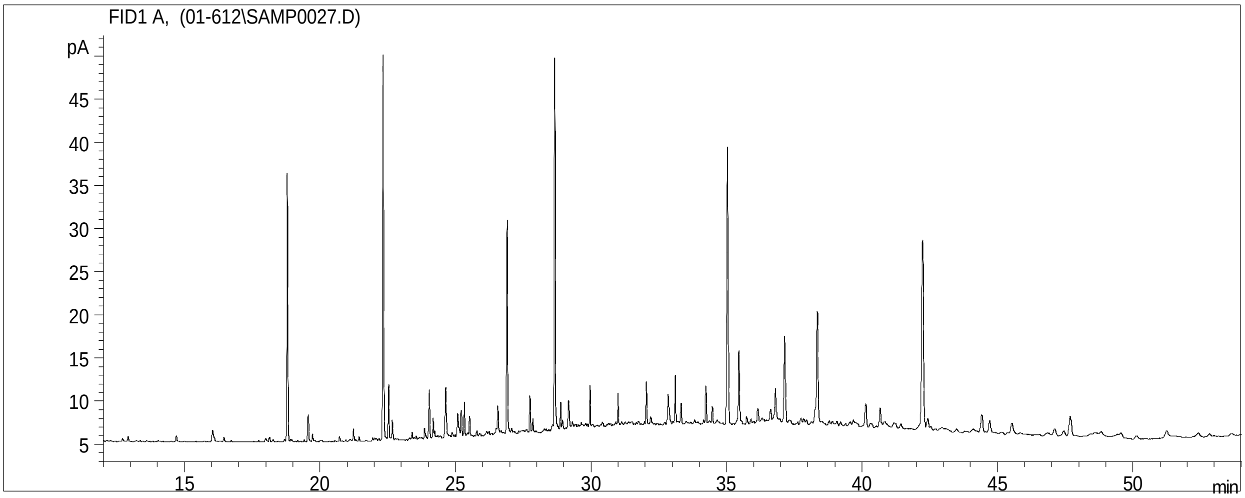

GC chromatograms

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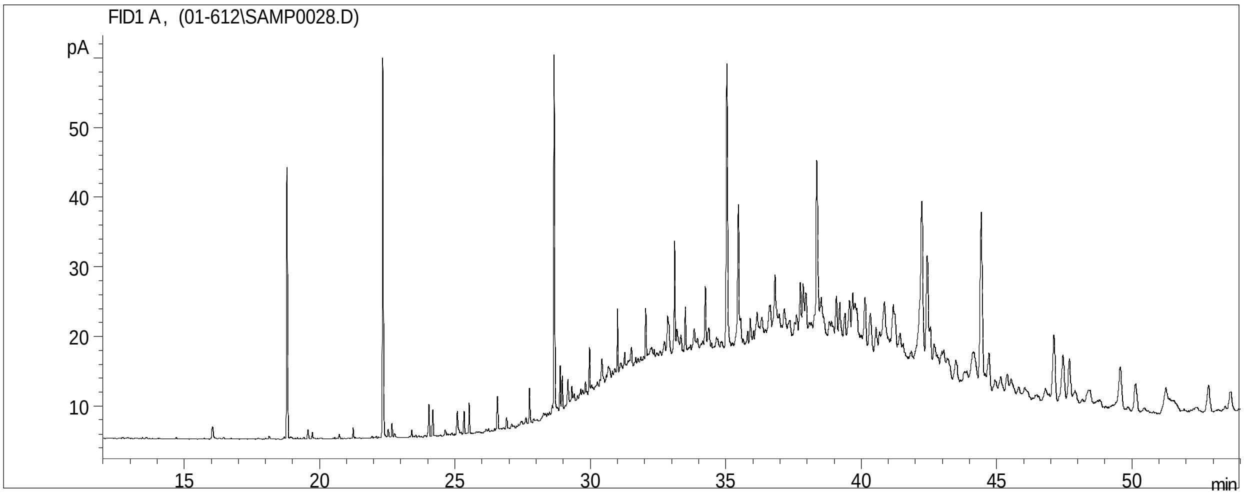

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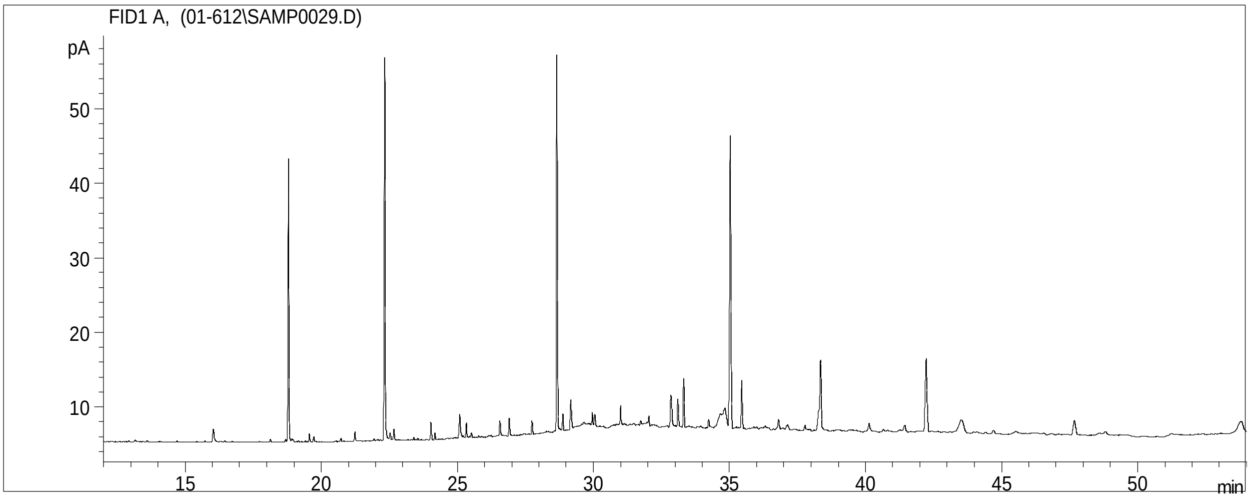

GC chromatograms

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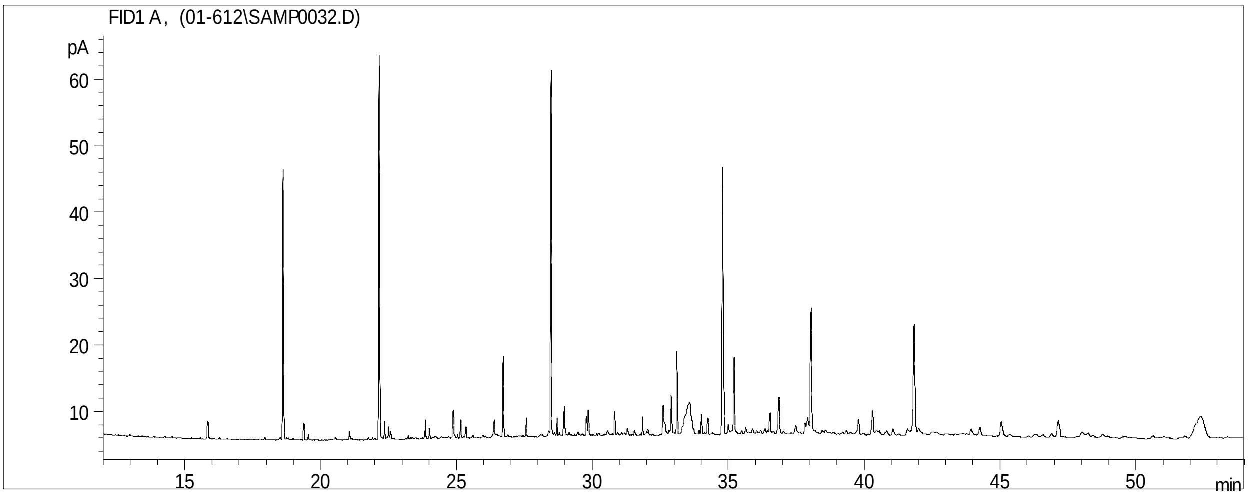

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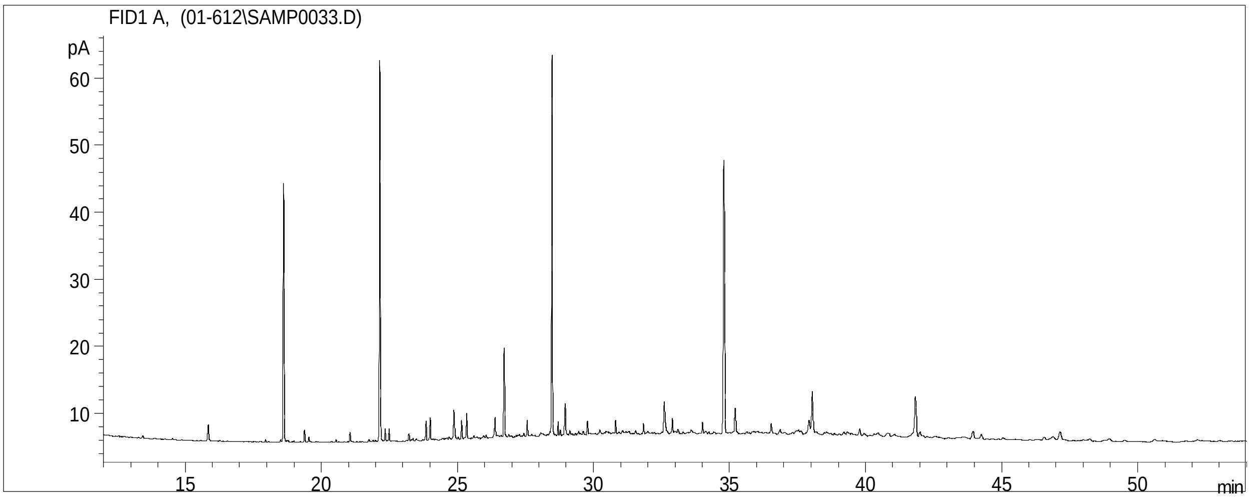

GC chromatograms

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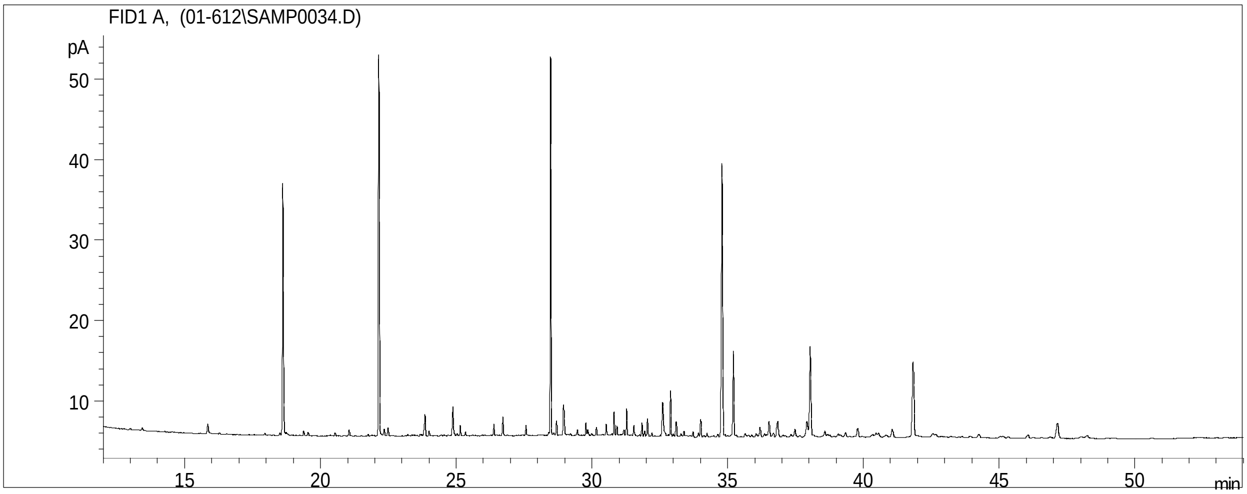

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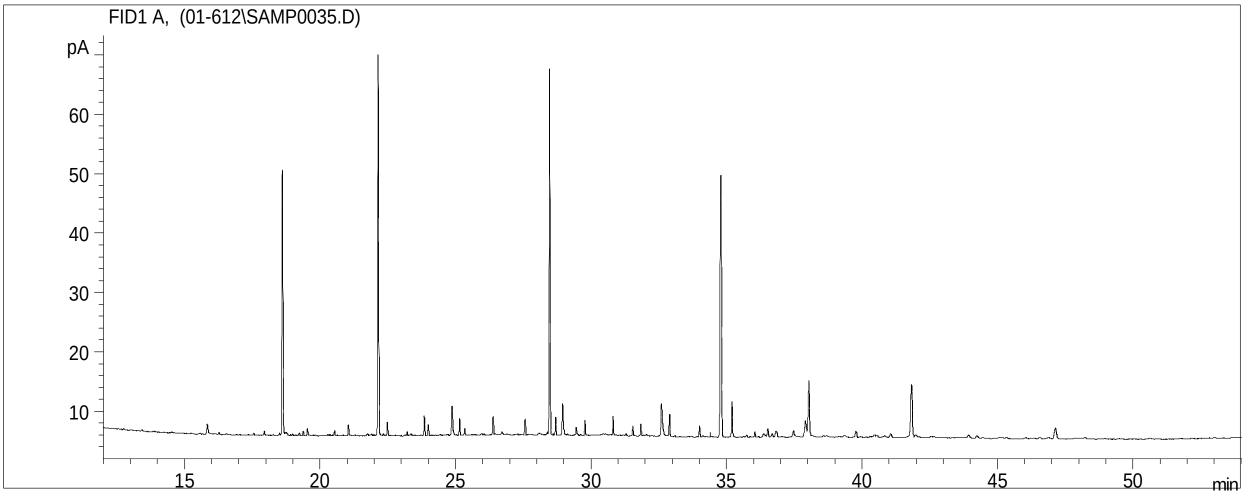

GC chromatograms

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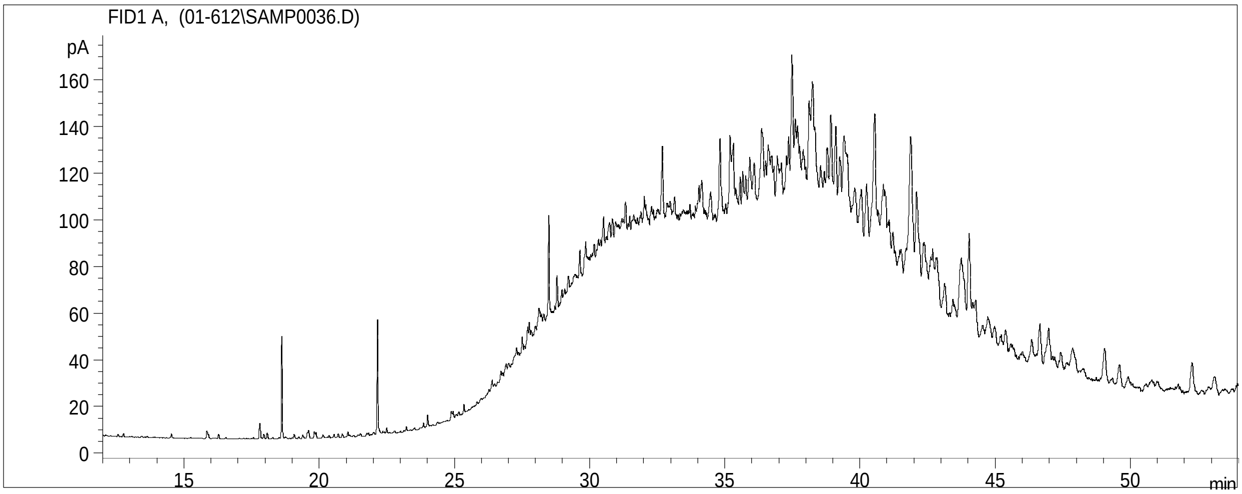

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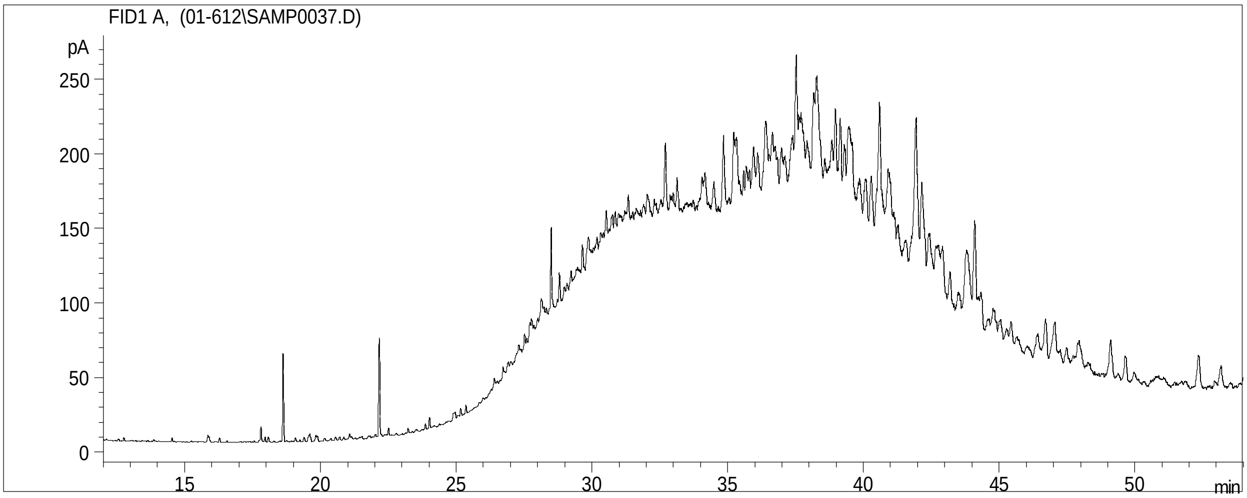
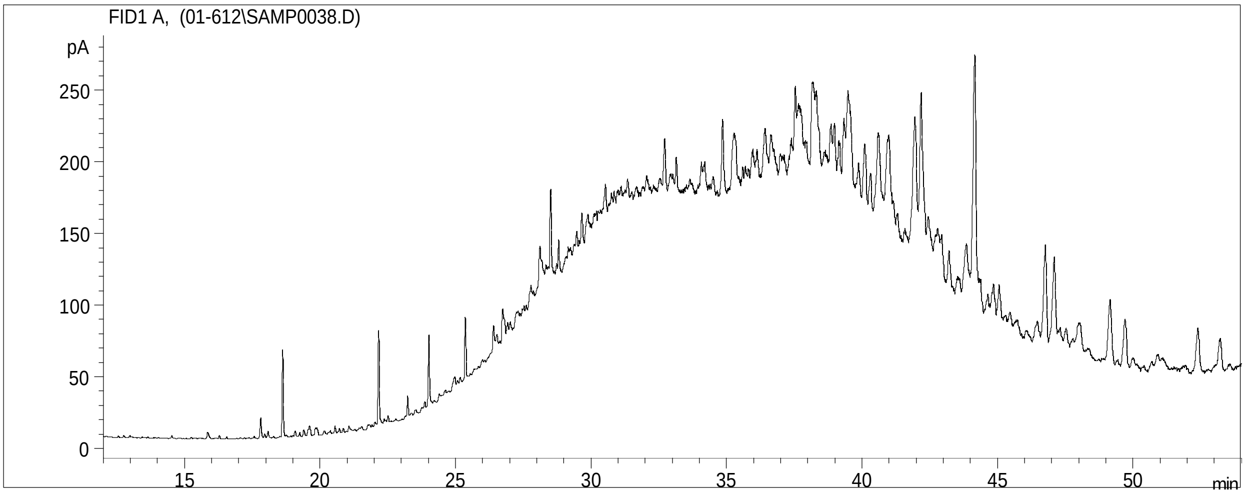


GC chromatograms

SS17



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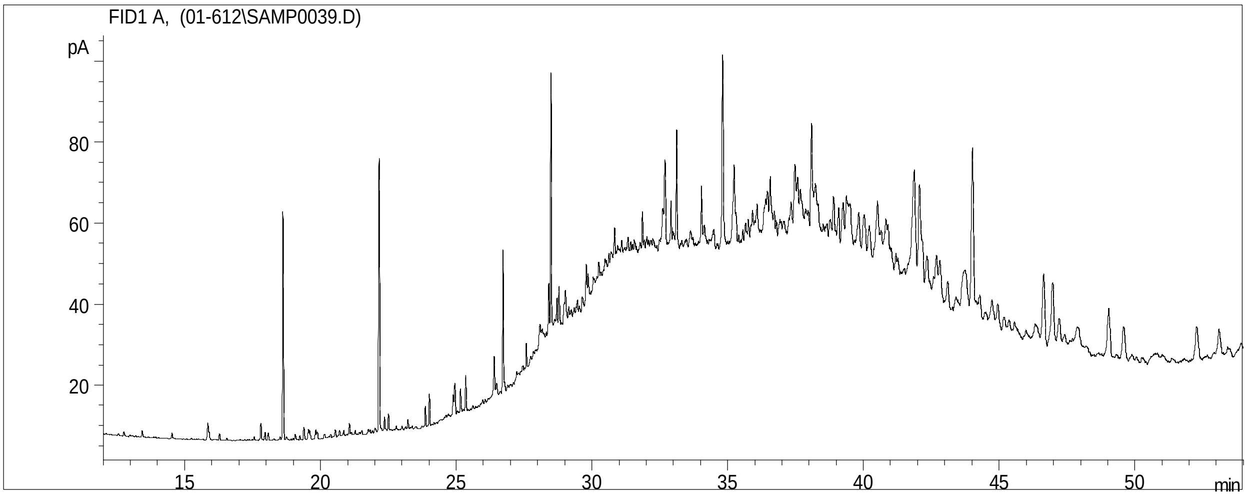
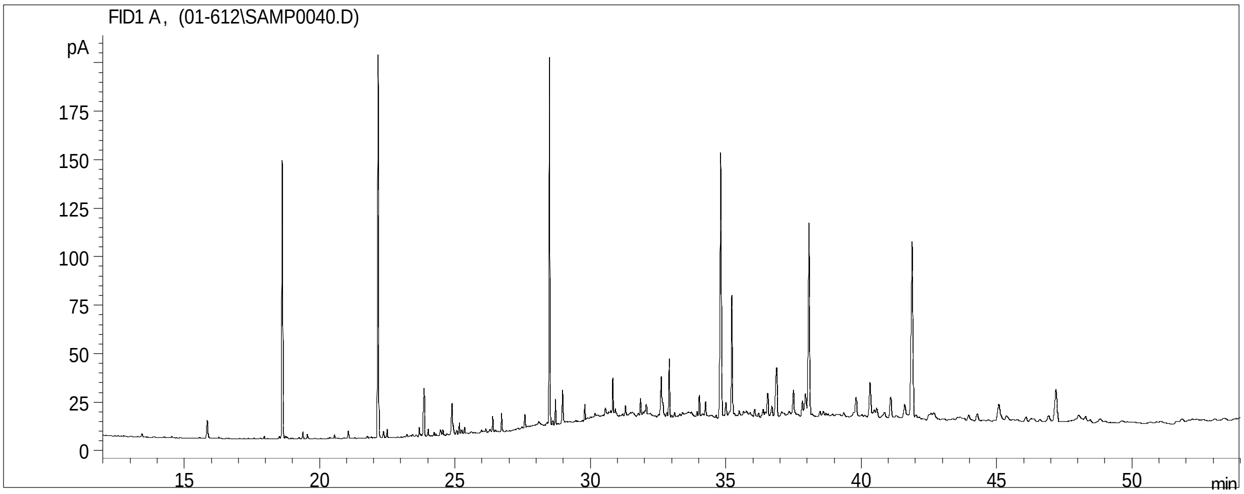


GC chromatograms

SS19



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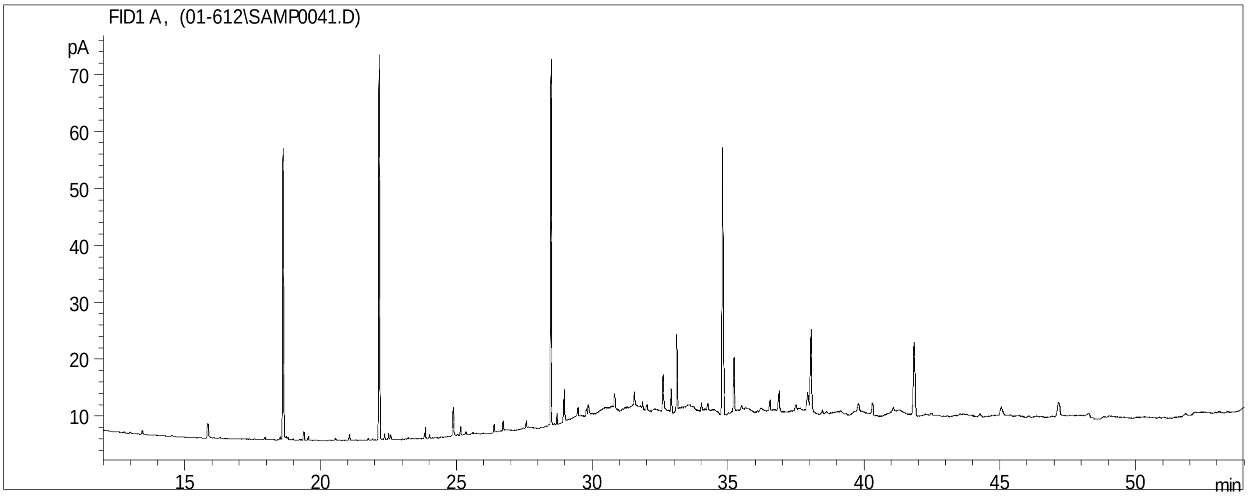

FINAL REPORT

ACG Phase 1 Technical Appendix 11

FAUNA and FLORA

BP EXPLORATION (CASPIAN SEA) LTD
BAKU, AZERBAIJAN

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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 Azeri, Chirag and Gunashli (ACG) Phase 1 development. A review of past assessment documents focussing on the Sangachal area highlighted a lack of site-specific information. The ACG Phase 1 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:

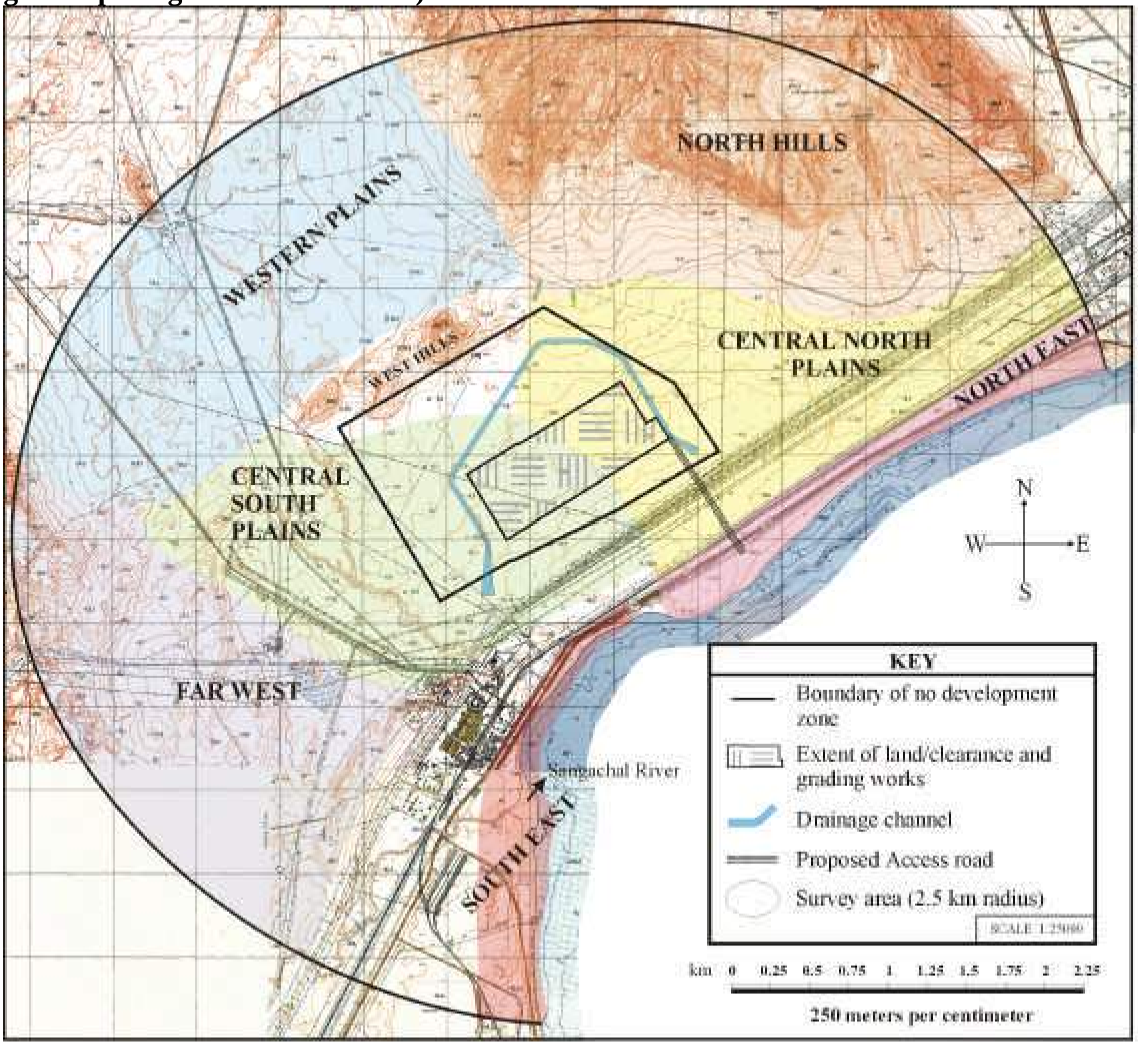
- Increase site specific information regarding a number of environmental parameters
- Account for any activities not planned within the early engineering documents

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

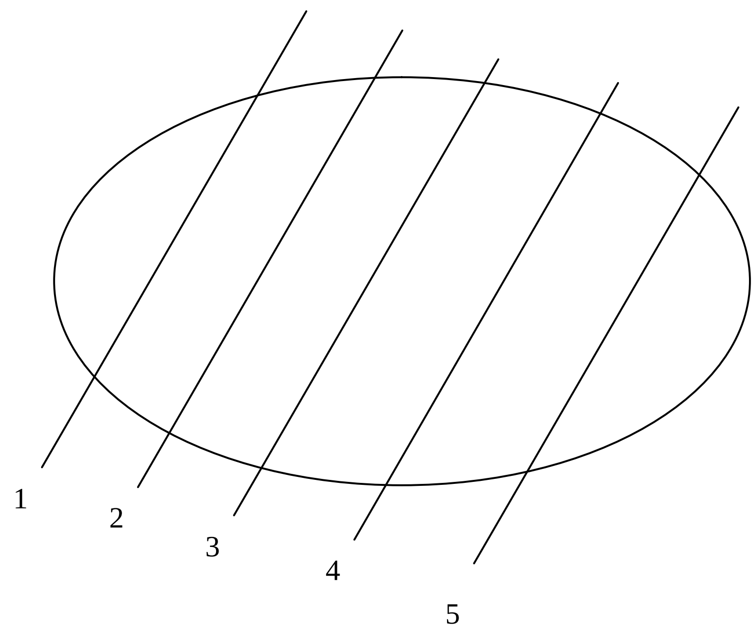
A URS consultant and translator accompanied the specialists listed above.

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

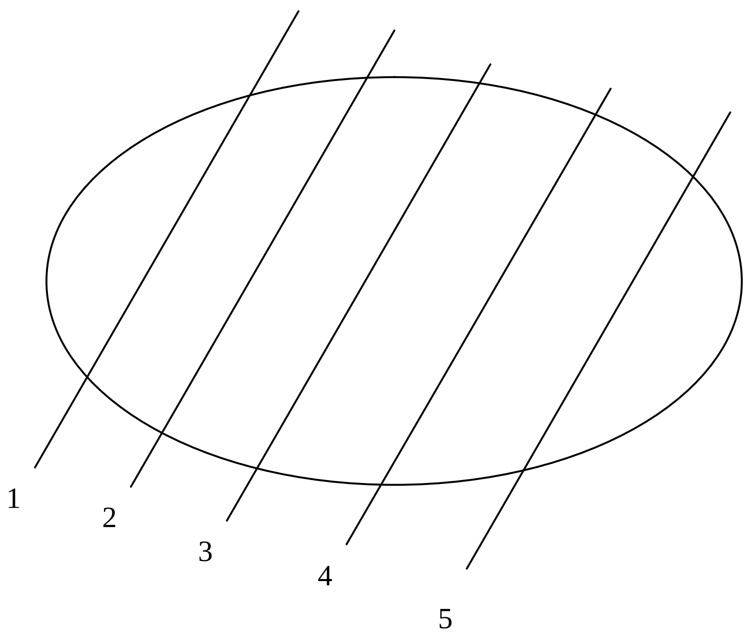
The survey to identify mammals, reptiles, and amphibians was undertaken over a period of three days and one night (11-6-01 to 13-6-01 and 14-6-01, respectively). The individuals involved and their affiliation are listed below.

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.

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.

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. ? .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: ? .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. ? . 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. rutheni?um 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. rutheni?um 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.:- ? .persicus L.
1	N4018307 E04948451	Argillaceous sand	Formation ? 10 Lucium ruthenicum Pp 30-35% Dominant		
			1. L. rutheni?um 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. rutheni?um 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	Argillaceous 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	Argillaceous 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	Argillaceous 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	Argillaceous 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 argillaceous 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 argillaceous 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 argillaceous 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. ? . 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. ? . 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. ? ???? ??? 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. ? . 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 ????????		
		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	Argillaceous 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.

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

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.

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
? 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.
? 04947237

Description ? 2
? 401996 — Formation Artemisietum tschernieviana Bess. Pp. 75-80 %
? 04947183 — Wormwood-efemeral desert. Shale soil .

Artemisietum tschernieviana Bess. :	Pp. 40-45 %	Agrostis tenuis Sibth. :	Pp. 10-15 %
? atabrosela 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
? 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
? 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. pp? 10-15%, Allium rubellium Bieb. individuals

Sample plot 4

Description 5.
? 4015048 Reed thickets – Phragmitesum australis on dry argillaceous,
often turf soils
? 04947181 pp 85-90 %

Encountered are Phragmites australis (Cav.)Trin pp 80-85, 1.5 - 2 ? . high, roots – 3 ? long.; Juncus acutus L. pp 15-20 % is encountered mainly in wet coastal sand, sometimes in water.

Description 6.
? 4015264 Argillaceous sand soil.
? 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 ?? 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 %
? 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
? 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 %.
? 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
? 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 %, ? ynodon 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
? 04947825 adventives account for pp 70-80%

A small coenosis with dominant ? anvolvulus 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 %
? 04948451
Lycium rutenicumpp20-25 %, Alhagi pseudalhagi (Bieb.)Fish.pp10-15.

.

Description 11
? 4020529 Formation Salsoletum nodulosae + Suaeda dendroidespp80-85 %
? 04948973 Desert of salt sand

Salsola nodulosa (Moq.) pp10-15 %, S. ericoides Bieb.pp10-15 %, Suaeda dendroides Pall.pp10-15 %, Halo?nemum 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
? 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 ? ontana 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 %
? 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 %
? 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 %

? 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 %.
? 04947367 Dendritic saltwort+tamariks, meadowlike soils
Salsola dendroides . (Moq.)Pall.pp60 %, Tamarix meyeri Boiss.pp20-30 %, ? ynodon 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 %.
? 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 %
? 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
? 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 %.
? 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
? 04945155 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 ?????????, ??????? ????? ?? ???? ???. 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%
? 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%

? 04945232

Tamarix meyeri Boiss.?/? 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
? 04945232

Tamarix meyeri Boiss. ?? ???? 2,5 ? ,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
? 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. ????? ????: ?????? ?????

?????????? ? ????? ??? , ? ????? ??????? ??? ???? ??? . ? ?????? ? ????????? ? ????? ????? ????? ????? ? ??????? ??? ??? ???????????? ?????? ? Poa bulbosa L. ? 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.

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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

English name	*Genus species*	Study area sub-section encountered in?*								Biotope	Evidence of encounter?*	Time (D/N)
Mammals												
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)

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**												

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

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***			

Trap No.	Live Trap Size (photos shown below)		Way Point	GPS Coordinates	entrapped group	biotope	sex
19.	**s**	54	**N**	***40.16077***	empty	riverside (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 ? 7 ??	**(M)edium = 23 ? 8,5 ??**	**(L)arge tra = 20 ? 10 ??**
		

Mist Nets Results

Bats cauight around the Sangachal terminal during 11 - 14 . 06. 2001								
	Catch time	**Net ?**	**Species**	**Sex**	**Weight**	**Age**	**Antibrachium length**	**Ring ?**
1	11 30	from cave	Barbastella 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

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* (? ? 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
N. A. Gasanov

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.

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
Nizami 86,
Baku,
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

Report prepared by:
Simon Aspinall
P.O. Box 45553,
Abu Dhabi,
United Arab Emirates

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.

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.

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).

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).

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*

Common English Name	Latin name (Genus species)	Common English Name	Latin name (Genus species)
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

ACG Phase 1 Technical Appendix 12

Cultural Heritage

BP EXPLORATION (CASPIAN SEA) LTD
BAKU, AZERBAIJAN

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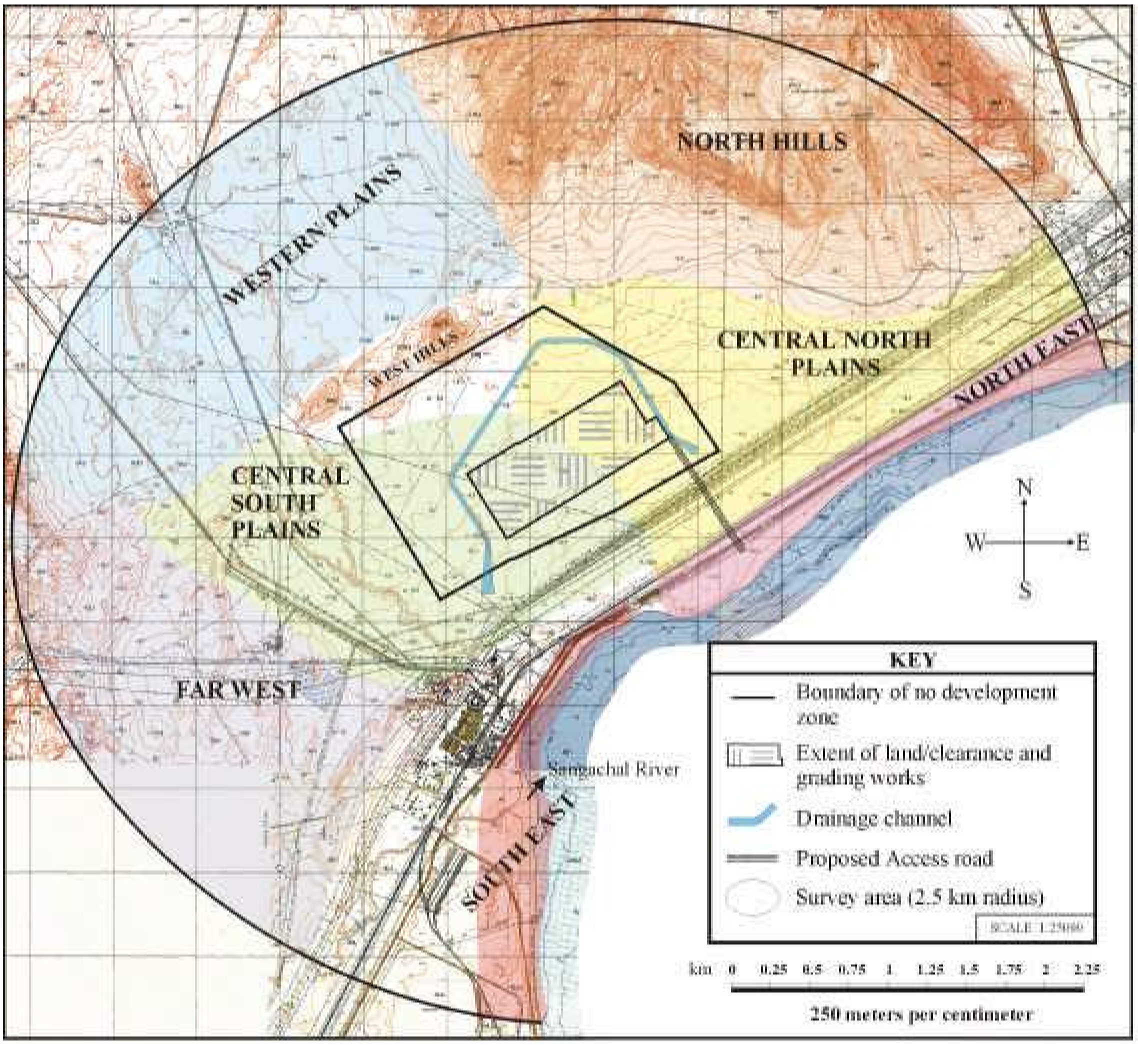
1 Introduction

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

ACG Phase 1 Upstream 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 Many/scattered	☐ ☐	Grouped/dense *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 C*omparative 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 tombstones (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*

FINAL REPORT

ACG Phase 1 Technical Appendix 13

Socio-Economic Baseline Data Gathering

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Contents

1. Preamble

The Technical Appendix describes the approach used in gathering socio-economic baseline data for the Environmental and Social Impact Assessment (ESIA) of the Azeri, Chirag and Gunashli (ACG) Phase 1 development. Earlier environmental and socio-economic assessment scoping studies had found that there were a number of gaps in the data available with respect to the social and economic environments in and around the proposed ACG Phase 1 development. The ACG Phase 1 ESIA data gathering process was designed to provide sufficient data to properly inform the ESIA process.

The socio-economic baseline data gathering was undertaken by URS with assistance from the Azerbaijani consulting company, Synergetics, who attended the majority of field visits and meetings alongside URS. In addition, Synergetics assisted with some of the data collection. Working in conjunction with Synergetics contributed to the collection of data in a more culturally sensitive and relevant manner by those with local knowledge, whilst still complying with internationally accepted practices and methods.

2. Approach to data collection

Socio-economic information for different spatial levels gathered - local, regional and national. Information on the local setting was essential to ascertain the site-specific impacts of the proposed developments. Data gathering focused on the area around the Sangachal terminal and associated utilities, but also considered nearshore, coastal and offshore issues such as fishing and shipping. Meanwhile, information on the regional and national development context allowed consideration of the wider economic and social impacts, for example, contribution to regional economic development, improvement in labour force skills, effect on population structure and impact on demand for services. The following information was sought wherever possible:

2.1 Regional and Local

- population, including demographics, centres of population and migration patterns;
- social development indicators and social infrastructure including education, health, recreation, unemployment, employment, refugees, ethnic tension, customs;
- social organisation including group hierarchy, household models;
- social development priorities;
- economic activity including economic activities, employment and labour market, community structure, distribution of income, goods and services;
- employment and income levels;
- cultural heritage, including cultural and religious buildings and any other distinctive features;
- development priorities and activities of development programmes especially the strategic context of the coast in regional development, and
- land use patterns including shipping, fishing, aquaculture, tourism and recreational amenities and activities.

2.2 National

- macro economic situation;
- economic activity including industry, agriculture, fishing and services;
- employment;
- trade;
- population including demographic and ethnic groups;
- social development indicators and social infrastructure including education, health, recreation;
- social organisation and politics, and
- development priorities, options and activities of national development programmes.

The above information was sourced via:

- collection and interpretation of secondary data sources,
- field visits
- survey data and
- consultation with key stakeholders

2.3 Secondary data sources

Secondary data sources included published government statistics, ministry data, IFI, UN and NGO research, published and unpublished socio-economic studies and regional development plans. Full details of all secondary data sources used during the compilation of the baseline are listed in the ESIA References. Footnotes throughout the baseline report provide references to the secondary data used.

Sources were reviewed to ensure data was relevant, reliable and up-to-date. As a result, various caveats apply to the information gathered from the secondary data sources. These caveats have been outlined in the introductions to, and footnotes for, the regional and local sections of the socio-economic baseline, ESIA Chapter 7.

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.

2.4 Field visits

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. Table 1 below details those consulted and the consultation method used. Field visits were undertaken by both URS and BP and information for the socio-economic baseline was drawn from both.

2.4.1 URS field visits

Questionnaires were used as the basis for collecting information during site visits and consultations. These questionnaires sought to gather information on topics such as economic activity, health and education. Two types of questionnaires were developed and used during the data gathering process. One questionnaire focused on individual households, whilst the other was for commercial entities. These questionnaires provided structure and consistency to the interview approach, in addition to providing a documented record of discussions. All those interviewed , with one exception, were made aware of the nature and purpose of the interview and questionnaire process. One field visit to the Central North herding settlement resulted in the fieldworker engaging herders in conversation without explaining the purpose of the visit. The information from the field notes gathered from this conversation has been used along with other data to build a picture of the socio-economic parameters of the herding community as a whole.

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.

In addition the cultural sensitivity to providing outsiders with information, oral or written combined with the sensitivity of individuals to being identified as information givers, may also have affected the reliability of the information given.

2.4.2 BP field visits

BP undertook a number of field visits to conduct interviews with affected stakeholders. For each of these interviews the nature and purpose of the visit was explained. For the majority of interviews and independent Azerbaijani sociological specialist was either present at the interviews and/or had time alone with the interviewees. In addition BP have undertaken a number of interviews and field visits as part of the proposed Resettlement Action Plan (RAP). Information from the RAP process has been drawn on for the purposes of the socio-economic baseline.

Survey data

In addition to the field visit interviews BP also undertook a sociological survey of the Sangachal/Umid/Primorsk area for the purposes of the BP Social Investment Programme. This survey was conducted by the Azerbaijan-Holland Friendship society. Although information from this survey has been included in the socio-economic baseline there were a number of methodological difficulties with the survey that rendered the data unreliable. The data has been used for illustrative purposes only and to indicate general trends.

Table 1 Field visits undertaken

Organisation	Individual	When	Attendees	Information requested	Data output
Umid Settlement	Head of Garadag Executive Power Representation	5/7/01	URS and Synergetics	Household questionnaire	Completed questionnaire
Garadag Executive Power	Socio-economic development department	23/7/01	URS and Synergetics	List of socio-economic data	Socio-economic data report
Garadag Executive Power	Secretary in Charge and Sangachal District Representative	5/7/01	URS and Synergetics	Household questionnaire	Completed questionnaire
Railway barrier operator	-	5/7/01	URS and Synergetics	General conversation	Notes/minutes
15th century historical restaurant (Caravansari)	Security guard	5/7/01	URS and Synergetics	General conversation	Notes of meeting
'Firuza' stone mine	Employee	5/7/01	URS and Synergetics	General conversation	Notes of meeting
'Firuza' stone mine	Director	27/08/01	BP	General conversation to ascertain scale of current activity and focus on power supply	Notes provided by BP
Central north herding settlement	Male representative	24/4/01	URS	General conversation	Notes of meeting
West hills herding settlement	Nobody present during visit	5/7/01	URS and Synergetics	N/A	N/A
Herding supervisors	Individual herding supervisors	15/09/01 and 28/09/01	BP and social scientist	General conversation to ascertain scale and nature of current activities	Notes provided by BP
Café/garage owner	Manager	18/10/01	BP	General conversation to ascertain scale of current activity	Notes provided by BP

2.5 Consultation with key stakeholders

As part of the execution plan for the socio-economic baseline, URS compiled a list of relevant stakeholders. It was proposed that these stakeholders be contacted to source information. However, URS were advised by BP[2] that as a result of the extensive data collection already being undertaken by ERM in completing the ACG Phase 1 Mid-Stream SIA that the information held by ERM be accessed, rather than submitting further data requests to these stakeholders. As a result URS made contact with a limited number of stakeholders only and not the 'full' list as initially envisaged. The full ACG Phase 1 development project was not discussed at these meetings. The meetings were held to gather broad information on social issues and the role of civil society in Azerbaijan. Those stakeholders consulted are detailed in Table 2 below.

Table 2 Stakeholder meetings

Organisation	Individual	When	Who was in attendance	Information requested	Data output
ISAR	Sara Feinstein	June, 2001	URS	Any information regarding social development programs outside the NGO arena	Information collated into ACG ESIA Socio-economic Baseline chapter
ASPA	Azer Karayev	June, 2001	URS	Curent projects statuses and sources of funding	Information collated into ACG ESIA Socio-economic Baseline chapter
Know How Fund, Ministry of Finance, Azerbaijan	Jacob Nell	June, 2001	URS	Any information regarding social development	Information collated into ACG ESIA Socio-economic Baseline chapter
Caspian Fish Company	Representative	27/06/01	URS	Input and output statistics by species over time	'FISHERY' Report provided by Aleksey Aleberov
Azer Fishery State Concern	Representative	28/06/01	URS	Data on fishing activities in the Caspian and specifically in Sangachal Bay (e.g catch levels, species caught, how caught, no of employees, markets)	Notes of meeting
Azer Fishery State Concern	Representative	05/07/01	URS		Notes of meeting
Fisheries Institute	Representative	06/07/01	URS		'CASPIAN FISHERY' Report provided by Zulfugar Guliyev

[2] Conference call on 16/6/01. Attendees included Richard Kingham, Rebecca Middleton, Karen St-John, Steve Makin, Mike Brown, Coos, Garry Stevenson, Fiona Bayne.