6 Environmental Description

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6.1 Introduction

This Chapter describes the terrestrial and marine environments associated with the Shah Deniz Stage 2 (SD2) Project. Four geographic zones are defined:

- Terrestrial: Vicinity of the Sangachal Terminal (including the area between the Terminal and the Baku-Salyan Highway);
- Coastal: The zone between the Baku-Salyan Highway and the Caspian Sea shoreline, including the Azerbaijan coastline for relevant regional coastal aspects e.g. birds;
- Nearshore: Sangachal Bay from the Caspian Sea shoreline to a water depth of approximately 12m; and
- Offshore**:** From the 12m water depth within Sangachal Bay, along the proposed SD2 subsea export pipeline corridor to the SDB Platform Complex and subsea infrastructure locations within the Shah Deniz (SD) Contract Area.

Figure 6.1 presents the key terrestrial, coastal, nearshore and offshore locations associated with the SD2 Project.

6.2 Data Sources

Between 1994 and 2004, environmental surveys focused on investigating baseline conditions for terrestrial and marine flora and fauna, air quality, noise and contamination. Since 2004, the Environmental Monitoring Programme (EMP) has collected data on:

- Ambient air quality at selected receptors in the vicinity of the Terminal;
- Soil, groundwater and surface water conditions from boreholes and surface water sampling points in the vicinity of the Terminal;
- Terrestrial flora, fauna and soil stability within the Terminal surrounds;
- Ongoing bird surveys in and around Sangachal Bay;
- Marine benthic flora and fauna; and
- Water quality and plankton surveys.

The primary aim of the EMP is to develop reliable and consistent time series data for each location within a clearly defined survey area to enable long-term trends to be identified.

Offshore baseline benthic and water column surveys have been undertaken across the SD Contract Area since 1998. The initial benthic survey, undertaken in 1998, in support of the exploration drilling ESIA, has been followed by more than 20 surveys between 2000 and 2011[1].

Under the SD Production Sharing Agreement (PSA), responsibility for the preparation and approval of environmental surveys associated with the EMP rests with the Environmental Sub-Committee (ESC), which carries out an annual review of planned survey activities. The ESC comprises representatives of key stakeholders such as the State Oil Company of Azerbaijan (SOCAR), the Council of Ministers, the Ministry of Ecology and Natural Resources (MENR) and the Azerbaijan National Academy of Sciences (ANAS). Practical supervision and review of ongoing activities is delegated to the ACG & SD Environmental Monitoring Technical Advisory Group (EMTAG), which comprises environmental specialists representing these organisations.

In addition to the ongoing EMP surveys, a number of specific surveys for the SD2 Project have been undertaken to gather additional environmental data. These include noise, odour, visual context, light, dust, hydrology, soil and groundwater, wetland and cultural heritage surveys, as well as offshore benthic and water column surveys at all manifold locations and the SDB Platform Complex.

[1] Results of the baseline survey associated with SD2 Project are discussed in Section 6.7 below.

A list of all relevant surveys completed since 1996 is provided in Table 6.1[2].

Table 6.1 Relevant Terrestrial/Coastal, Nearshore and Offshore Surveys and Studies, 1996-2012

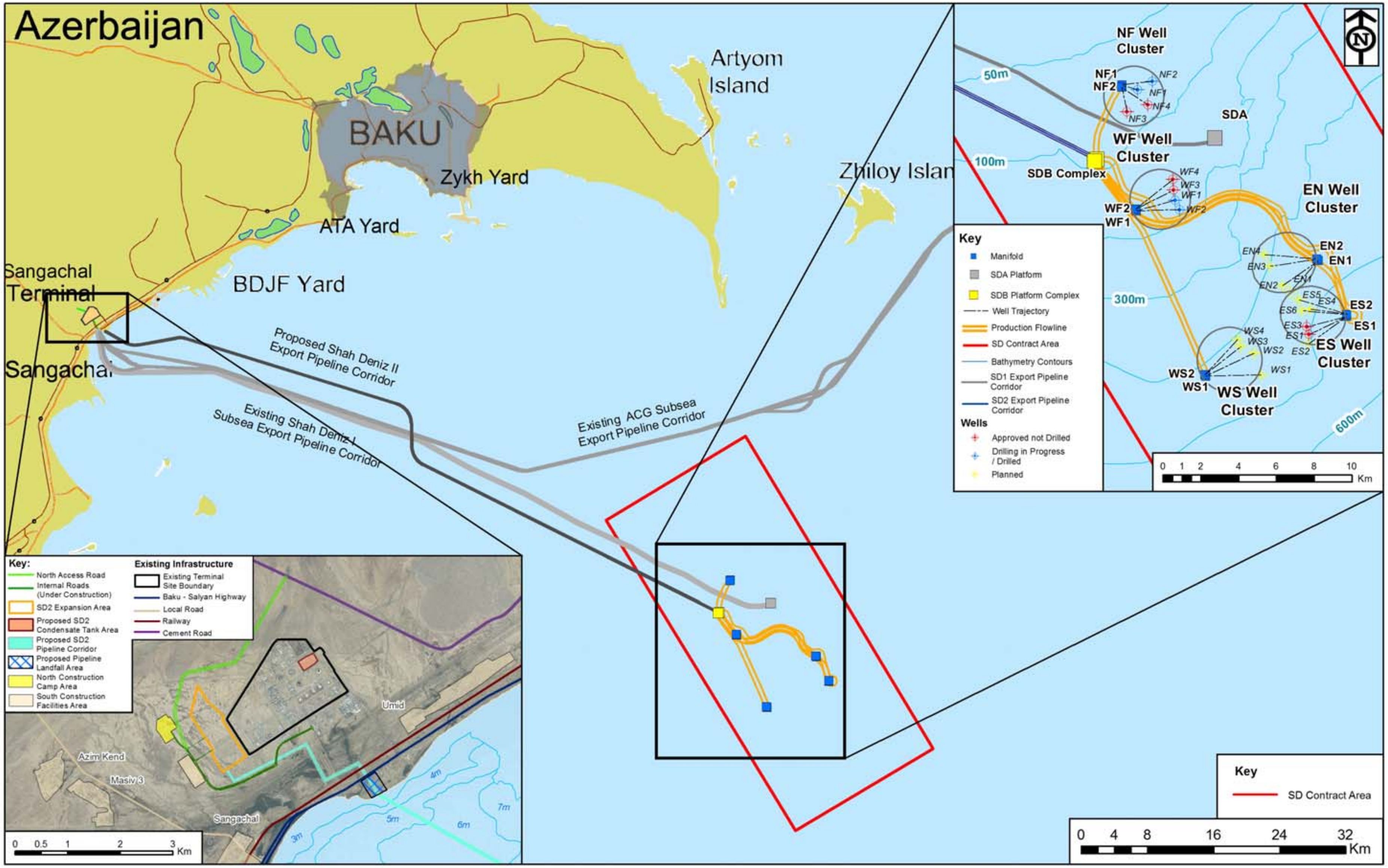
Date	Title of Survey	Survey ID.
Terrestrial/ Coastal Surveys		
1996	EOP Sangachal Terminal Survey	TS001
1996	Sangachal Coastal Environmental Survey	TS002
2000	Sangachal Coastal Environmental Survey	TS003
2001	Terrestrial Soil and Groundwater Survey	TS004
2001	Phase 1 Terrestrial Survey	TS005
2002	Phase 2 Terrestrial Survey	TS006
2003	Sangachal Terminal Watershed Analysis	TS007
2003	Sangachal Wetlands Survey Summer/Autumn 2002	TS008
2003	Overwintering Bird Survey, Absheron to Kura	TS009
2004	Overwintering Bird Survey, Absheron to Kura	TS010
2004	Breeding Bird Monitoring Survey Sangachal	TS011
2004	Winter Waterfowl Monitoring Study, Absheron to Kura	TS012
2004	Integrated Terrestrial Ecosystem Monitoring Survey - Spring	TS013
2004	Integrated Terrestrial Ecosystem Monitoring Survey – Autumn	TS014
2005	Integrated Terrestrial Ecosystem Monitoring Survey - Spring	TS015
2005	Integrated Terrestrial Ecosystem Monitoring Survey – Autumn	TS016
2005	Breeding Bird Survey, Sangachal	TS017
2005	Winter Waterfowl Monitoring Study, Absheron to Kura	TS018
2006	Winter Waterfowl Monitoring Study, Absheron to Kura	TS019
2006	Sangachal Terminal Ambient Air Quality Monitoring	TS020
2006	Sangachal Terminal Terrestrial Monitoring Survey - Spring	TS021
2006	Sangachal Terminal Terrestrial Monitoring Survey - Autumn	TS022
2006	Ambient Ground and Surface Water Monitoring	TS023
2006	Onshore Ambient Monitoring (Sangachal): Hydrology & Hydrogeology – Phase I	TS024
2006	Noise Monitoring Report. Sangachal Environmental Team	TS025
2007	Sangachal Terminal Ambient Air Quality Monitoring	TS026
2007	Sangachal Terminal Terrestrial Monitoring Survey - Spring	TS027
2007	Sangachal Terminal Terrestrial Monitoring Survey - Autumn	TS028
2007	EMP onshore ambient monitoring (Sangachal): Hydrology & Hydrogeology Analysis & Monitoring System Phase I	TS029
2008	Sangachal Terminal Bird Survey Report	TS030
2008	Sangachal Terminal Ambient Air Quality Monitoring	TS031
2008	Onshore Ambient Monitoring (Sangachal): Hydrology & Hydrogeology – Phase II	TS032
2008	Sangachal Terminal SD2 Expansion Area Flora and Fauna Survey	TS033
2008	Sangachal Terminal – Surface and Subsurface Water and Landscape Management Study	TS034
2008, 2009	Hydrological Survey Report	TS035, TS036
2009	Sangachal Terminal Bird Survey Report	TS037
2009	Sangachal Terminal Ambient Air Quality Monitoring	TS038
2009	Onshore Ambient Monitoring (Sangachal) Bird Monitoring Survey Report	TS039
2009	Terrestrial Monitoring Survey Report - Spring & Autumn	TS040
2010	Sangachal Terminal Bird Survey Report	TS041
2010	Soil & Vegetation Survey Report - Spring & Autumn	TS042
2010	Sangachal Ambient Air Quality Monitoring	TS043
2010	Sangachal Terminal Baseline Noise Survey	TS044
2010	Sangachal Terminal Light Baseline Survey Report	TS045
2010	Sangachal Terminal Odour Assessment	TS046
2010	Sangachal Terminal Visual Context Baseline Survey Report	TS047

[2] While EMP surveys were completed during 2012 the survey results are not yet available.

Date	Title of Survey	Survey ID.
2010	Sangachal Terminal Phase 2 Expansion: Additional Surface Water Studies	TS048
2010	EMP Onshore Ambient Monitoring (Sangachal): Bird Monitoring Survey Report	TS049
2010	Wetland Survey Report (AMC) – Water & Sediment Analysis	TS050
2010	Soil Bore and Groundwater Monitoring Well Installation, Sampling and Surveying Report	TS051
2010	Monthly Water Level of Monitoring Wells at Sangachal Terminal	TS052
2010	Sangachal Surface and Groundwater Monitoring 2010 1st Round Report	TS053
2010	Sangachal Surface and Groundwater Monitoring 2010 2nd Round Report	TS054
2010	Sangachal Terminal Wetland Flora and Faunal Survey 2010 – *Report in Progress*	TS055
2011	Interpretive Report Geotechnical Investigation SD2 Project Sangachal Terminal	TS056
2011	March 2011 Noise Surveys In Sangachal Terminal Vicinity	TS057
2011	June/July 2011 Noise Surveys In Sangachal Terminal Vicinity	TS058
2011	Traffic Survey in the Vicinity of Sangachal Terminal	TS059
2011	Wetland Characterisation Survey Report	TS060
2011	Cultural Heritage Baseline Surveys Report	TS061
2011	SD2 Early Infrastructure Work Contaminated Land Risk Assessment	TS062
2011	SD2 Early Infrastructure Work Dust Baseline Report	TS063
2011	Sangachal Groundwater and Surface Water Monitoring. Piezometer Installation and Monitoring Report	TS064
2011	Sangachal Terminal Ambient Air Quality Monitoring – *Report in Progress*	TS065
2011	Monitoring on Birds around the Sangachal Terminal – *Report in Progress*	TS066
2011	Sangachal Terminal Wetlands Faunal Survey – *Report in Progress*	TS067
2011	Soil and Vegetation Survey Report Spring Autumn 2011 – *Report in Progress*	TS068
2012	Wetlands Area Soil and Water Contamination Assessment for Land Adjacent to Sangachal Terminal	TS069
Nearshore Surveys		
1996	Pipeline Landfall Survey: Sediments and Macrobenthos	CS 001
2000-2005	Sangachal Fisheries Monitoring Programme	CS 002
2000	Sangachal Repeat Survey (Baseline)	CS 003
2000	*In situ* Biomonitoring: Baseline Studies in the Laboratory and at Sangachal Using the Bivalve Mollusc *Mytilaster lineatus* (Gmelin)	CS 004
2001	Sangachal Seabed Mapping Survey	CS 005
2002	Repeat Sea Grass and Red Algae Studies in Sangachal Bay	CS 006
2003	Biomonitoring at Sangachal (Sept-Dec 2003)	CS 007
2003	2003 Sea Grass Studies in Sangachal Bay	CS 008
2003	Sangachal Seabed Survey	CS 009
2004	Sangachal Offshore Survey	CS 010
2004	Sangachal Metocean Study	CS 011
2004	Biomonitoring at Sangachal (May-Sept-Dec 2004)	CS 012
2004	Monitoring the Impact of Pipeline Trenching Operations in Sangachal Bay	CS 013
2004	Trenching Monitoring	CS 014
2005	Fish Monitoring Sangachal Bay 2005	CS 015
2006	Sangachal Bay Benthic Survey	CS 016
2006	Mapping of Sea Grass in Sangachal Bay, Azerbaijan Using Drop-down Video and Acoustic Remote Sensing	CS 017
2008	Mapping Sea Grass in Sangachal Bay, Azerbaijan	CS 018
2008	Sea Grass Taxonomy and Weight Analysis Report: Based on Ninel Karavera (Botany Institute Specialist) Reports	CS 019
2008	Sangachal Bay Sediment and Plankton Survey	CS 020
2008	Mapping Sea Grass in Sangachal Bay, Azerbaijan	CS 021
2008	Fish Monitoring Sangachal Bay	CS 022
2009	Fish Monitoring Sangachal Bay	CS 023
2010	Sangachal Bay Environmental Survey	CS 024
Offshore Surveys - SD Contract Area		
1998	SD Contract Area Baseline Benthic Survey	MS 001
2000	SDX-1 Well Post-drilling Benthic Survey	MS 002
2001	Shah Deniz Stage 1 Platform and Baseline Survey	MS 003
2001	SD Contract Area Pipeline Benthic Survey	MS 004

Date	Title of Survey	Survey ID.
2001	SD Alpha Platform Location Baseline Benthic Survey	MS 005
2002	SDX-3 Post Well Monitoring Survey	MS 006
2005	SDX-4 Baseline Benthic Survey	MS 007
2005, 2007	SD Alpha Platform Benthic Survey	MS 008 MS 009
2005, 2007	SD Contract Area Regional Water Quality/Plankton Survey	MS 010 MS 011
2006	SDX-5 Baseline Benthic Survey	MS 012
2008	SDX-6 (NF1) Baseline Benthic Survey	MS 013
2008	Shah Deniz Regional Environmental Survey	MS 014
2009	WF1 Baseline Survey	MS 015
2009	Shah Deniz Regional Environmental Survey Report 2009	MS 016
2011	Environmental Survey around Shah Deniz Stage 2 East South Manifold Location	MS 017
2011	Environmental Survey around the SD2 Bravo Platform Complex – *Report in Progress*	MS 018
2011	Environmental Survey around the SD2 East North Manifold Location – *Report in Progress*	MS 019
2011	Environmental Survey around the SD2 West South Manifold Location – *Report in Progress*	MS 020
Offshore Surveys - Pipeline		
2006	ACG Pipeline Post Installation Survey	MS021
2008	ACG Pipeline Survey	MS022
2010	ACG Pipeline Survey	MS023

Figure 6.1 Key Onshore and Offshore Locations Associated with the SD2 Project



6.3 Physical Environment

6.3.1 Seismicity

The Caspian region, which is part of the Eurasian continental plate, has a convergent plate boundary with the Arabian and Indian continental plates. This has led to the destruction of an ocean (Tethys), which lay, between Eurasia to the north with Africa and India forming its southern shores. The mountain chains of the Alps, Caucasus and the Karakorum/Himalayas are composed of upthrusted rocks formed in, and around, this ancient ocean. Convergent plate movements are associated with relatively high levels of seismic activity and typically accompanied by earthquakes and volcanism.

The Southern Caspian area is defined by the Scythian microplate, as part of the Russian plate, the Turanian, Iranian and small Caucasian plates, as well as the South Caspian microplate. Current neotectonic (more recent) processes are leading to convergent movements of these plates of 1.8cm/year in the Caspian[3]. Convergent plate movements are generally associated with relatively high levels of seismic activity. Five earthquakes with a magnitude greater than 6.0 on the Richter scale have occurred in Azerbaijan since 1842 with the most recent, measuring 6.5, on 25th November 2000 with an epicentre 30km east-north east of Baku.

6.3.2 Climate

Climatic data, with the exception of wind and rainfall data, for the period 1977 to 2000 has been collected from the meteorological station at Alyat which is located approximately 25km south of Sangachal.

6.3.2.1 Temperature

The onshore Sangachal area is classified as being warm, semi-arid steppe, with an annual mean air temperature of 14.4 degrees Celsius (°C). July is the warmest month of the year with a 23-year mean average air temperature of 26.4°C between 1977-2000. January is the coldest month with an average of 0°C. Temperature extremes of –16°C and 41°C have been recorded historically in January and July, respectively.

6.3.2.2 Precipitation

The onshore Sangachal area is one of the driest in Azerbaijan. Rainfall data is collected from Alyat, Baku and Mashtaga. Mean annual rainfall in Baku from 1992 to 2006 was 263mm. The highest monthly rainfall from 2002 to 2006 was 184mm in December 2002. October to February are wet months which receive an average of 41 to 79mm rain/month, with drier months occurring from July to August which receive an average of 1 to 5mm rain/month.

Table 6.2 presents average monthly rainfall data from the meteorological station at Baku from 2002 to 2006.

Table 6.2 Average Monthly Rainfall Data (Baku) 2002 to 2006

	J	F	M	A	M	J	J	A	S	O	N	D
Average monthly rainfall (mm)	41	43	25	31	20	10	5	1	24	46	46	79

6.3.2.3 Wind

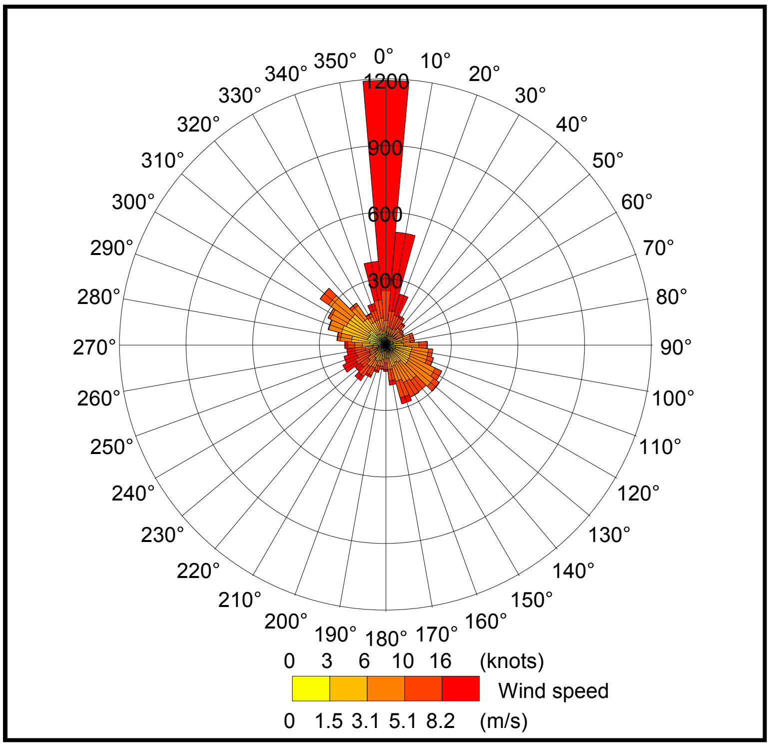
The wind regime in Sangachal Bay is generally consistent with that for the Absheron Peninsula, although it is recognised that there is a local thermally driven wind system. The effects of the local system are most noticeable offshore within the Bay, resulting in a slight (1m/s to 2m/s) offshore wind during the early hours of the morning, which reduces and becomes a stronger onshore wind as the land heats up during the warmer months of the year. This thermal influence,

[3] Karabanov, Institute of Geology, *pers comm*.

coupled with the meteorological dynamics of the region, can result in strong winds occurring with little forewarning.

Figure 6.2 shows a wind rose compiled from data collected during 2007 at Baku Airport[4]. The predominant wind direction is north, occurring approximately 15% of the year. North-north-westerly and north-north-easterly winds account for approximately 10-12% of other winds. Wind speeds typically range from 0.5m/s to 12m/s with approximately 30% of winds being greater than 8m/s.

Figure 6.2 Annual Wind Rose (Baku Airport), 2007



6.4 Terrestrial Environment

6.4.1 Setting

The existing Terminal, occupying an area of approximately 5.5km^2, is sited on a plain sloping gently towards the south east and to the Caspian Sea. The elevation of the Terminal site is around 15m to 20m below Mean Sea Level (MSL) (the mean level of the Caspian Sea is about 27 to 28m below MSL). There are a number of steeper hills to the north and north east of the Terminal rising to over 300m to the north and 400m around Mount (Mt) Qaraqush, a large mud volcano, which last erupted in 2000. The nearest hills lie to the northwest with a mean height of 70m to 85m above MSL.

There are four main settlements in the vicinity of the Terminal (Figure 6.1), the largest being Sangachal Town located approximately 2.5km southwest. Umid lies less than 1km to the southeast of the Terminal, and Azim Kend and Masiv 3 are located approximately 2.7km to the west.

Umid and Sangachal Town are adjacent to the Baku-Salyan Highway, a four lane hard-surfaced road that runs parallel to the Caspian Sea coastline. A raised railway line (2m to 4m above ground level) runs parallel to the highway, between the highway and the Terminal. Multiple underground and aboveground pipelines (oil, water and gas pipelines) also run parallel to the highway between the railway and Terminal within a third-party pipeline corridor.

[4] The anemometer is located 10m above ground level.

Other nearby industrial development includes the state-owned power station located between the Terminal and Sangachal Town which started operation at the end of 2008. The Sangachal Power Station has been designed to produce electricity using generators powered by gas combustion with the option of using heavy fuel oil.

Watercourses in the Terminal vicinity include:

- Shachkaiya Wadi - Flows from the Shachkaiya hills north of the Terminal and passes to the west of the Terminal area towards the Caspian Sea; and
- Umid Wadi - Located east of the Terminal.

A wetland area is located between the Terminal and the Baku-Salyan Highway.

A drainage channel has been constructed around the northern, western and eastern perimeters of the Terminal to protect it from potential flooding. The channel diverts floodwaters into existing natural drainage lines which exist between the Terminal and the Caspian Sea.

The coastal zone, between the Baku-Salyan Highway and the Caspian Sea shoreline, comprises a platform of layers of limestone and marine sediments. The landward slope has been quarried away for sand/aggregate. To the seaward, there is a limestone platform sloping down to the water's edge, with small areas of exposed finer material.

The SD2 Early Infrastructure Works (EIW) which comprise the civil works at the Terminal required to expand the Terminal for the SD2 Project, are currently underway.

It is assumed that at the time of the handover to the Main SD2 Construction Works contractor, the following EIW activities will be completed:

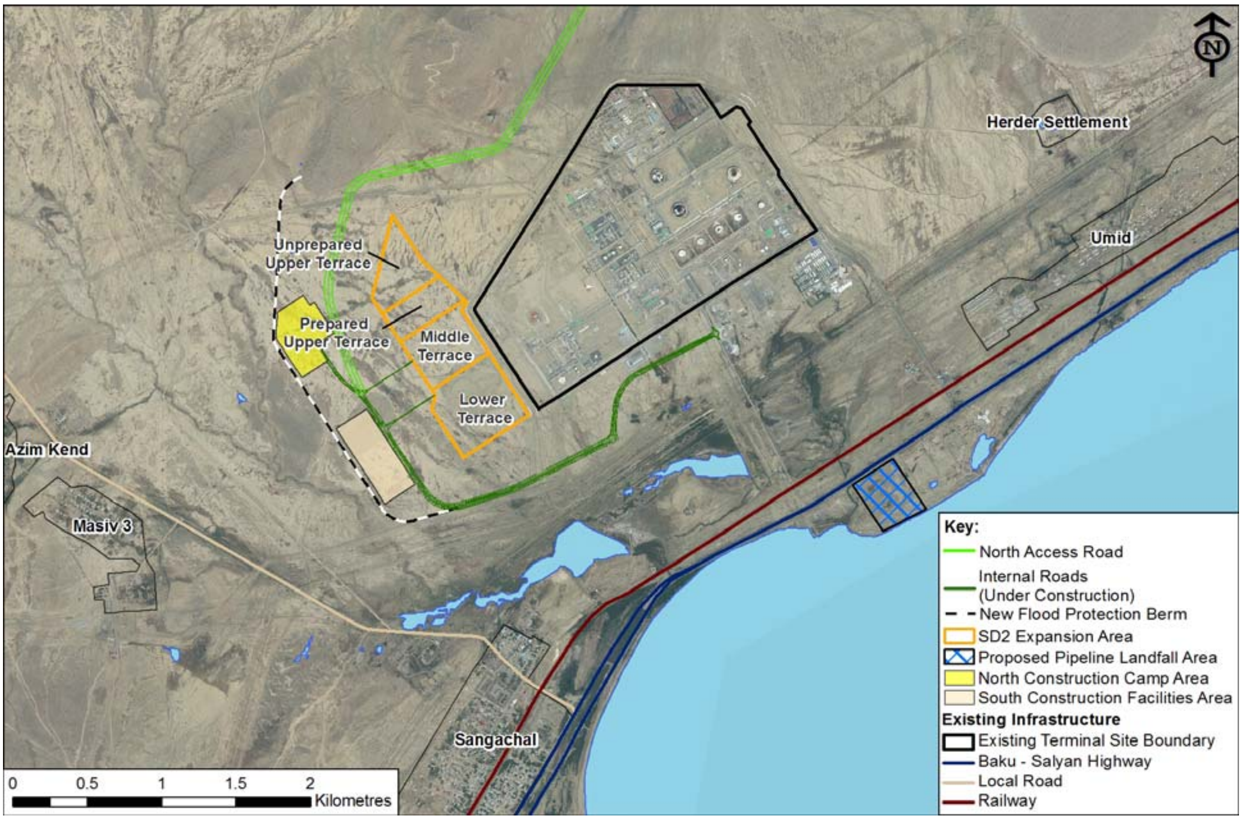
- Clearing and levelling of the terraces in the SD2 Expansion Area;
- Construction of a new access road;
- Construction of a flood protection berm; and
- Installation of a storm drainage system between the flood berm and the SD2 Expansion Area.

The impacts associated with these activities were previously assessed with the SD2 Infrastructure Project ESIA[5]. Figure 6.3 shows the scope of the SD2 EIW as assessed.

In addition to the works above, it is expected that the majority of the area between the flood protection berm and the SD2 Expansion Area would have been disturbed throughout the EIW and it is likely that the areas for the construction camp and construction facilities will have been cleared and levelled.

[5] SD2 Infrastructure Project ESIA (2012)

Figure 6.3 Scope of the SD2 EIW as Assessed within the SD2 Infrastructure ESIA

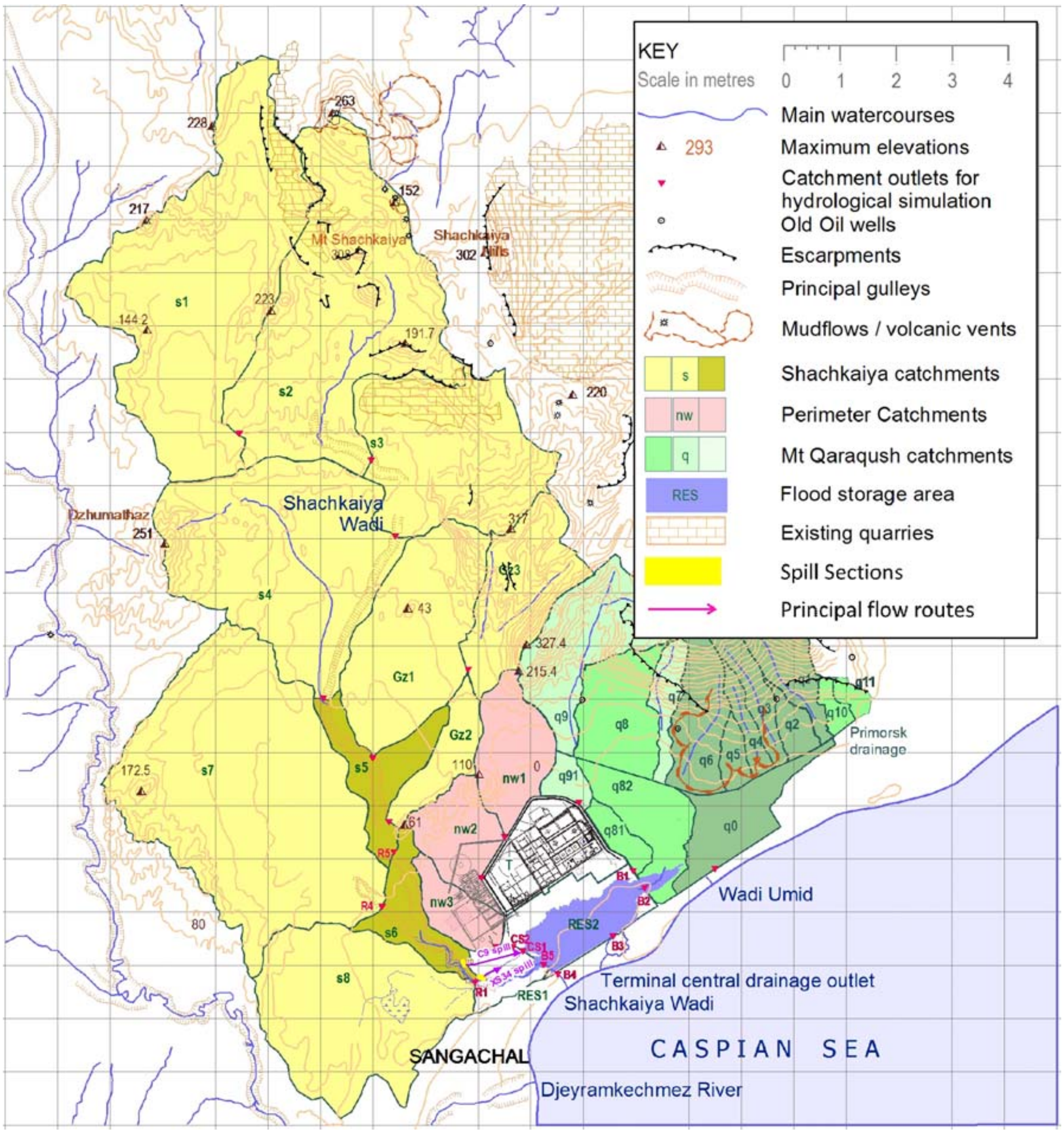


6.4.2 Hydrology

The hydrology in the vicinity of the Terminal area is complex due to its position within a number of drainage catchment areas (refer to Figure 6.4) which are:

- Shachkaiya catchment areas (the Shachkaiya Wadi and its western tributaries);
- Northern and western perimeter catchment areas;
- Flood storage areas between the Terminal and railway embankment;
- Mt Qaraqush catchment areas which comprise:
    - Western Qaraqush slopes and north east perimeter channel;
    - Central Qaraqush slopes and Umid Wadi outlet; and
    - Eastern Qaraqush slopes and rubbish dump draining towards Primorsk.

Figure 6.4 Main Drainage Catchment Areas in the Vicinity of the Terminal



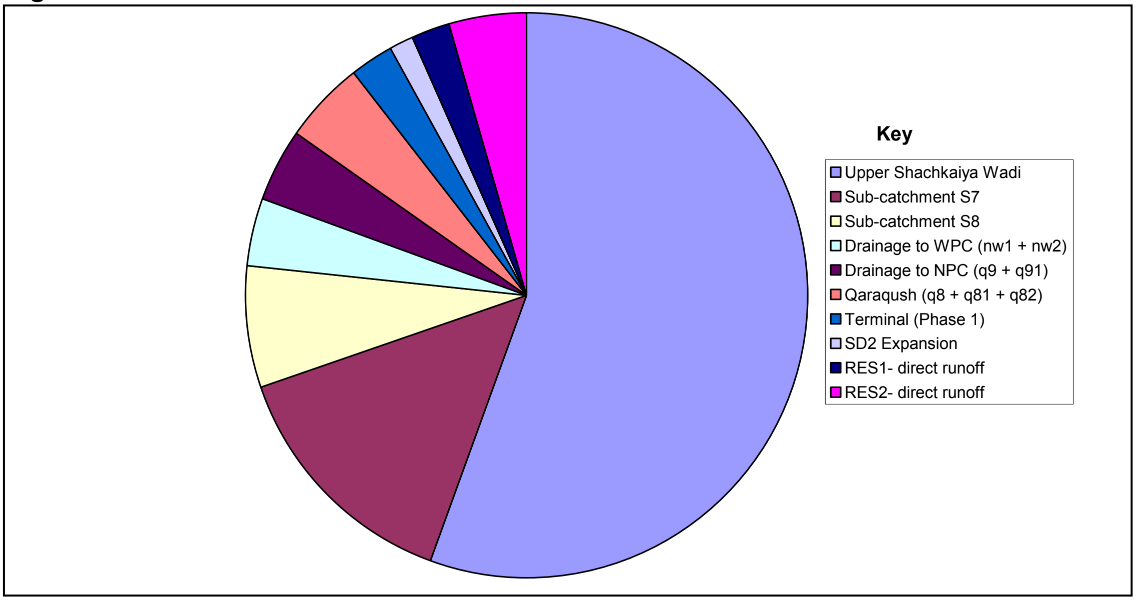
© Water Resource Associates Ltd. Based on Soviet mapping at 1:50,000 scale, with WRA data added.

The catchment area within the vicinity of the Terminal (and the SD2 Expansion Area) is 135km^2 which includes low-lying areas to the south east along the third-party pipeline corridor. The catchment area has two outlets which pass through the railway embankment and coastal highway:

- Bridge ‘B4’ under the railway and culvert B6 under the highway to the south close to Sangachal Town; and
- Bridge ’B3’ under the railway and culvert B9 beneath the highway midway between Sangachal Town and the current Terminal access road.

The Shachkaiya Wadi catchment accounts for 78% of the contributing flow area, upstream of the main coastal railway embankment. The wadi is followed in most part by the main haul road, leading from the quarries in the Shachkaiya Hills, to the north of the Terminal area. The remainder of the water entering the wetlands south of the Terminal is derived from catchments to the north of the existing Terminal. For the 100 year flood event, Figure 6.5 shows the relative proportion of total runoff volume contributed by each grouping of sub-catchments.

Figure 6.5 Relative Contributions of Sub-Catchment Areas to 100 Year Flood Volume



Source: Water Resource Associates (2011).

There are two key flood water storage areas south of the Terminal which flow into the Caspian Sea:

- RES1 (Shachkaiya storage area) - Outflow from this area is controlled by the dimensions of two openings: the proposed B8 box culverts beneath the new access road, and the railway bridge, B4. Storage in this area was estimated to be 0.751Mm^3 at -15m MSL.
- RES2 (central storage area) - The central flood storage area acts as a large, flood attenuation lake. Although the third-party pipeline corridor and associated surface pipes, trenches and bunds act as partial obstacles, they effectively cause dispersal and convergence of flow entering the storage area, and also divert outflow from the Terminal and perimeter channels along the more northerly of the Shachkaiya overspill routes at C9 and XS34. Storage in this area was calculated to be 1.848Mm^3 at -17m MSL.

Hydrological modelling was undertaken taking into account the EIW as assessed within the SD2 Infrastructure Project ESIA (i.e. including the works described in Section 6.4.1 and structures within the North and South Camp and Facilities areas) and the onshore project elements which form part of the SD2 Project (referred to hereafter as SD2 Terminal expansion). Both normal flow conditions and a major flood event (once in 100 years)[6] were considered. It was found that the works associated with the SD2 Terminal expansion would result in the following key changes to the flood regime:

- Normal Flow Conditions - Additional flows into the Shachkaiya Wadi would occur due to increase in runoff. The change to the runoff area compared to the total runoff area that drains to Shachkaiya Wadi would be less than 1%.
- Major Flood Event - Flood waters will be directed to preferentially flow to the flood storage area to the south of the Terminal east of the new access road (RES2). The flow to the east of the new access road will be reduced. The redirection of flow will reduce flood risk in the area south of the Terminal to the east, but will increase the overall area that experiences flooding from a major flood event.

[6] SD2 Infrastructure Project ESIA (2012).

Sensitivity

The key sensitive receptors susceptible to flooding around the Terminal are:

- Sangachal Town;
- Sangachal Power Station;
- The Caravanserai[7];
- The railway; and
- Baku-Salyan Highway

The hydrological modelling completed for the SD2 Terminal expansion showed that Sangachal Town and Sangachal Power Station are at low risk of flooding and the SD2 Terminal expansion would not affect the flood risk at either receptor. The Caravanserai is located in an area at existing risk of flooding. Modelling showed that, while no change to the risk of flooding under normal flow conditions following the SD2 Terminal expansion was predicted, the level of flooding is expected to marginally increase by 2mm during a major flood event due to Terminal expansion works. Under existing conditions the modelling showed that sections of the railway and highway are currently at risk of flooding during a major flood event. However, the modelling showed that the SD2 Terminal expansion would not increase the likelihood or severity of the existing flood risk in these locations. Overall, the risk of flooding at key receptors was shown to either marginally reduce or remain largely unchanged following the SD2 Terminal expansion works.

6.4.3 Geology and Soils

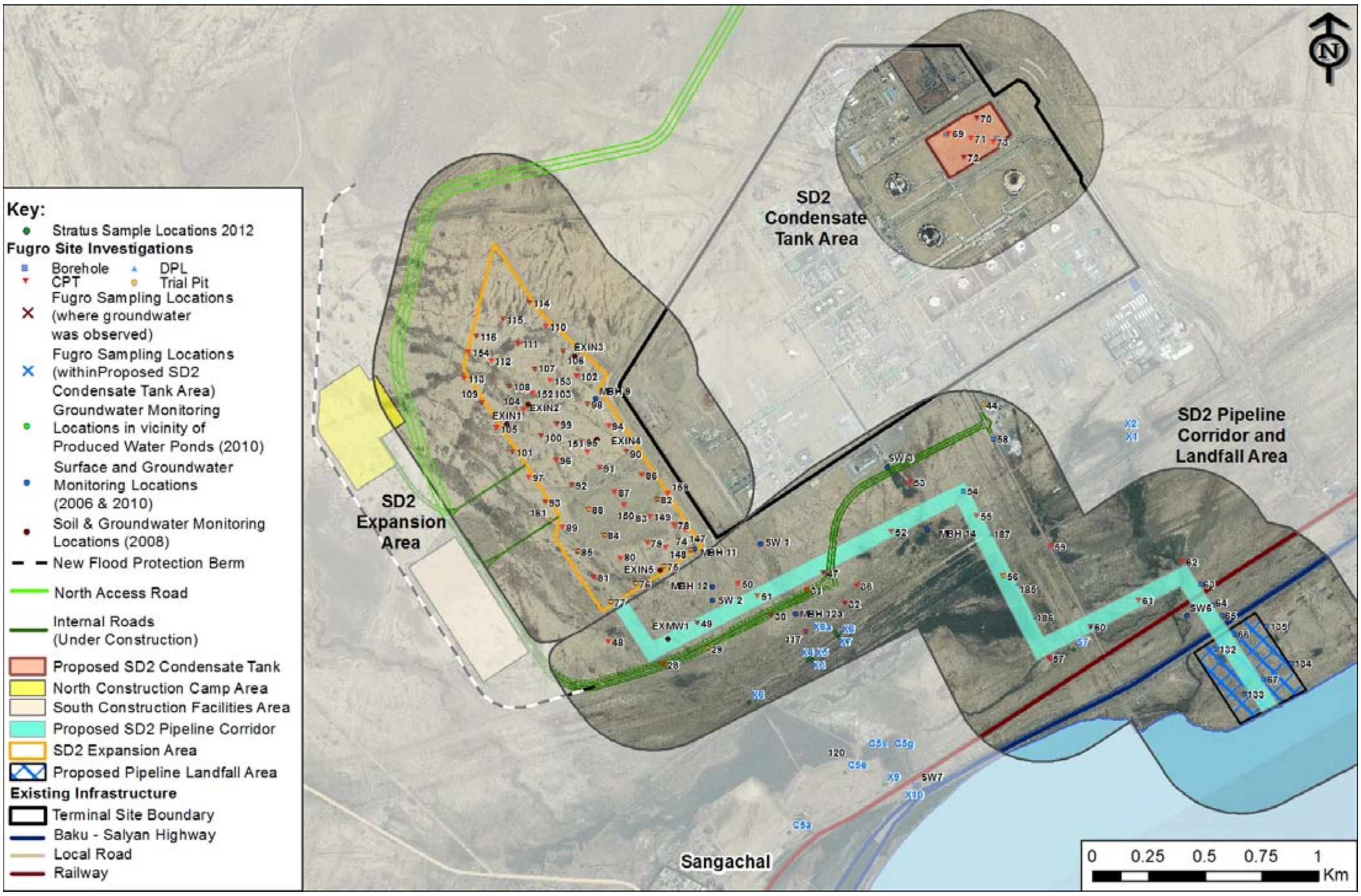
6.4.3.1 Geological Setting

This section focuses on the geology and soil conditions within the three areas of the SD2 Project onshore areas, namely, the SD2 Expansion area, the SD2 Pipeline Corridor and Landfall area and the SD2 Condensate Tank area (Refer to Figure 6.6).

Geological surveys have shown that superficial geology is relatively consistent across these areas and the wider vicinity, generally comprising surface deposits overlying variably weathered sedimentary bedrock units of the Absheron Group (termed Units 2, 3 and 4).

[7] State Protected Monument.

Figure 6.6 Soil and Groundwater Monitoring Locations

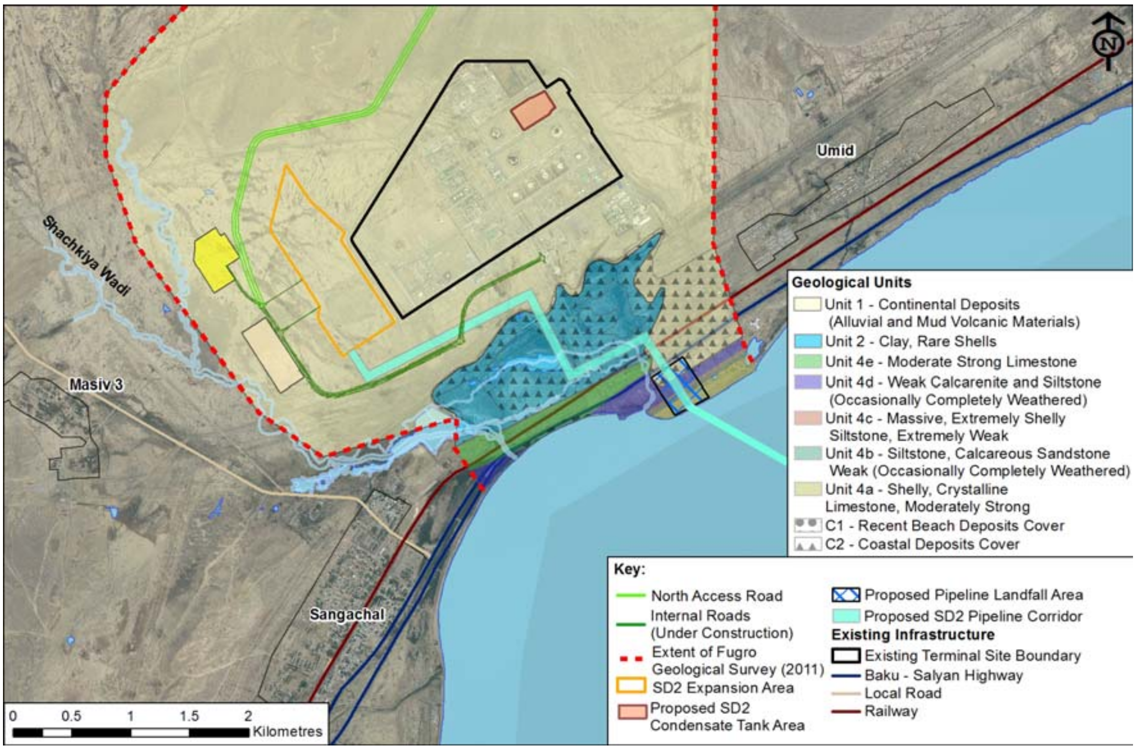


The following geological sequences have been encountered within the exploratory boreholes shown in Figure 6.6 (refer to Figure 6.7 for geological conditions):

- In the north, low permeability alluvial and mud volcanic deposits (Unit 1) are present at ground surface, overlying clayey deposits of Unit 2, which, in turn are, underlain by low permeability Unit 3 deposits. This sequence is encountered within the SD2 Expansion Area, the SD2 Condensate Tank Area and the northern portion of the proposed SD2 Pipeline Corridor;
- Further south, towards the Caspian Sea, a thin cover of coastal deposits (Unit C2) is generally present. These mainly comprise sandy silt and silty sand with shells and gravel but also include fine-grained sediments. Unit C2 mostly overlies Unit 2 deposits but the latter are exposed at surface where the coastal deposits have been eroded away. In the south eastern corner, Unit 1 deposits of volcanic origin remain beneath Unit C2. These conditions are encountered within the central portion of the proposed SD2 Pipeline Corridor; and
- Immediately adjacent to the Caspian Sea, superficial deposits are not present and bedrock geology is dominated by Unit 4 strata (limestones and siltstones). These conditions are encountered within the proposed SD2 Pipeline Landfall area.

With the exception of the SD2 Pipeline Landfall area, therefore, shallow geology within the SD2 Project onshore areas is dominated by low permeability deposits, with occasional thin lenses or layers of higher permeability materials. Regional evidence indicates that these low permeability strata continue to a depth of at least 50m, although drilling within and in the vicinity of SD2 Project areas has only proven them to a depth of 20m. These ground conditions result in soils and any underlying groundwater having a low vulnerability to near-surface releases of contamination.

Figure 6.7 Superficial Geological Conditions in the Vicinity of the Terminal



6.4.3.2 Soil Quality

The monitoring locations associated with soil surveys within and in the immediate vicinity of the SD2 Project onshore areas are shown in Figure 6.6. Inorganic and organic composition data obtained from the surveys are summarised in Tables 6.3 and 6.4, respectively.

Table 6.3 Soil Composition Data Within and Adjacent to the SD2 Project Onshore Areas – Inorganic and General Analytes

Analyte	Unit	Pipeline Landfall and Corridor			SD2 Condensate Tank			SD2 Expansion Area		
		Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Aluminium	mg/kg	3900	19312	34700	18100	23984	31500	14500	22305	28800
Arsenic	mg/kg	0.21	10	19.3	5.7	10	18.7	6.1	12	20.2
Barium	mg/kg	54.8	218	1200	130	162	192	80.9	186	578
Cadmium	mg/kg	0.14	0.46	1.40	0.06	0.18	0.71	0.16	0.44	0.68
Chromium	mg/kg	7.6	31	61.6	22.2	48	65.9	19.2	33	107
Copper	mg/kg	4.5	24	40.7	18.6	31	42.3	21	29	54.9
Iron	mg/kg	28900	28900	28900	ND	ND	ND	30100	36867	50800
Mercury	mg/kg	0.010	0.038	0.090	0.03	0.05	0.08	0.02	0.05	0.12
Manganese	mg/kg	385	685	1850	559	697	862	454	756	7895
Nickel	mg/kg	6.4	27	44.8	19.8	31	38.5	22.1	28	44.8
Lead	mg/kg	4.2	13	113	9.7	13	17.3	9.7	12	23.4
Lithium	mg/kg	9.1	37	55.7	39.2	46	54.4	28.3	47	470
Thallium	mg/kg	10.4	12	**15.6**	7.8	10	14	10.1	12	13
Vanadium	mg/kg	13.2	53	102	40.5	60	78.7	42.8	56	79.4
Zinc	mg/kg	12.6	55	89.5	53.4	67	83.5	45.5	61	113
TOC	mg/kg	<1000	3259	30400	1850	2739	4530	1150	2289	6580

ND = Not Determined.
Mean values are the arithmetic mean of all data points above the analytical limit of detection (LoD).
Values shown in bold are above applicable limit values – refer to Appendix 6E

Table 6.4 Soil Composition Data Within and Adjacent to the SD2 Project Onshore Areas – Organic Analytes

Analyte	Unit	Pipeline landfall and corridor			SD2 Condensate Tank			SD2 Expansion Area		
		Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
TPH										
Sum TPH	mg/kg	<2	26.4	403	<2	10	49	<2	30	611
Aliphatic EC6-8	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1
Aliphatic EC8-10	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1
Aliphatic EC10-12	mg/kg	<1	<1	<1	<1	10	11.9	<1	<1	<1
Aliphatic EC12-16	mg/kg	<1	1.7	5.7	<1	13	16.2	<1	2	2.3
Aliphatic EC16-35	mg/kg	<1	33.8	317	<2	5.2	14.9	<1	12	94.9
Aromatic EC5-7	mg/kg	<0.1	0.53	1.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aromatic EC7-8	mg/kg	<0.1	0.37	0.67	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aromatic EC8-10	mg/kg	<0.1	0.60	1.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aromatic EC10-12	mg/kg	<2	2.5	10.8	<2	<2	<2	<2	<2	<2
Aromatic EC12-16	mg/kg	<2	13.6	67.6	<2	<2	<2	<2	4	4.2
Aromatic EC16-21	mg/kg	<2	<2	<2	<2	<2	<2	<2	8	7.8
Aromatic EC21-35	mg/kg	<2	<2	<2	<2	<2	<2	<2	16	15.9
BTEX										
Benzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Toluene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sum xylenes	mg/kg	<0.02	<0.02	<0.02	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
PAHs										
Naphthalene	mg/kg	<0.5	1.8	8.2	<0.5	0.9	3.1	<0.5	1.6	9.5
Acenaphthylene	mg/kg	<0.5	1.0	2.6	<0.5	<0.5	<0.5	<0.5	2.0	2.8
Acenaphthene	mg/kg	<0.5	1.0	2.8	<0.5	1.4	2.8	<0.5	3.3	14.5
Fluorene	mg/kg	<0.5	4.2	18.2	<0.5	4.9	25.7	<0.5	10.0	53.1
Phenanthrene	mg/kg	<0.5	5.4	21.6	<0.5	2.5	17.8	<0.5	9.9	281
Anthracene	mg/kg	<0.5	4.5	23.7	<0.5	<0.5	<0.5	<0.5	14.4	84.3
Fluoranthene	mg/kg	<0.5	1.7	4.9	<0.5	1.1	2.5	<0.5	4.3	68.3
Pyrene	mg/kg	<0.5	2.7	8.4	<0.5	1.6	7.2	<0.5	3.7	64.9
Benzo(a)anthracene	mg/kg	<0.5	1.9	9.2	<0.5	0.7	1.1	<0.5	7.5	29
Chrysene/Triphenylene	mg/kg	<0.5	6.3	**24.3**	<0.5	2.8	7.7	<0.5	11.2	**322**
Benzo(b+j+k)fluoranthene	mg/kg	<0.5	5.4	19.9	<0.5	2.9	10.7	<0.5	5.1	56.3
Benzo(a)pyrene	mg/kg	<0.5	1.6	5.8	<0.5	0.9	1.5	<0.5	2.8	**15.7**
Indeno(1,2,3-cd)pyrene	mg/kg	<0.5	1.5	4.6	<0.5	1.0	2.8	<0.5	1.4	13.8
Benzo(ghi)perylene	mg/kg	<0.5	3.1	11.2	<0.5	1.8	8.9	<0.5	2.0	17.7
Dibenzo(ah)anthracene	mg/kg	<0.5	1.4	4.6	<0.5	1.0	3.2	<0.5	1.0	6.7
Sum EPA 16 PAH	mg/kg	<0.5	24.8	102	4.5	13.8	32.7	<0.5	36	941
Phenols										
Sum phenols	mg/kg	<0.03	0.3	0.6	<0.03	1.7	6.6	<0.03	1.1	5.0

Mean values are the arithmetic mean of all data points above the analytical LoD.
Values shown in bold are above applicable limit values – refer to Appendix 6E

Table 6.3 shows that metal and metalloid concentrations in the soils are consistent across the SD2 Project onshore areas. Further analysis showed the results are also consistent with soil and dust composition data collected more widely across the region. While a number of the recorded concentrations in the SD2 Project onshore areas are considered relatively high (i.e. arsenic and iron) this is considered to be due to the weathering of minerals within the natural geological units and not the result of contamination.

Organic contamination has not generally been recorded in soil within the SD2 Project areas but elevated concentrations of total petroleum hydrocarbons (TPH), including polycyclic aromatic hydrocarbons (PAHs), have been detected in a small proportion of soil samples.

In the SD2 Condensate Tank Area, TPH was recorded at low concentrations in the majority of samples, reaching a maximum of 40mg/kg in BH69 at 1m below ground level (bgl). PAH, benzene and toluene ethylbenzene and xylene (BTEX) concentrations were very low. Phenol concentrations ranged from non-detectable to 3.3mg/kg. The source of these organic contaminants is believed to be historic leakage of water from the produced water ponds in and adjacent to this area, although the distribution of this will have been limited by geological conditions.

Elsewhere, TPH concentrations are low with only two samples recording a total greater than 100mg/kg: BH84 at 1-2m bgl within the SD2 Expansion Area and MBH25 at 2-8m bgl within the SD2 Pipeline Corridor area. The hydrocarbon in these areas is of high molecular weight (suggesting weathering of historic contamination) and highly localised. Therefore, the potential for distribution of this contamination is considered low.

Given the data, it is considered that unknown local areas of historic hydrocarbon contamination may be present in subsurface soils within SD2 Project onshore areas but that these are unlikely to be extensive or significantly mobile.

Sensitivity

Surveys have shown that metal and metalloid concentrations within the SD2 Project onshore areas are typical for the region.

Concentrations of organic analytes indicate no widespread contamination. However, elevated concentrations of hydrocarbon from historical contamination are present within highly localised areas of soil. Although contaminant distribution is constrained by low permeability of the soils, it could potentially be mobilised by physical disturbance.

Surface soils are considered to be of low general quality supporting little vegetation, which is utilised by livestock. The wetland area through which the proposed SD2 Pipeline Corridor passes has some limited value for grazing (refer to Section 6.4.5.1 for habitat characteristics).

6.4.4 Groundwater and Surface Water Quality

6.4.4.1 Groundwater

Superficial strata generally comprise a significant thickness of low permeability estuarine and mud volcanic clays (Units 1 to 3) through which water permeation is low. Shallow groundwater is therefore only expected to be present in small quantities in occasional seams or lenses of higher permeability materials present within these strata and is likely to be discontinuous.

The absence of a widespread shallow groundwater body is confirmed by monitoring data across the SD2 Project onshore areas and the wider vicinity, with monitoring wells (locations shown in Figure 6.6) generally recording either no or intermittent groundwater presence.

Groundwater was not encountered within boreholes installed in the SD2 Expansion Area. These boreholes generally extended 8-15m below ground level (bgl) into Unit 2 soils, although some were advanced to approximately 40m bgl and penetrated into Unit 3 soils.

Within the proposed SD2 Pipeline Corridor area, groundwater was only encountered in near-surface Unit 2 and/or beach deposit soils that were subject to recharge from surface water within the wetland area. The depth to groundwater in this location was shallow (1-3m bgl). Elsewhere within the proposed SD2 Pipeline Corridor area groundwater was not encountered in boreholes, some of which extended to greater than 40m bgl. Discrete groundwater was, however, present within the Unit 4 deposits investigated within the SD2 Pipeline Landfall area. This is considered to be in hydraulic connectivity with the Caspian Sea, i.e. water levels are mainly controlled by sea level.

Within the SD2 Condensate Tank area, monitoring showed there are waterlogged Unit 1 and upper Unit 2 soils and some discrete groundwater considered to be a result of historical leakage from existing produced water holding ponds in the vicinity, which have been subsequently repaired. Where groundwater levels can be measured, these have generally been recorded at between 2 and 4m bgl. Consistent with the low permeability geological conditions, there is no evidence that this water has migrated more widely.

Inorganic and organic composition data for groundwater within the SD2 Project onshore areas are shown in Tables 6.5 and 6.6, respectively. This data relates to the shallow groundwater within the SD2 Condensate Tank Area and the SD2 Pipeline Landfall and Corridor only as no groundwater was encountered in the SD2 Expansion Area.

Table 6.5 Groundwater Composition Data Within and Adjacent to the SD2 Project Onshore Areas – Inorganic and General Analytes

Analyte	Unit	Pipeline Landfall and Corridor			SD2 Condensate Tank		
		Min	Mean	Max	Min	Mean	Max
pH	---	6.1	6.7	7.3	ND	ND	ND
Conductivity	mS/cm	21.5	75.2	193	ND	ND	ND
Salinity	‰	12.2	47.0	115	ND	ND	ND
Chloride	g/L	0.46	30.2	66.8	ND	ND	ND
Sulphate	g/L	0.27	2.7	6.7	ND	ND	ND
Fluoride	mg/L	<0.025	0.24	1.8	ND	ND	ND
Aluminium	mg/L	<0.02	173.1	902	ND	ND	ND
Arsenic	mg/L	<0.002	**0.18**	**0.86**	**380**	**380**	**380**
Barium	mg/L	0.017	1.0	6.6	ND	ND	ND
Cadmium	mg/L	<0.001	**0.01**	**0.01**	ND	ND	ND
Chromium	mg/L	<0.0005	**0.21**	**1.1**	0.003	0.003	0.003
Copper	mg/L	0.0008	**0.48**	**2.8**	**0.05**	**0.05**	**0.05**
Iron	mg/L	67.5	67.5	67.5	ND	ND	ND
Mercury	mg/L	<0.00001	**0.00084**	**0.0049**	ND	ND	ND
Manganese	mg/L	0.003	3.7	19.6	ND	ND	ND
Nickel	mg/L	0.002	**0.17**	**1.4**	ND	ND	ND
Lead	mg/L	<0.002	0.07	**0.16**	0.01	0.02	0.02
Lithium	mg/L	0.28	1.5	5.5	ND	ND	ND
Selenium	mg/L	<0.005	0.004	0.004	ND	ND	ND
Thallium	mg/L	<0.002	0.029	0.051	0.15	0.15	0.15
Vanadium	mg/L	<0.01	**0.60**	**1.67**	ND	ND	ND
Zinc	mg/L	<0.0007	**0.24**	**1.69**	0.002	0.002	0.002
TOC	mg/L	<0.25	8.5	35	ND	ND	ND

ND = Not Determined.
Mean values are the arithmetic mean of all data points above the analytical LoD.
Values shown in bold are above applicable limit values – refer to Appendix 6E

Table 6.6 Groundwater Composition Data Within and Adjacent to the SD2 Project Onshore Areas – Organic Analytes

Analyte	Unit	Pipeline Landfall and Corridor			SD2 Condensate Tank		
		Min	Mean	Max	Min	Mean	Max
TPH							
Sum TPH	µg/L	20	**266**	**2366**	ND	ND	ND
Aliphatic EC6-8	µg/L	1.9	3.1	5.5	ND	ND	ND
Aliphatic EC8-10	µg/L	0.35	2.6	16.7	ND	ND	ND
Aliphatic EC12-16	µg/L	12.5	94.5	501	ND	ND	ND
Aliphatic EC16-35	µg/L	11.0	177.3	1860	ND	ND	ND
Aromatic EC8-10	µg/L	0.06	2.0	5.4	ND	ND	ND
BTEX							
Benzene	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Toluene	µg/L	<0.05	0.35	0.57	<0.05	<0.05	<0.05
Ethylbenzene	µg/L	<0.05	0.09	0.09	<0.05	<0.05	<0.05
Sum xylenes	µg/L	<0.05	0.55	0.58	<0.05	<0.05	<0.05
PAHs							
Naphthalene	µg/L	<0.01	1.03	**5.1**	ND	ND	ND
Acenaphthylene	µg/L	<0.01	0.07	0.12	ND	ND	ND
Acenaphthene	µg/L	<0.01	0.42	0.75	ND	ND	ND
Fluorene	µg/L	<0.01	0.65	2.1	ND	ND	ND
Phenanthrene	µg/L	<0.01	0.85	4.0	ND	ND	ND
Anthracene	µg/L	<0.01	0.07	**0.11**	ND	ND	ND
Fluoranthene	µg/L	<0.01	**0.13**	**0.22**	ND	ND	ND
Pyrene	µg/L	<0.01	0.32	1.1	ND	ND	ND
Benzo(a)anthracene	µg/L	<0.01	0.06	0.11	ND	ND	ND
Chrysene	µg/L	<0.01	**0.20**	**0.37**	ND	ND	ND
Benzo(b+j+k)fluoranthene	µg/L	<0.01	**0.21**	**0.21**	ND	ND	ND
Benzo(a)pyrene	µg/L	<0.01	**0.20**	**0.2**	ND	ND	ND
Indeno(1,2,3-cd)pyrene	µg/L	**<0.01**	**<0.01**	**<0.01**	ND	ND	ND
Benzo(ghi)perylene	µg/L	**<0.01**	**<0.01**	**<0.01**	ND	ND	ND
Dibenzo(ah)anthracene	µg/L	<0.01	<0.01	<0.01	ND	ND	ND
Sum EPA 16 PAH	µg/L	<0.01	2.4	13.2	ND	ND	ND
Phenols							
Phenol	µg/L	<0.02	0.04	0.09	ND	ND	ND
2-methylphenol	µg/L	<0.01	0.05	0.07	ND	ND	ND
3&4-methylphenols	µg/L	<0.01	0.02	0.02	ND	ND	ND
2,4-Dimethylphenol	µg/L	<0.01	0.04	0.04	ND	ND	ND
3,4-Dimethylphenol	µg/L	<0.01	<0.01	<0.01	ND	ND	ND

ND = Not Determined.
Mean values are the arithmetic mean of all data points above the analytical LoD.
Values shown in bold are above applicable limit values – refer to Appendix 6E

The data shows that the salinity and inorganic chemistry of the groundwater within the proposed SD2 Pipeline Corridor area is consistent with a coastal environment. Metal and metalloid concentrations are generally low, although individual samples show notably elevated manganese and iron concentrations, which may reflect local mineralogy, redox hydrochemistry and/or anthropogenic sources. Concentrations of organic contaminants are more variable with the majority of samples showing non-detectable or very low concentrations but a small proportion having moderately elevated concentrations. Of the latter, samples from BH41 and BH56 recorded respective TPH concentrations of 2,366 and 219µg/L and sum PAH concentrations of 13.2 and 7.8 µg/L. These samples were collected in groundwater within the wetland areas impacted by surface hydrocarbon spills (refer to Section 6.4.4.2).

Very few wells within the SD2 Condensate Tank area contained sufficient water to sample and therefore only very limited analysis has been possible. The few results available do not show significant contamination with those metals, metalloids or BTEX components analysed. However, samples close to (but outside) the SD2 Condensate Tank area have shown moderately elevated concentrations of TPH, PAHs and BTEX. This is considered to be due to historical leakage from an adjacent produced water holding pond. Given this, localised historic hydrocarbon contamination may be present in groundwater within the SD2 Condensate Tank area.

Sensitivity

Groundwater was only found to be present within the proposed SD2 Pipeline Corridor and Landfall area and the SD2 Condensate Tank area. Groundwater within the proposed SD2 Pipeline Corridor was considered to be typical of a coastal environment. It is considered likely that the groundwater encountered is in hydraulic connectivity with the Caspian Sea.

Moderate levels of hydrocarbon contamination may be present locally in the vicinity of the SD2 Condensate Tank area and within wetland areas historically impacted by third-party releases. Although the distribution is constrained by geological conditions, contamination could potentially be mobilised by physical disturbance.

There is no evidence to suggest that groundwater is abstracted and utilised by the local community for consumption or for industrial use and therefore it is of limited value. It may however, provide an intermittent baseflow to the wetlands areas and surface watercourses.

6.4.4.2 Surface Water

This section specifically discusses the chemical quality of water and sediments associated with watercourses and permanent and temporary wetlands within and around the SD2 Project onshore areas.

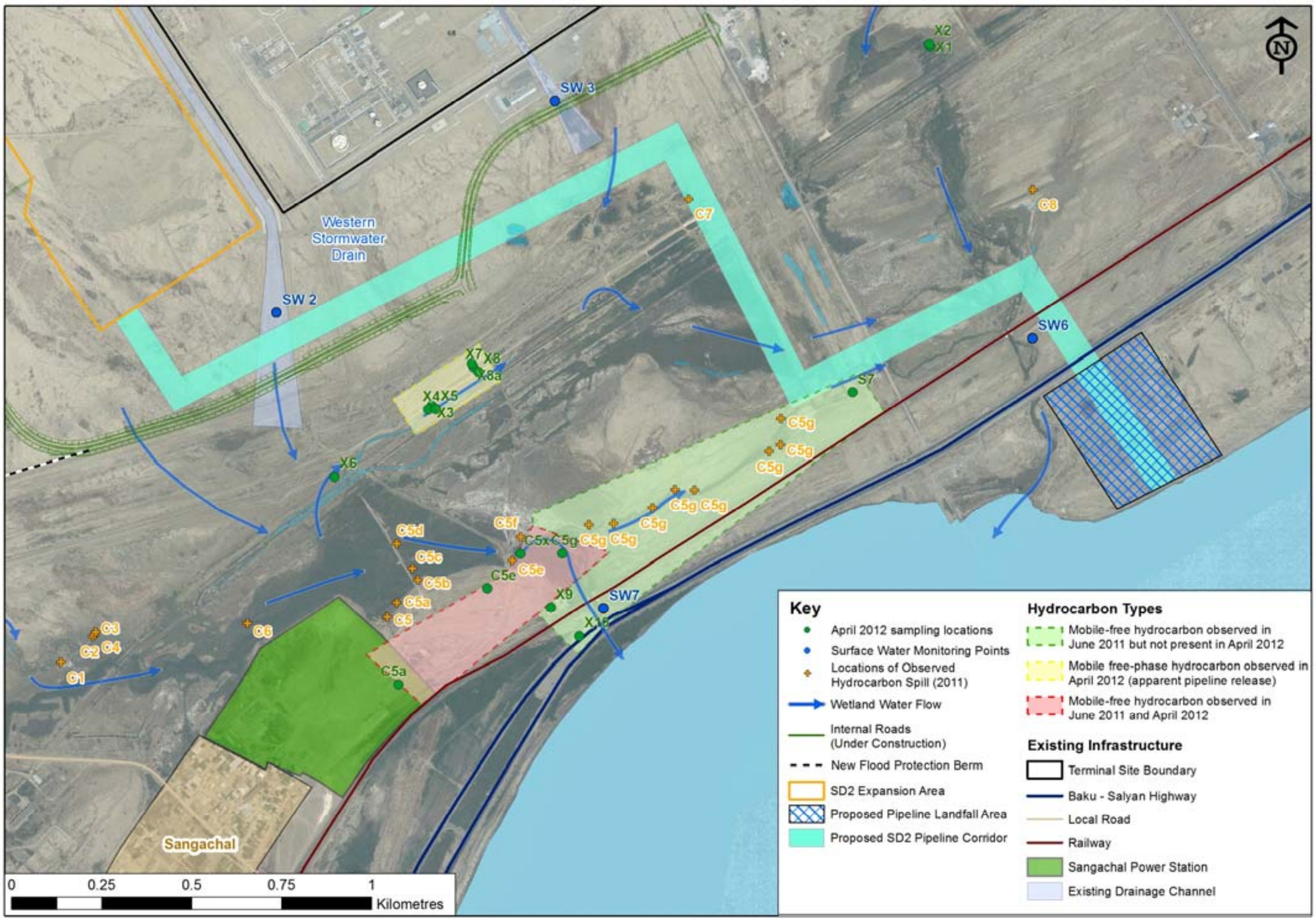
Walkover Surveys

In addition to sampling surveys, visual evidence collected over time provides information on the sources and distribution of contamination, as well as any changes.

Localised hydrocarbon contamination within wetland areas and surface waters downstream of the wetland area have been previously observed but in June 2011 a focused survey was undertaken. This involved a detailed wetland walkover survey during which a number of discrete areas of significant hydrocarbon contamination were identified and recorded. All of these appeared to be associated with the release of oil from third-party sources. The majority of the contamination appeared to originate from a large release at location RES1 (refer to Figure 6.4), which was distributed with surface water flow through area RES2 to the outfall at location B3. Other localised spills were observed in the vicinity of the third-party pipelines but no ongoing leaks were visible.

A follow-up walkover survey and sampling exercise was undertaken in April 2012. This examined changes to contaminant distribution since the June 2011 survey and included both permanent and temporary (seasonal) areas of wetland within the third-party pipeline corridor to the south of the existing Terminal. Areas of observed significant contamination in June 2011 and April 2012 are shown in Figure 6.8.

Figure 6.8 Wetland Sample Locations and Contamination Observations 2011 and 2012



In April 2012, an area of weathered free-phase oil contamination was present in the wetland area immediately adjacent to the eastern boundary of the Sangachal Power Station, as had been the case in June 2011. This contamination appeared to have been distributed by wetland flow to the east and south with accumulations evident around culvert entries and areas of dense reed growth and entrapment within sediment, which in some places had been buried by clean, freshly deposited sediments. Samples from further downstream did not show evidence of significant residual contamination.

A separate, discrete area of free-phase oil contamination was observed in April 2012 within part of the northern portion of the third-party pipeline corridor, which is believed to have resulted from a release from an adjacent third-party pipeline. The area was relatively dry at the time of the survey but residual standing water pools remained, suggesting that the area would be waterlogged during periods of prolonged rainfall.

Chemical Data

For clarity, given the visual observations, chemical data has been subdivided into those samples collected from permanent and temporary wetland areas and those collected from general watercourses in the SD2 Project onshore areas. Sampling locations are shown on Figure 6.8.

Analytical data from general surface watercourse samples are presented in Tables 6.7 and 6.8. These samples have low salinity and exhibit low concentrations of potential inorganic contaminants and of BOD_5. Within the SD2 Pipeline Corridor area, elevated concentrations of TPH were recorded in the samples from location SW2 collected in 2006 but not that collected in 2008; similarly, elevated TPH concentrations were recorded in sample SW6 collected in November 2010 but not those collected in 2008 or July 2010.

Table 6.7 Surface Water Composition Data for General Watercourses Within and Adjacent to the Proposed SD2 Pipeline Corridor and Landfall Area– Inorganic and General Analytes

Component	Units	Pipeline Landfall and Corridor		
		Min	Mean	Max
pH	---	8.0	8.1	8.1
Conductivity	mS/cm	1.5	1.8	2.0
Salinity	‰	0.70	0.85	1.0
TDS	mg/L	956	958	960
BOD-5	mg/L	0.7	1.0	1.2
COD	mg/L	5.6	11.1	16.5
Bicarbonate	mg/L	180	182	184
Aluminium	mg/L	0.04	0.05	0.05
Arsenic	mg/L	<0.002	0.01	0.01
Cadmium	mg/L	<0.001	<0.001	<0.001
Chromium	mg/L	<0.0005	0.003	0.003
Copper	mg/L	<0.0008	**1.5**	**3.0**
Iron	mg/L	<0.01	0.04	0.05
Mercury	mg/L	<0.00001	**0.014**	**0.014**
Manganese	mg/L	<0.002	0.001	0.001
Nickel	mg/L	<0.001	0.001	0.001
Lead	mg/L	<0.002	<0.002	<0.002
Selenium	mg/L	<0.002	<0.002	<0.002
Zinc	mg/L	<0.0007	0.002	0.002

ND = Not Determined.
Mean values are the arithmetic mean of all data points above the analytical LoD.
Values shown in bold are above applicable limit values – refer to Appendix 6E

Table 6.8 Surface Water Composition Data for General Watercourses Within and Adjacent to the Proposed SD2 Pipeline Corridor and Landfall Area – Organic Analytes

Component	Units	Pipeline Landfall and Corridor		
		Min	Mean	Max
Sum TPH	µg/L	51.0	174	**297**
BTEX				
Benzene	µg/L	<0.05	<0.05	<0.05
Toluene	µg/L	<0.05	<0.05	<0.05
Ethylbenzene	µg/L	<0.05	<0.05	<0.05
Sum of Xylenes	µg/L	<0.05	<0.05	<0.05
Sum BTEX	µg/L			
Naphthalene	µg/L		0.01	
Acenaphthylene	µg/L		<0.01	
Acenaphthene	µg/L		<0.01	
Fluorene	µg/L		<0.01	
Phenanthrene	µg/L		<0.01	
Anthracene	µg/L		<0.01	
Fluoranthene	µg/L		<0.01	
Pyrene	µg/L		0.01	
Benzo(a)anthracene	µg/L		<0.01	
Chrysene	µg/L		<0.01	
Benzo(b+j+k)fluoranthene	µg/L		<0.01	
Benzo(a)pyrene	µg/L		<0.01	
Indeno(1,2,3-cd)pyrene	µg/L		**<0.01**	
Benzo(ghi)perylene	µg/L		**<0.01**	
Dibenzo(ah)anthracene	µg/L		<0.01	
Sum EPA 16 PAH	µg/L		0.04	

ND = Not Determined.
Mean values are the arithmetic mean of all data points above the analytical LoD.
Only 1 set of data is available for PAHs within the SD2 Pipeline Landfall and Corridor area.
Values shown in bold are above applicable limit values – refer to Appendix 6E

Analytical data for water and sediment samples collected from permanent and temporary wetland areas were obtained in April 2012. These samples were all collected from the proposed SD2 Pipeline Corridor area and were targeted at areas of visible gross contamination and the surrounding non-visibly contaminated areas. Sediment samples underwent both total and leachable analysis to ascertain relative mobility of sediment-associated contamination. Results for wetland water samples taken in April 2012 are presented in Table 6.9 and those for sediment samples in Tables 6.10 and 6.11.

Table 6.9 Summary of Wetland Surface Water Analytical Data, 2012

Parameter	Unit	Non-visibly Contaminated Areas			Areas Of Gross Contamination			
					Release Area Adjacent to Sangachal Power Station		Pipeline Release Area Adjacent to Third-Party Pipeline	
		Min	Mean	Max	Min	Max	Min	Max
TPH (sum)	µg/L	<80	<80	<80	1.2E6	7.4E7	1.8E6	2.1E6
PAHs (sum)	µg/L	<0.16	1.5	4.4	1399	1.4E6	8365	181000
Benzene	µg/L	<0.40	0.40	0.42	<0.4	**15.4**	<0.4	10.3
Toluene	µg/L	<0.3	4.5	25.2	<0.3	**124**	<0.3	**226**
Ethylbenzene	µg/L	<0.2	0.5	2.0	<0.2	1.9	<0.2	9.0
Xylenes (sum)	µg/L	<1.0	3.0	12.8	<1.0	**437**	1.1	**140**
Phenols	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
COD	mg/L	9	94	433	4050	634000	296000	313000

Mean values are the arithmetic mean of all data points above the analytical LoD.
Values shown in bold are above applicable limit values – refer to Appendix 6E

Table 6.10 Summary of Wetland Sediment Analytical Data for Total Contaminant Concentrations, 2012

Parameter	Unit	Non-visibly Contaminated Areas			Areas Of Gross Contamination			
					Release Area Adjacent to Sangachal Power Station		Pipeline Release Area Adjacent to Third-Party Pipeline	
		Min	Mean	Max	Min	Max	Min	Max
Arsenic	mg/kg	0.2	11.1	13.0	9.3	13.3	10.5	11.4
Cadmium	mg/kg	0.14	0.18	0.22	0.14	0.20	0.04	0.16
Chromium	mg/kg	32.8	43.7	46.0	34.8	51.4	44.7	48.2
Copper	mg/kg	0.04	25.7	32.8	22.8	30.6	24.3	26.3
Lead	mg/kg	13.1	15.3	19.3	11.6	17.5	13.3	14.7
Mercury	mg/kg	0.03	0.04	0.04	0.04	0.05	0.05	0.14
Zinc	mg/kg	64.6	80.4	109.1	83.3	88.2	66.6	72.1
Organic Analytes								
TPH (sum)	mg/kg	<16	<16	<16	5142	65100	6309	16800
PAHs (sum)	mg/kg	0.015	0.068	0.165	2.0	93.6	2.32	3.03
Benzene	mg/kg	0.26	0.37	0.47	0.37	0.41	0.43	0.54
Toluene	mg/kg	0.10	1.38	2.45	2.4	2.7	1.13	17.0
Ethylbenzene	mg/kg	0.03	0.08	0.22	0.07	0.11	0.02	23.0
Xylenes (sum)	mg/kg	0.08	0.16	0.39	0.09	0.31	1.84	**236**
Phenols	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Mean values are the arithmetic mean of all data points above the analytical LoD.
Values shown in bold are above applicable limit values – refer to Appendix 6E

Table 6.11 Summary of Wetland Sediment Analytical Data for Leachable Contaminant Concentrations, 2012

Parameter	Unit	Non-visibly Contaminated Areas			Areas Of Gross Contamination		
		Min	Mean	Max	Min	Mean	Max
Arsenic	mg/kg	0.0002	0.0056	0.0184	0.0003	0.0007	0.0010
Cadmium	mg/kg	0.0001	0.0004	0.0007	0.0000	0.0000	0.0001
Chromium	mg/kg	0.0000	0.0012	0.0025	0.0001	0.0004	0.0008
Copper	mg/kg	0.0010	0.0058	0.0150	0.0009	0.0026	0.0060
Lead	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Mercury	mg/kg	0.0003	0.0073	0.0199	0.0007	0.0021	0.0038
Zinc	mg/kg	0.0000	0.0003	0.0007	0.0000	0.0001	0.0002
Organic Analytes							
TPH (sum)	mg/kg	<1.67	<1.67	<1.67	<1.67	<1.67	<1.67
PAHs (sum)	mg/kg	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016
Benzene	mg/kg	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Toluene	mg/kg	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ethylbenzene	mg/kg	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Xylenes (sum)	mg/kg	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Phenols	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Mean values are the arithmetic mean of all data points above the analytical LoD.
Values shown in bold are above applicable limit values – refer to Appendix 6E

Visual observations in both June 2011 and April 2012 demonstrated that third-party hydrocarbon releases have taken place in the permanent and temporary wetland areas including areas through which the SD2 Pipeline Corridor is proposed to run. This has resulted in areas of free-phase oil contamination within the wetland surface water and associated sediments, with oil burial beneath clean sediment taking place in some stretches. While free-phase oil can be distributed by surface water flow, low permeability ground conditions will otherwise limit migration.

Chemical data shows that hydrocarbon components (including PAHs and BTEX) were present at non-detectable to very low concentrations in wetland surface water outside the areas containing free-phase oil (Table 6.9).

In sediments, metal and metalloid concentrations did not differ between oil-contaminated and uncontaminated areas (Table 6.10) and were consistent with soils data from across the SD2 Project onshore areas (Table 6.3). Organic contaminant concentrations were very low in samples collected outside areas of visible contamination. All sediments showed very low concentrations of leachable components, even when gross oil contamination was present (Table 6.11).

While the proposed SD2 Pipeline Corridor area encroaches upon the eastern end of the contamination area seen in June 2011 there was no significant residual contamination during the walkover inspection of the same area in April 2012 and the results for soil sample S7 (refer to Figure 6.8) indicated only a residual concentration of hydrocarbon contamination with low mobility. It is, therefore, likely that the contamination in this specific area had largely been removed by third-party clean-up activities and/or natural attenuation processes.

It is possible that unknown localised areas of buried historical hydrocarbon contamination may be present in shallow subsurface soils within SD2 Project onshore areas associated with the wetland areas.

Sensitivity

Walkover surveys in 2011 and 2012, supported by sediment and surface water sampling, have indicated that significant contamination, comprising free-phase oil, is present within permanent or temporary wetland areas as a result of historic third-party contamination. While this is not widely distributed, there is evidence that it can be mobilised by high flow conditions and it could potentially be mobilised along surface water flow pathway by physical disturbance.

The wetland areas are of limited value, supporting some local grazing for livestock. The ecological value of the wetland habitat and the flora and fauna present is discussed in Section 6.4.5 below.

6.4.5 Terrestrial Ecology

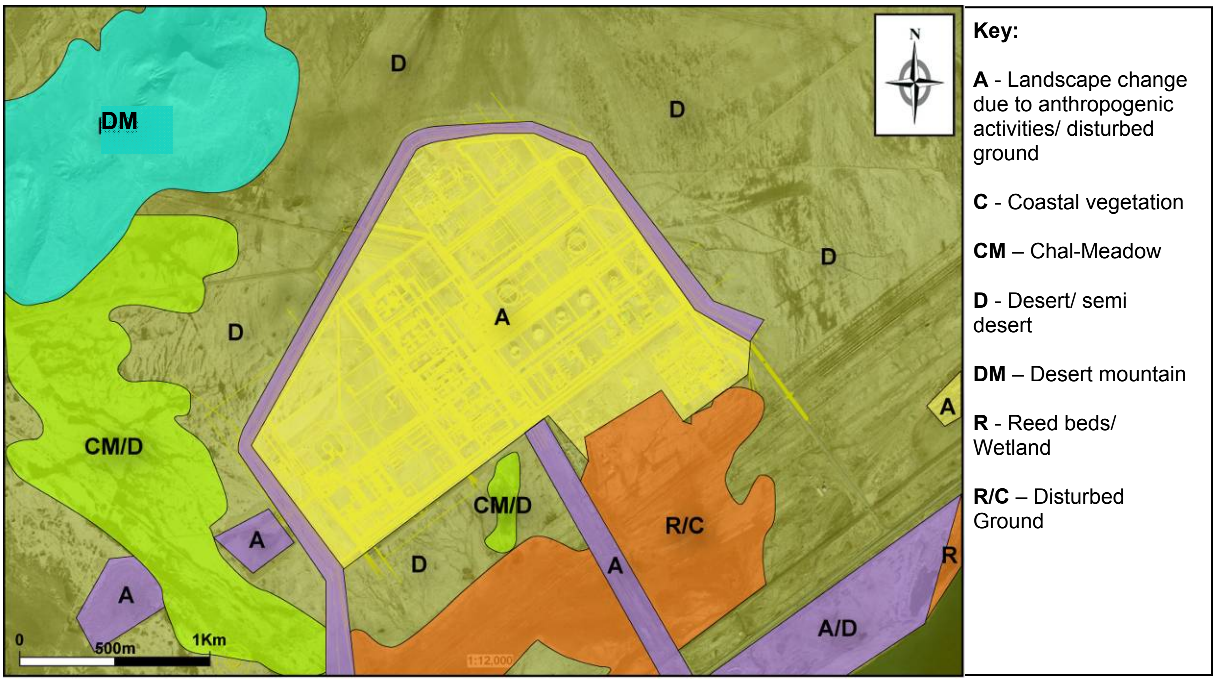
A number of habitat surveys have been undertaken in the vicinity of the Terminal since 2001. The methodology, monitoring locations and species included in the surveys has varied. Since 2006, annual spring and autumn flora surveys of the terrestrial areas surrounding the Terminal have been undertaken to identify change using ecosystem indicators.

This section provides an overview of the ecology of the area in which the Terminal is located which may be affected by the SD2 Project activities and then focuses on the area of the proposed SD2 Pipeline Corridor and SD2 Pipeline Landfall area south of the Terminal.

6.4.5.1 Habitats

Areas of disturbed ground are prevalent south of the Terminal (which includes the proposed SD2 Pipeline Corridor and Landfall area) and includes desert/semi-desert and wetland habitats (refer to Figure 6.9).

Figure 6.9 Approximate Distributions of Plant Community Types (Habitats) Around the Terminal, 2009



In 2005 and 2006, areas of disturbed ground within the Terminal vicinity were included within the terrestrial survey monitoring. Surveys were undertaken to establish the extent of re-vegetation of the areas in the period between the surveys. It was shown that regrowth was focused in locations which were previously subject to surface water ponding and, more recently, in areas where heavy machinery had been used and where rainwater had collected in the indentation left in the ground by the machinery.

The survey indicated that the rate of natural regeneration was generally low, with some areas featuring zero regrowth. Observations made during a site walkover in May 2011 indicated that the rate of natural regeneration within the disturbed/bare soil areas remains low with sparse growths of *Salsola nodulosa* and *Poa bulbosa*.

The dominant habitats south of the Terminal are described below (refer to Figure 6.9).

Desert/semi-desert - This habitat type comprises a variety of elements including:

- Exposed silt/bare soil;
- Silt with a growth of lichens and algae (a microbiotic crust);
- Sparse growth of perennial shrubs (desert vegetation); and
- Patches of perennial shrubs with a closed cover of grasses and annual species (semi-desert vegetation).

The main vegetation assemblages in the vicinity of the Terminal are dominated by low perennial shrubs (*Salsola nodulosa*, *Salsola dendroides, Suaeda dendroides*, *Salsola ericoides* and *Artemisia lerchiana*) including coastal zone variants and others in association with grasses. None of the species present identified within the desert/semi-desert habitats area is included in the Azerbaijan Red Data Book (AzRDB) or classified as vulnerable/threatened by the IUCN. The survey noted that the desert habitats in the vicinity of the Terminal are generally well grazed.

Wetland – the primary wetland area is located to the south of the Terminal. The wetland appears to be primarily fed by ephemeral watercourses including the Shachkaiya Wadi, together with other surface water runoff and some contribution from leakages in water pipes and discharges from the Sangachal Water Pump Station Baku Water Channel Department. Wetland surveys recording habitats, flora and fauna present were undertaken in 2002 (as reported within the ACG Phase 1 ESIA[8]), 2010 and 2011.

In general, the wetlands are considered to comprise a complex mixture of habitats, which developed following construction of the Baku-Salyan Highway, adjacent railway line and the third-party pipeline corridor between the railway line and the Terminal. The wetlands experience high rates of siltation which has resulted in an impeded water flow that causes water to be retained across a series of topographical depressions (see Section 6.4.4). Variations in topography determine the boundaries of the wetland and the vegetation types occurring.

The main surface-water dependent habitats within the wetlands are tall reedbeds (*Phragmites australis*), which occur along the edge of the wetland closest to Sangachal, within the third-party pipeline corridor and in other locations where deeper water occurs. In shallower permanent water, stands of reedmace (*Typha angustifolia*) and extensive marshes dominated by sea rush (*Juncus maritimus*) and sea club-rush (*Bolboschoenus maritimus*) are prominent. At the edges of the swamp/marsh areas, a scrub of Tamarisk (*Tamarix meyeri*) with alhagi (*Alhagi pseudoalhagi*) typically occurs, together with areas of mudflat, frequently colonised by glasswort (*Salicornia europaea*).

Additional habitats which occur in the wetlands include wadi channels with flat terraces that support vegetation which is similar to that of chal-meadow and includes Tamarisk shrubs (*Tamarix meyeri*) and low growing grasses (e.g. *Poa bulbosa*) and herbaceous species. Permanent pools also occur in certain locations, with vegetation such as Charophytes (aquatic multicellular algae) and water buttercup (*Ranunculus* sp.) which require permanent water.

Sensitivity

The terrestrial monitoring surveys completed to date (between 2006 and 2011[2]) have focused on identifying potential changes and trends in floral species present and vegetation cover.

With regard to desert/semi-desert vegetation assemblages, no significant change in their distribution or status over time has been observed. Disturbed ground has shown a poor level of natural recovery with faster re-vegetation observed in areas where temporary surface water has been present after rainfall events.

[8] ACG Phase 1 ESIA, (2002).

The surveys do indicate that there has been a change in vegetation cover within the area surrounding the Terminal. In general, the extent of plant cover appears to be increasing and there appears to be a decrease in the number of sites which have a measurable microbiotic crust. The reason for the decline in the abundance of microbiotic crust is not known, but it may be related to difficulty in observing the crust, given recent increases in grass cover.

Some deterioration in vegetation cover has been observed in the immediate vicinity of the Terminal where diverted runoff and construction/other activities have been ongoing during the time period covered by the surveys.

With the exception of physical activities, such as earthworks, there have been no observed changes to the habitats south of the Terminal as a result of the Terminal operations. In addition, from observation, the contaminated areas within the wetland areas (see section 6.4.4.2), do not appear to have had a significant adverse affect on the wetland habitats.

No unique habitats have been identified in the Terminal vicinity.

6.4.5.2 Flora

A number of species which are included in the AzRDB or classified as vulnerable/threatened by the IUCN, were previously recorded by the 2004 terrestrial survey including:

- *Ferula persica* (AzRDB) - a herbaceous perennial plant of the Family Apiaceae which grows in arid climates, typically occurring on lower habitats;
- *Cladochaeta candidissima* (IUCN, Indeterminate) – which occurs within coastal sands, rubbly places, dry stream beds and in plains;
- *Glycyrrhisa glabra* (AzRDB) - (European licorice) shrub/semi-shrub in arid habitats;
- *Nitraria schoberii* (AzRDB) – a wood shrub perennial; and
- *Ammochloa palaestina* (AzRDB) – which is found at sandy, arid habitats.

The following two species have been recorded in the vicinity of the Terminal:

- *Astragalus bakuensis* (AzRDB) - Shrub/semi-shrub coastal recorded in the 2001 Baseline Report survey report and 2006 Pipeline Landfall Monitoring Report; and
- *Iris acutiloba* (AzRDB) - Arid, sandy habitats recorded in the 2001 Baseline report survey and the 2005, 2008 and 2009 flora surveys. The 2009 and 2011 survey recorded this species at monitoring location SS1-2 which lies to the north east of the Terminal.

None of the above species were recorded during the EMP vegetation survey undertaken in 2011 south of the Terminal. It is considered highly unlikely that colonisation of these species would have occurred within the area since this date.

Sensitivity

While the results of previous surveys have indicated the presence of floral species included in the AzRDB or IUCN lists within the regional area, the latest 2011 data indicates that none of these species are located south of the Terminal. Local vegetation is therefore characterised by floral species which are typical for the area and are neither rare nor threatened.

6.4.5.3 Fauna

Terrestrial and wetland faunal surveys in the Terminal vicinity have been undertaken between 2001 and 2011.

During the 2002 wetland survey, three species of amphibians were recorded: European green toad (*Bufo viridis*), European tree frog (*Hyla arborea*) and lake frog (*Rana ridibunda*) and one reptiles species, the European pond turtle (*Emys orbicularis*). All three amphibian species have been assessed against IUCN criteria and have been categorised as Least Concern. The European pond turtle is classified as Near Threatened by the IUCN. None of these species are included in the AzRDB. Another wetland survey was undertaken in 2010 and Table 6.12 lists the fauna species recorded during the survey.

Table 6.12 Summary of Sangachal Wetland Fauna Survey Results 2010

Scientific Name	Common Name	Number
Bufo viridis[1]	European Green Toad	11
Microtus socialis[1]	Social Vole	10
Rana ridibunda[1]	Marsh Frog	134
Eremias velox[3]	Rapid Racerunner	1
Natrix tessellata[1]	Tessellated water Snake	9
Emys orbicularis[2]	European Pond Turtle	2

Notes:
[1] IUCN Least Concern - Species that have been evaluated against IUCN criteria and do not satisfy the criteria for the Critically Endangered, Endangered or Vulnerable categories. Species do not qualify for Conservation Dependent or Near Threatened.
[2] IUCN Near Threatened - Species that have been evaluated against IUCN criteria and do not satisfy the criteria for the Critically Endangered, Endangered or Vulnerable categories. Species do not qualify for Conservation Dependent, but are close to qualifying for Vulnerable.
[3] Not Evaluated - A species is Not Evaluated when it is has not yet been assessed against the IUCN criteria.

During the 2005 fauna survey for the area surrounding the Terminal the presence of the following species were identified:

- Sunwatcher agama (*Phrynocephalus helioscopus*);
- Spur-thighed tortoise (*Testudo graeca*);
- Small five-toed jerboa (*Allactaga elater*);
- Grey hamster (*Cricetulus migratorius*);
- Marbled polecat (*Vormela peregusna*); and
- Wolf (*Canis lupus*).

The sunwatcher agama, small five-toed jerboa, grey hamster and wolf have been assessed against the IUCN criteria and have been categorised as Least Concern. The spur-thighed tortoise and marbled polecat are listed as Vulnerable by the IUCN and are included in the AzRDB. The small five-toed jerboa is also included in the AzRDB.

The 2008 survey for the same approximate area identified three species of reptile, rapid racerunner lizard (*Eremias velox*), snake-eyed lizard (*Ophisops elegans*) and Caspian bent-toed gecko (*Cyrtopodion caspium)*. The Caspian bent-toed gecko has been assessed against the IUCN criteria and has been categorised as Least Concern. The rapid racerunner and snake-eyed lizards have not yet been evaluated against the IUCN criteria.

Table 6.13 lists the mammal and herpetofauna species recorded during the 2011 Terminal survey.

Table 6.13 Summary of Sangachal Terminal Mammals and Herpetofauna Survey Results 2011

Scientific Name	Common Name	Observed	Signs
Crocidura gueldenstaedti[4]	Gueldenstaedt's Shrew	1 (trapped)	
Meriones libycus[1]	Libyan Jird	4 (trapped)	44
Eremias arguta[4]	Steppe Runner Lizard	8	-
Ophisops elegans[4]	Snake-Eyed Lizard	26	-
Vulpes vulpes[1]	Red Fox	2	6
Rana ridibunda[1]	Marsh Frog	98	-
Eremias velox[4]	Rapid Racerunner Lizard	55	-
Vipera lebetina[4]	Blunt–Nosed Viper	1	-
Bufo viridis[1]	European Green Toad	26	-
Lepus europaeus[1]	European Hare	3	24
Emys orbicularis[2]	European Pond Turtle	1	1
Hierophis schmidti[1]	Schmidt's Whip Snake	2	
Testudo graeca[3,5]	Spur-Thighed Tortoise	1	1
Hystrix indica[1]	Indian Crested Porcupine	-	1
Allactaga elater[1]	Small Five-Toed Jerboa	-	17
Mus musculus[1]	House Mouse	-	1
Microtus socialis[1]	Social Vole	-	13

Notes:
[1] IUCN Least Concern - Species that have been evaluated against IUCN criteria and do not satisfy the criteria for the Critically Endangered, Endangered or Vulnerable categories. Species do not qualify for Conservation Dependent or Near Threatened.
[2] IUCN Near Threatened - Species that have been evaluated against IUCN criteria and do not satisfy the criteria for the Critically Endangered, Endangered or Vulnerable categories. Species do not qualify for Conservation Dependent, but are close to qualifying for Vulnerable.
[3] IUCN Vulnerable – A species is Vulnerable when it is not Critically Endangered or Endangered but is facing extinction in the wild in the medium-term future.
[4] Not Evaluated - A species is Not Evaluated when it is has not yet been assessed against the IUCN criteria.
[5] AzRDB

Sensitivity

While fauna surveys have been undertaken over a number of years, it is not yet possible to identify trends in relation to populations or geographical distribution. This is mainly due to species variation and perceived low populations found to date, but also to a small extent due to some identification issues in earlier years. There is no evidence, however, to suggest that the activities at the Terminal have had a significant impact on fauna. The presence of a number of species included within the IUCN and/or AzRDB lists have been recorded. However, these have generally been limited to a single survey. The exception is the spur-thighed tortoise (which is an IUCN Red list Vulnerable and AzRDB listed species).

While spur-thighed tortoise have been consistently recorded in the area surrounding the Terminal, their precise distribution has not been determined. The likely reason for the consistent records of this species is due to the relocation programme undertaken prior to and following the previous ACG and SD projects in which spur-thighed tortoise were collected prior to the works and then reintroduced away from the Terminal once the works were completed.

Table 6.14 presents a summary of the faunal sensitivity including the expected presence in the SD2 project areas, protection status and seasonal sensitivity.

Table 6.14 Summary of Faunal Sensitivity

Species	Status	Observed	Signs	Presence Anticipated	Seasonal Sensitivity J	F	M	A	M	J	J	A	S	O	N	D
Amphibians																
Bufo viridis (European green toad)	IUCN LC	✓		Possible - SD2 pipeline corridor												
Rana ridibunda (marsh frog)	IUCN LC	✓		Possible - SD2 pipeline corridor												
Hyla arborea (European tree frog)	IUCN LC	✓		Possible - SD2 pipeline corridor												
Reptiles																
Emys orbicularis(European pond turtle)	IUCN NT	✓	✓	Possible - SD2 pipeline corridor												
Eremias velox(rapid racerunner)	Not evaluated	✓		Possible - SD2 pipeline corridor												
Natrix tessellata (tessellated water snake)	IUCN LC	✓		Possible - SD2 pipeline corridor												
Phrynocephalus helioscopus (sunwatcher agama)	IUCN LC AzRDB	✓		Possible - all SD2 project areas												
Testudo graeca (spur-thighed tortoise)	IUCN V AzRBD	✓	✓	Yes - all SD2 project areas												
Ophisops elegans (snake-eyed lizard)	Not evaluated	✓		Possible - all SD2 project areas												
Cyrtopodion caspium (Caspian bent-toed gecko)	IUCN LC	✓		Possible - all SD2 project areas												
Eremias arguta (Steppe runner lizard)	Not evaluated	✓		Possible - all SD2 project areas												
Vipera lebetina (Blunt–nosed viper)	Not evaluated	✓		Possible - all SD2 project areas												
Hierophis schmidti (Schmidt's Whip Snake)	IUCN LC	✓		Possible - all SD2 project areas												
Mammals																
Cricetulus migratorius (grey hamster)	IUCN LC	✓		Possible - all SD2 project areas												
Vormela peregusna (marbled polecat)	IUCN V AzRBD	✓		Possible - all SD2 project areas												
Canis lupus (wolf)	IUCN LC	✓		Possible - all SD2 project areas												
Crocidura gueldenstaedti (Gueldenstaedt's shrew)	Not evaluated	✓		Possible - all SD2 project areas												
Meriones libycus (Libyan Jird)	IUCN LC	✓	✓	Possible - all SD2 project areas												
Vulpes vulpes (Red Fox)	IUCN LC	✓	✓	Possible - all SD2 project areas												
Lepus europaeus (European Hare)	IUCN LC	✓	✓	Possible - all SD2 project areas												
Hystrix indica (Indian Crested Porcupine)	IUCN LC		✓	Possible - all SD2 project areas												
Allactaga elater (Small Five-Toed Jerboa)	IUCN LC		✓	Possible - all SD2 project areas												
Mus musculus (House Mouse)	IUCN LC		✓	Possible - all SD2 project areas												
Microtus socialis (Social Vole)	IUCN LC	✓	✓	Possible - all SD2 project areas												

Breeding Period

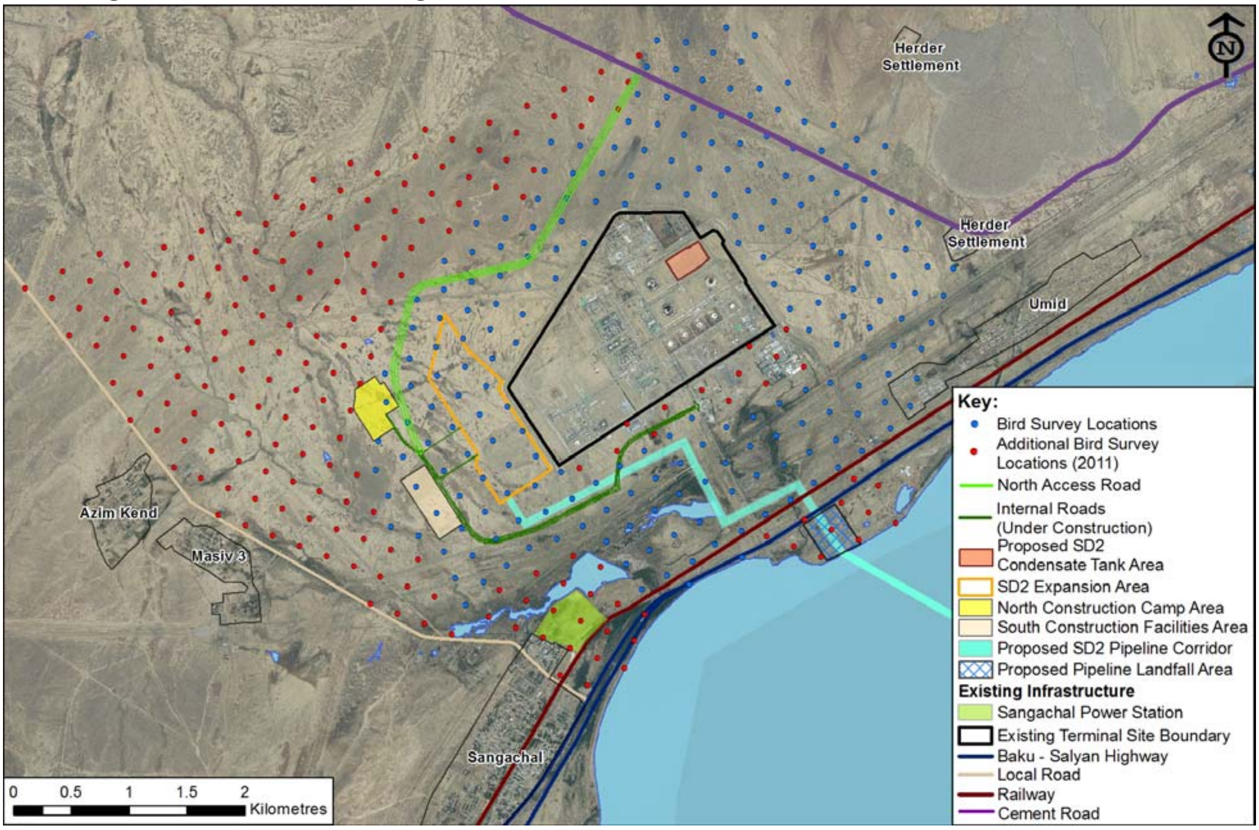
Notes:
IUCN Categories:
LC – Least concern – Species that have been evaluated against IUCN criteria and do not satisfy the criteria for the Critically Endangered, Endangered or Vulnerable categories. Species do not qualify for Conservation Dependent or Near Threatened.
NT – Near Threatened – Species that have been evaluated against IUCN criteria and do not satisfy the criteria for the Critically Endangered, Endangered or Vulnerable categories. Species do not qualify for Conservation Dependent, but are close to qualifying for Vulnerable.
V- Vulnerable – A species is Vulnerable when it is not Critically Endangered or Endangered but is facing extinction in the wild in the medium-term future.
Not evaluated - A species is Not Evaluated when it is has not yet been assessed against the IUCN criteria.

AzRBD – Azerbaijan Red Data Book list

6.4.5.4 Birds

Breeding bird surveys have been undertaken in the Terminal vicinity since 2001 with the most recent surveys completed in 2008, 2009, 2010 and 2011. The sampling locations used during the later surveys, which used a fixed-point sampling grid and point sampling techniques, are shown in Figure 6.10.

Figure 6.10 Bird Monitoring Locations Around the Terminal



Over the period 2008 to 2011, bird surveys have recorded 139 species with 25 species (18%) recorded as resident (i.e. species that normally remain within the Sangachal area throughout the year). The remaining 114 species were migratory species. This pattern of a larger number of migratory species and a limited number of resident species is reflected in the earlier survey results from 2005 onwards.

The most widespread species occurring during these surveys (recorded at more than 25 recording locations) included common swift (*Apus apus*), common quail (*Coturnix coturnix*), house martin (*Delchion urbica*), barn swallow (*Hirundo rustica*), and Isabelline wheatear (*Oeanthe isabellina*). All these are common breeding birds. They have all been assessed against the IUCN criteria and categorised as Least Concern and are not included in the AzRDB.

Of the bird species recorded during the 2008 and 2009 surveys in the Terminal vicinity, a total of 23 species are considered to be resident. The 2010 and 2011 bird surveys recorded a similar number species, 86 and 88, respectively, with 27% of the bird species recorded as resident.

During the 2010 wetland survey bird species were also recorded during the survey, they include:

- Barn swallow (*Hirundo rustic*a);
- Snowy plover/Kentish plover (*Charadrius alexandrines*);
- Herring gull (*Larus argentatus*);
- Marsh warbler (*Acrocephalus palustris*);
- European starling (*Sturnus vulqaris*);
- Magpie(*Pica pica*);
- Northern wheatear (*Oenante oenante*); and
- European bee-eater (*Merops apiaster*).

All these species have been assessed against the IUCN criteria and have been categorised as Least Concern.

Table 6.15 lists the bird species which are of conservation significance, recorded in the Terminal vicinity during the 2008-2011 bird surveys.

Table 6.15 Birds Species of Conservation Significance Recorded Within the Vicinity of the Terminal, 2008-2011

Scientific Name	Common Name	Conservation Status	Bird Surveys			
			2008	2009	2010	2011
Anser erythropus	Lesser white-fronted goose	IUCN Vulnerable				✓
Aquila clanga	Greater spotted eagle	IUCN Vulnerable				✓
Circus macrourus	Pallid harrier	IUCN Near Threatened and AzRDB		✓	✓	✓
Coracias garrulous	European roller	IUCN Near Threatened	✓		✓	
Cygnus olor	Mute swan	AzRDB	✓	✓		
Falco cherrug	Saker falcon	IUCN Endangered	✓			
Falco vespertinus	Red-footed falcon	IUCN Near Threatened			✓	✓
Neophron percnopterus	Egyptian vulture	IUCN Endangered	✓			
Pterocles orientalis	Black-bellied sandgrouse	AzRDB			✓	✓

Sensitivity

Table 6.16 presents a summary of the bird species sensitivity including the protection status and seasonal sensitivity.

Table 6.16 Summary of Bird Species Sensitivity

Species	Status	Resident	Breeding	Overwintering	Migrant
Acrocephalus palustris (Marsh warbler)	IUCN LC		✓		
Anser erythropus (Lesser white-fronted goose)	IUCN V				✓
Alectoris chukar (Chukar)	IUCN LC		✓		
Apus apus (Common swift)	IUCN LC		✓		
Aquila clanga (Greater spotted eagle)	IUCN V				✓
Calandrella cinerea (Red-capped lark)	IUCN LC		✓		
Calandrella rufescens (Lesser short-toed lark)	IUCN LC		✓		
Charadrius alexandrinus (Snowy plover/Kentish plover)	IUCN LC	✓			
Circus macrourus (Pallid harrier)	IUCN NT / AzRDB				✓
Coracias garrulus (European roller)	IUCN NT				✓
Coturnix coturnix (common quail)	IUCN LC		✓		
Cygnus olor (Mute swan)	AzRDB				✓
Delichon urbica (house martin)	IUCN LC		✓		
Falco cherrug (Saker falcon)	IUCN E AzRDB				✓
Falco vespertinus (Red-footed falcon)	UCN NT				✓
Galerida cristata (crested lark)	IUCN LC		✓		
Hirundo rustica (Barn swallow)	IUCN LC		✓		
Larus argentatus (Herring gull)	IUCN LC				✓
Merops apiaster (European bee-eater)	IUCN LC		✓		✓
Melanocorypha calandra (Calandra lark)	IUCN LC		✓		
Neophron percnopterus (Egyptian vulture)	IUCN E				✓
Oenanthe isabellina (Isabelline wheatear)	IUCN LC		✓		
Oenanthe oenanthe (Northern wheatear)	IUCN LC				✓
Pterocles orientalis (Black-bellied sandgrouse)	AzRBD	✓			
Sturnus vulgaris (European starling)	IUCN LC	✓			
Pica pica (Magpie)	IUCN LC	✓			

Notes:
IUCN Categories:
LC – Least concern – Species that have been evaluated against IUCN criteria and do not satisfy the criteria for the Critically Endangered, Endangered or Vulnerable categories. Species do not qualify for Conservation Dependent or Near Threatened.
NT – Near Threatened – Species that have been evaluated against IUCN criteria and do not satisfy the criteria for the Critically Endangered, Endangered or Vulnerable categories. Species do not qualify for Conservation Dependent, but are close to qualifying for Vulnerable.
V- Vulnerable – A species is Vulnerable when it is not Critically Endangered or Endangered but is facing extinction in the wild in the medium-term future.
E- Endangered – A species is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.

AzRBD – Azerbaijan Red Data Book list

Birds are most sensitive to disturbance during the breeding season (typically mid-March – end August). Of the species identified since 2008, five[9] are ground nesting, and have been recorded in the semi-desert habitat in the vicinity of Sangachal Terminal and the SD2 Expansion Area. While the field data collected during the 2010 and 2011 surveys indicates whether the birds are nesting or not, the bird location rather than the nest location is recorded. However, the birds do not nest in the same location each year. It is therefore not appropriate to state the number of breeding individuals that use the area around the Terminal as this will vary from year to year. There is no evidence within the surveys completed to date to indicate that the habitat within the area around the Terminal is of unique value to breeding birds.

[9] These include chukar (*Alectoris chukar*), red-capped lark (*Calandrella cinerea*), lesser short-toed lark (*Calandrella rufescens*), Calandra lark (*Melanocorypha calandra*), and crested lark (*Galerida cristata*).

Breeding birds are most sensitive to sudden unexpected and loud noise such as hammering. Studies have shown, however, that birds frequently become habituated to anthropogenic noise including construction noise, with no recorded effect on behaviour or breeding success[10]. Equally, impacts to breeding success due to noise impacts have also been recorded. The survey results obtained within the Terminal vicinity show there has been little change in the richness and number of bird species over time and suggest that the breeding birds are likely to be habituated to the industrial noise from the Terminal, Sangachal Power Station, highway traffic noise and other industrial activities in the area.

6.4.6 Air Quality

Ambient air quality monitoring has been undertaken around the Terminal since 1997, prior to the start of the Early Oil Project (EOP) activities. The monitoring locations, parameters recorded and analytical methodology used have varied across the monitoring surveys. The most recent air quality monitoring surveys for which results are available were undertaken during 2008, 2009, 2010 and 2011. For each survey, NO_2, SO_X, benzene and Volatile Organic Compounds (VOC) were monitored using passive diffusion tubes. Hourly real-time monitoring data was also collected at an automatic monitoring station (station AAQ23) for periods during 2009 and 2010[11].

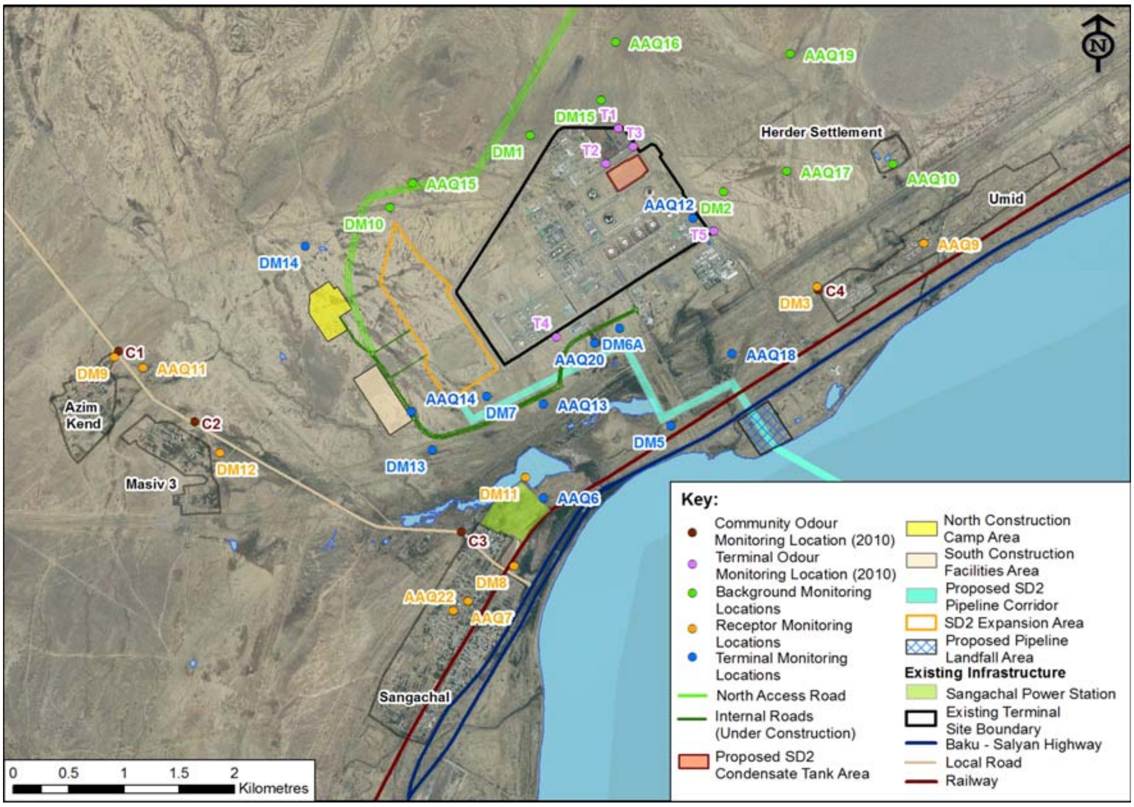
The measured concentrations at the 2008 to 2011 monitoring locations have been grouped and averaged to provide an analysis of pollutant concentrations over time, in relation to potential local sources and in relation to the predominant wind direction (primarily northerly). The three groups comprise:

- Background: locations upwind of the Terminal and away from local communities and major sources (e.g. the Power Station and Highway);
- Terminal: locations around the Terminal and the SD2 Expansion Area, predominantly downwind of the Terminal; and
- Receptors: locations within the local communities i.e. Sangachal, Azim Kend/Masiv 3 and Umid.

Figure 6.11 presents the location of the air quality monitoring stations.

[10] Melissa Anne Lackey, (2009), Avian Response to Road Construction Noise with Emphasis on the Endangered Golden-Cheeked Warbler.
[11] Interruptions to the monitoring station power supply prevented further data from being obtained.

Figure 6.11 Ambient Air Quality (2008 to 2011) and Odour Monitoring Locations (2010)



Measured data for all the monitoring stations is provided in Appendix 6.A. Results obtained from the surveys are compared against relevant ambient air quality standards including International Finance Corporation (IFC)[12], former World Bank[13] and World Health Organisation Guidelines[14] (WHO), and in the case of benzene, the European Union (EU) Guidelines.[15,16,17]

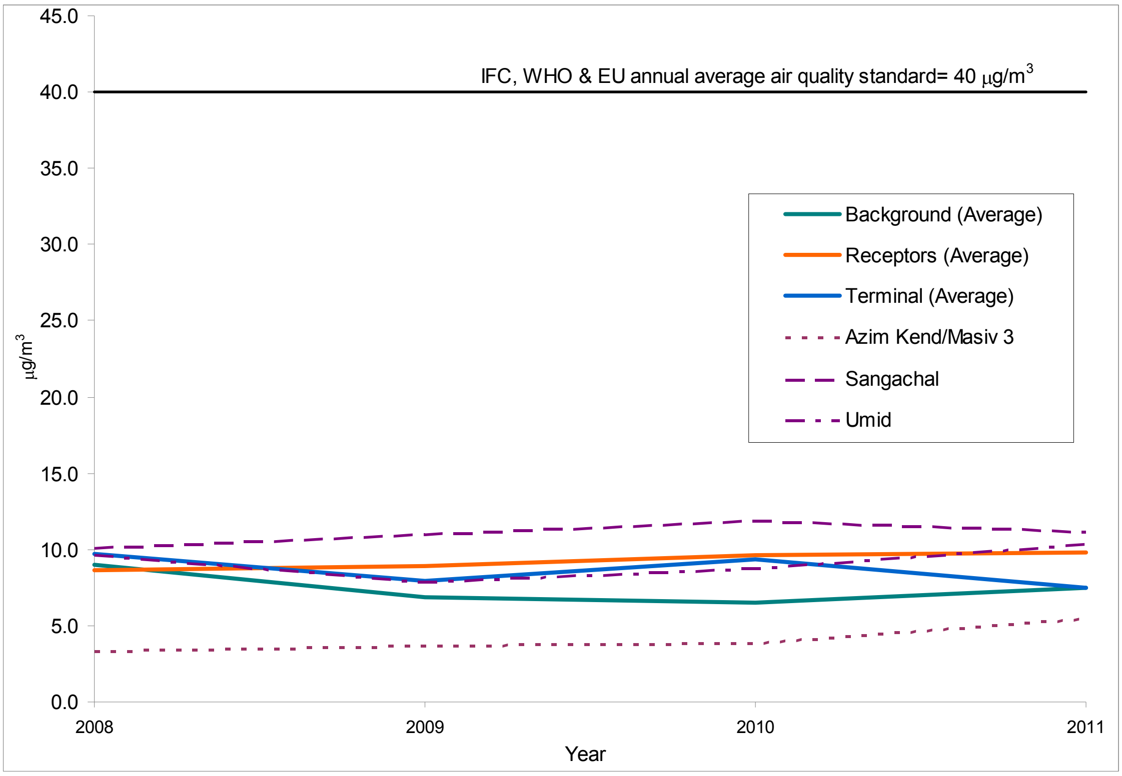
Odour monitoring was also undertaken in 2010 based on a "sniff test" approach as recommended by the UK Environment Agency Guidance[18]. Figure 6.11 also shows the odour survey monitoring locations.

6.4.6.1 NO_2 Concentrations

Annual averaged NO_2 concentrations for the background, terminal and receptor locations are shown in Figure 6.12. The figure also shows the averaged concentrations recorded at Sangachal Town, Azim Kend/Masiv 3 and Umid.

[12] IFC Environmental, Health and Safety Guidelines. General EHS Guidelines: Environmental, Air Emissions and Ambient Air Quality (2007).
[13] World Bank Pollution Prevention and Abatement Handbook (1998).
[14] World Health Organisation Guidelines (1999).
[15] European Union Guidelines (2005).
[16] No guidelines were available for total VOC.
[17] Historically in Azerbaijan ambient concentrations of NO_2, SO_2, CO and PM_{10} have also been assessed against 24-hour and one-hour standards. These standards were not derived using the same health-based criteria as the IFC, WHO and EU guideline values and the standards derived are not widely recognised.
[18] Odour monitoring was undertaken separately to the 2010 air quality monitoring and does not form part of the EMP.

Figure 6.12 Annual Average Measured NO_2 Concentrations, 2008-2011



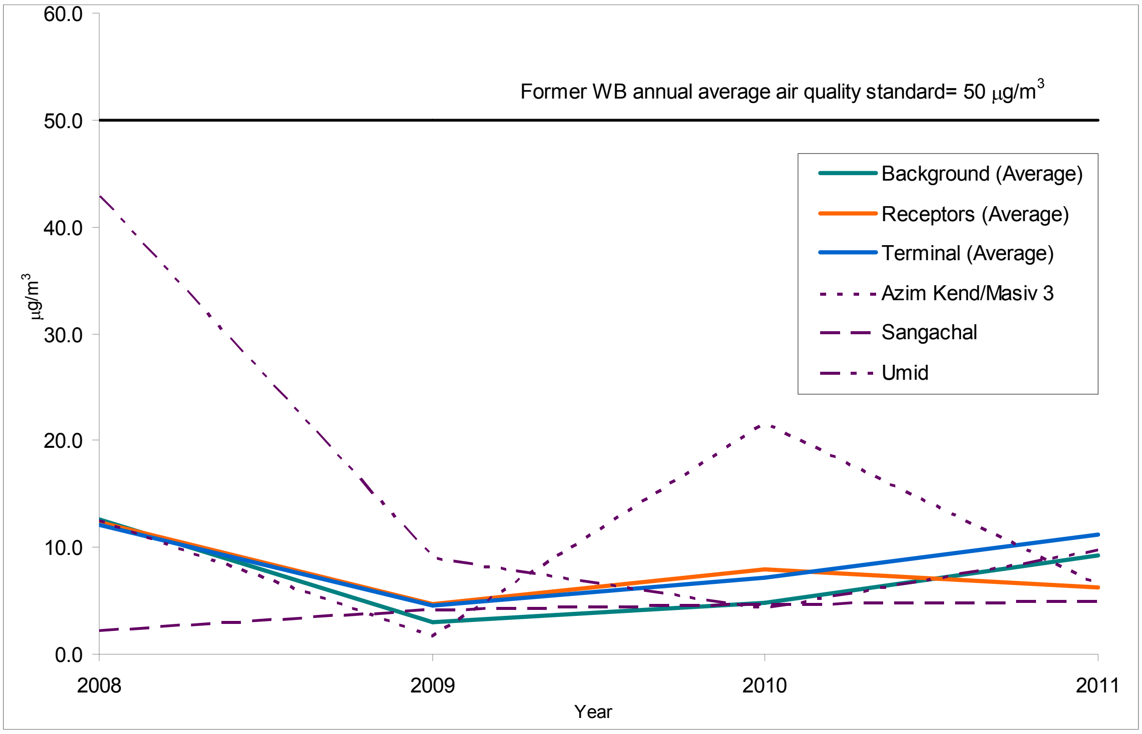
The survey results showed that annual average ambient air quality standard for NO_2 was not exceeded at any of the monitoring stations. Concentrations ranged between 6% and 48% of the annual average standard with the highest concentration reported in 2010 at the monitoring station AAQ13 at a value of 19 $\mu g/m^3$ (immediately downwind of the Terminal).

Averaged one hour concentrations recorded at the automatic monitoring station (located at AAQ23) during 2009 and 2010 did not exceed the relevant IFC, WHO and EU one-hour ambient air quality standard of 200 $\mu g/m^3$. The automatic station was not functioning in 2011. Figure 6.12 shows that highest NO_2 concentrations have been recorded at the receptor and terminal monitoring locations. With regard to specific receptors, concentrations at the Sangachal locations have been consistently highest, with concentrations at Azim Kend/Masiv 3 consistently lowest. The results obtained, however, show that there is not a significant difference between the monitored concentrations (no more than 8 $\mu g/m^3$). Consistently higher concentrations have been recorded at AAQ6 and AAQ13 (immediately downwind of the Terminal). However, similar higher results have also been recorded at AAQ7 and AAQ22 (within Sangachal Town), which may be a result of the adjacent Highway and/or unknown local sources. The results obtained do not show any significant changes over time, indicating that NO_2 concentrations have remained relatively stable between 2008 and 2011.

6.4.6.2 SO_2 Concentrations

Annual averaged SO_2 concentrations for the background, terminal and receptor locations between 2008 and 2011 are shown in Figure 6.12. The figure also shows the averaged concentrations recorded at Sangachal Town, Azim Kend/Masiv 3 and Umid.

Figure 6.13 Annual Average Measured SO_2 Concentrations, 2008-2011



The survey results showed that annual average ambient air quality standard for SO_2 was not exceeded at any of the monitoring stations during the 2008-2011 monitoring periods[19].

Results obtained from the automatic monitoring station (located at AAQ23) during 2009 and 2010 indicated that concentrations did not exceed the relevant IFC and WHO 24 hour ambient air quality standard of 125μg/m^3.

Figure 6.13 shows that the annual average SO_2 concentrations are slightly higher at the receptor and terminal locations when compared to the background locations (except for 2011), although the difference is very small. For all locations (except Sangachal), SO_2 concentrations appeared to peak in 2008, then drop in 2009. The reason for this is not clear. Neither is the reason for the higher SO_2 concentrations recorded at Umid in 2008 and at Azim Kend/Masiv 3. While there has been a general small increase in SO_2 levels from 2008 to 2011, anomalous higher results have been recorded at a number of locations (refer to Appendix 6A) across the monitoring periods. These may be due to the presence of transient local sources (e.g. trucks) close to the monitoring locations. The small increase (approximately 3-5 μg/m^3) in SO_2 levels, most noticeable for the Sangachal receptors, may be associated with the Sangachal Power Station, which began operation in 2008.

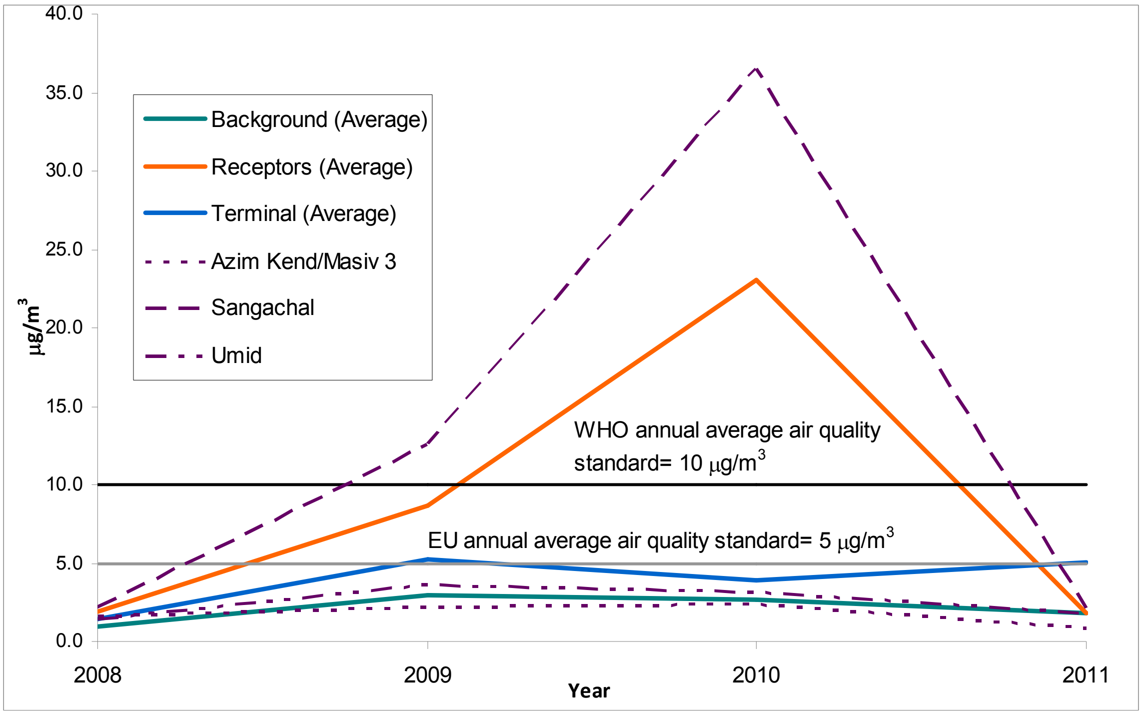
6.4.6.3 Benzene and VOC Concentrations

VOCs comprise a number of organic components including benzene.

Annual averaged benzene concentrations for the background, terminal and receptor locations between 2008 and 2011 are shown in Figure 6.14. The figure also shows the averaged concentrations recorded at Sangachal Town, Azim Kend/Masiv 3 and Umid.

[19] IFC, WHO and EU ambient SO_2 standards are established for 24-hour, one-hour and 10 minute averaging periods. It is not appropriate to compare annual averaged monitoring data to these standards.

Figure 6.14 Annual Average Measured Concentrations of Benzene, 2008-2011

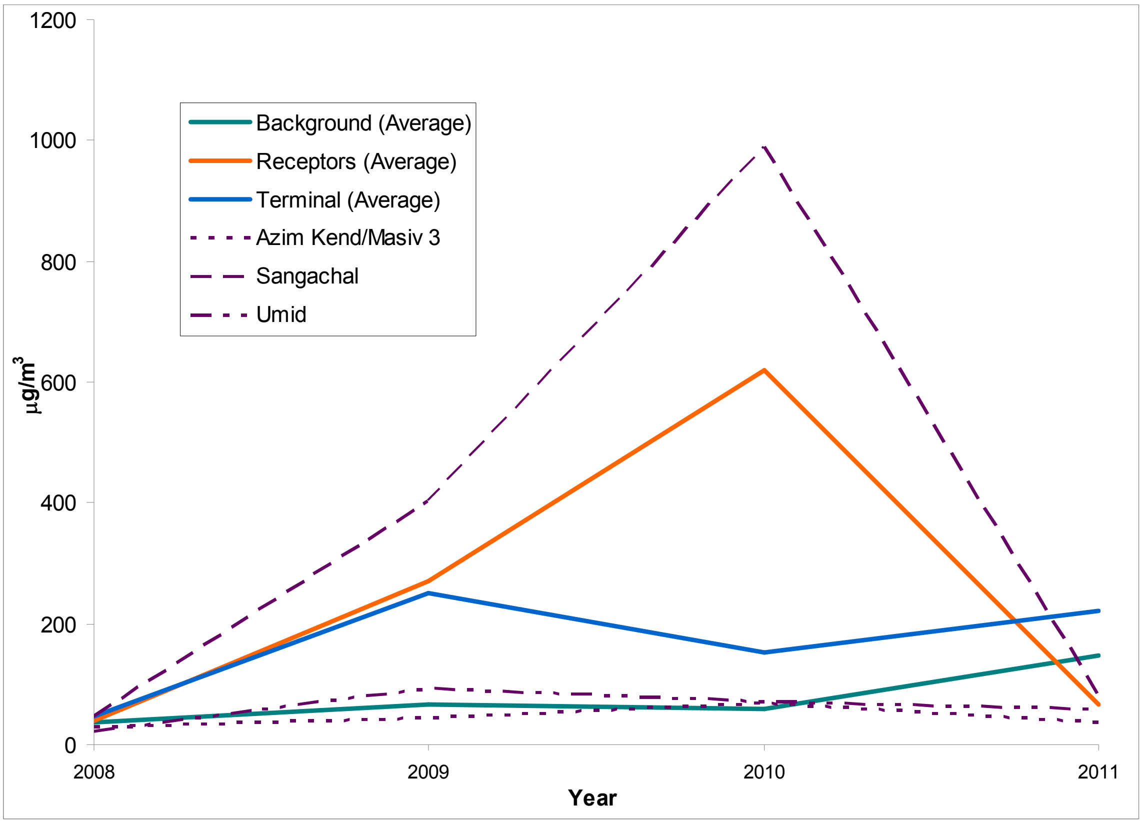


The survey results show that annual averaged measured benzene concentrations do not exceed WHO and EU air quality standards between 2008 and 2011 at background locations. Benzene concentrations at terminal locations comply with these standards in 2008 and 2010 but exceed them marginally in 2009 and 2011. Concentrations measured at receptor locations exceed benzene air quality standards in 2009 and 2010, but both years are skewed by extremely high data values recorded at monitoring station AAQ7 in Sangachal (refer to Appendix 6A). In general, there are no evident trends between years.

At Azim Kend/Masiv 3 and Umid, benzene concentrations have remained close to those recorded at background locations. The results obtained for Sangachal are discussed further below in the context of VOC concentrations.

Figure 6.15 shows the annual average total VOC concentrations for 2008 to 2011.

Figure 6.15 Annual Average Measured Concentrations of VOC, 2008-2011



The results obtained show the same pattern as observed for the benzene concentrations over the same period, including the unusually high data value at monitoring station AAQ7 in 2010. The consistently high concentrations recorded at AAQ7 indicate it is very likely that a local emission source is influencing benzene and VOC results at this location.

In 2008, the National Physics Laboratory (NPL) was commissioned by BP to review the air quality monitoring and modelling at Sangachal Terminal and its surroundings. Based upon this review, a number of recommendations were made including changing the absorbent within the diffusion tubes used to monitor benzene and VOCs. The implementation of the recommendations in 2009 could be a reason for the general increase in VOC and benzene concentrations between 2008 and 2009.

As mentioned above, an odour assessment was undertaken in 2010 along the Terminal boundary and in locations within the four communities surrounding the Terminal (see Figure 6.11). The primary odour detected was a tarry, oily smell from the Terminal produced water ponds, which are located in the north east of the Terminal. The odour was reported to be strong around the produced water ponds (locations T1, T2 and T3) and faintly detectable (under north-easterly wind conditions) at Sangachal Town (location C3). Odours that are associated with nearby farming activities were detected at location C2. It is possible that evaporation of volatile compounds from produced water ponds may contribute to the higher benzene and VOC concentrations recorded downwind of the Terminal.

6.4.6.4 PM_{10} Concentrations

The measured PM_{10} concentrations for 2009 and 2010 are shown in Table 6.17. Results were obtained from the automatic monitoring station (location AAQ23).

Table 6.17 PM_{10} Concentrations 2009 and 2010 (µg/m^3)

Month	PM_{10} Concentrations (µg/m^3)	
	2009	2010
February	102	-
March	52	-
April	26	-
May	115	51
June	-	56
July	-	33
August	-	125
September	-	146
October	-	118
November	-	160
December	-	180
Average	74	109
Applicable Limits	40µg/m^3 (annual average)[1], 50 µg/m^3 (24 hour standard)[2]	
Notes: 1. EU annual average standard. 2. WHO, IFC and EU 24 hour standard.		

The average monthly PM_{10} concentration ranged between 26µg/m^3 in April 2009 and 180µg/m^3 in December 2010, with considerable variance between the months. The average PM_{10} concentration for the four-month monitoring period in 2009 was 74µg/m^3 and 109µg/m^3 in 2010. This exceeds the EU annual average standard. In addition, the PM_{10} results also exceeded the WHO, IFC and EU 24-hour standard of 50µg/m^3 for all months excluding March and April 2009 and July 2010. In semi-arid and arid environments, ambient PM_{10} concentrations often exceed international air quality standards regardless of the presence of local man-made activities due to the natural entrainment of dust in the atmosphere which is typical of dry, windy conditions.

The PM_{10} results recorded in 2009 and 2010 show no clear trend although higher concentrations were recorded during winter months when wind conditions are stronger.

Table 6.18 shows the PM_{10} data obtained from three monitoring stations carried out over two-weekly intervals between 12th March and 4th September 2012 during the SD2 EIW.

Table 6.18 24-Hour Average Gravimetric PM_{10} Concentrations (µg/m^3), 12 March – 4 September 2012

Location	Monitoring Period 1 (13th - 20th March)	Monitoring Period 2 (24th - 31st July)	Average
Background	14.48	47.62	31.05
Terminal	16.87	80.89	48.88
Receptor	29.56	46.00	37.78

On average, the terminal and receptor location PM_{10} concentrations were higher than the concentrations at the background locations. While PM_{10} air quality standards were met at the receptor and background locations, they were exceeded at the terminal locations, and significantly during Monitoring Period 2. This is considered to be due to the high levels of windborne and fugitive PM_{10} in this area, which was being disturbed due to the ongoing SD2 EIW.

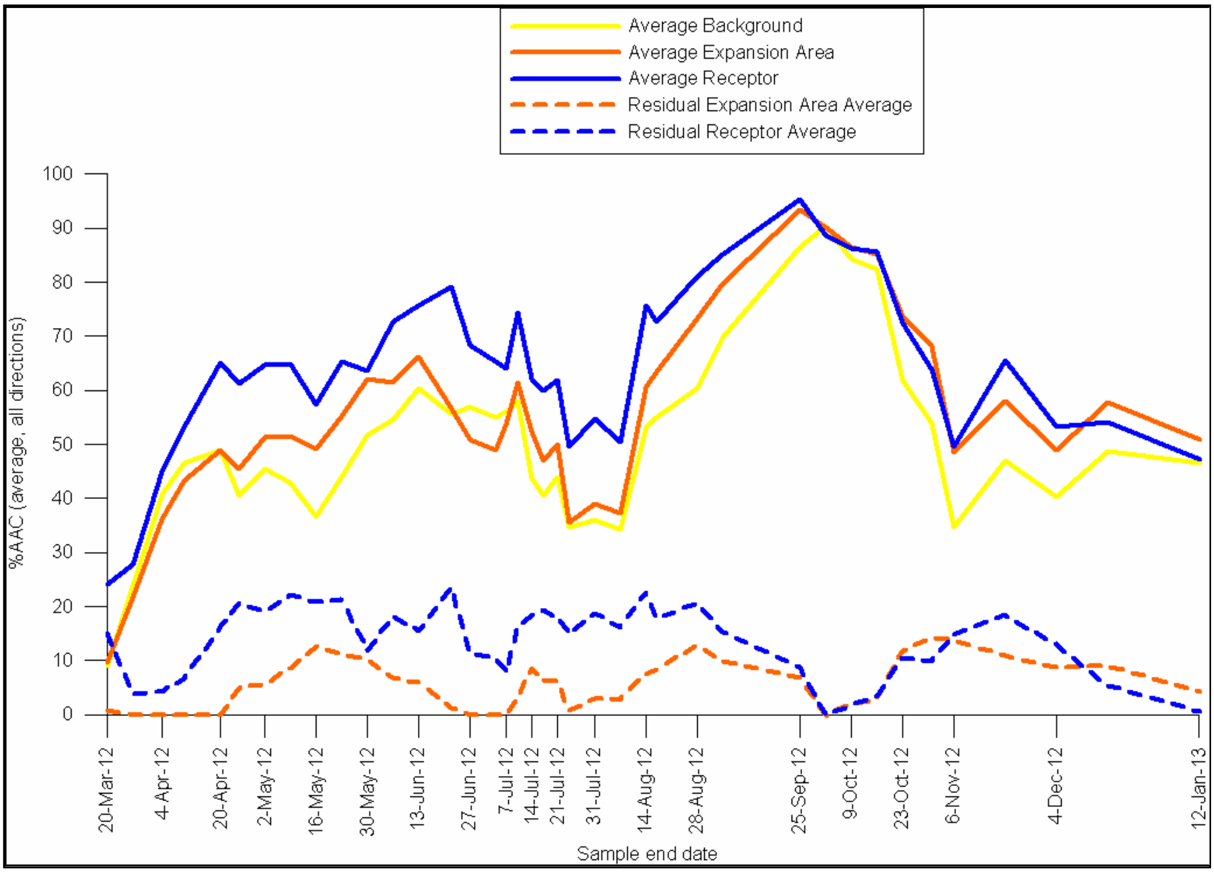
6.4.6.5 Dust

Dust monitoring was initially completed in 2011 and has been continued during the SD2 EIW in 2012. The 2011 baseline survey showed that dust in the vicinity of the Terminal generally travels from the north to south under the influence of the prevailing wind direction and that dust levels were generally higher at monitoring locations to the north of the Terminal than to the south. This suggests that dust originates from areas of open land to the north of the Terminal. A higher variation in directional dust and dust levels were recorded at location DM9, which was immediately adjacent to a poorly surfaced road used by quarry traffic. Single high dust levels were also recorded at locations DM1 and DM2 which are also close to local roads. Field observations suggested that the levels in location DM1, DM2 and DM9 were associated with traffic movements rather than wind blown dust.

Analysis of the deposited dust against samples of exposed surface soil taken at each monitoring location show that mineralogy and metal concentrations of the surface soil and dust samples were found to be broadly similar and consistent with the composition of local soils. Higher calcium levels were recorded at road location DM9, considered to be the result of road wear and spillages of materials from quarry traffic. None of the metals identified in dust are considered to represent a risk to human health at the concentrations recorded.

Figure 6.16 presents the rolling average directional Absolute Area Coverage (%AAC used as a measure of dust deposition rates) at the background, terminal (referred to as SD2 Expansion Area) and receptor sampling locations for 2012.

Figure 6.16 Average % AAC of Dust Recorded at Terminal, Background and Receptor Locations, 12 March 2012 – 12 January 2013



Generally, the trend in measured average dust deposition (expressed as %AAC) is similar for all three groups of sampling locations over the ten-month monitoring period.

Overall, higher deposition rates were reported at the receptor and terminal locations; approximately 5-15% higher than at background locations.

Residual dust deposition rates were calculated by subtracting the recorded concentrations at background locations from the measured terminal and receptor location rates. This gave an indication of the dust likely to originate from sources downwind of the background locations. The results for the terminal (termed SD2 Expansion Area within Figure 6.16) indicated that dust deposition rates associated with these sources (primarily the SD2 EIW that were underway at the time) ranged from zero to 12% average AAC. Residual dust levels at receptor locations were generally higher, ranging from zero to 20%. However, directional dust monitoring showed that the dust was largely originating from other sources and not from the direction of the SD2 EIW. Based on the monitoring to date, it is considered unlikely that fugitive dust levels recorded at the receptor locations are a direct result of the SD2 EIW.

Similar to the 2011 survey, the 2012 survey indicated that much of the directional dust sampled arose from the north and can be associated with propagation from exposed surfaces (especially the poorly-vegetated local soils) by the strong northerly winds. There appeared to be a correspondence between wind speed and dust coverage, and between wind speed, temperature, precipitation and dust loading. Dust levels were highest after a prolonged period of dry weather immediately followed by a period of moderate to strong winds.

Sensitivity

Air quality concentrations have been regularly monitored at locations in the Terminal vicinity since 2006 and the results from 2009, 2010 and 2011 surveys are presented above. While survey locations and methods have varied, it is possible to compare the earlier results to those obtained in 2009, 2010 and 2011. For example, NO_X results at location AAQ07 have ranged between 11 and 13µg/m^3 with the exception of an anomalous result in 2007 during a period when the Terminal was shutdown.

The results for SO_2 concentrations in the same location have varied between 1.6µg/m^3 (in 2007) and 7.6µg/m^3 (in 2009). No trends indicating deteriorating air quality are evident.

With the exception of PM_{10} and benzene, air quality data is consistently below applicable limit values. A slight change in SO_2 levels was observed at Sangachal locations between 2008 and 2009 following the start of operations at the Sangachal Power Station but this change is not considered to be significant in terms of overall air quality. For all species monitored a number of high values were recorded during specific survey rounds. It is considered likely that the intermittent stationary sources and vehicles passing near to the monitoring locations influence the monitoring results to a greater extent than emissions associated with operations at the Terminal and at Sangachal Power Station. Overall air quality has remained relatively stable over the period of Terminal operations.

The results of dust monitoring indicate that dust within the vicinity of the Terminal is predominantly wind blown from open land areas to the north and is heavily influenced by the use of local unsurfaced or poorly surfaced roads. No high concentrations of metals were recorded in dust or the soil samples collected, and dust levels recorded are considered to be typical of a semi-desert environment.

6.4.7 Noise

Ambient noise monitoring surveys have been completed to inform the previous ACG and SD ESIAs. More recently, regular surveys have been completed in 2010 and 2011[20]. The 2010 noise survey included five locations (R1 to R5) which are located adjacent to, or within, Azim Kend, Masiv 3, Sangachal Town and Umid. Additional locations (R8, R11, A1, A3 and A4) also within the local communities were included within the 2011 survey (refer to Figure 6.17).

[20] Surveys were also completed in 2012 during the SD2 EIW. These include the intermittent effect of construction plant operation. As such, they do not represent the baseline conditions and are not reported here.

Figure 6.17 Noise Survey Locations 2010 and 2011

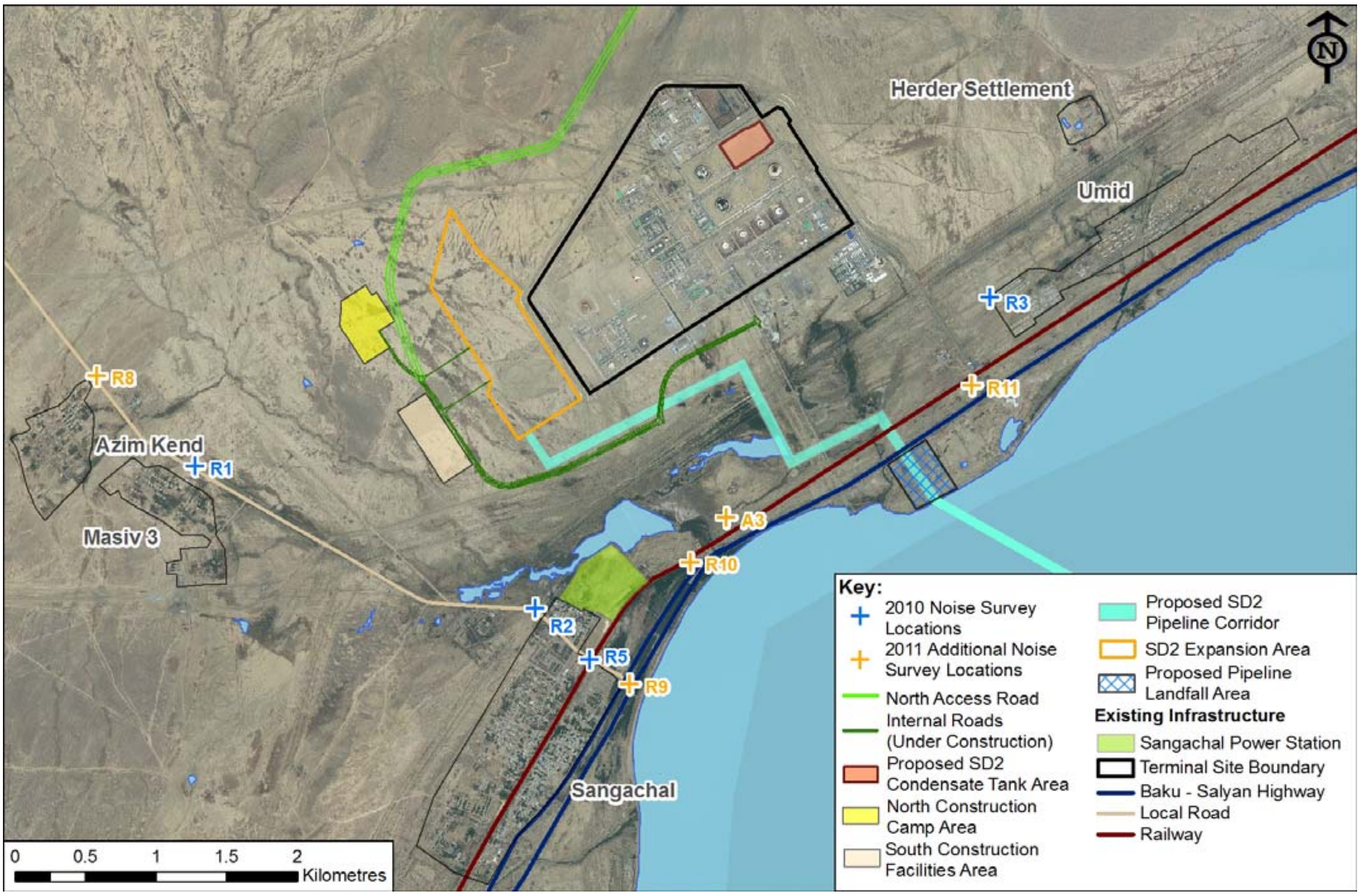


Table 6.19 presents the noise levels recorded (as L_{Aeq}[21]) during day and night time periods at the sensitive receptors.

Measurements were recorded during May 2010 and March 2011. During each survey, weather conditions were fair, with winds predominantly from the north. Monitoring results obtained when winds speeds exceeded 5m/s were excluded as, under these conditions, results are affected by wind noise.

Observations were made throughout the surveys to record the noise sources and identify dominant sources in each location. Operational data was obtained to confirm that the Terminal was operating under normal operations (i.e. there was no emergency flaring or other abnormal noise generating activity at the Terminal).

[21] The average ambient noise level including all potential sources (e.g. the Terminal, Sangachal Power Station, traffic, animals).

Table 6.19 2010 and 2011 Noise Survey Results at Sensitive Receptors

ID	Location	Receptor	2010		2011	
			Measured Ambient Noise Range (Daytime) dB L_{Aeq}	Measured Ambient Noise Range (Night Time) dB L_{Aeq}	Measured Ambient Noise Range (Daytime) dB L_{Aeq}	Measured Ambient Noise Range (Night Time) dB L_{Aeq}
Sensitive Receptors						
R1	Masiv 3	Low rise residences	44 – 56	46 – 48	50 - 53	39 - 51
R2	Sangachal	Low and high rise residences	48 – 66	46 – 59	62 - 70	52 - 53
R3	Umid West	Low rise residences	48 – 66	49 – 53	49 - 58	45 - 55
R5	Sangachal Railway Crossing	Shops and low rise residences	62 – 69	49 – 59	55 - 63	*
R8	Azim Kend	Low rise residences	-	-	43 - 50	39 - 49
A3	North of Highway	One residence about 50m north of the highway	-	-	69	*

Notes:
* Night time noise measurements were not undertaken in this location.
- Noise measurement not taken at this location.

Daytime noise levels recorded during the 2010 and 2011 surveys were characterised by a noise associated with the Baku-Saylan Highway and the Sangachal Power Station. Road traffic noise from the use of local roads at Sangachal Town affected noise levels recorded at one location (R2) only. Daytime measurements did not detect noise generated from operation of the Terminal at any of the locations surveyed in 2010 or 2011.

Night time measurements in 2011 detected noise generated from the operation of the Terminal at Azim Kend and Umid West. In addition, a consistent low-frequency noise could be identified at Sangachal Town and Azim Kend/Masiv 3 associated with the Sangachal Power Station. Night time road traffic noise from the Baku-Salyan Highway was audible at all 2010 and 2011 monitoring locations.

Both data sets for the 2010 and 2011 surveys indicate a large range in recorded average noise levels (L_{Aeq}) which is typical of surveys influenced by intermittent road traffic noise. Given the range of noise levels recorded at R1 to R5 during daytime and night-time periods, there were no significant differences between noise levels recorded during the 2010 and 2011 surveys.

Sensitivity

The noise environment within the local communities is generally quietest at night, with the lowest noise levels consistently recorded at Azim Kend. During daytime and night time periods, traffic noise (associated with the Baku Salyan Highway) is audible at all locations, with noise levels highest at those locations closest to the highway (e.g. location R2 and A3). Noise from the Sangachal Power Station was significant for receptors R2, R5 and A1. Other noise sources noted during the surveys included helicopters, animal noise and the occasional passing of construction vehicles. Noise from the existing Terminal was not dominant at any of the receptors during the survey periods.

Residential dwellings represent the most sensitive receptors to operational noise. The guidance set out by the IFC sets absolute noise limits for the day and night time noise levels at residential receptors of 45dB and 55 dB (L_{Aeq}), respectively. To determine the existing noise levels at the sensitive receptors associated with current Terminal operations, surveys and noise modelling was undertaken (as described within Appendix 11D). This confirmed that current noise levels at receptors associated with current Terminal operations (under routine conditions) are approximately 43dB at Sangachal, 39dB at Azim Kend/Masiv 3, and 43dB at Umid (measured as L_{Aeq}), which is below the most stringent night time noise limit of 45dB (L_{Aeq}).

6.5 Coastal Environment

6.5.1 Setting

The coastal zone, between the Baku-Salyan Highway and the Caspian Sea shoreline, comprises a platform of layers of limestone and marine sediments. The landward slope has been quarried away for sand/aggregate. To the seaward there is a limestone platform sloping down to the water's edge, with small areas of exposed finer material.

6.5.2 Coastal Habitat

The area previously quarried, as discussed in Section 6.5.1, within the coastal zone supports desert vegetation similar to that of disturbed habitat around the SD2 Expansion Area and is dominated by sparse *Salsola nodulosa*. The limestone platform to the seaward also supports *Salsola nodulosa,* with other species, including *Suaeda* spp, *Artemesia* spp and *Armeria* spp. The area where the previous ACG/SD pipelines were installed has been rehabilitated using live plants. The results of surveys undertaken in 2007 and 2010 indicate that this effort has been successful with up to 57% vegetation cover by perennial species identified in 2010.

Sensitivity

Surveys completed to date show that, following rehabilitation, the disturbed coastal habitat is recovering following the pipeline works completed between 2001 and 2006. There are no rare or threatened species present and habitat is typical of the area within the Terminal vicinity.

6.5.3 Coastal Birds

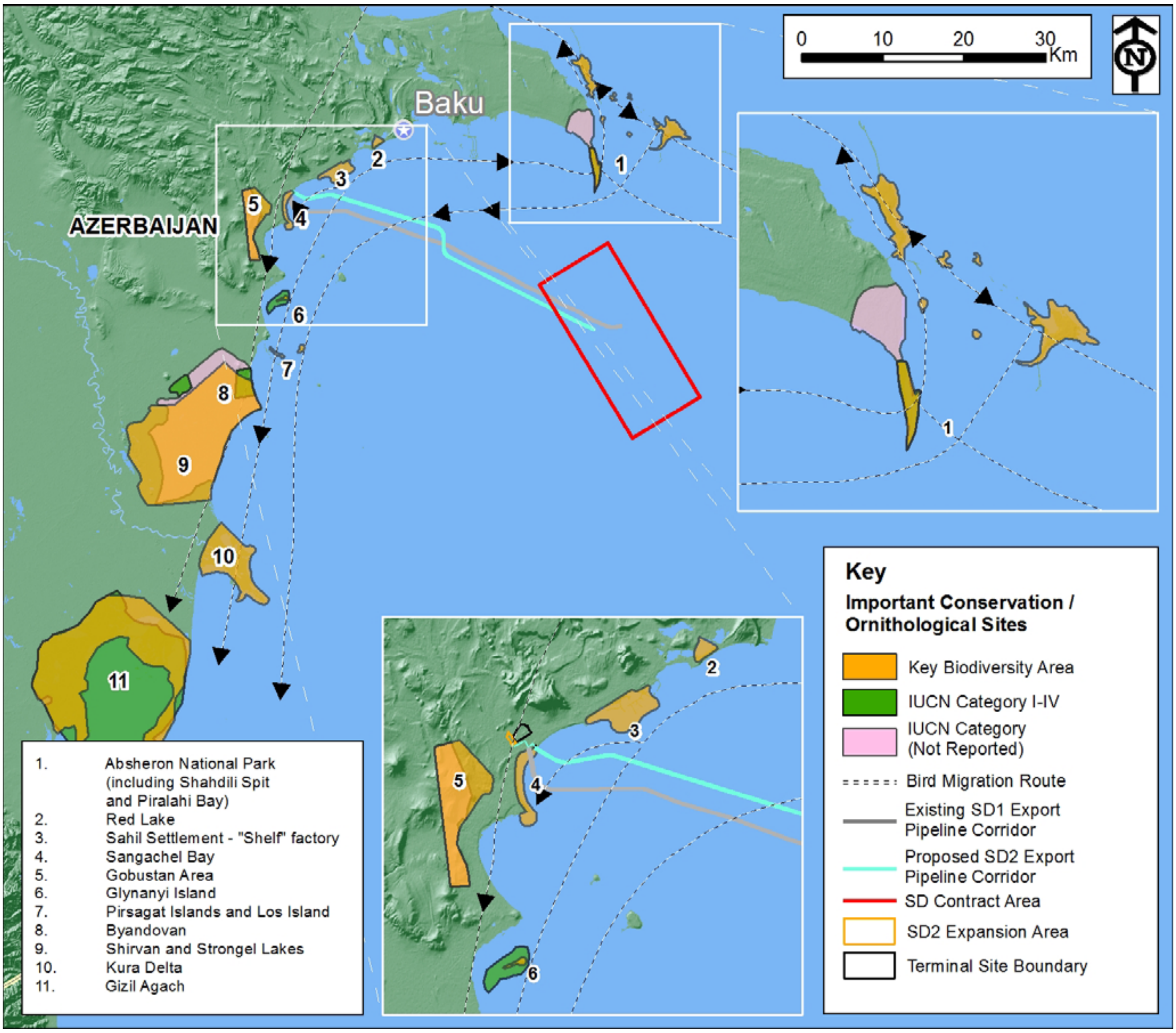
At a regional level, the coastal zone of the Caspian Sea has been identified as an area of ornithological importance as it supports both internationally and nationally significant numbers of migrating and overwintering birds. Bird species of local and international importance are also known to frequent the coastline. Important ornithological sites, located on the Azerbaijan coastline, are listed in Table 6.20 below and shown in Figure 6.18.

Table 6.20 Sites of Ornithological Importance

Sites of Ornithological Importance		Designation	Reasons for Designation
1	Absheron National Park (including Shahdili spit and Pirilahi Island)	KBA[1]/IBA[2] IUCN not reported[3] IUCN IV[4]	KBA/IBA - The area is important for overwintering and migrating bird species. IUCN not reported – Absheron National Park IUCN IV – 46 RDB species occur within and in the surroundings of the national park.
2	Red Lake	KBA/IBA	Significant populations of globally threatened bird species are known to occur here. The area is important for breeding bird species.
3	Sahil Settlement – 'Shelf Factory	KBA/IBA	Significant populations of globally threatened bird species are known to occur here. The area is important for overwintering and migrating bird species.
4	Sangachal Bay	KBA/IBA	The area is important for overwintering and migrating bird species.
5	Gobustan Area	KBA/IBA IUCN not reported	KBA/IBA - Populations of globally threatened bird species are known to occur here. The area is important for breeding bird species. IUCN not reported – Gobustan State Nature Reserve.
6	Glinyani Island	KBA/IBA IUCN IV	KBA/IBA - The area is important for breeding bird species. IUCN IV – two RDB species occur in the area.
7	Pirsagat Islands and Los Island	KBA/IBA	Populations of globally threatened bird species are known to occur here. The area is important for breeding bird species.
8	Byandovan	IUCN IV	49 RDB species known to occur here.
9	Shirvan and Shorgel Lakes	KBA/IBA IUCN not reported IUCN Ia[5]	KBA/IBA - Significant populations of globally threatened bird species are known to occur here. The area is important for overwintering and breeding bird species. IUCN not reported – Shirvan Reserve. IUCN Ia – 56 threatened species occur in this area.
10	Kura Delta	KBA/IBA	Significant populations of globally threatened bird species are known to occur here. The area is important for overwintering and migrating bird species.
11	Gizil Agach	KBA/IBA IUCN Ia Ramsar Site[6]	KBA/IBA - Important breeding and overwintering area for birds. A large number of globally threatened species occur here. IUCN Ia – Gizilagach State Reserve is located within this area. Fifty nine threatened species occur in this area. Ramsar - A wetland of international importance for migrating and breeding birds.

Notes:
[1] Nationally identified sites of global significance that address biodiversity conservation at a local scale (individual protected areas, concessions and land management units). Key Biodiversity Areas (KBAs) comprise an 'umbrella' which includes globally important sites (e.g. Important Bird Areas (IBAs), Important Plant Areas (IPA), Important Sites for Freshwater Biodiversity, Ecologically & Biologically Significant Areas (EBSAs) in the High Seas, Alliance for Zero Extinction (AZE) sites).
[2] Key sites for the conservation of bird species, identified by BirdLife International. These sites are small enough to be conserved in their entirety, and are different in character or habitat or ornithological importance from the surrounding area.
[3] A nationally protected area as listed by the World database on protected areas, but with an unknown IUCN category, e.g. Gobustan State Nature Reserve.
[4] Protecting a particular species or habitats and management of the reserves prioritises these species or habitats.
[5] Strictly protected areas set aside to protect biodiversity and also possibly geological features, where human visitation, use and impacts are strictly controlled.
[6] Convention on Wetlands of International Importance - ensuring the conservation and wise use of wetlands in national environmental planning; and consulting with other parties in regard to trans-boundary wetlands, shared water systems, and shared species.

Figure 6.18 Important Ornithological Sites Located on the Southwest Caspian Coast and Migration Routes



A literature review was undertaken in January 2010 focusing on the number and species of birds observed in surveys between 2002 and 2006 along the coastlines of the Shahdili spit and Pirilahi Island (refer to Appendix 6B).

The review highlighted that the breeding season of birds on the Shahdili and Pirilahi coastline begins at the end of April/beginning May and continues until mid-July. At the end of July and beginning of August, the birds leave their nesting places and disperse. During the breeding season, 18 species were recorded along the Pirilahi coastline and 16 species along the Shahdili coastline.

During the overwintering surveys between 2002 and 2006 an average of 24,873 waterfowl and 181 coastal birds and 20,004 waterfowl and 198 coastal birds were recorded along the Pirilahi coastline and Shahdili coastline, respectively. Four species recorded along both coastlines exceeded the 1% limit[22] for the provision of Ramsar status and four rare and endangered bird species listed in the AzRDB and the IUCN Red List of Threatened Species were also recorded (refer to Table 6.21).

[22] Criterion 6 of the Ramsar Convention states that a wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

Table 6.21 Overwintering Birds of Importance Recorded in 2002 – 2006 Surveys

Bird Species	Pirilahi Coastline	Shahdili coastline	Exceeds limit for the provision of Ramsar Status	Red Book of Azerbaijan	IUCN Red List of Threatened Species
Aythya ferina	✓	✓	✓		
A. fuligula	✓	✓	✓		
Cygnus olor	✓	✓		✓	
Falica atra	✓	✓	✓		
Numenius arquata	✓				✓ (NT)
Pelecanus crispus		✓		✓	✓ (VU)
Podiceps cristatus	✓	✓	✓		
Porphyrio porphyrio		✓		✓	

The Shahdili and Pirilahi coastlines are located within a major flyway for migrating waterfowl and coastal birds, who nest in the European parts of Russia, western Siberia, and north-western Kazakstan and migrate to the southern coast of the Caspian Sea, the Kur-Araz lowland, Turkmenistan, southwest Asia and Africa for the winter. The migration routes are indicated in Figure 6.18.

The autumn migration begins in the second half of August and continues until mid-December, with the most active period during November. The spring migration starts in the second half of February and ends in April, with the most active period during March.

Survey work completed between 2002 and 2006, during the spring migration, identified 19 and 29 bird species in the coastal waters of Pirilahi Island and the Shahdili coastline, respectively. In total, nine species recorded between 2002 and 2006 exceeded the 1% limit established for the provision of Ramsar status. During the same period, five endangered species were also recorded (refer to Table 6.22).

Table 6.22 Migrating Birds of Importance Recorded in 2002 – 2006 Surveys

Bird Species	Pirilahi Coastline	Shahdili Coastline	Exceeds 1% Limit for provision of Ramsar Status	Red Book of Azerbaijan	IUCN Red List of Threatened Species
Aythya ferina	✓	✓	✓		
A. fuligula		✓	✓		
A. nyroca		✓			✓ (NT)
Cygnus cygnus		✓	✓		
C. bewickii		✓	✓	✓	
C. olor	✓	✓	✓	✓	
Netta rufina		✓	✓		
Pelecanus crispus	✓	✓		✓	✓ (VU)
Podiceps cristatus	✓	✓	✓		
Phoenicopterus roseus		✓		✓	

Sensitivity

Part of Sangachal Bay, immediately to the south of the proposed SD2 Pipeline Corridor, has been designated as a KBA/IBA as it is used by up to 25,000 migratory and overwintering birds. Unlike the more important bird areas to the south and north (Absheron National Park and Gizil Agach) the area has not been nationally designated. The area of the KBA nearest the Terminal is currently disturbed year round by noise from highway traffic which passes approximately 50m from the shoreline. Birds using the area are therefore likely to be habituated to vehicle noise. The major flyway for migrating waterfowl and coastal birds, which is most active during March and November, passes over the route of the proposed SD2 Pipeline Corridor. Birds using this route are primarily migrating to the southern coast of the Caspian Sea, the Kur-Araz lowland, Turkmenistan, southwest Asia and Africa for the winter and then fly north along the same route during spring.

6.6 Nearshore Environment

6.6.1 Setting

Sangachal Bay is a dynamic shallow water area with a mixture of habitats and sediment types. The seabed slopes gently from the shore and reaches a depth of 10m approximately 3km from the water's edge. In the centre of the Bay there is a slight depression which acts as a sediment sink.

The Caspian Sea is effectively non-tidal and wind and pressure gradients are the driving mechanisms for currents in the sea. Typical pressure induced currents are caused by:

- Freshwater discharges;
- Secondary wind effects (stow-up currents); and
- Thermohaline circulation.

A year long metocean survey was undertaken from 29th May 2003 to 4th June 2004 within Sangachal Bay. Recording current meters were deployed on 29th May at three locations in the nearshore waters adjacent to the Sangachal Terminal. During the course of the survey drifter devices were periodically deployed and tracked to ascertain the directional movement of currents in the nearshore environment.

The results of the survey have determined that the current regime within the Bay is complex, and that it is governed by seabed topology, large-scale water circulation in the Caspian, as well as local and regional wind strength and direction. The main current direction in the nearshore area of Sangachal Bay follows the seabed contours and is to the south west. The maximum current speed measured was 40cm/s, mean speed was between 6 and 9cm/s. No significant seasonal trends in the current velocity data were identified.

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 exceed 10m in offshore waters during severe storm conditions. Longer time scale internal waves within the water column 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 Terminal.

6.6.2 Nearshore Benthic Flora

Benthic flora species within Sangachal Bay are predominately seagrass and algae. Seagrass surveys were undertaken in Sangachal Bay in 2001, 2002, 2003, 2006 and most recently in 2008. 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 and included shelly mud, coarse shelly sand as well as gravel. Dense beds of seagrass were present close to the shoreline in water depths of 1-3m, which form a coastal band approximately 200-500m wide. A narrow band of seagrass was also found in deeper water (6-7m) nearly 2km 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.

The 2008 survey detected an increase in seagrass throughout Sangachal Bay since the 2006 survey and a fall in the area of algal habitat.

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 5-11m.

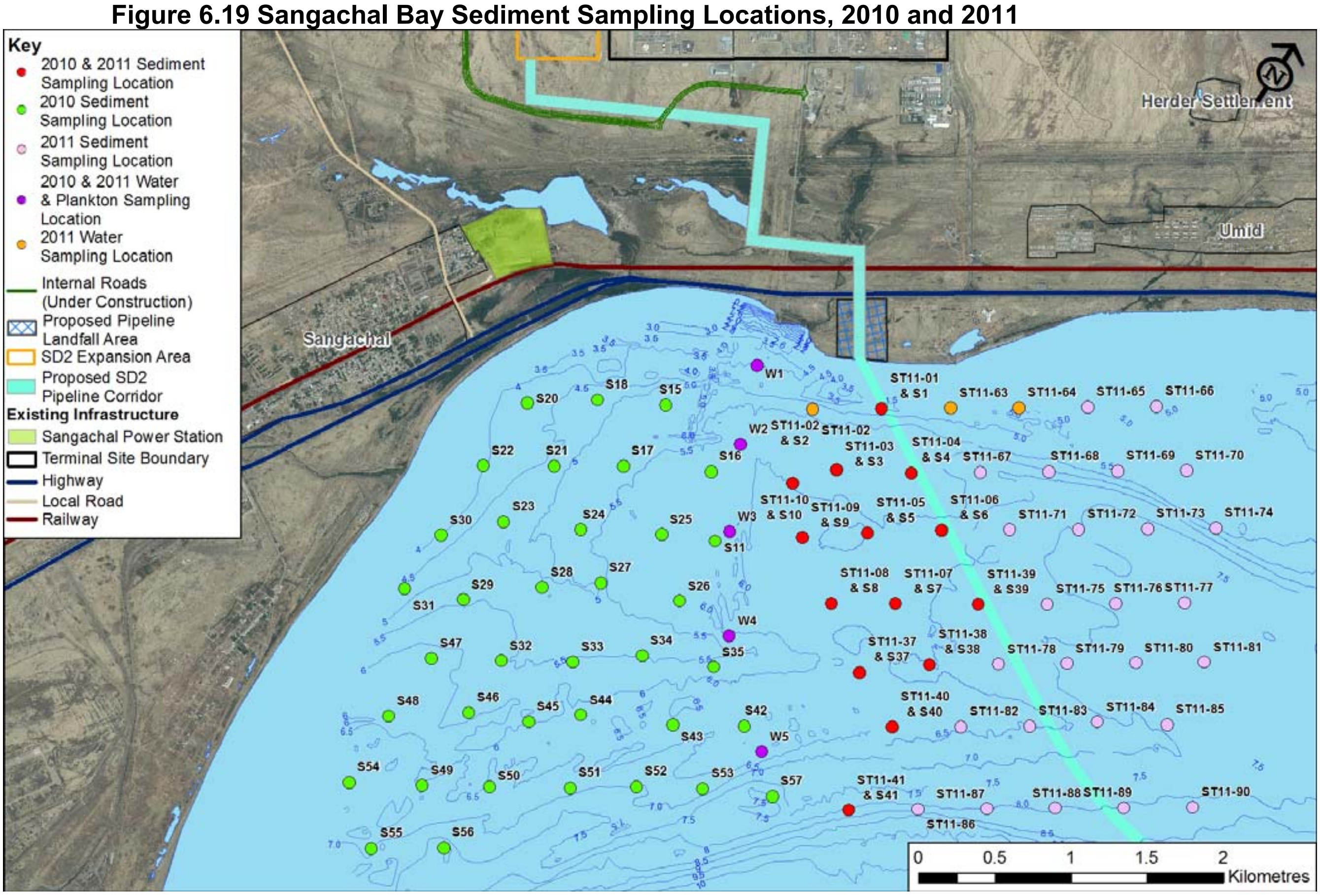
Sensitivity

The species of seagrass and algae, which are neither rare nor threatened, are present throughout Sangachal Bay. Evidence suggests that the seagrass beds are either stable or expanding – the vigour of the seagrass is best indicated by the fact that the thickest beds currently occupy an area which was dry land prior to the sea level rise of the late 20th century. In particular, no significant impacts were identified associated with the previous pipeline construction works within the Bay.

6.6.3 Nearshore Biological, Physical and Chemical Characteristics

Environmental surveys have been conducted in the Sangachal Bay area in 1996, 2000, 2003, 2006, 2008 and most recently in 2010 and 2011. The objective of the surveys is to provide information on the sediment chemistry, physical characteristics, macrobenthic fauna and plankton of Sangachal Bay. The locations of the 2010 and 2011 sampling stations can be seen in Figure 6.19. Stations 1-57 (2008 and 2010) provide coverage of the area of the Bay occupied by the present ACG/SD pipeline corridors and the Azpetrol terminal to the south. The 2011 survey focused further to the north, to cover the area likely to be occupied by the proposed SD2 pipeline corridor; this survey included stations 1-10 and 37-41 from the 2010 survey, and added an array of stations numbered 63-90.

Figure 6.19 Sangachal Bay Sediment Sampling Locations, 2010 and 2011



6.6.3.1 Benthic Invertebrates

The Sangachal Bay benthic survey in 2008 recorded a total of 39 macrobenthic taxa from the 57 samples collected. These included six polychaete taxa, six oligochaete taxa, one Cirripedia taxa, one Cumacea taxa, 15 amphipod taxa, one decapod taxa, three gastropod taxa and thee bivalve taxa. In contrast, only 17 taxa were recorded in the 2010 survey; the principal difference was the absence in 2010 of gastropods and cumacea, and the almost complete absence of amphipods. The 2010 data were similar to those reported in the 2006 survey, and the results therefore illustrate the variable nature of the Sangachal Bay benthos.

In addition to the taxonomic groups, the presence of Demospongiae species *Metschnikowia tuberculata tuberculata*, Bryozoan species *Conopeum seurati* and Hydrozoan species *Bouganvilleia megas* were recorded. The stations with higher numbers of species were found to the east and north-east of Sangachal Bay.

Bivalves were the most abundant taxonomic group in 2008, with a total abundance of 46,070 individuals which represented 71% of the overall abundance, while oligochaetes and polychaetes accounted for 14% and 9%, respectively. Bivalve abundance was greatest to the east and north-east of the Bay, and lowest to the west of the Bay. In 2010, oligochaetes and polychaetes represented 48% and 18% of total abundance, respectively, while bivalves accounted for 23% of total abundance.

A total of 15 amphipod species were recorded in 2008. Abundance and occurrence was generally very low with 10 species being present at only one station. *Cardiophilus baeri* was the most abundant amphipod species and was present at nine stations with a total abundance of 340 individuals. In general, amphipods were present at a small group of stations to the east of the Bay and to the north within 500-100m from the shore. In 2010, only three amphipod taxa with a total of 100 individuals were recorded.

In 2008, only one cumacean species (*Pterocuma pectinata*) was recorded with one individual. Gastropods were present at 12 stations in 2008, with a total of three species being recorded with *Caspiohydrobia gemmata* being the most abundant and prevalent. No cumacea or gastropods were recorded in 2010.

2011 Survey

The purpose of the 2011 survey was to extend the standard monitoring area to include the proposed SD2 Export Pipeline Corridor. A total of 43 stations were sampled, 15 of which were common to the standard survey pattern which was used in 2008 and 2010; the inclusion of these stations provided a basis for identifying any major natural changes between 2010 and 2011. An additional 28 stations were positioned to the north and east of the standard stations; a comparison between these stations and the 16 standard stations provided a basis for determining whether there were any ecologically important differences between the proposed SD2 Export Pipeline Corridor and the established monitoring area.

The 2011 survey recorded 27 taxa, a number intermediate between the 2008 and 2010 survey results. There was a greater number of amphipod and gastropod taxa (nine and four respectively) than in 2010, but cumacea remained completely absent. Both taxonomic groups occurred at only a small number of stations, and in low abundance. Polychaetes were dominant throughout the survey area, accounting for 50% of total abundance at the ‘original’ 15 stations and 45% of total abundance at the 28 ‘new’ stations. Bivalves accounted for 35% and 45% of abundance, and oligochaetes for 14% and 10% of abundance. There were no major or systematic differences in overall community composition between the two groups of stations. A comparison with the 2010 survey results suggests a general overall increase in abundance. While polychaetes remain dominant throughout, the relative abundance of bivalves increased and the relative abundance of oligochaetes decreased.

The results indicate that the area of the Bay in which the proposed SD2 Export Pipeline Corridor is located is biologically similar to the main Bay survey area. No ‘new’ taxa were observed, and the natural variability between stations within the proposed SD2 Export Pipeline Corridor area was similar to that routinely observed within the main survey area. The 2008, 2010 and 2011 surveys also provide a clear indication of temporal variability, with a notable fluctuation in the numbers of amphipod and gastropod taxa. While amphipods and gastropods influence the overall species richness of the area, they occur at low frequency and abundance and therefore are unlikely to represent a significant component of community function.

Sensitivity

The benthic communities are dominated by polychaetes, oligochaetes, and bivalves; most of the biomass is contributed by invasive or introduced polychaete and bivalve species. While there are changes in dominance between successive surveys, there is no persistent trend. Native species of cumacea, amphipod and gastropod (all of which are common in offshore sediments) are occasionally present at a few stations, and in low numbers, but these taxa do not appear to be consistent components of the community or to be present in sufficient abundance to make a significant contribution to community function.

Although benthic community structure show little overall change or trends over a series of surveys, there is, between successive surveys, invariably some indication of changes at individual stations. This is a reflection of the dynamic nature of the Bay; it is a shallow water environment, in which storm wave action will tend to occasionally redistribute sediment within the Bay, and may also occasionally introduce sediment from the adjacent coastal shelf area. Such shallow water areas are generally robust, as the communities are adapted to regular physical disruption. The macrobenthic community is dominated by relatively hardy annelids and bivalves; those taxa likely to be most sensitive to pollution, such as amphipods and gastropods, are a minor and inconsistently present part of the community.

6.6.3.2 Plankton

Phytoplankton and zooplankton characteristics have been recorded by surveys completed most recently in 2008, 2010 and 2011. The results of these surveys are described below.

Phytoplankton – in 2008, a total of 40 taxa were recorded, of which 22 were diatoms (*Bacillariophyta*), seven were dinophytes (*Dinophyta*), 10 were blue-green algae (*Cyanophyta*), and one green alga (*Chlorophita*). The 22 species of diatom were represented by 11 genera, with *Chaetoceros*, *Coscinodiscus* and *Nitzschia* the most diverse of the genera, with *Thalassionema nitzschioides Gru, as* the most abundant taxa. Bacillariophyta, constituted 74% of total phytoplankton abundance followed by Cyanophytes (18%), Dinophytes (7%) and Chlorophyta (1%). In 2010 and 2011, only 27 and 32 taxa were recorded respectively, but with a similar distribution between taxonomic groups.

Zooplankton - Three distinct zooplankton taxa were recorded in samples retrieved during the Sangachal Bay survey in 2008; two copepods *Acartia tonsa* and *Eurytemora minor* and the ctenophores *Mnemiopsis leidyi*. Juvenile life-stages of Copepoda, Cirripedia, Polychaete, and Mollusca were also observed in samples.

The zooplankton community recorded in 2008 was low in abundance and species richness, and was dominated by invasive species: *Acartia tonsa* and *Mnemiopsis leidyi*. Overall, the plankton is dominated by three invasive species: *Pseudosolenia calcar-avis* (key contributor to Phytoplankton biomass), *Acartia tonsa* (key contributor to zooplankton biomass) and *Mnemiopsis leydii* (main predator of zooplankton). All three species are likely to have been introduced over the past few decades in the ballast water of commercial shipping entering the Caspian Sea.

In 2010, the zooplankton was again dominated by *Acartia, Eurytemora,* and *Mnemiopsis*, but three native cladoceran taxa were also present in low abundance. In 2011, the overall dominance was similar, but only one cladoceran species was present. The cyclopid copepod *Halicyclops* was recorded for the first time since 2000, and two species of the genus *Estinostoma* were recorded for the first time. Bivalve and polychaete larvae were also recorded in some samples.

Sensitivity

Plankton within Sangachal Bay is dominated by alien/invasive species. The 2008 survey reports that since 2006, the zooplankton community of *Acartia tonsa* and *Mnemiopsis leidyi* has increased in abundance by nearly eight times. The results of the 2010 survey indicate a continued dominance by these invasive taxa.

6.6.3.3 Physical and Chemical Composition of Nearshore Seabed Sediments

The physical and chemical composition of nearshore seabed sediments has been investigated by routine surveys completed in 1996, 2000, 2003, 2006, 2008 and 2010, and in an additional survey carried out in 2011 to cover the area associated with the proposed SD2 Export Pipeline Corridor. The results indicate that the physical composition of nearshore sediment ranges from very fine silt to coarse sand, with the majority of samples having poorly, or extremely poorly, sorted sediment. Coarser grained sediment was made up of a high proportion of broken down shell material. As sediment depth increases, there is a reduction in silt and clay content and an associated increase in carbonate content.

The results of the 2011 survey indicate that the proposed SD2 Export Pipeline Corridor area is very similar in sediment structure to the rest of the Bay. Median particle diameter at the ‘old’ (i.e. 1996 to 2010) and ‘new’ (i.e. 2011) station samples was 204 and 194 μm respectively, with an overall survey median of 204 μm. Summary statistics for all other physical parameters were equally similar between the two groups of stations.

The result of chemical analysis on nearshore sediments indicates that THC and PAH concentrations are relatively low at the majority of sample locations within Sangachal Bay. Higher concentrations were obtained from samples located to the east of the Bay at a distance of approximately 1.5km from the shoreline, although the relationship between the concentration of THC and PAH is not consistent. The results of the 2011 survey indicated that THC ranged from 17 to 101 μg/g, with a median value of 65 μg/g. Range and median values were similar between the ‘old’ and ‘new’ samples. While the range was similar to that observed in 2010, the 2010 median was considerably lower, at 17.9 μg/g. However, the median for the 15 ‘old’ stations revisited in 2011 was 51 μg/g; this confirms previous observations that, although hydrocarbon concentrations in the Bay are generally low, there is a trend towards higher concentrations in the north and east of the Bay area.

Heavy metal analysis on sediment samples undertaken in 2006 to 2008 indicate consistency between data sets, with the highest concentrations recorded to the west of the Bay. However, the concentration of barium and mercury within sediment is highest in concentration to the east of the Bay. In the 2011 survey, the range and median values for all metals were similar between the ‘old’ and ‘new’ stations, and generally similar to the results of the 2010 survey. Concentrations of barium, iron and manganese were lower in 2011 than in 2010, and there appears to be an overall trend towards lower concentrations of these metals over the period of 2006-2011. Cadmium concentrations in the 2011 survey were lower than in 2010 (medians of 0.26 and 0.36 μg/g, respectively), and the 2011 values were close to those recorded in 2008. The apparent increase in cadmium concentrations between 2008 and 2010 was noted in the 2010 survey report; no obvious explanation was available at the time, but it is clear that there is no permanent or consistent upward trend in cadmium concentrations.

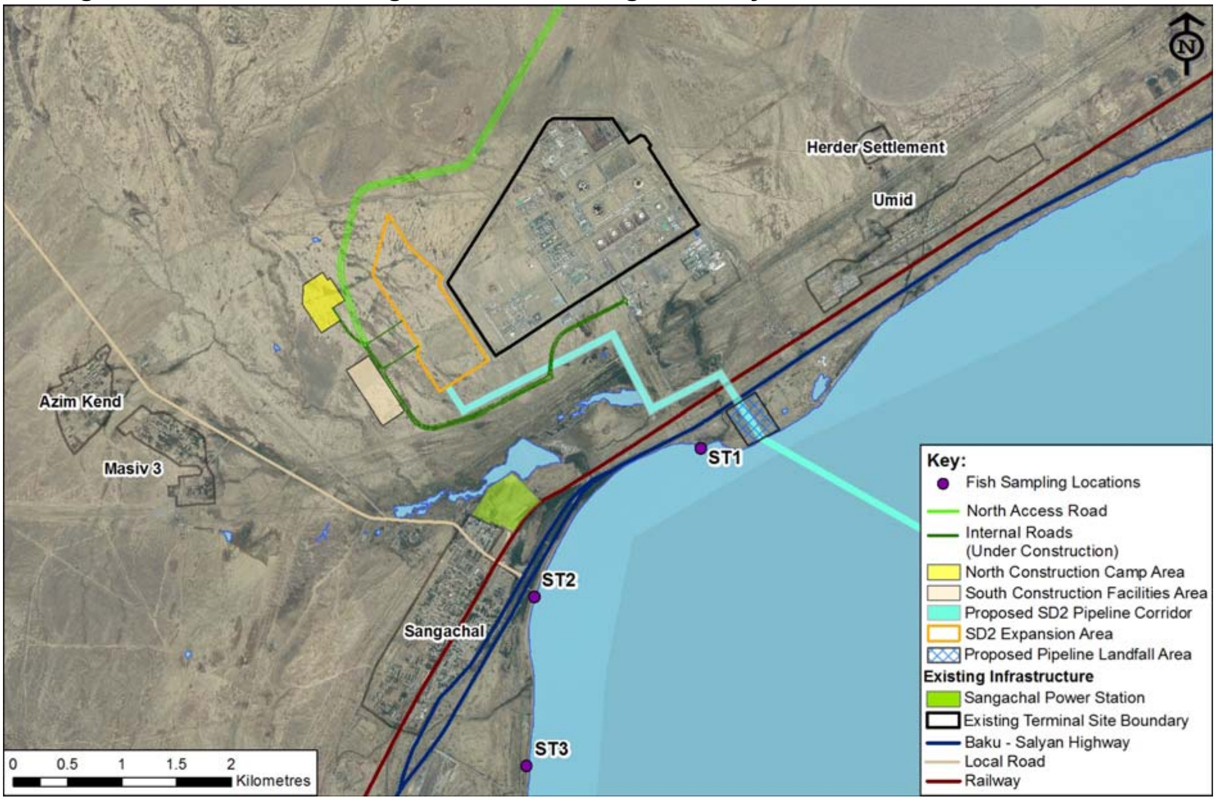
Sensitivity

The area occupied by the proposed SD2 Export Pipeline Corridor is similar in sediment composition to the adjacent, previously-surveyed area of the Bay. Sediments are variable in composition, ranging from silt to sand, and there is no evidence of significant hydrocarbon or metal contamination.

6.6.4 Nearshore Fish and Mammals

As part of the EMP, regular fish monitoring is undertaken in the Sangachal Bay to ascertain the presence, contamination levels and health status of the fish population. The most recent surveys were completed in 2008 and 2009. Fish were collected using a beach trawl net at three locations (Figure 6.20).

Figure 6.20 Fish Monitoring Locations in Sangachal Bay



A total of 11 fish species were caught, identified and enumerated in October 2008, and 10 fish species were identified and enumerated in May 2009. The Sandsmelt (*Atherina boyeri caspia*) and Goby (*Neogobius sp*) were the most abundant species in the Sangachal Bay area from the spring and autumn surveys. Mullet (*Liza saliens Risso*) and Caspian roach (*Rutilus rutilus kurensis*) were most abundant in the autumn surveys. A considerable difference in the number of fish per season was observed with the spring catch being three times greater than the autumn catch. Table 6.23 shows the number of different fish species collected during the 2008 and 2009 surveys.

Table 6.23 Fish Species Found in Sangachal Bay from 2008 and 2009 surveys

Fish Species	Total per Species	
	October 2008	May 2009
Sprat (*Clupeonella cultriventris caspia (Svetovidov)*)	18	11
Caspian Roach (*Rutilus rutilus kurensis (Berg)*)	50	5
Caspian kutum (*Rutilus frisii kutum (Kamensky)*)	4	2
Asp *(Aspius aspius (Linne))*	1	7
Thornback *(Gasterosteus aculeatus Linnaeus)*	65	4
Needlefish (*Syngnathus nigrolineatus caspius Eichwald)*	13	3
Mullet (*Liza saliens Risso)*	60	17
Sandsmelt *(Atherina boyeri caspia (Eichwald))*	121	1,081
Gobies (*Neogobius sp)*	64	112
Total	**396**	**1,242**

Among fish present in the catch, Sprat (*Clupeonella cultriventris caspia*), Caspian roach, Kutum (*Rutilus frisii kutum*), Zherekh (*Aspius aspius*) and Mullet have a commercial value whereas the Sandsmelt and Gobies have no commercial value. However, Sandsmelt and Gobies form part of the diet of valuable commercial fish such as Sturgeon (*Acipenser sp*), Salmon (*Salmo sp*) and predatory herrings.

Catches of Sandsmelt and Gobies, which are permanently resident in Sangachal Bay, have been analysed to monitor their health status and contamination level to perform a check on the impact associated with wastewater effluents discharged by the Terminal. The number of fish used for analytical study was 15 Sandsmelts and 15 Gobies per station. They were analysed for the following:

- Standard physical and biological measurements (weight, length, liver-somatic and gonado-somatic index);
- PAH metabolites in bile;
- Metal concentrations in liver tissue;
- Micronuclei assay of blood cells;
- Histopathology analysis of liver and gill tissue; and
- Cytochrom P-450 in muscle tissue.

In general, the results indicated that the health status of the fish in the survey area is satisfactory although some trends were identified as described below.

The Caspian Seal (*Phoca caspica*) is the only marine mammal in the Caspian Sea basin and is endemic to the area. An aerial survey carried out under the Darwin Initiative project in the North Caspian found that in the past decade the numbers of seals in the Caspian Sea reduced from approximately 400,000 to 111,000. In 2008, the Caspian Seal was listed as ‘Endangered’ on the IUCN red list. No seals are known to currently breed in the Azerbaijani sector of the Caspian Sea and there are no records of seals occurring within Sangachal Bay.

Sensitivity

The analysis of the Sandsmelt and Gobies revealed the following differences when compared with a similar study in 2005:

- Physical measurements indicated the presence of larger individuals in spring than autumn and fish maturity was more than 6.5 times greater and hepato-somatic indices (which provide an indication of energy reserves in an animal) were almost two times higher in spring. Females were numerically dominant within spring catches;
- Increased levels of naphthalene were recorded in spring and autumn studies when compared with 2005 levels;
- The concentration of trace metals in the spring were lower than those recorded in the autumn and it was identified that there was an increase in mercury and lead content and a decrease in chromium and iron concentrations compared to 2005; and
- Histopathology analysis on liver and gills showed generally normal morphological composition of tissue.

Fish present in Sangachal Bay will be especially sensitive during the spawning season which is from April to August.

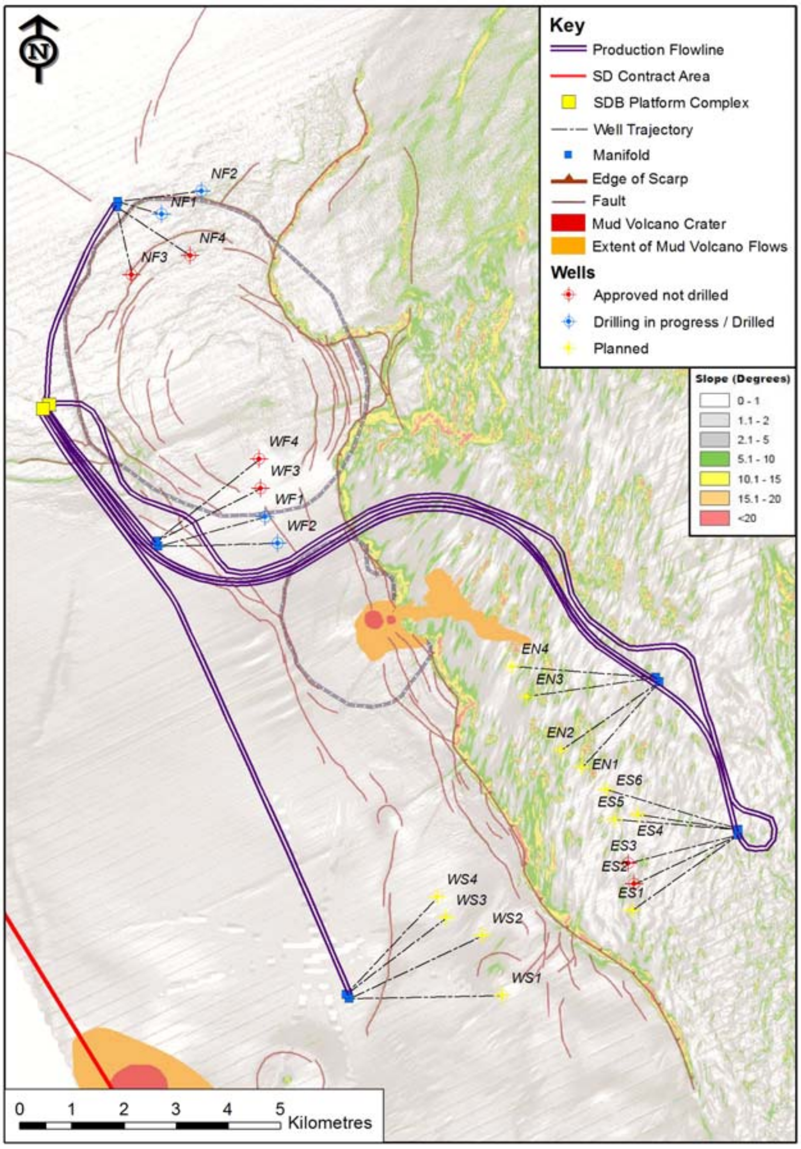
6.7 Offshore Environment

6.7.1 Bathymetry and Physical Oceanography

The Caspian Sea is the largest landlocked water body on earth with a surface area of approximately 371,000km^2. It is fed by numerous rivers; the largest of which is the Volga to the north. The Sea is made up of three basins: the Northern, Central and Southern Basins. The Northern Basin is the smallest (about 25% of the total surface area), but is very shallow. The Central and Southern Basins have similar surface areas, but the Southern is deeper and contains almost twice the volume of water as the Central Basin. The deepest recorded depth is in the Southern Caspian Basin at just over 1,000m.

The SD Contract Area lies within the Central Caspian Basin, and comprises a shelf edge (or escarpment) and a sloped area. The escarpment (a raised anticline or crest) dissects the Contract Area from north-west to south-east (refer to Figure 6.21). The sloped area ranges from a minimum water depth of approximately 60m in the north-east to a maximum of almost 700m in the south-east.

Figure 6.21 Slope Areas and Major Mud Volcano Locations within the SD Contract Area[23]



[23] The locations of the final four wells has not yet been confirmed. Their locations will be determined once additional well performance and subsurface information becomes available.

Figure 6.21 shows the difference in the seabed topography across the Contract Area, where the seabed floor of the escarpment shelf (to the west) is generally even with some faulting, to the east within the slope area where the seabed is very uneven with numerous sharp peaks. This is indicative of slumping and seabed instability created by erosion of the escarpment edge. There are two active mud volcanoes within the Contract Area. The major ring faulting just to the north of the main escarpment that runs through the Contract Area is indicative of a collapsed former mud volcano.

6.7.1.1 Water Temperature

During the winter months, surface water temperatures may fall to 5ºC at the shelf edge and 7ºC over the slope, with the monthly average temperatures at 8ºC and 10ºC, respectively.

During summer, the temperature of the waters in the southern Caspian becomes stratified and a strong thermocline develops that inhibits vertical mixing. Surface water temperatures can reach a maximum of 28ºC in August[24]. Temperatures at depth remain approximately 6ºC all year round[25].

6.7.1.2 Salinity

The average salinity of the Caspian is approximately 12.9‰. The middle and southern areas of the Caspian Sea have very small seasonal and spatial differences. For example, sampling conducted as part of the 2009 SD Regional Environmental Survey found little variation in salinity at the stations sampled, ranging from 11.1-11.6‰[26].

6.7.1.3 Oxygen Regime

Offshore areas of the Caspian, including the Contract Area, are characterised by high oxygenation of the surface water throughout the year. They experience high saturation levels in the spring due to phytoplankton activity. During summer, the water column becomes stratified resulting in decreased oxygen levels below the thermocline.

6.7.1.4 Wave and Current Regime

Storms in the Caspian region blow along a north-westerly/northerly axis, although the Absheron Peninsula shelters the SD Contract Area from the most severe of these. A large gradient in extremes of waves also exists across the region. The 100-year significant wave height in the SD Contract Area is about two-thirds the size of comparable statistics in the open sea to the east of the Peninsula. The largest waves to affect the Contract Area come from the north-easterly sector.

Currents of the region are complicated and are affected by season with lower current speeds measured during summer as compared to winter. The severity of winter also affects current speeds and currents may be strong at both the surface and near the sea bed. For example, the measured mean flow in the SD Contract Area shelf edge region during the relatively benign winter of 2000 - 2001 was just 0.03m/s, while during the relatively severe winter of 2005 - 2006 it was 0.13m/s. More recently, the mean flow was measured at 0.10m/s during the winter of 2008.

The predominant direction of the strong currents is from the north-east. The currents may act from surface to seabed, or surface flows may differ from the deepwater flows whereby strong currents may act in either layer. The currents may be driven directly by local weather events or by distant forcing mechanisms. In the latter case the currents may occur during periods of unremarkable local weather. Approximate expected winter maxima current values are shown in Table 6.24.

[24] OceanMetrix (2009), Shah Deniz Wind, Wave, Surge and Current Criteria V3.1a. Report developed for BP Exploration Operating Company Ltd.
[25] BP, 2002.
[26] AmC, 2010

Table 6.24 SD Expected Winter Maxima Current Values

Location	Water Depth	Current Speed
Shah Deniz Shelf	Near surface	1.0 m/s
Shah Deniz Shelf	Near bottom	0.5 m/s
Shah Deniz Slope	Near bottom (200m)	0.5 m/s
Shah Deniz Slope	Near bottom (400m)	0.4 m/s

The mechanism that drives the current can be traced back to the Northern Caspian basin. Here, very cold winter air temperatures, shallow waters, and large fluvial inputs, lead to rapid ice development and the formation of a reservoir of cold, dense water on the boundary with the Central Caspian basin. The cold water is transported along the western Central basin under the influence of cyclonic winds associated with the winter low pressure trough. A component sinks and flushes the bottom waters of the Central Caspian basin, but in normal years a large volume finds its way over the western section of the Absheron sill and into the Southern Basin where it appears to mix and sink. A counter flow of relatively warm Southern Caspian water along the eastern section of the Absheron sill balances the cold water inflow.

The irregular depth of the Absheron sill complicates the winter seasonal flow further. The sill is deeper on the western side, near Deepwater Gunashli (with a maximum depth over 200m), than on the eastern side (where depths are usually less than 150m). Therefore, the cold water inflow penetrates beneath the level of the warm water outflow. This is thought to cause currents along the continental slope of the eastern sill to flow towards the west.

6.7.1.5 Storm Surges and Waves

Storm surges occur in the Caspian causing temporary rises or falls in sea level. Significant sea level changes occur in the middle basin of the Caspian. These events are associated with persistent strong winds, particularly the strong prevailing regional winds that blow along the axis of the Caspian, from north and north-west or from south and south-east. Strong winds from the north are more frequent and more severe than strong winds from the south. Waves in the Caspian Sea are wind driven and subsequently the windiest months also exhibit the greatest wave action.

Wave height data recorded at Nyeftyanye Kamni/Oil Rocks indicates that the months of July, August and September have the strongest winds and storms, with a greater frequency of wave heights in excess of 2m recorded. The period of October to February, however, shows the greatest number of wave heights between 1 and 2m, reflecting the steady occurrence of strong winds during this period.

South of the Absheron Peninsula, northerly winds will create a fall in sea level while southerly winds result in a rise. In Baku Bay this change can be ±70-80cm. The typical time period for a storm surge is estimated to be 6-24 hours.

The area of greatest wave development extends from the western portion of the Middle Caspian basin, down and across the central section of the Absheron Ridge.

6.7.1.6 Geology and Lithology Overview

The Caspian Basin represents one of the largest continental lake systems in the world. The recent geological sequence is characterised by Fluvial Deltaic sandstones and Lacustrine Shales. Sedimentation rates were rapid with 8km of sediment deposited over six to ten million years. Pliocene deposition in a low gradient, lacustrine basin formed regionally extensive sandstone sheets. Fluctuations in lake level, driven primarily by climate change, allowed rapid large scale avulsion of the Volga Delta and the deposition of laterally continuous lacustrine Shales.

The rapid deposition resulted in compaction disequilibrium and the building of severe overpressures. Tectonic activity at the end of Pliocene resulted in the current structural geometry of the SD field.

6.7.1.7 Physical and Chemical Composition of Seabed Sediments

The physical and chemical composition of seabed sediments in the SD Contract Area have been established through the surveys detailed within Table 6.1. The locations of survey stations are shown in Figure 6.22 below.

Physical Properties

Sampling has shown that sediments in the Contract Area are predominantly fine silts, with a median particle size of six micrometres (μm). Coarser sediments have been recorded at the three stations closest to the SD Alpha (SDA) platform (stations 26, 27 and 29) and at the majority of the SDA specific stations indicating a zone of coarser sediment in the middle of the SD Contract Area. At two of the SDA stations, sediments have become progressively coarser since 1998, and at one SDA station, sediments have changed from fine sand to fine silt in the same period. The SDA locations lie close to an area of smaller mud volcano vents, and it is likely that the margins of this area change with time, leading to changes in sediments at stations which lie close to the margins. With the exception of these 'marginal' stations, there has been no detectable change in the physical properties of sediments at the regional survey stations.

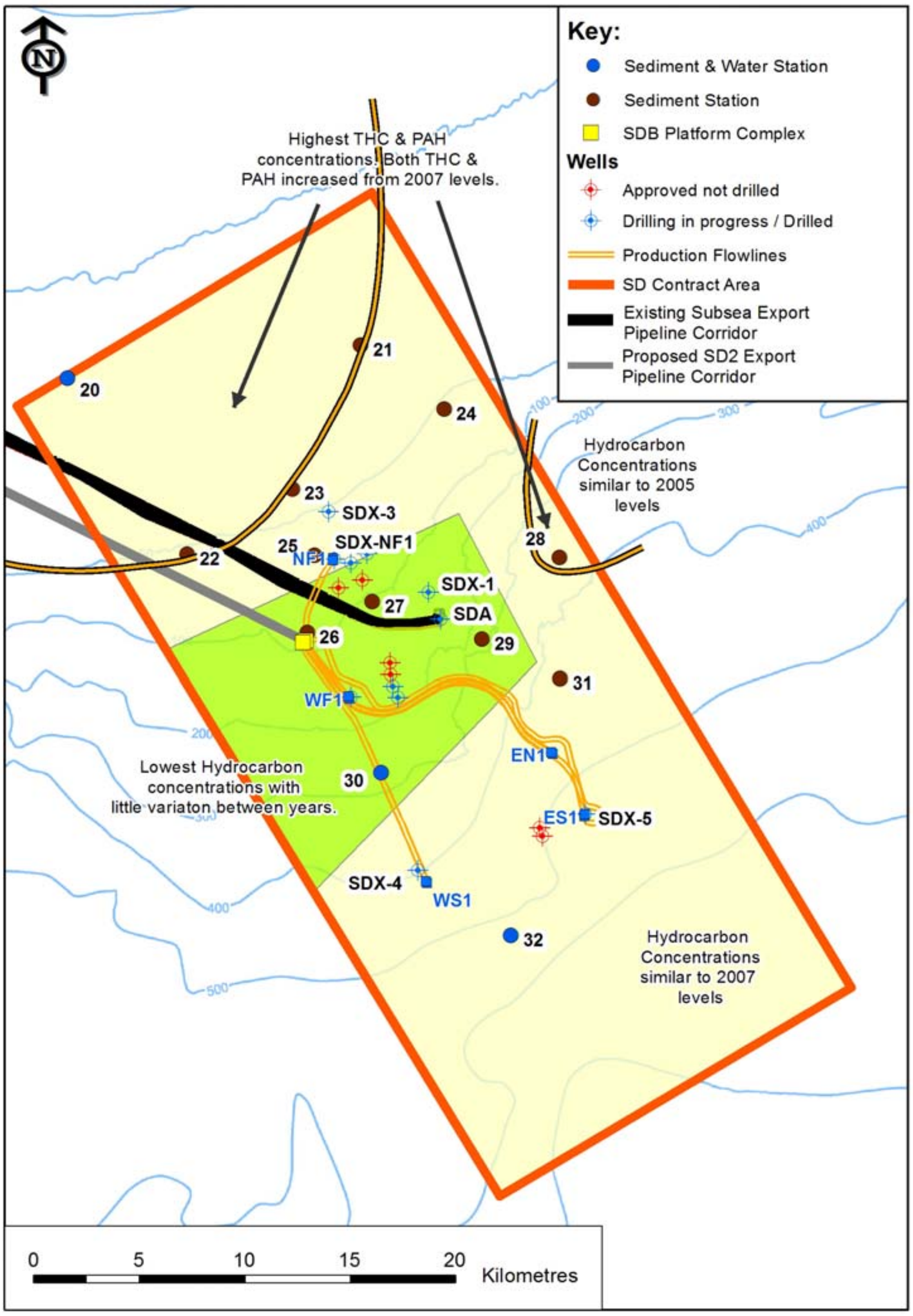
Hydrocarbon Concentrations

THC concentrations within SD Contract Area sediments in 2009 ranged from 11 to 390 μg/g (Table 6.25), with an average value of 133 μg/g. The lowest concentrations were observed in sediments at the stations with the coarsest sediment, with relatively little variation among stations with fine silty sediments. Overall, THC concentrations have decreased progressively by about 70% since 1998. The largest changes have been observed in the deeper water stations in the south of the Contract Area. There has been relatively little change in the shallower water stations in the north of the Contract Area (see Figure 6.22).

Table 6.25 Statistical Summary of Trends in Sediment Hydrocarbon Content in SD Regional Survey 1998 - 2009 (μg/g) – Mean, Minimum and Maximum Concentrations

	THC (μg/g)			UCM (μg/g)			%UCM			Phenol (μg/g)		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
1998	46	**463**	919	35	**396**	807	75	**85**	90			
2000	55	**309**	542	45	**255**	473	57	**81**	88			
2001	36	**258**	544	28	**221**	486	76	**84**	89			
2005	12	**135**	284	7	**108**	247	61	**79**	89	0.94	**3.43**	7.69
2007	7	**86**	176	5	**71**	155	48	**80**	97	0.31	**2.14**	4.97
2009	11	**133**	390	7	**108**	330	61	**79**	86	1.41	**3.42**	6.05
	2-6 Ring PAH (ng/g)			**NPD (ng/g)**			**%NPD**			**USEPA 16 PAH (ng/g)**		
	Min	Mean	Max	Min	Min	Min	Min	Mean	Max	Min	Mean	Max
1998	294	**2310**	4512	160	**1250**	2376	50	**54**	61	51	370	598
2000	297	**1903**	2755	136	**970**	1338	43	**51**	65	45	367	604
2001	336	**1837**	3048	192	**983**	1495	39	**53**	60	61	354	590
2005	59	**782**	1757	24	**348**	778	36	**47**	68	8	144	316
2007	80	**651**	1419	26	**227**	521	28	**36**	49	-	-	-
2009	118	**819**	2035	55	**416**	951	38	**51**	62	28	148	378

Figure 6.22 Summary of Trends in Sediment Hydrocarbon Content, SD Regional Survey 2009



Heavy Metal Concentrations

Heavy metal concentrations vary relatively little across the SD Contract Area and are generally typical of natural fine silts (see Table 6.26). The greatest variation in 2009 was observed for mercury, where concentrations were highest in the shallow water stations in the north of the SD Contract Area, with increases at these stations observed between 1998 and 2000. Fluctuating but consistently moderately high concentrations have been maintained since 2000. A similar temporal trend was observed for cadmium.

Barium concentrations have increased progressively from a regional average of 270μg/g in 1998, to a regional average of 547μg/g in 2007, slightly decreasing to 495μg/g in 2009. In contrast, lead concentrations decreased from a regional average of 40μg/g in 1998 to 20μg/g in 2000; and have remained close to this lower level in subsequent surveys.

Table 6.26 Statistical Summary of Trends in Sediment Heavy Metal Concentrations, SD Regional Surveys 1998 – 2009 (µg/g)

	Arsenic (As)			Barium (Ba) Nitric Acid (HNO_3)			Barium (Ba) Fusion		
	MIN	**MEAN**	MAX	MIN	**MEAN**	MAX	MIN	**MEAN**	MAX
1998	-	**-**	-	176	**270**	403	-	**-**	-
2000	-	**-**	-	287	**446**	705	-	**-**	-
2001	-	**-**	-	347	**497**	669	-	**-**	-
2005	4.7	**10.9**	33.1	8	**369**	820	308	**974**	2032
2007	9.2	**16.9**	30.6	274	**547**	1092	405	**709**	1170
2009	4.1	**10.7**	19.1	255	**495**	872	299	**549**	900
	Cadmium (Cd)			**Chromium (Cr)**			**Copper (Cu)**		
	MIN	**MEAN**	MAX	MIN	**MEAN**	MAX	MIN	**MEAN**	MAX
1998	0.06	**0.09**	0.14	37.8	**61.5**	71.3	17.0	**30.3**	37.6
2000	-	**-**	-	26.0	**51.4**	61.5	20.9	**28.0**	33.8
2001	0.08	**0.26**	0.79	19.1	**50.9**	65.2	9.3	**27.0**	35.6
2005	0.06	**0.10**	0.15	12.3	**77.0**	92.6	4.7	**25.8**	37.7
2007	0.11	**0.18**	0.30	23.1	**76.2**	101.9	4.7	**28.9**	42.5
2009	0.10	**0.15**	0.23	27.6	**71.0**	89.8	6.5	**26.4**	35.5
	Iron (Fe)			**Mercury (Hg)**			**Manganese (Mn)**		
	MIN	**MEAN**	MAX	MIN	**MEAN**	MAX	MIN	**MEAN**	MAX
1998	24,272	**33,700**	38,008	0.05	**0.07**	0.10	-	**-**	-
2000	20,919	**36,100**	41,875	0.05	**0.12**	0.24	-	**-**	-
2001	16,096	**35,600**	44,890	0.01	**0.10**	0.23	456	**602**	784
2005	9,237	**35,178**	41,653	0.01	**0.09**	0.17	-	**-**	-
2007	15,300	**36,800**	46,200	0.03	**0.11**	0.18	507	**718**	986
2009	16,200	**35,611**	43,700	0.02	**0.10**	0.22	466	**697**	953
	Lead (Pb)			**Zinc (Zn)**					
	MIN	**MEAN**	MAX	MIN	**MEAN**	MAX			
1998	30.9	**40.1**	44.6	50.7	**85.0**	94.9			
2000	17.3	**20.8**	23.0	53.3	**76.5**	86.7			
2001	14.9	**23.2**	30.5	36.6	**83.2**	98.7			
2005	5.3	**17.6**	25.8	19.6	**76.2**	91.5			
2007	4.1	**18.1**	24.6	27.9	**81.1**	96.1			
2009	7.3	**21.0**	28.4	33.6	**85.2**	103			

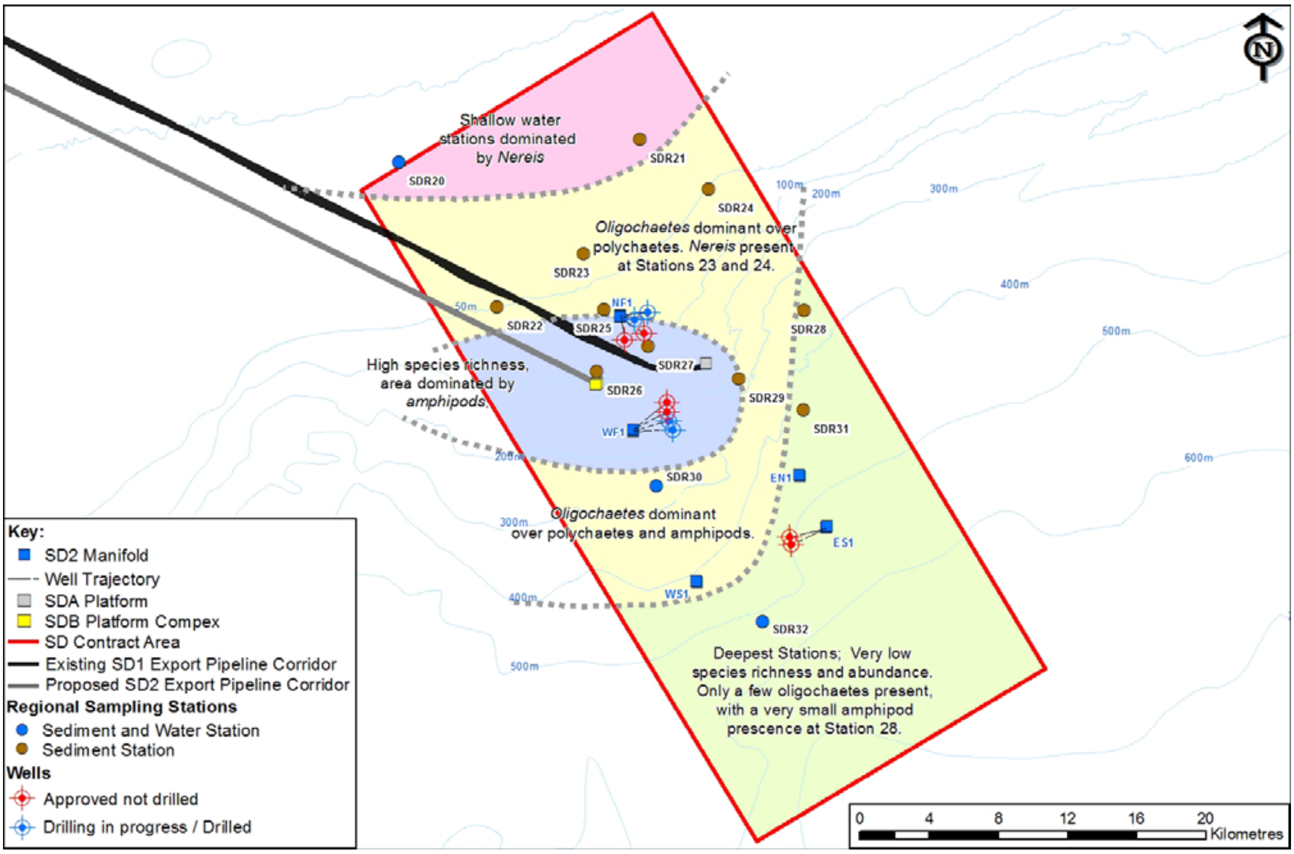
6.7.1.8 Biological Characteristics of Seabed Sediments

A total of 69 taxa were identified in the 2009 SD Contract Area Regional Survey, with 1-51 taxa per station and an average of 13 taxa per station. This is considerably less than the 108 taxa identified in the 2007 SDA Platform Location Baseline Benthic Survey and emphasises the distinctive nature of the area around the SDA location. Amphipods were represented by 30 taxa, and gastropods by 12 taxa during the 2009 SD regional survey, compared to 38 and 29 respectively in the SDA area, observed during the 2007 SDA survey. Amphipod, oligochaete and gastropod species richness has declined moderately over time at the SD regional stations, while the number of polychaete, cumacean and bivalve species has remained fairly constant. There is, however, no consistent trend in average abundance for any taxonomic group.

The total number of species was considerably higher in 1998 (at 90), but has remained relatively constant at between 56 and 62 since 2000. This contrasts with a progressive increase in species richness within the coarser sediments around the SDA platform.

Figure 6.23 summarises the macrofaunal biology spatial trends across the Contract Area in 2009.

Figure 6.23 Macrofaunal Trends across SD Contract Area, 2009



Sensitivity

The benthic environment is dominated by small amphipods, polychaetes and oligochaetes, the majority of which are native or endemic species. These animals are dependent for food on organic material within the sediments, or in particulates immediately above the sediment. The primary forms of potential sensitivity are:

- Chemical contamination of the sediment;
- Smothering of the habitat by solids deposition (such as from deep deposits of drill cuttings); and
- Physical disturbance of the habitat (such as from shallow deposits of drill cuttings).

In the past, water based mud (WBM) cuttings (which do not contain toxic chemical additives) have been discharged to the seabed as part of project activities within the ACG and SD Contract Areas. Extensive monitoring[27] over a number of years at ACG and SD offshore facilities has demonstrated that such discharges do not lead to the contamination of the sediment with harmful, or potentially harmful, chemicals.

Where cuttings deposits are deep (tens of centimetres to metres), the benthic habitat is effectively eliminated. With shallower deposits (less than 10cm, for example), burrowing organisms are capable of re-establishing themselves near the surface quite rapidly. Monitoring has shown that substantial populations can be found in areas of sediment with high barium concentrations (which are the most distinct indication of the presence of shallow drill cuttings deposits).

Alteration of the structure of the habitat by physical events such as cuttings deposition has the potential to interfere with the construction of burrows and with feeding. Extensive monitoring has shown that, even when high barium concentrations indicate the presence of cuttings,

[27] The monitoring surveys form part of the EMP and reported to the MENR within annual EMP reporting.

there is little evidence that the structure of the habitat has been substantially altered. This is likely to be because only cuttings from the top hole sections are discharged, and these consist of poorly-consolidated sediments which are similar in composition to the surficial seabed sediments in which the benthic organisms live.

During periods of discharge, very short-term disruption might occur within a small area, but adaptation will take place rapidly. The dominant benthic infaunal species can produce several generations per year, and can therefore replace short-term losses within weeks or a few months. The period of greatest sensitivity to short-term disruption is likely to be from the end of the breeding season until the beginning of the next breeding season – that is, between autumn and spring. During this period, losses cannot be replenished.

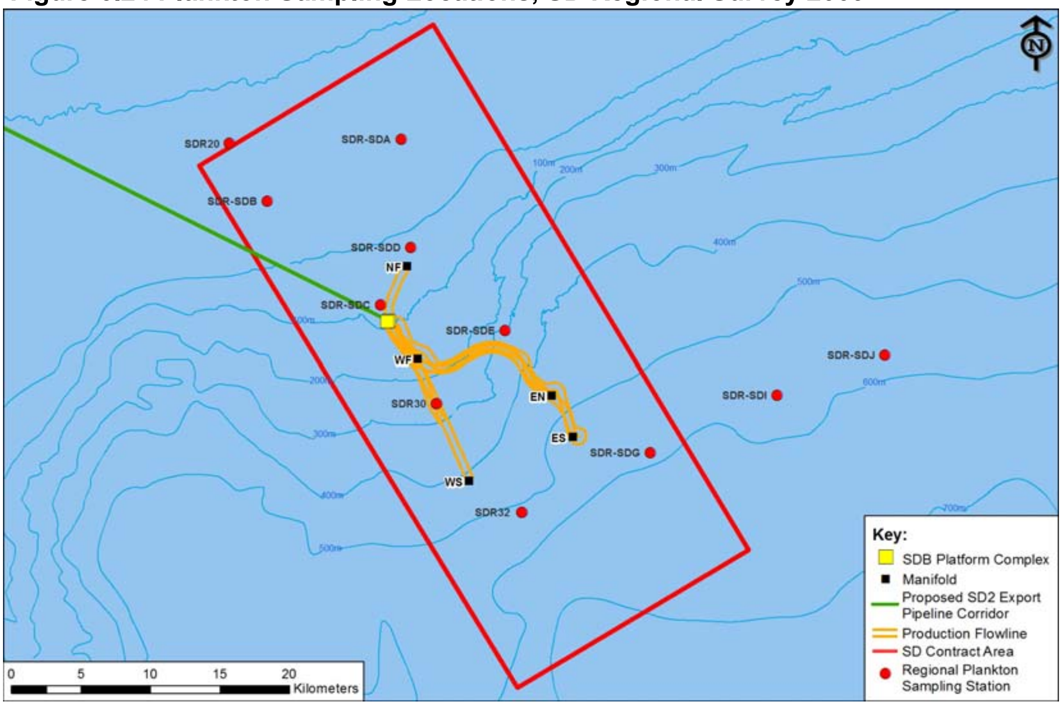
Most offshore biological communities contain one to three native species of filter-feeding bivalves. These organisms are not highly vulnerable to short-term high water turbidity arising from cuttings discharge, as they can close their valves and isolate themselves for several days if necessary. They are, however, effectively immobile and attached to their substrate, and are consequently more vulnerable to smothering from deposits of more than 1-2cm. The presence and abundance of bivalves is very variable at most locations, and they do not therefore form a consistent and permanent component of any local community. This is because they have planktonic larvae, and at any location the persistence of a population depends on a flow of larvae from another location. Larval settlement and recruitment is therefore unpredictable and intermittent, resulting in the occasional development of populations which subsequently decline. Any localised sensitivity to smothering will not effectively alter this pattern of occasional colonisation, although it will have an effect on any populations at other locations which depend on a supply of larvae from the affected site.

6.7.2 Water Column: Biological Environment

6.7.2.1 Plankton

Plankton surveys within the SD Contract Area were undertaken in 2000, 2001, 2005 and 2009[28] with the earlier surveys using a different methodology and sampling locations. Figure 6.24 shows the 2009 regional SD plankton sample locations.

Figure 6.24 Plankton Sampling Locations, SD Regional Survey 2009



[28] Plankton surveys have been regularly undertaken as part of EMP and reported to the MENR within annual EMP reporting.

6.7.2.2 Zooplankton

Zooplankton abundance and diversity were very low in all surveys conducted prior to 2005. The 2005 plankton survey and subsequent surveys used significantly improved equipment and methods. In addition, a greater number of stations were sampled than previously; 10 in total. The most striking aspect of the 2005 results is that, despite methodological improvements and substantially increased sampling effort, the diversity of zooplankton has clearly declined significantly in recent years. These results are supported by similar observations from the SD Contract Area Regional Water Quality/Plankton Surveys conducted in 2007 and 2009.

Over the course of the surveys since 2000, a total of 31 taxa were found, of which 28 were identified to species level (the remaining three were larvae of various types). Three main types of zooplankton were encountered:

- Copepods - small, shrimp-like animals often no more than 1mm long, some native to the Caspian Sea and some introduced from other areas;
- Cladocerans - 'water fleas', often larger than copepods (1 - 5mm long), predominantly native to the Caspian; and
- Ctenophore - 'comb jelly' - one species, which is not native to the Caspian and was first recorded in the Caspian Sea in 1999 (this species may have been transported into the Caspian from the Black Sea via the Azov Sea and the Don canal system).

The most abundant zooplankton species in the surveys between 2000 and 2009 were the native copepods *Eurytemora sp* and the invasive copepod *Acartia sp.* Since 2005, *Acartia sp* has been the dominant copepod species present, but was found in very high abundance in many samples. Native cladocera were represented by very low numbers of only two or three species (10 species were present in the 2001 survey). This data appears to reflect a significant decline in zooplankton diversity, which may be associated with the continued presence of *Mnemiopsis sp*, an invasive species of comb jelly, which has no natural predators and which itself is an effective predator on zooplankton and fish larvae.

6.7.2.3 Phytoplankton

The composition and diversity of the phytoplankton has remained comparatively unchanged. The phytoplankton was of similar diversity to the zooplankton in 2000 and 2001, with a total of 33 species identified in samples collected from three surveys. An additional four species were identified in the 2005 regional survey, bringing the total for the Contract Area to 37 species. With the exception of the July 2000 survey, when only 10 species were present in samples, the number of species found per survey has remained fairly constant at 18 - 21. The diversity and abundance of phytoplankton was lower in 2000 than in 2001, but this difference is probably due to a combination of natural variability and the very limited extent of the surveys. In the 2009 regional survey, a total of 34 species were identified; this is the highest number recorded in any regional survey to date.

Baccillariophyta (which are diatoms) were the most diverse group overall, represented by 15 species. Dinophytes were the next most diverse group, represented by 11 species. Cyanophytes (blue-green algae) were represented by eight species and chlorophytes by six species. Two species of the dinophyte *Prorecentrum (cordata* and *obtusum*) were present in all surveys. The diatoms *Pseudosolenia fragilissima* and *Chaetoceros wighamii* occurred in similar frequency, and often similar abundance, to the two dinophyte species. The cyanophytes *Oscillatoria sp* and *Lyngbya sp* were abundant in all surveys.

Sensitivity

Although phytoplankton and zooplankton are sensitive to chemical contamination at an individual level, this does not mean high sensitivity at the population level. Plankton populations can grow rapidly from just a few individuals (phytoplankton populations can double in 12 hours, copepod zooplankton populations in 2-3 days). This means that populations can re-establish quickly, which is a natural feature of plankton ecology. In some instances, rapid growth can offset the effects of chemical contamination.

Phytoplankton are dependent on light to photosynthesise and are therefore, confined to the upper layers of the water column. Periods of high turbidity, such as those associated with cuttings discharge, can interfere with this process. Cuttings from drilling rigs are usually discharged about 10m below the sea surface. The thermocline (above which the phytoplankton populations grow) is located at a depth of 30-40m in the summer. Consequently, a cuttings 'plume' will only travel 20-30m downwards before crossing the thermocline. Over this distance, the plume will have undergone little dispersion, and the volume of water subject to high turbidity will therefore be small. Even on a local scale, this means that phytoplankton at a population level are not sensitive to cuttings discharge.

Both phytoplankton and zooplankton can be sensitive to aqueous discharges, such as cooling water which has been treated with corrosion control systems. However, dispersion modelling of this type of discharge has demonstrated that sufficient dilution will occur within a short distance so that any impact will be minimal and the viability of local populations will not be affected.

6.7.2.4 Fish

Fish commonly found in the SD Contract Area can be categorised into the three following types:

- Migratory species: This includes sturgeon and shad species whose spawning grounds are the river Kura and other rivers of the south-western and southern Caspian. They will only be present in the Contract Area as individuals passing through;
- Resident species: Several non-commercial species such as gobies are present within the nearshore and, less frequently, in offshore waters of the South Caspian throughout the year. Therefore, individuals may be present within the Contract Area during all seasons; and
- Other species (Semi Migratory): The kilka (herring family) is the most abundant fish in Caspian fisheries. Kilka are plankton feeders and have a wide distribution in the Caspian with important areas in the south and the middle Caspian, which is likely to include the Contract Area. They are themselves important prey for other species such as sturgeon, salmon and the Caspian seal. They have been observed in the Contract Area mostly during the winter. Mullet were introduced from the Black Sea in the 1930s. They normally overwinter in the southern Caspian and they migrate in the spring to feeding grounds in the middle and northern Caspian. Spawning takes place in deep waters between June and September. Mullet can be expected in the Contract Area.

The migration routes and spawning areas of fish species found within the SD Contract Area are shown in Figures 6.25 and 6.26.

Figure 6.25 Herring, Mullet and Sturgeon Migration Routes

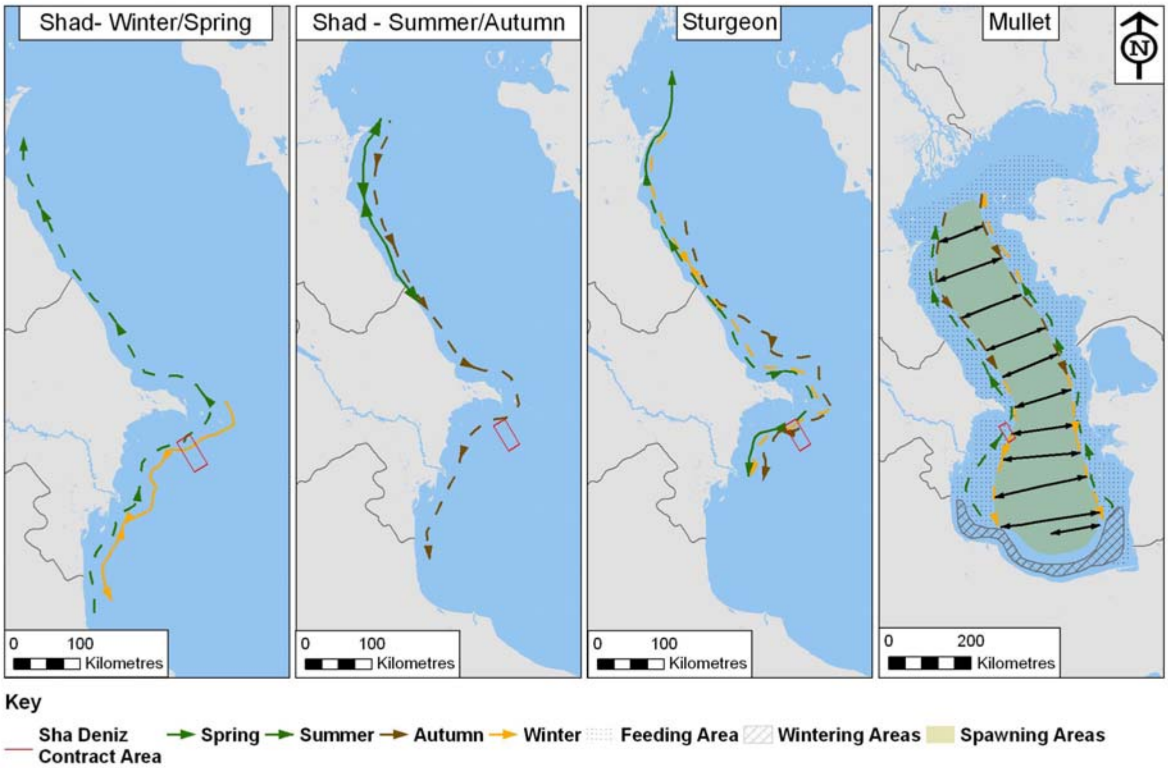


Figure 6.26 Kilka and Beluga Migration Routes

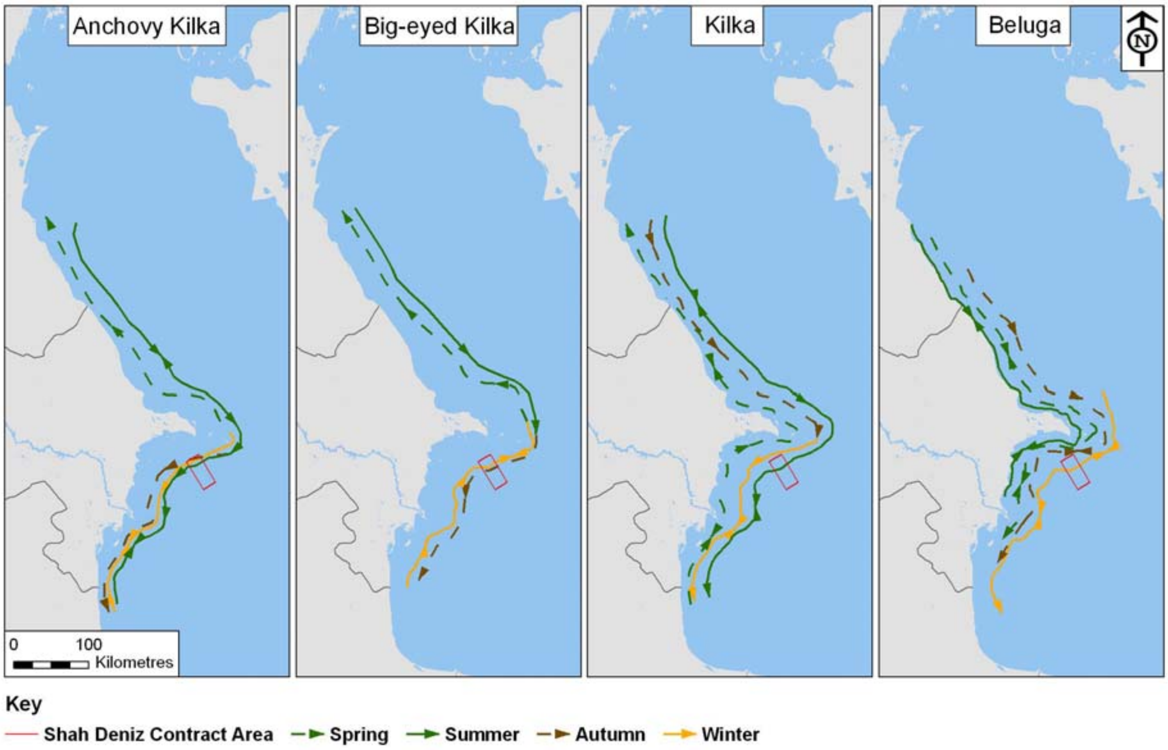


Table 6.27 shows the months when species are likely to be present in the vicinity of the Southern Caspian and SD Contract Area.

Table 6.27 Seasonal Fish Presence in the Vicinity of the Southern Caspian and SD Contract Area

Species	Activity	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Resident Fish e.g. Goby	Feeding	■	■	■	■	■	■	■	■	■	■	■	■
	Breeding				■	■	■	■					
Carp/Herring	Feeding				■	■	■	■	■	■	■	■	
Sturgeon	Migrating			■	■					■	■	■	
Shad	Migrating								■	■	■	■	
Kilka	Feeding				■	■	■	■	■	■	■	■	■
	Breeding	■	■	■	■	■	■	■	■	■	■	■	
Mullet	Feeding	■	■	■	■	■	■	■	■	■	■	■	■
	Breeding						■	■	■	■			

A review undertaken in 2008 of the fish recorded in the SD Contract Area and adjacent areas of the Caspian Sea is summarised in Table 6.28[29].

Table 6.28 Summary of the Review of Fish Species in the SD Contract Area and Adjacent Areas of the Caspian Sea, 2008

Name of Species	Importance	Depth of Occurrence*** (m below sea level)
Acipenseridae family – sturgeons* **		
Beluga – *Huso huso* (Linne)*	IUCN Endangered	Sp/Sum: up to 70m A/W: up to 80-100m
Sturgeon, Russian sturgeon – *Acipenser guldenstadti* (Brandt)*	IUCN Endangered	
Kura (Persian) sturgeon – *Acipenser güldenstädtii persicus natio cyrensis* (Belyaeff) *	IUCN Endangered	
Kura barbel sturgeon – *Acipenser nudiventris* (Derzhav, Borsenko)*	IUCN Endangered	
Kura (South-Caspian) stellate sturgeon – *Asipenser stellatus stellatus natio cyrensis* (Berg) *	IUCN Endangered	Sp/Sum: up to 50m A/W: up to 75-100m
Clupeidae family – Herrings **Clupeonella genus (Kessler) – Kilka ******		
Anchovy kilka – *Clupeonella engrauliformis* (Borodin) *	IUCN Low Vulnerability	Sp/Sum: up to 40m A: up to 60-80m W: up to 100-300m
Big-eyed kilka – *Clupeonella grimmi* (Kessler) *	IUCN Low Vulnerability	Sp/Sum: up to 80m A: up to 80-100m W: up to 130-450m
Caspian common kilka – *Clupeonella delicatula caspia* (Stetovidov)*	IUCN Low Vulnerability	Sp/Sum/A/W: up to 30-40m
Alosa Cuvier genus – herring ******		
Caspian shad – *Alosa caspia caspia (Eichwald)* *	IUCN Least Concern	Sp/Sum/A: up to 30-40m W: Deeper, depth not known
Big-eyed shad – *Alosa brashnikovi autumnalis (Berg)* *	IUCN Least Concern	
Volga shad – *Alosa kessleri volgensis* (Berg)*	IUCN Least Concern	Sp/Sum/A: Depth not known W: Greater than 100m
Black-backed shad – *Alosa kessleri kessleri* (Grimm) *	IUCN Least Concern	
Cyprinidae family – Carps		
Kutum – *Rutilus frisii kutum* (Kamensky)*	IUCN Least Concern	Sp/Sum/A/W: up to 20-50m
Mugilidae family – Gray Mullets ******		
Golden mullet – *Lisa auratus* (Risso) *	IUCN Least Concern	Sp/Sum/A/W: up to 400-500m
Leaping mullet – *Lisa saliens* (Risso) *	IUCN Least Concern	Sp/Sum/A/W: up to 200-300m
Gobiidae family – Gobiids, ********		
Caspian goby – *Neogobius caspius* (Eichwald)	IUCN Least Concern	Sp/Sum/A/W: up to 30-50m Less frequent up to 80-100m
Round goby – *Neogobius melanostomus affinis* (Eichwald)	IUCN Least Concern	
Caspian syrman goby – *Neogobius syrman eurystomus* (Kessler)	IUCN Least Concern	
Monkey goby – *Neogobius fluviatilis pallasi* (Berg)	IUCN Least Concern	
Knipovich long-tailed goby – *Knipowitschia longicaudata* (Kessler)	IUCN Least Concern	
Caspian big-headed goby – *Neogobius kessleri gorlap* (Iljin)	IUCN Least Concern	Sp/Sum/A/W: up to 30-50m
Grimm big-headed goby – *Benthophilus grimmi* (Kessler)	IUCN Least Concern	Sp/Sum/A/W: up to 30-50m
Deepwater goby – *Neogobius bathybius* (Kessler)	IUCN Least Concern	Sp/Sum/A/W: up to 300-500m
Knipowitschia Iljini (Berg)	IUCN Least Concern	Sp/Sum/A/W: up to 300-400m
Mesogobius nonultimus (Iljin)	IUCN Least Concern	
Anatrirostrum profundorum (Berg)	IUCN Least Concern	
Persian Goby - *Benthophilus ctenolepidus* (Kessler)	IUCN Least Concern	

* Have swim bladder
** Sometimes lacking swim bladder depending on species.
*** All species valuable commercial fish
**** All species important food source for other fish and seals.
*** Sp – Spring Sum – Summer A – Autumn W – Winter

[29] Refer to Appendix 6C

Gobies are second only to herring by their number of species in the Caspian Sea; they are present in all regions of the sea, predominantly in shallower areas (up to 30-70m in spring and summer, migrating to greater depths in winter). Based on commercial fishing catch records, kilka is the most abundant fish present (in terms of biomass) in the Caspian and associated river estuaries, accounting for 75% of total fish catch in the Caspian, with sturgeon representing the second highest catch (Refer to Appendix 6C for more details).

Sensitivity

Seasonal sensitivity for fish species is shown in Table 6.28. Fish species that are known to breed in the area include resident fish species, such as gobies, kilka and mullet. Gobies breed between April and July, mullet between June and September, while kilka breed between January and November.

During previous drilling activities undertaken in the SD Contract Area drilling discharges generated turbid plumes of limited duration and dimension. It is anticipated that fish species will avoid these plumes.

As noted in Table 6.28, most of the fish species possess a swim-bladder. The swim-bladder is a gas-filled sac found in most bony fishes of the class Osteichthyes. The swim-bladder performs a number of different functions such as acting as a float which gives buoyancy, as a lung and as a sound-producing organ. In addition, the swim bladder can enhance the hearing capability of the fish species through the amplification of underwater sound. Fish with swim-bladders therefore tend to be more sensitive to sound than those that do not possess such an organ. Subsequently, there is potential for such species of fish to be more susceptible to underwater noise than fish with no swim-bladder.

In Table 6.28 a number of the fish species with swim-bladders have also been classified as 'endangered' or 'near threatened', such fish include all the sturgeon species.

6.7.2.5 Caspian Seal

The Caspian seal (*Phoca Caspica)* is endemic to the Caspian Sea and has been listed on the IUCN red list as 'Endangered' since October 2008[30]. The Caspian seal population has decreased by more than 90% since the start of the 20th century and continues to decline, considered to be due to commercial hunting, habitat degradation (through introduction of invasive species), disease, industrial development, pollution and fishing operations using nets. Historically, the population of Caspian seals was estimated to have exceeded one million. In 2005, it was estimated that the total population was approximately 111,000[31]. Subsequent surveys[32,33] of Caspian seal pup numbers carried out on the winter ice-field in Kazakhstan territory (the primary breeding ground for Caspian seals) have reported further reductions in population as a result of reductions in pup production[34].

The Caspian seals distribution throughout the Caspian Sea is dictated by migration patterns. Migration routes are illustrated in Figure 6.27. They typically spend the summer months in the Central and Southern Caspian, migrating north-east in the autumn (October–December). Females typically give birth in the early winter (mid-January to late February) on ice at haul out sites in the Northern Caspian and pups enter the water around late March. Migration to the south begins around April to May. It should be noted that the Caspian seal is a transboundary species which migrates throughout the whole of the Caspian over an annual cycle. As such there is no exclusive Azerbaijan population although the species does make

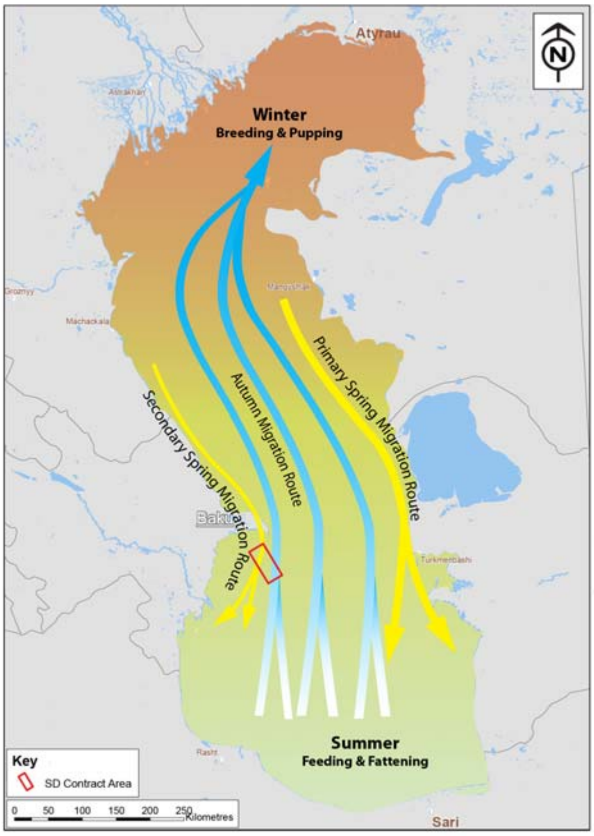
[30] www.iucnredlist.org/apps/redlist/details/41669/0
[31] Caspian International Seal Survey (2005). Population size and density distribution of the Caspian seal (*Phoca caspica*) on the winter ice field in Kazakh waters 2005.
[32] Caspian International Seal Survey (2008). Caspian seal survey 2007 Final Report.
[33] Harkonen, T, Jussi, M., Baimukanov, M., Bignert, A, Dmitrieva, L., Kasimbekov, Y., Verevkin, M., Wilson, S. and Goodman, S. J. (2008). Pup Production and Breeding Distribution of the Caspian Seal (*Phoca caspica*) in Relation to Human Impacts. Ambio Vol. 37, No. 5, 356-361.
[34] The reports from the latest surveys do not provide estimates for the total population of Caspian seals and base their population estimates on pup production only.

use of Azeri waters at different times of the year. Both breeding and migration timings can change by up to a month subject to weather conditions.

Analysis of seal monitoring studies undertaken in 2009 (see Appendix 6D) suggests that the population of seals visiting the Azerbaijani sector of the Caspian Sea includes approximately 10-15,000 individuals. The maximum concentration of seals is observed during spring around the islands of the Absheron archipelago. Their number in this region is estimated to be a minimum of 5,000 individuals[35]. Small groups of seals have also been observed along the shoreline, from Yalama seashore to the Lenkoran coast, during the spring-summer-autumn season[24]. Evidence from Krylov[36] has indicated that approximately 10-15,000 seals remained in the Southern Caspian at the end of the 20th century at the rookeries and in the open sea. Seal activity in the Contract Area is expected to be highest in spring when up to 4,000 seals may migrate towards Iranian Waters to the south. During the migration north in the autumn, numbers are expected to be less (1,000-2,000 individuals), with the seals travelling alone or in small shoals. Small numbers of seals are expected to be present in summer (approximately 500) with only very low numbers present in the winter months.

The diet of Caspian seals is poorly understood, particularly in relation to patterns of spatial and temporal data. There are no up to date comprehensive studies of seal diet at present although a literature review carried out in 1995[37] suggests a large percentage of the total seal population migrates to the middle and southern Caspian between May and June to feed in areas rich in pelagic (deepwater) fish species. During late summer and early autumn, many seals move offshore to feed in deeper waters, which include the SD Contract Area. It is thought they feed here until September when the majority of them migrate to the north. While commercially important species such as herring and kilka are probably eaten by seals, there is little quantitative information available to confirm this.

Figure 6.27 Caspian Seal Migration Routes



35 Unpublished data collected as part of the Darwin Initiative – due for publication Summer 2010.
36 Krylov I. V. (1990), Resources and rational use of Caspian Seals in current ecological conditions, pp78-98. In: Some aspects of biology and ecology of Caspian Seal, VNIRO, Moscow, 1990. 100p.
37 AIOC (1995). Environmental Baseline Study Literature Review, 1995, Woodward Clyde International.

Sensitivity

The main causes of the Caspian seal's population decline are complex but are thought to be associated with hunting, fishing activities, outbreaks of Canine Distemper Virus (CDV), invasive species and pollution (mainly organochlorides such as DDT).

Seals are directly and indirectly sensitive to spills (such as oils or chemicals) and ongoing discharges which contribute to contamination over time. They are most vulnerable during the breeding season and feeding periods (May to November). Seals are dependent on eyesight to hunt and are therefore sensitive to any increases in turbidity which may result from oil and gas activities such as vessel movements, platform operations and installation activities involving disturbance of the seabed sediment.

Although seals are classed as marine mammals they spend considerable periods of time on land. As a consequence, seals are known to hear very well in-air as well as underwater. When diving or swimming, they may be susceptible to impacts arising from high levels of underwater sound. The response to noise is determined by its duration, sound pressure level and frequency and ranges from changes in behaviour to, in extreme instances, fatality. Physical injury or fatalities have been observed to occur at a sound level of 220 dB re. 1μPa and 240 dB re. 1μPa, respectively and auditory damage (temporary and permanent) has been observed at 75dB and 95dB, respectively. Temporary duration is usually assumed to be up to 30 minutes and permanent over eight hours. As with fish, Caspian seals can detect sound at lower sound levels and may adopt an avoidance response. The same impact level criteria as presented above are commonly used to determine avoidance.

Table 6.29 sets out the most sensitive times of the year for the Caspian seals in the Southern Caspian with particular reference to the SD Contract Area.

Table 6.29 Caspian Seal Sensitivity per Season within SD Contract Area

Sensitivity	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Most sensitive period/ expected presence												
Moderately sensitive period/ some presence												
Least sensitive period/ not present												

6.7.3 Water Column: Chemical Environment

Water samples taken at three of the same regional survey stations as the plankton samples (stations 20, 30 and 32 – see Figure 6.24) indicated that water quality was generally good in 2005, 2007 and 2009 (Tables 6.30 and 6.31), with no evidence of significant contamination.

Table 6.30 Hydrocarbon and Phenol Concentrations in Water Samples, SD Regional Surveys 2005, 2007 and 2009

Station	Year	Depth (m)	THC (µg/l)	16 US EPA PAH, (µg/l)	Phenols (µg/l)
20	2009	5	<20	<0.01	-
	2007	5	<20	<0.01	<30
	2005	5	80	<0.01	60
	2009	25	<20	<0.01	-
	2007	25	<20	<0.01	<30
30	2009	5	<20	<0.01	-
	2007	5	<20	<0.01	<30
	2005	20	62	<0.01	<30
	2009	100	<20	<0.01	-
	2007	100	<20	<0.01	<30
	2005	100	53	<0.01	<30
32	2009	5	<20	<0.01	-
	2007	5	<20	<0.01	<30
	2005	10	67.5	<0.01	<30
	2009	100	<20	<0.01	-
	2007	200	<20	<0.01	<30
	2005	200	48.5	<0.01	60

2005 phenol concentrations at locations 20 (at 5m depth) and 32 (at 200m depth) may be anomalous and should be disregarded

Table 6.31 Heavy Metal Concentrations in Water Samples, SD Regional Surveys 2005, 2007 and 2009 (µg/l)

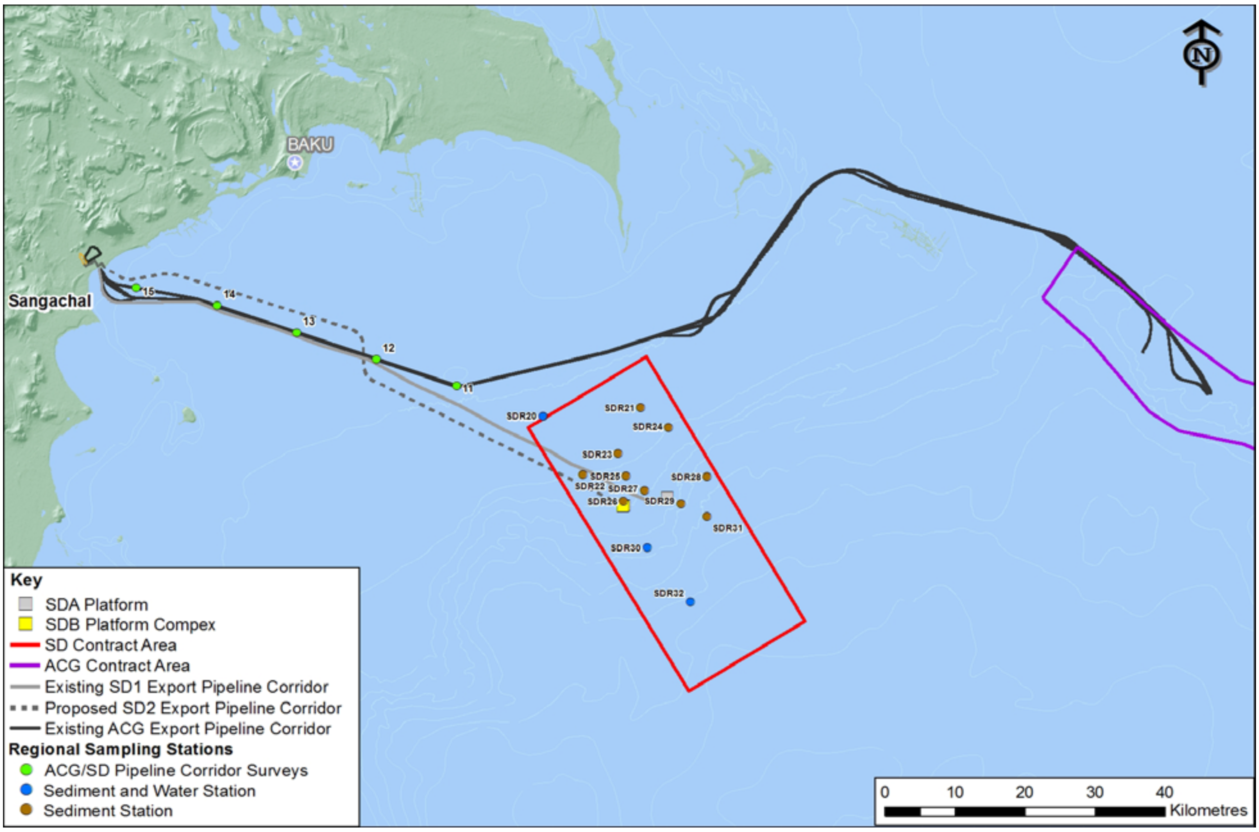
Station	Year	Depth (m)	Iron	Cobalt	Nickel	Copper	Zinc	Cadmium	Lead
20	2009	5	17.8	0.055	1.12	0.93	2.6	<0.02	1.45
	2007	5	<10	0.027	0.93	1.04	3.41	0.18	0.12
	2005	5	<10	0.046	1.08	0.77	1.63	0.02	0.06
	2009	25	37.5	0.055	1.25	0.81	3.28	<0.02	0.21
	2007	25	<10	0.026	0.89	0.98	2.94	0.01	0.10
30	2009	5	2.5	0.050	0.92	0.75	1.99	<0.02	<0.10
	2007	5	<10	0.019	0.76	0.76	0.73	0.01	0.05
	2005	20	<10	0.039	0.99	0.71	3.78	0.02	0.08
	2009	100	8.5	0.026	1.11	0.58	3.54	<0.02	<0.10
	2007	100	<10	0.008	0.79	0.62	0.57	0.02	0.02
	2005	100	<10	0.021	1.01	0.64	2.02	0.02	0.06
32	2009	5	<2.0	0.049	0.92	0.78	1.7	<0.02	0.25
	2007	5	<10	0.019	0.75	0.68	1.09	0.01	0.05
	2005	10	<10	0.032	1.03	0.73	1.43	0.01	0.04
	2009	100	4.6	0.037	1.17	0.70	2.09	<0.02	<0.10
	2007	200	<10	0.006	0.91	0.68	0.79	0.02	0.04
	2005	200	<10	0.008	0.7	0.41	0.8	0.01	0.02

6.8 Offshore Environment Specific to the SD2 Project Locations

6.8.1 SD2 Subsea Export Pipeline Route

The ACG Export Pipeline Corridor accommodates the ACG EOP, Phase 1 and Phase 2 oil and gas condensate pipelines. Environmental surveys have been carried out along this corridor in 1995 (prior to first pipeline installation), and in 2000, 2006, 2008 and 2010 (covering the period during and after the installation of the ACG Phase 1 and 2 pipelines). Sample stations 15, 14, 13, 12 and 11 lie along the route of the proposed SD2 Subsea Export Pipeline. These stations lie in water depths of 13-19m, roughly perpendicular to the Sangachal Bay shoreline, with station 11 located close to the northern edge of the SD Contract Area. In addition, SD regional survey sample stations 20, 22, 25 26 and 27 are located in close proximity to the proposed SD2 Subsea Export Pipeline Route (Figure 6.28).

Figure 6.28 Survey Sample Locations in the Vicinity of the Proposed SD2 Subsea Export Pipeline Route



6.8.1.1 Physical and Chemical Composition of Seabed Sediments

Physical Properties of Sediments

The 2010 survey indicated that sediments found closest to shore at stations 14 and 15 (13-15m water depth) (Figure 6.28) are composed of coarse grained silt with higher carbonate content and lower silt-clay and organic content. At stations 11-13, located further offshore in depths of 16-19m, sediment are classified as fine silt, with higher silt-clay and organic and lower carbonate content. Sediment samples collected from stations 12 and 13 were similar to sediments in the north-western part of the Contract Area at regional stations 20 and 22 (Table 6.32). The sediments of the pipeline route in the vicinity of the proposed SD Bravo (SDB) Platform Complex are distinctive (regional stations 26 and 27). These sediments are composed of medium to fine sands with high carbonate content and low organic and silt/clay content.

Table 6.32 Physical Properties of Sediments, SD Regional Survey Stations, 2009

Parameter	Station Number				
	20	22	25	26	27
Mean diameter µm	9	7	6	231	60
% Carbonate	27	25	25	63	43
% Organic	5.4	7.3	6	2.9	4.6
% Silt/Clay	95	99	99	38	60

Hydrocarbon Concentrations

Data on hydrocarbon concentration in sediments within the SD Contract Area and along the proposed SD2 Export Pipeline route are available from pipeline surveys conducted in 2000, 2006, 2008 and 2010, and a SD Contract Area regional survey conducted in 2009.

ACG pipeline stations all lie in water of less than 20m depth, on the coastal shelf. Hydrocarbon concentrations (Table 6.33) decrease with distance from the coast (from pipeline survey stations 15 to 11), but show some temporal variation. Over the ten-year period covered by the surveys, there has been an overall decline in hydrocarbon concentrations at these shallow-water stations, although concentrations at stations 14 and 15 were higher in 2006 than in 2000. The results of the 2008 and 2010 surveys reported much lower concentrations which were more consistent with the observations at stations 11, 12 and 13.

Table 6.33 Hydrocarbon Concentrations at the ACG Pipeline Sediment Survey Stations, 2002, 2006, 2008 and 2010

Station Number	THC (µg/g)			
	2000	2006	2008	2010
11	453	296	107	69
12	440	435	153	123
13	552	364	149	250
14	465	709	202	215
15	431	1,175	250	206

Within the proposed SD2 Subsea Export Pipeline Route within the SD Contract Area, sediment hydrocarbon concentrations range from 20-37 µg/g at stations 26 and 27, to 140-294 µg/g in the shallower water stations closer to shore (refer to Table 6.34). The higher near-shore concentrations are partly due to proximity to shore-based sources of contamination, and partly because the sediments at these stations contain a high proportion of silt and clay, and therefore adsorb organic compounds to a greater extent than the coarser sediments near the SDB Platform Complex location.

Table 6.34 Hydrocarbon Concentrations within the Proposed SD2 Subsea Export Pipeline Corridor, 2009

Station Number	THC (µg/g)
20	148
22	294
23	145
25	160
26	20
27	37

Heavy Metal Concentrations

The levels of trace metals in the sediment follows the same general pattern of the sediment physical properties along the ACG subsea pipeline route. Arsenic concentrations varied little along the pipeline route, and were typical of Caspian sediment background levels at all stations. Several metals (copper, zinc, chromium, cadmium and iron) exhibited similar trends to arsenic in which concentrations increased slightly along the shelf route, then decreased again at stations 14 and 15.

The pattern for lead differed from other metals, with concentrations following an almost linear gradient from typical offshore levels and increasing towards the coast.

Concentrations of mercury in the shallow-water pipeline stations were consistently 3-5 times higher than typical offshore background levels. It is probable that most of the mercury present at stations 11-15 are a result of historical industrial contamination.

6.8.1.2 Biological Characteristics of Seabed Sediments

The macrobenthic community within the SD Contract Area section of the proposed SD2 Subsea Export Pipeline Route was characterised by a generally low abundance and species richness. Four groups of stations were found to exist within the data and were related to depth and distance from the coast (Figure 6.28).

- Shallow water stations 20, closest to the shore, had low abundance and species richness, with species numerically dominated by the polychaetes *Nereis sp*;
- Stations 22 and 25, also located in shallow water, had generally low abundance and species richness. Oligochaetes were numerically dominant over polychaetes and amphipods; cumacea were either absent or present in very low numbers; and
- Stations 26 and 27 were adjacent to one another and located in the centre of the SD Contract Area. Abundance and species richness were highest at these stations and the communities present were dominated by abundant, diverse populations of amphipods. Station 26 also had a high abundance of cumaceans. However, cumacean abundance at station 27 was low.

The available data indicates that the macrobenthic communities along the proposed SD2 Subsea Export Pipeline Route were influenced by the sediment composition. Table 6.35 summarises the overall trend in terms of numbers of taxa and individual organisms.

Table 6.35 Summary of Species Richness and Individual Abundance, Pipeline Survey, 2006, 2008 and 2010

Station Number	Taxa			Individuals (m^2)		
	2006	2008	2010	2006	2008	2010
11	9	5	9	593	67	243
12	8	3	5	823	427	493
13	7	10	12	2,023	1473	1947
14	5	8	8	2,003	367	1580
15	11	9	7	597	510	2280

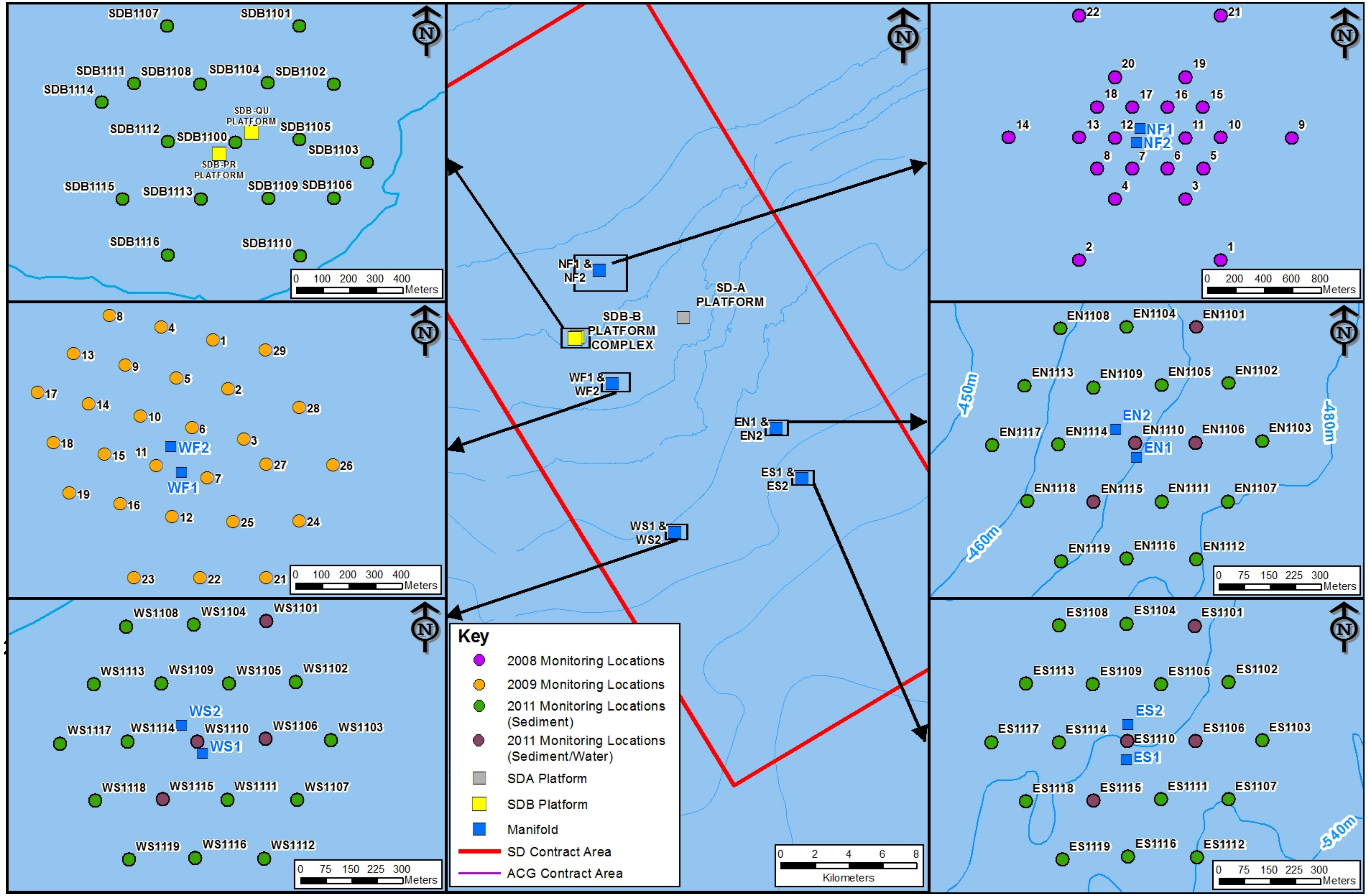
Species richness and abundance were higher in the deeper water locations (68m or more), and then reduced considerably to lower levels at stations 11 and 12.

Species richness and abundance at stations 11-15 vary between years. The communities of stations 11-15 are dominated by a small number of alien or invasive species, with only one typical offshore species (*Hypaniola kowalewskii*) consistently present in abundance. The alien polychaete *Nereis sp* was the dominant or subdominant presence at all stations.

6.8.2 SDB Platform Complex Location

A baseline survey in the vicinity of the proposed SDB Platform Complex location was carried out in 2011. The water depth in this location is approximately 95-99m. Figure 6.29 shows the monitoring survey locations in addition to the monitoring locations in the vicinity of the proposed SD2 manifolds.

Figure 6.29 Survey Sample Locations in the Vicinity of SDB Platform Complex and SD2 Manifold Locations



6.8.2.1 Physical and Chemical Composition of Seabed Sediments

Physical Properties of Sediments

Table 6.36 summarises the physical properties of the sediments at the SDB Platform Complex location. Sediments are predominantly in the range of medium to coarse sand, with low organic content, low silt-clay content, and high carbonate content. These properties are similar to those observed at the SDA and NF locations (refer to Section 6.8.4).

Table 6.36 Average Physical Sediment Characteristics – SDB Platform Complex Location (2011)

	Mean Diameter µm	% Carbonate	% Organic	% Silt/Clay	% Silt	% Clay
Min	229	55	1	11	4	7
Max	1,077	79	4	36	14	22
Median	455	66	2	20	8	13
Mean	499	67	2	22	8	13

Hydrocarbon Concentrations

Table 6.37 summarises the 2011 sediment hydrocarbon concentrations at the SDB Platform Complex location. Concentrations within each sample were low; a characteristic of locations within the central area of coarse sediment within the SD Contract Area.

Table 6.37 Statistical Summary of Sediment Hydrocarbon Concentrations, SDB Platform Complex Location (2011)

	THC (ug/g)	UCM (ug/g)	% UCM	2-6 PAHs (ng/g)	NPD (ng/g)	%NPD	16 EPA (ng/g)
Min	5	4	64	110	65	51	26
Max	56	43	82	414	246	63	125
Median	29	24	79	243	143	58	58
Mean	29	23	78	247	140	57	63
St Dev	11	9	3	62	34	3	21
CV	36	37	4	25	24	5	34

Heavy Metal Concentrations

Table 6.38 provides a statistical summary of the concentrations of metals in sediments at the SDB Platform Complex location. The range of concentrations for each metal was similar to those observed over a number of surveys at the SDA location, and at the NF location. In general, these concentrations reflect the high carbonate and low mineral (silt and clay) content of the sediments.

Table 6.38 Statistical Summary of Heavy Metal Concentrations in SDB Platform Complex Location Sediments (µg/g)

	As	Ba HNO^3	Ba Fusion	Cd	Cr	Cu	Hg	Fe	Mn	Pb	Zn
Min	6	320	385	0.094	22	10	0.023	17,200	479	10	35
Max	17	840	1,085	0.171	51	24	0.076	29,900	751	17	73
Median	11	474	698	0.121	37	18	0.049	22,750	590	12	55
Mean	11	527	720	0.124	37	18	0.047	22,765	592	13	53

6.8.2.2 Biological Characteristics of Seabed Sediments

Table 6.39 summarises the biological characteristics of the SDB Platform Complex location, and compares these to the characteristics of the SDA location, which have been determined over a series of surveys. In the 2011 SDB Platform Complex survey, overall biological diversity was high, with a total of 94 taxa recorded. However, the majority of these taxa occurred infrequently and were present in low abundance: 90% of the total abundance was accounted for by only one-third of these taxa, and overall more than 60% of abundance was accounted for by two genera of amphipods (*Corophium* and *Gammarus*). While in total annelids represented about 10% of overall abundance, no individual species accounted for more than 4% of abundance. The high diversity, accompanied by high dominance of amphipods, reflects a seabed habitat which provides a varied habitat which can be more effectively exploited by more mobile organisms, while providing niches for a broader spectrum of other species.

Table 6.39 indicates that the benthos at the SDB Platform Complex location is similar in composition to that at the SDA location. As noted above, sediment composition and chemistry are also similar at the two locations.

Table 6.39 Comparison of Species Richness and Total Abundance between SDA Location (2001-2009) and SDB Platform Complex Location (2011)

	SDA				SDB
	2001	2005	2007	2009	2011
Class Polychaete Species	6	8	10	8	7
Class Polychaete Individuals	20,324	38,280	26,614	19293	9,210
Class Oligochaete Species	6	6	4	3	4
Class Oligochaete Individuals	5,594	5,407	3,429	3540	4,907
Order Cirripedia (*Balanus*)	48	1,797	2,253	4427	3,350
Order Cumacea Species	10	11	15	10	7
Order Cumacea Individuals	2,256	4,750	5,287	1033	4,550
Order Amphipod Species	32	31	38	35	38
Order Amphipod Individuals	12,616	44,047	36,811	36037	44157

6.8.3 WF Location

The WF location is situated in approximately 163m of water; almost midway between regional survey stations 26 and 30 (see Figure 6.29).

6.8.3.1 Physical and Chemical Composition of Seabed Sediments

Physical Properties of Sediments

Stations 26 and 30 have very different sediment properties; the former has coarse sediment (mean particle diameter of 439μm in 2007), while the sediments at the latter station are very fine silt (mean particle diameter of 6μm in 2007).

The WF location is close to the southern margins of the central area of relatively coarse sediment, and it lies within the depth range of the regional stations within this zone (92 - 250m). During 2009, sediment samples were taken from a total of 29 stations in the vicinity of the WF location (refer to Figure 6.28 for location survey area). Sediments were predominantly in the range of fine to coarse silt, with overall average characteristics as summarised in Table 6.40.

Table 6.40 Average Physical Sediment Characteristics – WF Location (2009)

	Mean Diameter µm	% Carbonate	% Organic	% Silt/Clay	% Silt	% Clay
Min	7	19	2.16	25	9	17
Max	109	41	7.18	96	41	60
Median	19	27	3.63	66	23	41
Mean	26	27	3.89	66	25	41

There was a general trend towards coarser sediment in the north-west of the survey area, and finer sediment in the south-east of the survey area (refer to Figure 6.30).

Hydrocarbon Concentrations

The WF location lies within the area identified in Figure 6.22, within which sediment hydrocarbon concentrations have been consistently low over time.

Sediment THC concentrations were low or very low at most stations, with a median concentration of 11µg/g. Higher concentrations (247-323µg/g) were observed only at stations 20 and 26, to the extreme south and east of the survey area respectively (see Figure 6.30). With the exception of these two stations, THC concentrations ranged from 2.6 to 49µg/g. The concentrations of PAH were proportional to the THC concentrations, and all components were heavily weathered, with no indication of recent fresh inputs. Comparison of the sediment diameter sizes and THC across the WF survey area indicates that, in general, the lowest hydrocarbon concentrations were associated with the coarser sediments.

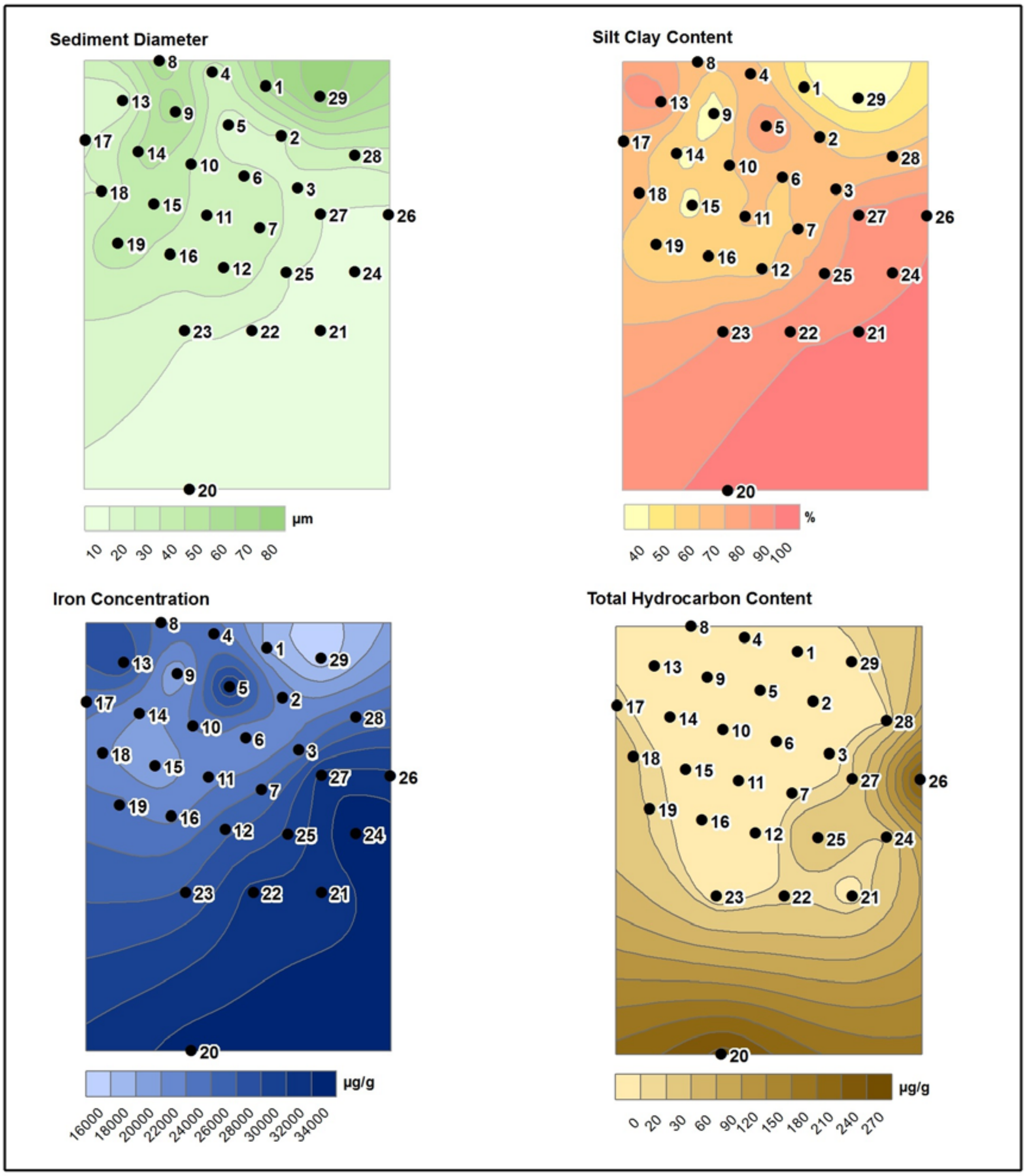
Heavy Metal Concentrations

Table 6.41 presents a statistical summary of sediment heavy metal concentrations. Overall variation between stations was low (coefficient of variation between 6 and 36% of average values), and was particularly low for barium and manganese. However, despite the low variation, there was a distinct pattern of distribution of concentrations for most metals; this pattern is illustrated in Figure 6.30 for iron, but is very similar for chromium, copper, mercury, lead and zinc. As is the case with hydrocarbons, there is a tendency towards higher concentrations in sediment with finer particle size and higher silt-clay content. For barium, manganese and cadmium there was no clear pattern of distribution.

Table 6.41 Statistical Summary of Heavy Metal Concentrations in WF Location Sediments (µg/g)

	As	Ba HNO^3	Ba Fusion	Cd	Cr	Cu	Hg	Fe	Mn	Pb	Zn
Min	4.4	232	386	0.06	32.9	10.7	0.01	16,500	453	5.6	38.6
Max	28.1	416	646	0.18	97.6	35	0.12	39,500	698	24.3	96.9
Median	18	326	482	0.13	57	19.1	0.05	25,300	526	15.6	61.5
Mean	17.8	325	489	0.13	59.7	21.2	0.05	26,371	525	15.9	63.4
St Dev	5.2	37	59	0.03	15.9	6.8	0.02	5,434	34	3.5	14.7
%CV	29	11	12	20	27	32	36	21	6	22	23

Figure 6.30 WF Location Sediment Survey Results



6.8.3.2 Biological Characteristics of Seabed Sediments

A total of 55 valid, discrete, macrobenthic invertebrate taxa were identified in the sediment samples. Species richness ranged from eight at station 26 to 34 at station eight, and total abundance (excluding ostracods) ranged from 177m^2 at station 20 to 1,413m^2 at Station 13. The lowest species richness and abundance were associated with the two stations at which particularly high hydrocarbon concentrations were observed. Average species richness and abundance were 17 and 888m^2, respectively.

Species richness and total survey abundance are compared in Table 6.42 between the WF survey, 2009 and four successive surveys at the SDA location. This indicates that the community at WF location is numerically dominated by oligochaetes (principally of the genera *Isochaetides* and *Psammoryctides*), but that amphipods and gastropods are represented by the largest number of taxa (21 and 13 respectively). Polychaetes are relatively poorly represented both in terms of abundance and of species richness, and bivalves were completely absent. Overall, the benthos of the WF location is less diverse and less abundant than at the SDA location.

Table 6.42 Comparison of Species Richness and Total Abundance between SDA Location Surveys (2001-2009) and WF Survey (2009)

	SDA				WF
	2001	2005	2007	2009	2009
Class Polychaete Species	6	8	10	8	4
Class Polychaete Individuals	20,324	38,280	26,614	19293	1,603
Class Oligochaete Species	6	6	4	3	4
Class Oligochaete Individuals	5,594	5,407	3,429	3540	17,593
Order Cirripedia (*Balanus*)	48	1,797	2,253	25340	23
Order Ostracod Individuals	7,000	6,847	7,000	25340	400,333
Order Cumacea Species	10	11	15	10	8
Order Cumacea Individuals	2,256	4,750	5,287	1033	1787
Order Amphipod Species	32	31	38	35	21
Order Amphipod Individuals	12,616	44,047	36,811	36097	3717
Order Isopoda Individuals	64	287	44	37	3
Class Insect Individuals	490	907	634	497	683
Class Gastropod Species	5	18	28	18	13
Class Gastropod Individuals	554	2,170	4,192	430	120
Class Bivalve Species	7	6	5	4	0
Class Bivalve Individuals	5,802	21,910	3,437	1023	0

A comparison of the WF location benthos with nearby regional survey stations (Table 6.43) indicates that the WF location is more similar to these stations than it is to the SDA location. Although amphipod and gastropod species richness is higher at the WF location in 2009, most of the taxa in both groups are present in very low abundance. However, amphipods are numerically more important at Regional Stations 26 and 27 than at WF location or Regional Station 30.

Table 6.43 Comparison of Species Richness and Average Abundance between Four SD Regional Survey Stations and WF Survey

	Station 26			Station 27				Station 30				WF
	2001	2007	2009	2001	2005	2007	2009	2001	2005	2007	2009	2009
Class Polychaete Species	2	3	5	1	5	2	4	1	2	3	2	4
Class Polychaete Individuals	119	216	1113	502	333	208	47	66	333	522	50	55
Class Oligochaete Species	3	3	3	4	3	3	2	3	2	2	3	4
Class Oligochaete Individuals	208	166	117	684	547	238	53	179	87	454	397	607
Order Cumacea Species	4	5	5	5	3	5	3	3	8	3	1	8
Order Cumacea Individuals	274	214	297	238	43	114	30	343	247	114	7	62
Order Amphipod Species	7	12	27	12	15	10	13	2	2	1	2	21
Order Amphipod Individuals	412	1,056	2377	1,469	2,823	878	527	6	10	54	67	128
Order Isopoda Individuals	0	0	0	0	3	6	3	0	0	0	0	0
Class Insect Individuals	0	6	0	0	3	10	0	30	40	14	0	24
Class Gastropod Species	0	1	7	0	0	1	1	7	1	2	0	13
Class Gastropod Individuals	0	4	43	0	0	2	20	66	3	6	0	4
Class Bivalve Species	2	3	2	3	3	3	0	0	0	0	0	0
Class Bivalve Individuals	195	196	100	119	197	52	0	0	0	0	0	0

There was a weak spatial trend towards higher oligochaete, cumacean and amphipod abundance and species richness in the north and north-west of the survey area. In contrast, polychaete abundance was higher in the south-east of the survey area. Overall, species richness and total abundance was higher in coarser sediments and lower in sediments with the highest silt-clay content.

6.8.4 NF Location

A benthic survey was conducted at the NF location in 2008 during which a total of 23 stations were sampled in water depths ranging from 66 to 80m (see Figure 6.29).

6.8.4.1 Physical and Chemical Composition of Seabed Sediments

Physical Properties of Sediments

The mean particle diameter of sediments ranged from 5 to 1,613µm, with median and average values of 148 and 276µm, respectively. Sediment at most stations was classified as fine to coarse sand; the fine silt which is characteristic of most of the SD Contract Area was encountered at only two stations. The sediments at the NF location appear to be similar to the comparatively coarse sediments found in the area around the SDA location.

Hydrocarbon Concentrations

Sediment TPH concentrations ranged from 10 to 460µg/g with median and mean concentrations of 33 and 67µg/g, respectively. High concentrations were observed at only the two stations where fine silt was present; excluding these stations, total hydrocarbon concentrations were uniformly low and within the range of 12 - 65µg/g. PAH concentrations were closely correlated with total hydrocarbon concentrations. The hydrocarbon in all samples was heavily weathered, indicating that there had been no recent inputs of new material within the survey area.

Heavy Metal Concentrations

Sediment heavy metal concentrations are summarised in Table 6.44. The low coefficient of variation (% CV or the standard deviation as a percentage of the average) indicates that there was little systematic variation across the survey area. Typically, the CV associated with sampling and analytical variation is 15 - 20%. Therefore, values lower than this indicate that the true variation is less than the methodology can measure with precision. Concentrations were similar to, or lower than, concentrations observed at regional survey stations.

Table 6.44 Statistical Summary of Sediment Heavy Metal Concentrations (µg/g) at the NF Location, 2008

Station	As	Ba HNO3	Ba Fusion	Cd	Cr	Cu	Hg	Fe	Mn	Pb	Zn
Min	6.6	280	335	0.05	54.3	21.3	0.14	28,750	519	12.3	66.1
Max	18.5	495	550	0.102	81.7	31.2	0.23	40,350	673	20.6	102.3
Median	11.2	330	410	0.066	65	23.5	0.18	33,050	557	13.6	76.4
Mean	11.5	359	431	0.069	65.2	24.3	0.18	33,224	572	14.4	78.1
St Dev	3	72	66	0.015	7	2.6	0.03	2,929	44	2.1	8.5
%CV	26	20	15	22	11	11	17	9	8	14	11

6.8.4.2 Biological Characteristics of Seabed Sediments

A total of 98 macrobenthic taxa were identified in samples from the 23 stations, with between 43 and 64 taxa per station (excluding the two stations with fine silty sediment). The number of taxa per major group and the total abundance per group are summarised in Table 6.45. This shows that amphipods (the genus *Corophium* in particular) are dominant in terms of both species richness and abundance. Species richness at the NF location is considerably higher overall than was observed in the 2007 regional survey; and is comparable to the consistently high richness observed at the SDA location. The results of the survey therefore confirm previous observations that the coarser sediments of the central zone of the SD Contract Area consistently support a more diverse and abundant benthic community than the rest of the SD Contract Area.

Table 6.45 Summary of the Species Richness and Total Abundance in the 2008 NF Location Survey

Class/Order	Number of Species	Abundance
Turbellaria	1	7
Nematodes	1	1,643
Polychaeta	7	9,160
Oligochaeta	4	7,827
Hirudinea	1	13
Cirripedia	1	26,940
Ostracoda	1	37
Mysidacea	1	30
Cumacea	10	6,793
Amphipoda	47	53,709
Isopoda	1	7
Insecta	1	167
Bivalvia	11	6,683
Gastropoda	11	337

Overall, the NF location is similar to the SDA location in terms of sediment structure, chemistry and biology. Compared to most of the Contract Area, these locations have coarser sediment, with lower levels of hydrocarbons and heavy metals; and with a richer and more abundant benthic biological community.

6.8.5 WS Location

The WS Manifold location is the most southerly within the SD Contract Area and is situated at a water depth of 407-420m. The environmental baseline information for WS presented below is based on surveys carried out at the SDX4 well location in 2005 and at the WS location in 2011. A survey of the SDX4 location was also carried out in 2008. However, the results of the 2008 survey are not included here as they are very similar to the 2005 results in terms of sediment composition, chemistry and biology. This indicates the baseline conditions in this location appear to be relatively stable and that there is no evidence to date of any environmental impact from drilling activities. Figure 6.29 indicates the survey sample locations for the 2011 survey.

6.8.5.1 Physical and Chemical Composition of Seabed Sediments

Physical Properties of Sediments

A benthic survey, undertaken in 2005, for the SDX4 exploration well location comprised five sampling stations. Sediments in all samples were classified as fine silt, and there was very little variation in mean particle size (5-10 μm) and silt-clay content (>99.9%) across the survey area.

The 2011 baseline survey was more extensive, covering 19 stations in a triangular array. Sediments at all stations were classified as very fine silts, with mean particle diameter ranging from 5-6 μm, carbonate content of 22-25%, organic content of 7-9.6%, and silt/clay content of 99.9-100%. The sediments around the WS location are, therefore, very uniform in composition.

Hydrocarbon Concentrations

Table 6.46 presents a summary of the SDX4 2005 and WS 2011 baseline surveys.

Table 6.46 WS Hydrocarbon Sampling Results, 2005 and 2011

	SDX4 2005	WS 2011	SDX4 2005	WS 2011	SDX4 2005	WS 2011	SDX4 2005	WS 2011	SDX4 2005	WS 2011
	THC, µg/g		UCM, %		Total 2-6 ring PAH ng/g		% NPD		USEPA 16 PAH ng/g	
Min.	137	159	72	74	664	784	36	50	129	175
Max.	266	364	77	85	1,623	1,429	43	59	328	350
Median	181	301	75	78	987	1,276	41	55	190	300
Mean	183	295	75	78	982	1,276	41	55	196	297
St. Dev.	36	43	1	3	279	106	2	2	59	25
%CV	20	15	2	3	28	8	5	4	30	8

The homogeneity of the sediments in the SDX4 survey was reflected in a very small degree of variation in hydrocarbon concentrations, with an average THC value of 183µg/g and a coefficient of variation of 20%. UCM concentration was consistently around 75%, indicating that the hydrocarbons were well-weathered and that there had been no recent contaminating inputs. Variation was even lower in the 2011 survey, with a coefficient variation of 15%. Average THC concentrations in 2011 were higher than in 2005, however, at 295 µg/g. Average concentrations of 2-6 ring PAH and USEPA 16 PAH were also higher, although the range of values was very similar between the two surveys, The percentage UCM was similar in both surveys. The percentage of PAH represented by NPDs was higher in 2011 than in 2005, possibly indicating the deposition of some relatively fresh PAH in the interval between surveys, although in both cases the evidence indicates considerable weathering at the time of sampling.

Heavy Metal Concentrations

Table 6.47 presents the summary statistics for sediment heavy metal concentrations in the 2005 and 2011 surveys. Heavy metal concentrations were very uniform, and typical of background 'crustal' levels. There was little difference in concentrations between surveys. Arsenic and cadmium concentrations were slightly higher in 2011, while barium and mercury concentrations were slightly lower.

Table 6.47 Statistical Summary of Sediment Heavy Metal Concentrations at WS1 Well Location

		Concentration of Heavy Metals, µg/g									
		As	Ba HNO_3	Ba Total	Cd	Cr	Cu	Fe	Hg	Pb	Zn
Min.	2005	5.9	335	1021	0.14	65	22	27,750	0.08	20	77
	2011	9.9	777	879	0.19	62	35	34,490	0.05	23	88
Max.	2005	9.2	504	5347	0.17	87	39	32,799	0.19	27	90
	2011	11.9	1,090	1,130	0.24	73	41	38,740	0.1	28	96
Median	2005	7.5	404	3,948	0.16	74	24	29,704	0.1	23	84
	2011	10.7	853	925	0.22	68	37	35,775	0.08	23	91
Mean	2005	7.7	415	3,672	0.16	75	28	29,963	0.11	23	83
	2011	10.8	871	950	0.22	68	37	35,829	0.076	24	91

6.8.5.2 Biological Characteristics of Seabed Sediments

A total of nine taxa were identified in the 2005 survey as shown in Table 6.48. These comprised two polychaete species, four oligochaete species, two amphipod species and one cumacean species. Both abundance and biomass were relatively low; polychaetes and oligochaetes represented the bulk of the biomass at all stations.

In the 2011 survey, a total of 10 taxa were recorded, including two species of hydrozoa and one species of bryozoan. A single nematode was recorded. The bulk of the community comprised three species of oligochaete, one species of cumacean, and two amphipod species. Only the oligochaete species were present at all stations and in moderate abundance; the cumacean and amphipod species were represented by single individuals. In 2011, polychaetes were completely absent, as were gastropods and molluscs. In both surveys, the community was sparse and largely dominated by a single species of oligochaete, *Iisochaetides michaelseni*.

Table 6.48 Summary of the Species Richness and Total Abundance in the 2005 WS1 Location Survey

Taxon	Abundance	Frequency of Occurrence (%)
Hypania invalida	537	100
(Hypania invalida juv)	3	20
Hypaniola kowalewskii	7	20
Isochaetides michaelseni	1,310	80
Psammoryctides deserticola	420	100
(Psammoryctides spp indet)	3	20
Tubificidarum spp	3	20
Stylodrilus cernosvitovi	16	40
(Mysidae spp)	72	100
Schizorhynchus eudorelloides	363	60
Gmelina costata	9	60
Niphargoides grimmi	3	20

6.8.6 ES Location

A baseline survey, comprising 13 stations, was undertaken at the SDX5 well location in 2007 which is within the vicinity of the ES location. Water depth ranged from 530m to 557m. Further surveys were carried out in 2010 (SDX5 post-drilling survey, 15 stations) and 2011 (ES baseline survey, 19 stations). Figure 6.29 presents the samples locations in the 2011 ES baseline survey.

6.8.6.1 Physical and Chemical Composition of Seabed Sediments

Physical Properties of Sediments

During the 2007 survey it was found that sediments were uniformly very fine silts, with mean particle diameter of 4-7 µm at all stations, and were very similar to sediments previously sampled during regional surveys at stations of similar depth.

Summary statistics for the surveys undertaken in 2010 and 2011 are presented in Table 6.49 below. This data confirms the observations of 2007, that is, that sediments are generally very fine silts. The range of values for most parameters is larger than in 2007, however; this is attributable to the presence of coarser sediment at a single station in each survey (SDX5-8 and ES-10). With the exception of these stations, sediments were very similar in all three surveys, over the entire area covered by sampling.

Table 6.49 Summary of Physical Properties of Sediments at the ES Location

		Mean diameter Xµm	Carbonate %	Organic %	Silt/Clay %	Silt %	Clay %
Min.	2011	5	19	4.0	95	31	8
	2010	5	14	1.9	82	36	7
Max.	2011	17	33	11.7	100	87	68
	2010	26	35	12.2	100	74	64
Median	2011	5	27	7.7	100	38	61
	2010	6	26	8.7	100	40	59
Mean	2011	6	27	7.8	99	40	59
	2010	7	25	8.3	99	43	55

Hydrocarbon Concentrations

Sediment total hydrocarbon concentrations in 2007 ranged from 109-241 parts per million (ppm), with an average concentration of 160 ppm, and were all highly weathered. There was little systematic variation in concentration across the survey area as can be seen in Table 6.50. Concentrations were, however, 2-4 times lower than in regional survey stations at similar depth.

Maximum concentrations of THC and PAH were higher in 2010 and 2011 than in 2007, and the range of values was also wider. In both surveys, traces of Linear alpha olefin (LAO) drilling fluid were found in a small number of sample replicates, corresponding to those in which coarser sediment was observed.

Table 6.50 ES Location Hydrocarbon Sampling Results, 2007, 2010 and 2011

		THC, µg/g	UCM, %	Total 2-6 ring PAH ng/g	NPD ng/g	% NPD	Phenols µg/g
Min	2007	109	66	525	281	43	0.6
	2010	103	43	528	289	49	0.38
	2011	23	71	103	43	35	0
Max	2007	241	80	1,405	732	54	6.6
	2010	786	77	2,433	1,245	81	3.25
	2011	2,847	88	1,813	707	63	4
Median	2007	155	74	997	485	52	3.4
	2010	236	73	1,581	794	51	1.98
	2011	214	76	839	323	40	2
Mean	2007	160	74	994	499	50	3.5
	2010	269	71	1,489	770	53	1.89
	2011	399	76	954	382	41	2

Heavy Metal Concentrations

Heavy metal concentrations were, at most stations in all surveys, typical of natural silt-clay mixtures, and varied very little between replicates and stations (refer to Table 6.51). In 2010 and 2011, however, extremely high concentrations of barium were observed at the same stations (SDX5-8 and ES-10) in which coarser sediment occurred. These barium concentrations were sufficiently high to suggest that the samples consisted mainly of water-based drilling mud. High barium concentrations were associated with higher cadmium concentrations. With the exception of barium and cadmium, there was little systematic or substantial variation between surveys, although the range for most metals was wider in 2011 than in 2007; the wider range is likely to be attributable to the apparent presence of WBM in some samples, which will have 'diluted' natural sediment to some extent.

Table 6.51 Statistical Summary of Sediment Heavy Metal Concentrations at the ES Location

		Concentration (µg/g)										
		As	Ba HNO3	Ba Fusion	Cd	Cr	Cu	Fe	Hg	Mn	Pb	Zn
Min	2007	8.7	446	658	0.18	51.8	41.8	33,021	0.07	777	22.9	76.5
	2010	2.7	635	778	0.18	11.6	36.1	20,500	0.03	739	24.7	33
	2011	8	414	683	0.01	29	37	28,800	0.04	711	14	49
Max	2007	14.5	643	802	0.27	77.9	46.5	41,674	0.09	934	25.6	88.5
	2010	13.0	24,800	426,000	0.88	70.6	63.3	43,800	0.15	1,740	38.2	115
	2011	13	6,199	169,600	0.88	75	45	45,900	0.21	1160	25	97
Median	2007	11.7	563	751	0.24	67.3	44.2	36,864	0.08	831	24.5	83
	2010	7.0	735	885	0.23	62.9	40.6	39,600	0.10	839	27.7	105
	2011	11	660	937	0.25	72	41	41,150	0.09	790	24	88
Mean	2007	11.4	553	742	0.23	66.1	44.1	37,174	0.08	838	24.4	82.7
	2010	7.0	2,607	33,556	0.27	59.5	41.7	38,269	0.10	893	28.3	99
	2011	11	923	9153	0.25	71	41	40,806	0.09	831	23	87

6.8.6.2 Biological Characteristics of Seabed Sediments

As shown in Table 6.52 only four taxa were recorded during the 2007 survey, all at very low abundance; one species of polychaete, two species of oligochaete, and one amphipod species. This is typical for such deep water stations, and is similar to data from regional survey stations at a similar depth.

Only three taxa were recorded in the 2010 post-drilling survey (refer to Table 6.53), while 12 taxa were recorded in the 2011 survey (refer to Table 6.54). However, five of these taxa were represented by only a single individual, Only ostracods were present in moderate abundance at all stations, and at most stations only one or two taxa were present.

Overall, the three surveys are consistent in indicating that the community at this location and depth is impoverished and marginal.

Table 6.52 Recorded Taxa at SDX5 Well Location in 2007 per m^2

Taxon	Station												
	01	02	03	04	06	07	08	09	11	12	13	14	15
Nereis sp	0	0	0	3	0	0	0	0	0	0	3	0	0
Tubificidae sp.indet	0	0	0	0	3	0	0	0	0	0	0	7	0
Isochaetides michaelseni	16	10	23	3	0	27	33	13	0	57	3	3	10
Niphargoides caspius	0	0	3	0	0	0	0	0	0	0	0	0	0

Table 6.53 Recorded Taxa in SDX-5 Post Drill Survey 2010 per m^2

Taxon	Station												
	01	02	03	04	06	07	08	09	11	12	13	14	15
Isochaetides michaelseni	3	0	7	3	0	3	0	0	0	7	13	3	3
Balanus improvisus	0	0	0	0	0	0	823	0	0	0	0	0	0
Ostracoda spp	13	17	0	0	220	43	0	37	0	0	0	23	0

Table 6.54 Recorded Taxa in the ES Baseline Survey 2011 per m^2

Taxon	Station																		
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
Cordylophora caspia						p	p			p	p	p		p	p		p		
Bougainvillia megas			p				p						p					p	
Tubificidae spp.	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Balanus improvisus	0	7	3	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	7
Ostracoda spp	3	33	60	10	7	7	70	7	53	0	17	20	17	3	13	13	10	20	37
Mysidae caspia	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Gammaridae spp.	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus pauxillus	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corophium spp	0	20	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dreissenidae spp	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mytilaster lineatus	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Conopeum seurati		p	p	p	p	p	p		p	p	p			p	p	p	p	p	p

6.8.7 EN Location

The EN location is situated in a water depth of 456-480m. A baseline survey was carried out in 2011, in which samples were collected from 19 stations. Figure 6.29 presents the sampling locations of the 2011 survey.

6.8.7.1 Physical and Chemical Composition of Seabed Sediments

Physical Properties of Sediments

Table 6.55 summarises the physical properties of sediments. With the exception of one station replicate, all samples were classified as very fine silts, with mean particle diameters of 6-7 µm, consisting of 99-100% silt-clay.

Table 6.55 Summary of Physical Properties of EN Location Sediments 2011

	Mean diameter Xµm	Carbonate %	Organic %	Silt/Clay %	Silt %	Clay %
Min	6	21	7	97	41	49
Max	16	32	11	100	51	59
Median	6	27	9	100	47	53
Mean	7	27	9	100	47	53

Hydrocarbon Concentrations

Table 6.56 summarises the hydrocarbon concentrations in the sediments collected during the 2011 baseline survey. With the exception of phenols, coefficients of variation were very low, indicating that there was no real or systematic variation in concentrations across the survey area. Hydrocarbon concentrations were consistent with those previously observed for very fine, deep-water sediments in the SD Contract Area. Percentage UCM and NPD values indicated that the aliphatic and aromatic components were weathered, with no indication of recent fresh inputs of hydrocarbon material.

Table 6.56 Summary of EN Location Hydrocarbon Concentrations 2011

	THC (ug/g)	UCM (ug/g)	% UCM	2-6 PAHs (ng/g)	NPD (ng/g)	%NPD	16 EPA (ng/g)	Phenols (ug/g)
Min	285	210	71	1,201	662	53	251	0.041
Max	490	388	81	1,616	996	64	351	0.183
Median	351	272	77	1,399	840	60	295	0.079
Mean	356	274	77	1,397	837	60	297	0.088
St Dev	42	38	3	84	66	2	20	0.056
CV	12	14	3	6	8	4	7	64

Heavy Metal Concentrations

Metal concentrations are summarised in Table 6.57. Concentrations were typical of earth crust values, reflecting the high silt and clay content, and showed extremely low variation between stations.

Table 6.57 Summary of Sediment Heavy Metal Concentrations at the EN Location 2011

	Concentration (µg/g)										
	As	Ba HNO3	Ba Fusing	Cd	Cr	Cu	Hg	Fe	Mn	Pb	Zn
Min	10.3	641	727	0.15	63	37	0.089	34,850	707	23	88
Max	16.6	848	947	0.27	75	39	0.113	39,470	1,142	24	99
Median	12.6	802	900	0.24	68	38	0.094	37,200	1,011	24	91
Mean	12.6	799	895	0.24	69	38	0.094	37,165	1,016	24	91

6.8.7.2 Biological Characteristics of Seabed Sediments

The sediments at the EN location were almost abiotic. Only 133 individuals (70 oligochaetes and 63 ostracods) were recorded in the entire survey area.

6.8.8 Summary

Tables 6.58 and 6.59 summarise the physical, chemical and biological characteristics of the sediments at the six locations. These characteristics are influenced by two principal factors – water depth, and sediment coarseness. Although Table 6.59 would seem to indicate that there is a very strong relationship between depth and coarseness, this is partly a coincidence, due to the fact that the NF and SDB Platform Complex locations lie within an area of comparatively coarse sediment in the centre of the SD Contract Area; there are many locations at similar depth elsewhere in the Contract Area where sediments are much finer.

Overall, concentrations of hydrocarbons and heavy metals are higher in the WS, ES and EN sediments and lower in the WF and NF sediments. This reflects the variation in silt and clay content, with concentrations of most parameters higher in the finer, silty sediments. Hydrocarbons at all locations were heavily weathered, and no indication of organic or inorganic chemical contamination was observed at any of the locations.

Macrobenthic invertebrate species richness and abundance were very low in the deepwater WS, ES and EN locations.

Species richness and abundance at the WF location was typical of the central area of the SD Contract Area, and polychaetes, oligochaetes, amphipods and gastropods were well-represented. Species richness and (for some taxonomic groups) abundance was substantially higher at the SDB Platform Complex and NF locations, and were similar to levels routinely observed at the SDA location. NF and SDB Platform Complex locations lie within a central area of relatively coarse sediments, and this area consistently supports a more diverse fauna than the rest of the SD Contract Area. The WF location is intermediate in characteristics between the area of shallow-water coarse sediment occupied by NF, SDB Platform Complex and SDA, and the deepwater, fine sediments of the WS, ES and EN locations.

Table 6.58 Comparison of Sediment Median Particle Size (um), Total Hydrocarbon Concentration (THC, µg/g) and Heavy Metal Concentrations (µg/g)

Location	Depth (m)	Median Particle Size	µg/g											
			THC	As	Ba HNO3	Ba Fusion	Cd	Cr	Cu	Hg	Fe	Mn	Pb	Zn
SDB	95	455	28	11	474	698	0.12	37	18	0.05	22,750	590	12	55
NF	70	148	33	11	330	410	0.07	65	23	0.18	33,050	557	13	76
WF	163	19	11	18	326	482	0.13	57	19	0.05	25,300	526	15	61
WS	410	6	301	11	853	925	0.22	68	37	0.08	35,775	849	23	91
ES	550	5	214	11	660	937	0.25	72	41	0.09	41,150	790	24	88
EN	475	6	351	12	802	900	0.24	68	38	0.09	37,165	1,016	24	91

Table 6.59 Comparison of Species Richness and Total Abundance

Taxon	SDB	NF	WF	WS	ES	EN
Year of Survey	2011	2008	2009	2011	2011	2011
Water depth (m)	95	70	163	410	550	475
Median particle size (um)	455	148	19	6	5	6
Class Polychaete Species	7	7	4		1	
Class Polychaete Individuals	9,210	9,160	1,603		6	
Class Oligochaete Species	4	4	4	3	2	3
Class Oligochaete Individuals	4,907	7,827	17,593	5,570	206	70
Order Cirripedia (*Balanus*)	3,350	26,940	23	0		
Order Cumacea Species	7	10	8	1		
Order Cumacea Individuals	4,550	6,793	1,787	3		
Order Amphipod Species	38	47	21	2	1	
Order Amphipod Individuals	44,157	53,709	3,717	7	3	
Order Isopoda Individuals	50	7	3			
Class Gastropod Species	1	11	13			
Class Gastropod Individuals	3	337	120			
Class Bivalve Species	4	11				
Class Bivalve Individuals	1,233	6683				
Total number of taxa	65	98	55	10	4	7

6.9 Archaeology and Cultural Heritage

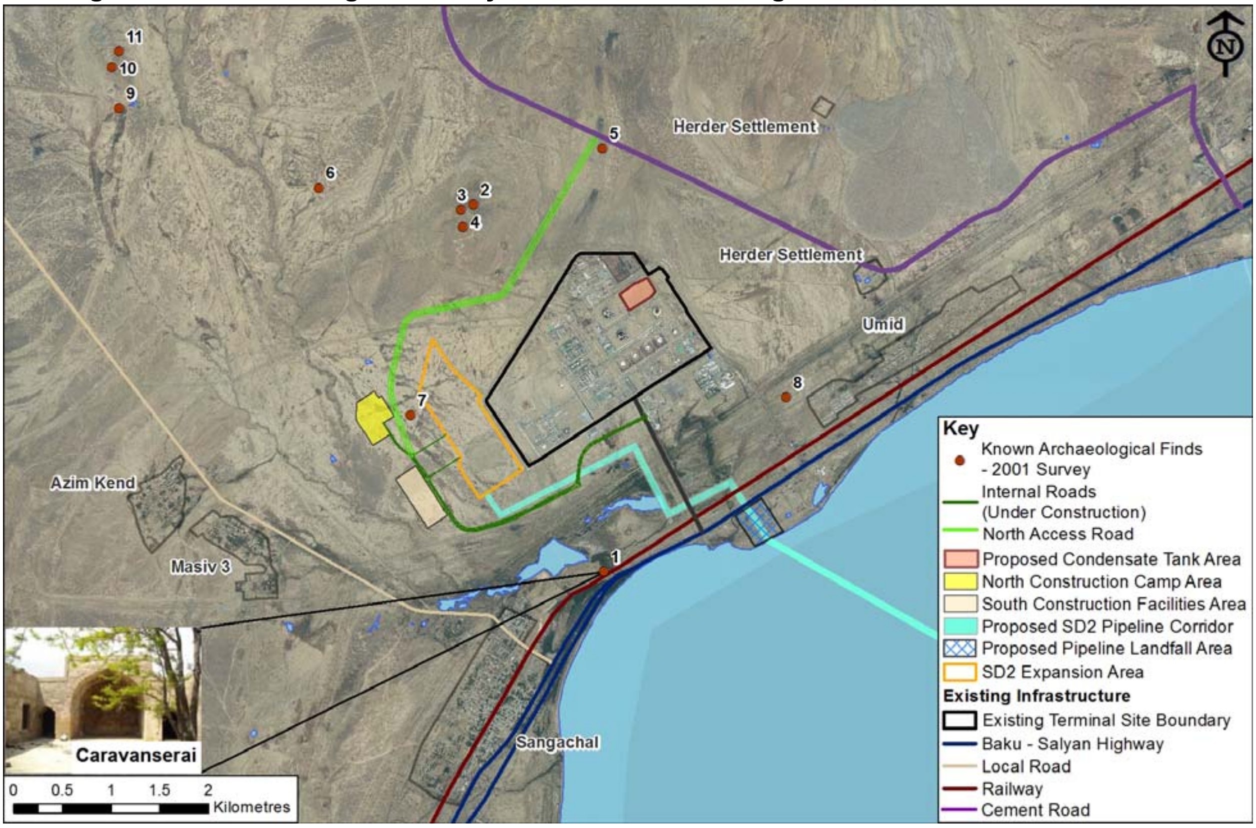
A non-intrusive archaeology and cultural heritage field survey was undertaken in 2001 for the Shah Deniz Stage 1 (SD1) Project[38] and covered an area within a 2.5km radius of the current Terminal. Key finds within the survey area are detailed within Table 6.60 and shown on Figure 6.31. A second survey in 2002 conducted by a team of UK archaeologists confirmed the presence of several archaeological sites (ID2-4 within Figure 6.30) in the area north of the current Terminal.[39]

[38] SD1 ESIA,2002
[39] Desmond et al. 2002

Table 6.60 Summary of 2001 Archaeological Survey Finds/Cultural Heritage Sites

ID	Find/Site	Comment
1	Caravanserai	Medieval inn. Protected state monument.
2	1st and 2nd Sangachal Settlements	Medieval and Antique structural remains and extensive habitation area. Reportedly dating back to 2nd century BC. Rock art found within one rockshelter.
3	3rd Sangachal Settlement	Structural remains noted in 3rd Sangachal Settlement. Glazed and unglazed pottery shards indicating potential medieval settlement of between 2-20 hectares.
4	4th Sangachal Settlement	
5	5th and 8th Sangachal Settlements	This medieval settlement may cover several hectares. Structural remains were recorded in 8th Sangachal.
6	6th Sangachal Settlement	This possible medieval settlement includes the remains of several structures and a variety of domestic ceramics.
7	9th Sangachal	Glazed and unglazed pottery shards indicating potential medieval settlements of between 2-20 hectares.
8	Sangachal Gochdash Memorial	
9,10 & 11	Sangachal cemetery and Sophi-Hamid Sepulcher	Approximately 20 hectares. Reported to contain burials from 13th century towards the north of the cemetery footprint.
n/a	Sand Cave	Cave with man-made interior walls. Protected state monument.

Figure 6.31 Archaeological Survey Finds/Cultural Heritage Sites, 2001



These surveys identified several monuments or archaeological sites in the vicinity of the Terminal that date from the Medieval period. Several of the archaeological sites also date from the Antique period. One of these (ID7 within Figure 6.31) was located in the EIW footprint. This archaeological site is referred to as 9th Sangachal[1].

In 2011, a reconnaissance survey was undertaken covering the following areas:

- SD2 Expansion Area;
- Areas west of the SD2 Expansion Area;
- The proposed SD2 Pipeline Landfall Area; and
- The vicinity of the Caravanserai.

The reconnaissance survey determined that the SD2 Expansion Area had undergone extensive disturbance, including the creation of two spoil heaps, earthen berms, pipelines, fences and roads. Within the SD2 Pipeline Landfall area, approximately 60-80% of the area has been disturbed by quarrying. Even though these areas have been heavily disturbed, they were identified as having potential for archaeological finds and it was therefore recommended that an archaeological baseline survey be undertaken.

Consultation with the Ministry of Culture and Tourism (MoCT) during the survey revealed a Sand Cave adjacent to the pipeline landfall area, listed as a protected State monument. Therefore, the survey also recommended that an architectural baseline survey of the Caravanserai and Sand Cave be undertaken.

In 2011, baseline archaeology and architectural surveys were undertaken with the Institute of Archaeology and Ethnography (IoAE). The archaeology baseline survey area included all SD2 Project elements (including the EIW), and resulted in the identification of 182 Isolated Finds and 13 archaeological sites, the majority of which occurred within or near the EIW project area. No evidence of buried archaeological or other data to indicate the presence of buried archaeological remains was found during the survey.

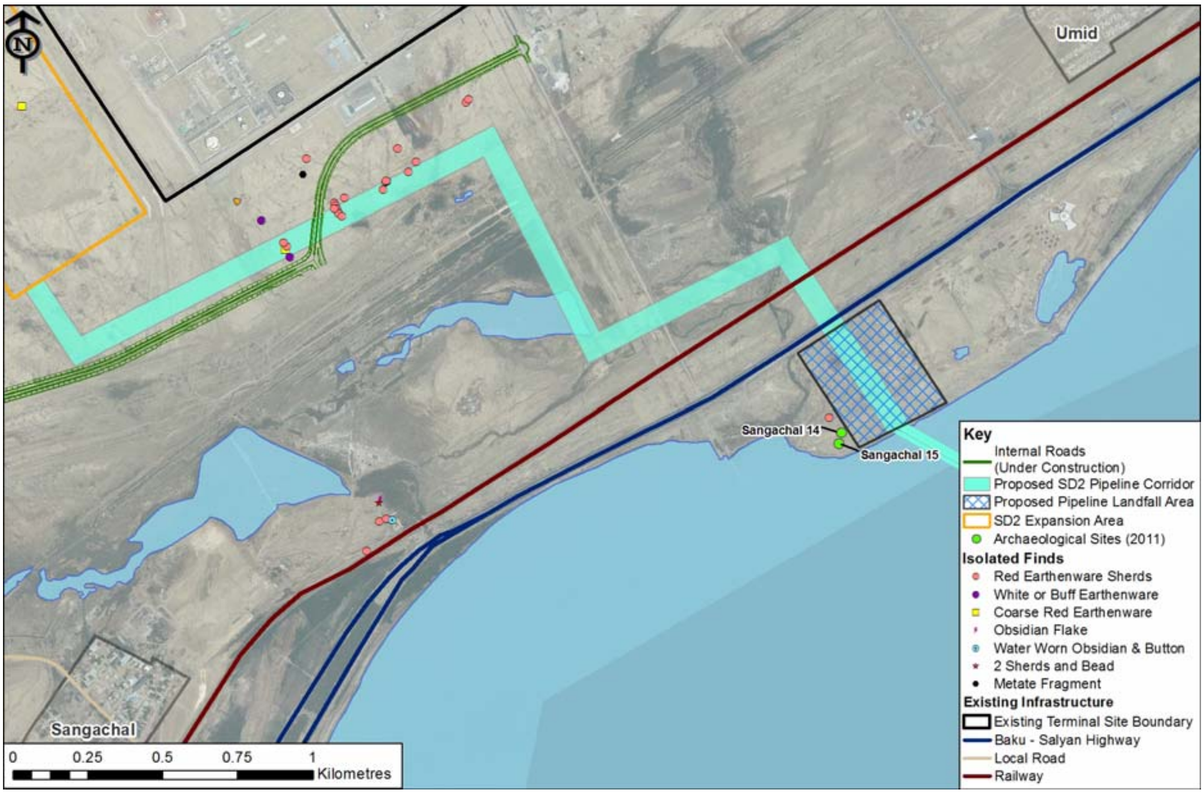
Table 6.61 summarises the finds at the 13 archaeological sites identified during the survey. The survey results indicated that the SD2 Project onshore areas (including the SD2 EIW) did not contain permanent settlements or buried archaeological deposits. Rather, the discovered artefacts were the results of rural seasonal activities in the area during the late Middle Ages, probably representing shepherds or caravan camps.

Table 6.61 CHBS Archaeological Site Summary Data

Site	Site Size (m^2)	Number of Artefacts	Site Type and Characteristics
Sangachal 9	1,386	23	Unknown age. Ceramic scatter
Sangachal 10	2,500	17	$11^{th}/12^{th}$ century A.D. Ceramic scatter
Sangachal 11	1,290	15	Late medieval. Ceramic scatter
Sangachal 12	598	51	$16^{th}/17^{th}$ century A.D. Ceramic scatter
Sangachal 13	525	72	$17^{th}/18^{th}$ century A.D. Ceramic scatter
Sangachal 14	121	31	Unknown age. Ceramic scatter
Sangachal 15	16	11	$17^{th}/18^{th}$ century A.D. Ceramic scatter
Sangachal 16	1,100	42	$16^{th}/17^{th}$ century A.D. Ceramic scatter
Sangachal 17	1,350	95	Late medieval. Ceramic scatter
Sangachal 18	300	15	Unknown age. Ceramic scatter
Sangachal 19	3,325	48	Unknown age. Ceramic scatter
Sangachal 20	507	81	Unknown age. Ceramic scatter
Sangachal 21	2,700	100+	20^{th} century shepherd's campsite

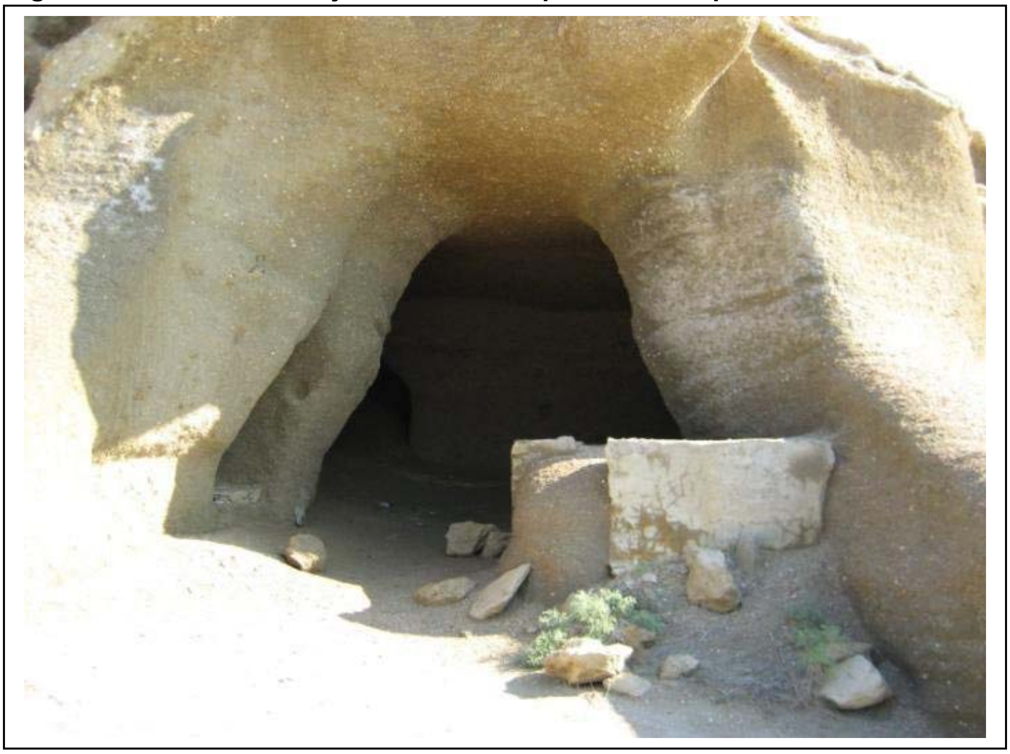
In the area to the south of the Terminal and north of the third-party pipeline corridor, 18 Isolated Finds were identified (Figure 6.32). The majority of these consisted of red earthenware sherds. Adjacent to the proposed SD2 Pipeline Landfall area, one Isolated Find was identified also consisting of red earthenware sherds. Two archaeological sites were also identified. Ceramic scatter was found at Sangachal 14, the age of which is unknown. Sangachal 15 consisted of 17th/18th century A.D ceramic scatter.

Figure 6.32 Archaeological Sites Identified South of the Terminal and Near the Pipeline Landfall Area



The architectural baseline survey determined that the history and significance of the Sand Cave is unclear (Figure 6.33). While the MoCT believe that the feature is naturally-formed and has been present for some time, this could not be confirmed during the survey. If the Sand Cave is a natural formation that has been adapted to human use over an extended period of time, then the resource may possess historical significance for its natural physical characteristics as well as its social associations. The survey revealed the Sand Cave to be in a fair, but fragile condition.

Figure 6.33 Sand Cave Adjacent to the Proposed SD2 Pipeline Landfall Area



An archaeological watching brief programme was established for EIW. As of December 2012, a total of 16 chance finds have been identified, which included:

- Six isolated archaeological finds consisting of individual ceramic sherds of Medieval or undetermined age;
- One piece of cooked bone determined to be an Isolated Find;
- Four artefact scatters comprising 2-3 ceramic sherds dating to the Late Medieval Period;
- One scatter of modern ceramic sherds;
- One natural sinkhole; and
- Three archaeological features.

During the EIW, three archaeological sites identified have been moved, namely, Sangachal 9, Sangachal 11, and Sangachal 18. Ground works within and around these sites were monitored by two watching brief archaeologists. Archaeological monitoring during these works resulted in the identification of the three archaeological features. These features were comprised of red soil stains and associated deposits of charcoal and ash. They have been interpreted as the remains of small campfires of indeterminate age. Two of these features were identified in the immediate vicinity of Sangachal 18; the third was located near Sangachal 11.

The watching brief has identified intact, subsurface features in the archaeological sensitivity zones around two archaeological sites. This suggests there is high potential for encountering additional archaeological deposits or features, which have been adversely affected by physical disturbance. The Sand Cave, which is in a fair but fragile condition, may also be affected by physical disturbance in addition to factors including ground-borne vibration.