Chirag Oil Project

Environmental
&
Socio-economic Impact Assessment

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Companies

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Academic and Scientific Experts

Individual	Expertise
Mehman M. Akhundov	Fish Specialist
Tariel Eybatov	Caspian Seal Specialist
Amrita G. de Soyza	Terrestrial Ecology Specialist
Urkhan Alakbarov	Socio Economic Specialist
Alun Lewis	Oil Spill Specialist
Ilyas Babayev	Bird Specialist

Academic and Scientific Institutions

Azerbaijan Ministry of Ecology and Natural Resources
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Non Governmental Organisations

Ecograph
Sulh
Our House Common
Ecoscope
Sadr
Azerbaijan Green Movement

Executive Summary

This Executive Summary presents a concise non technical overview of the Chirag Oil Project (COP) Environmental and Social Impact Assessment (ESIA). It is intended to provide a summary of the project design and activities, of the issues considered in the ESIA and of the main conclusions with respect to environmental and socio-economic impact. Detailed technical descriptions of discharge modelling, mitigation and monitoring are presented in the main sections of the ESIA.

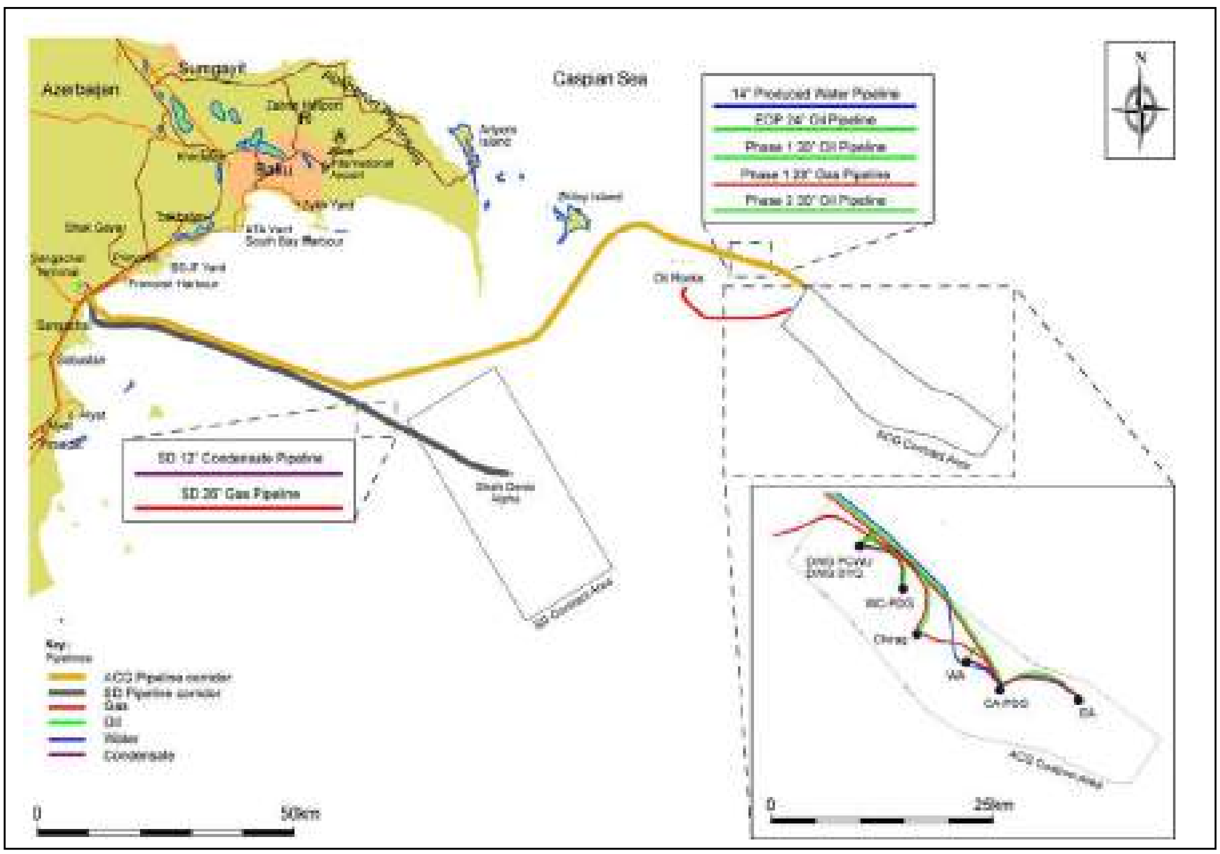
E.1 Introduction

The Azeri Chirag Gunashli (ACG) Contract Area covers approximately 432km^2 and lies approximately 120km east of Baku, the Azerbaijan capital. Development of the Contract Area, which is operated by BP on behalf of the Azerbaijan International Operating Company (AIOC),is being pursued in phases and to date has included:

- Early Oil Project (EOP);
- ACG Phase 1;
- ACG Phase 2; and
- ACG Phase 3.

Operations at the ACG field started in November 1997 with the start-up of production from the Chirag-1 platform (Early Oil Project). The Central, West and East Azeri facilities (including the EA, WA, CA-C&WP and CA-PDQ platforms) were developed under Phases 1 and 2 and Deepwater Gunashli (DWG) portion was developed under Phase 3. The Chirag Oil Project (COP) represents the next stage of development in the ACG Contract Area. Figure E.1 shows the location of the existing ACG and proposed COP offshore facilities within the ACG Contract Area in addition to the subsea pipeline network, connecting the facilities to the onshore processing facilities at Sangachal Terminal.

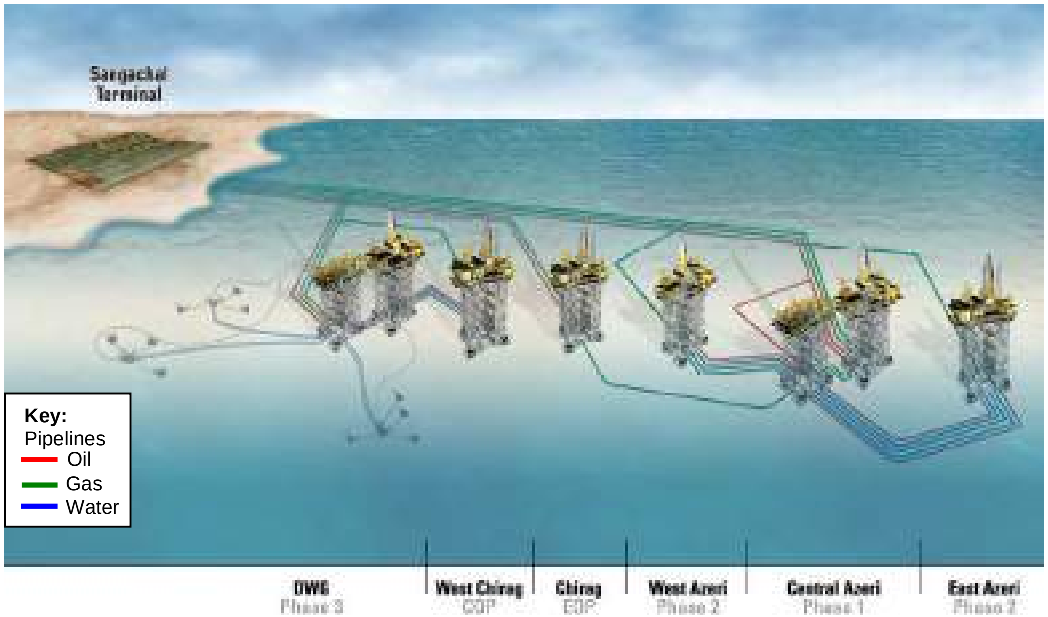
Figure E.1 Location of Azeri Chirag Gunashli Contract Area



E.2 Project Overview and Need for an ESIA

The COP includes the construction and the installation of a new Production, Drilling and Quarters platform (designated West Chirag (WC)-PDQ), to be located between the existing Chirag-1 and DWG platforms, and the installation of infield pipelines connecting the platform to the existing ACG subsea oil and gas pipelines. Infield pipelines will also be installed for the transfer of produced water and injection water between the WC-PDQ platform to the nearby DWG facilities. Figure E.2 shows the proposed platform and infield pipelines in the context of the existing operational ACG offshore facilities.

Figure E.2 ACG Contract Area Offshore Facilities (Including COP)



COP activities will occur primarily at the WC-PDQ platform location and, during the construction period, at existing onshore fabrication sites used for previous ACG projects. No new onshore facilities are planned as the existing facilities have sufficient capacity for handling production received from the WC-PDQ platform.

Given the location, scale and planned activities associated with the COP, AIOC and the Ministry of Ecology and Natural Resources (MENR) concluded that the project should be subject to an ESIA, and the ESIA should take account of applicable national and international legislation, the AIOC PSA and relevant BP standards.

The COP ESIA has been developed to make the most effective use of lessons learned during previous ACG projects and of the large amount of environmental and social information that has been acquired during the design, construction and subsequent operation of these projects.

The COP impact assessment methodology has been refined to take advantage of the fact that, unlike for previous ACG project ESIAs, it has been possible to:

- Directly observe and document interactions with environmental receptors during all phases of development, including routine platform operations;
- Utilise a large amount of regional environmental data to enable local operational impacts to be assessed more quantitatively and in context; and
- Define receptor sensitivity more directly and quantitatively.

The COP ESIA has also addressed aspects such as predrilling activities and non-routine events in more detail than possible in previous ACG project ESIA.

E.3 Options Assessed and COP Design

Options assessed during the evolution of the COP design focused on the following:

- The identification of a suitable location within the ACG Contract Area for the offshore facilities to exploit the selected reservoirs;
- Platform design and the extent of integration with existing ACG offshore facilities;
- Efficiency and performance improvements offered by technology alternatives; and
- Maximising in-country fabrication of offshore facilities.

Those design options previously considered throughout the development of the ACG Phase 1, 2 and 3 Projects were also assessed.

The option of not developing the COP offshore facilities was also recognised and considered. A decision not to proceed would, however, result in a reduction of potential oil revenues to the Azerbaijan government with a resultant inability to deliver the associated benefits to the Azerbaijan economy. Pursuing the COP will result in employment creation for national citizens during both the construction phase and operational phase of the development as well as increased use of local facilities, infrastructure and suppliers. The option of not proceeding was therefore disregarded when considered against these socio-economic benefits.

The assessment of project design options led to the selection of a single-platform design, which will utilise available water injection capacity at the nearby DWG Production, Drilling, Water injection and Utilities (DWG-PCWU) platform. Produced water separated from crude oil on the WC-PDQ platform will be transferred to DWG-PCWU, mixed with both treated seawater and DWG-PCWU produced water and returned to the WC-PDQ platform under pressure for injection to the reservoir.

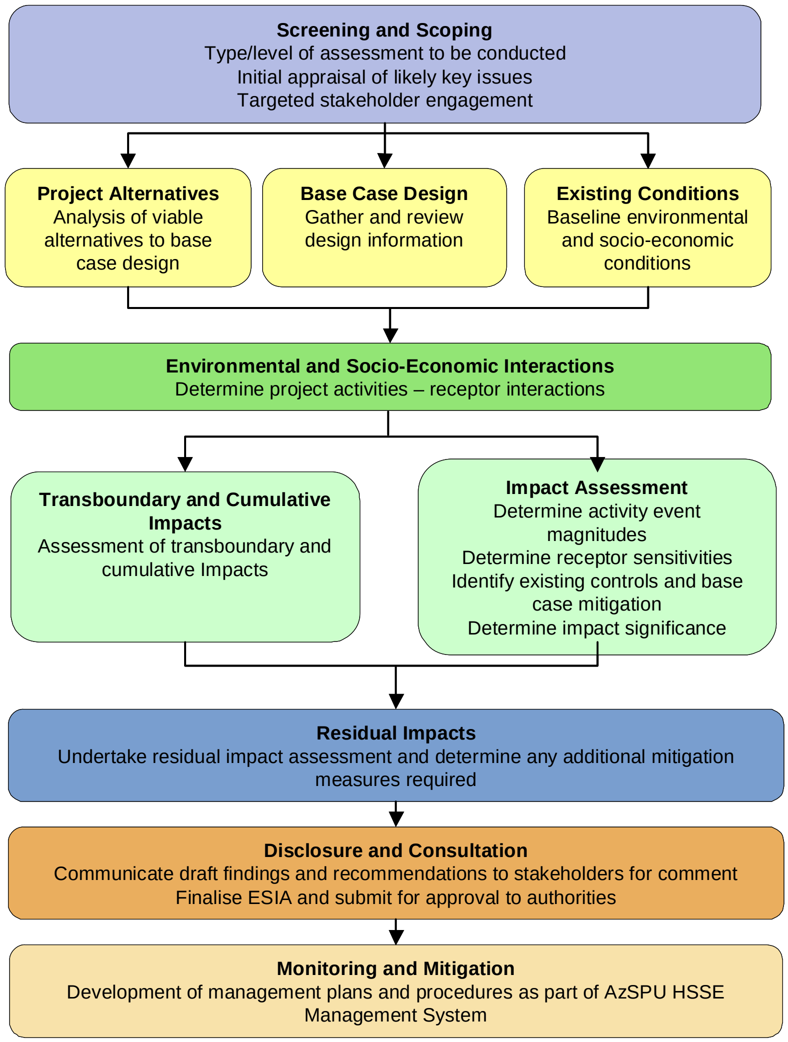
The selected design of the WC-PDQ platform is based largely on established ACG single-platform design with improvements based on experience in constructing and operating existing ACG platforms. These improvements include:

- A more effective and reliable design for the platform sewage treatment plant;
- Improved offshore sand separation and management; and
- An alternative concept to a standard design option whereby the gas turbine direct drives for gas export compression are replaced with electric motor drives and the onboard main power generation capacity is increased, the benefits of which are expected to include:
  - More efficient use of the power provided by the main platform generators;
  - Increased availability of the gas export compressors;
  - Increased reliability and associated reduction in safety risk and potential for accidental events;
  - Reduced frequency of non-routine flaring by up to 40%; and
  - Significantly reduced emissions, specifically greenhouse gas emissions, from the platform.

E.4 Assessment Methodology

The ESIA process adopted for the COP, as illustrated in Figure E.3, constitutes a systematic approach to the evaluation of the project and its associated activities throughout the project lifecycle from pre-construction, to construction and through to operation.

Figure E.3 The ESIA Process



Assessment of COP environmental impacts has been undertaken based on identified COP activities and events for each project phase that have the potential to interact with the environment. The expected significance of the impact has been assessed taking into account:

- **Event Magnitude**: Determined based on the following parameters;
  - ***Extent*** – the size of the area that is affected by the activity being undertaken;
  - ***Duration*** – the length of time that the activity occurs;
  - ***Frequency*** – how often the activity occurs; and
  - ***Intensity of the impact*** - concentration of an emission or discharge with respect to standards of acceptability that include applicable legislation and international guidance, its toxicity or potential for bioaccumulation, and its likely persistence in the environment.

- **Receptor Sensitivity**: Determined based on:
  - ***Presence –*** whether species/people are regularly present/transient, and whether species present are unique, threatened or protected; and
  - ***Resilience*** – how vulnerable people/species are to the change or disturbance associated with the environmental interaction with reference to existing baseline conditions and trends (e.g. trends in ecological abundance/diversity/status, ambient air quality etc).

The COP impact assessment process has benefited from the fact that offshore ACG discharges and emissions have been comprehensively studied and characterised during the five years over which the existing ACG platforms have become operational. As a result, impacts have been evaluated and understood to a far greater extent than was previously possible.

The evaluation of impacts has been based on three principal sources of information:

- Previous environmental risk assessments, including results of toxicity tests and modelling studies which are applicable to the COP;
- Modelling studies, including onshore and offshore noise assessments and air dispersion modelling, undertaken specifically for the COP; and
- Results from the Azerbaijan Strategic Performance Unit (AzSPU) Integrated Environmental Monitoring Programme (IEMP), which has included systematic and regular offshore monitoring at all new and operational platforms and which has regularly carried out ‘regional’ monitoring to identify and quantify natural environmental trends, and with onshore surveys including ecological and air quality monitoring in and around Sangachal Terminal.

The IEMP has been instrumental in providing a clearer picture of the composition and sensitivity of benthic biological communities in the ACG Contract Area and of the effect of platform and pipeline installation, drilling activities and platform operations on these receptors. With ACG Phases 1, 2 and 3 now in operation, the IEMP demonstrates that the control measures (design and operation) included in previous ESIAs have adequately mitigated impacts on the marine environment.

E.5 Consultation

The first stages of the Public Consultation and Disclosure process were initiated and completed before the drafting of the main ESIA document began. Scoping meetings were held in September 2008 to inform and receive comment from representatives of civil society, the scientific community, the key regulatory authorities and government and allow key issues to be incorporated into the ESIA scope.

The Draft ESIA document was subsequently publically disclosed and Non Governmental Organisations (NGO), the scientific community, the public and state organisations (including the Ministry of Ecology and Natural Resources (MENR)) were invited to provide written comment and to attend public meetings to discuss issues of concern. Comments received on the Draft Final ESIA report were collated, analysed and detailed responses issued to the consultees. The ESIA report was then revised and finalised for approval.

During the development of the COP detailed design, the MENR will be provided with regular updates to communicate materially significant technical changes.

E.6 Socio-Economic Impact

The majority of COP related Activities (with the exception of the construction phase) occur offshore and use existing operational onshore infrastructure capacities (e.g. Sangachal Terminal, the Baku Deep Water Jacket Factory (BDJF)). With reference to the experience gained on from the previous ACG Phases, the following key socio-economic issues were assessed:

- Employment creation;
- End of construction phase workforce reduction;
- Training and skills development;
- Economic activity; and
- Community disturbance.

The assessment concluded that the national workforce to be employed during the COP construction phase is likely to peak at approximately 2,000 and will likely exceed 1,000 for a period of approximately 18 months. Additional and new employment during the operations phase will be less in terms of new positions. Employment impacts are likely to be distributed within the local area with the majority of employees expected to be recruited from the local Garadagh area. It is anticipated therefore that employment will not require establishment of workforce accommodation or significant migration of populations to the construction areas.

Although the jobs created during the construction phase will not be required once the COP construction phases are complete, training and skills development, similar to that undertaken during the previous ACG projects, will provide a positive impact in developing the construction workforce skills and qualifications.

As the construction phase will only deliver temporary employment, planning for the conclusion of contracts will begin at the outset of the construction phase and related activities. Staff communications will ensure the workforce is aware of project progress and completion dates and staff will be provided with financial planning advice to encourage them to make provision for after the construction period.

The overall socio-economic impacts of the COP, particularly from employment creation throughout the construction, installation and hook-up and commissioning phases were assessed as positive.

Increased road traffic during the COP construction and operation phases has the potential to disrupt communities and businesses along the routes used through increased noise and traffic flows. BP and its main construction contractors implemented a successful driving and vehicle management plan during earlier ACG projects and this will be adopted for the COP to ensure that this impact is adequately mitigated. Overall the residual impact to communities and businesses from the increased traffic is considered to be minimal and significantly outweighed by the employment and business opportunities gained.

Economic developments in the Garadagh area since the completion of previous ACG projects include the relocation of the airport market to Lokhbatan, the proposed expansion of existing cement production facilities and the construction of new cement production facilities. These developments will have an impact on both local employment and traffic and will tend to reduce the relative magnitude of the impact of the COP development.

E.7 Environmental Impact Assessment

Environmental impact was assessed for each of the three main phases of the project.

- **Predrill:** The project has adopted the established ACG practice of using a mobile drilling rig to predrill a number of producer, water injection and a cuttings injection well prior to WC-PDQ platform installation to facilitate early production once the platform is in place;
- **Construction, installation, hook-up and commissioning:** Includes all onshore construction and commissioning activities, offshore pipelay and pipeline commissioning and connection to the platform and existing ACG export pipeline network; and
- **Operations:** Platform production drilling and onshore hydrocarbon processing using the existing Sangachal Terminal facilities.

Evaluation of impacts took into account the existence and effectiveness of existing controls and mitigation measures implemented by previous construction phases or in place on operational ACG platforms, which are also relevant for the COP.

For each phase:

- Activities and events leading to interactions with the environment were identified;
- Scoping was undertaken to identify those COP activities that could be excluded from the full assessment process based on their limited potential to result in discernable impacts; and
- The impact of the remaining COP activities and the associated events were assessed based on event magnitude and the receptor sensitivity parameters.

The receptors and interaction categories considered are presented in Table E.1.

Table E.1 Receptors

Receptors	Impact Type/Interaction
Onshore communities (people)	Atmospheric emissions
	Noise
Seals and fish	Marine Environment:
Zooplankton	• Discharges;
Phytoplankton	• Underwater noise;
Benthic invertebrates	• Seabed disturbance; and • Physical presence.

E.7.1 Predrill

Table E.2 summarises the outcome of impact assessment for the predrill phase of the project.

Emissions associated with mobile drilling rig power generation, well test flaring and the activity of support vessels will all occur offshore and disperse into the atmosphere. Modelling was undertaken to determine the concentration of key pollutants associated with these activities at receptor locations (i.e. onshore) and hence event magnitude. Based on existing good air quality relative to recognised standards for the protection of health, receptor sensitivity was considered to be low and the impact of atmospheric emissions was considered to be minor.

Table E.2 Summary of Predrill Residual Environmental Impacts

	Event	Receptor	Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from mobile drilling rig power generation	Onshore communities (people) Birds Seals and fish	Medium	Low	**Minor Negative**
	Emissions from well test flaring		Medium	Low	**Minor Negative**
	Emissions from support vessel engines		Medium	Low	**Minor Negative**
Marine Environment	Underwater noise from drilling and vessel movements	Seals and fish	Medium	Low	**Minor Negative**
	Drilling discharges	Seals and fish Zooplankton Phytoplankton Benthic Invertebrates	Medium	Low	**Minor Negative**
	Vessel and drilling rig cooling water intake and discharge	Seals and fish Zooplankton Phytoplankton	Medium	Low	**Minor Negative**
	Vessel and drilling rig ballast water discharge		Medium	Low	**Minor Negative**
	Vessel and drilling rig treated black water discharge		Medium	Low	**Minor Negative**
	Vessel and drilling rig grey water discharge		Medium	Low	**Minor Negative**
	Vessel and drilling rig drainage discharges		Medium	Low	**Minor Negative**
	Cement discharges	Benthic Invertebrates	Medium	Low	**Minor Negative**
	Seabed disturbance from anchor handling		Low	Low	**Negligible**

During predrilling, the largest discharges to the marine environment by volume are drilling discharges, specifically the discharge of drill cuttings and water based drilling mud, and the discharge of cooling water from the mobile drilling rig generators. Modelling of the drilling discharges was undertaken to confirm the extent and scale of mud and cuttings predicted to be deposited on the seabed during COP predrilling. This was compared to trends observed during pre- and post- drilling surveys at existing platforms undertaken as part of the IEMP. These surveys have shown that such discharges, which are required to meet applicable standards prior to discharge, have a very limited ecological impact to marine receptors. Based on the predicted event magnitude, receptor characteristics and observed sensitivities the impact was assessed as minor.

Small quantities of cement may be discharged to the seabed whilst cementing well casings into place. These will remain close to the well-head in the same area as drill cuttings are deposited. The impact to benthic invertebrates, which were evaluated as having a low sensitivity to cement discharges, was therefore assessed as minor.

Cooling water discharges are estimated to have a zone of influence (i.e., where temperature and trace biocide concentrations might have a minor effect) of only a few metres and are also considered to have a minor impact upon biological receptors in the water column (i.e. zooplankton, phytoplankton, seals and fish).

The remaining discharges to sea (ballast water, black water, grey water and deck drainage) are all small in volume (relative to drilling and cooling water discharges and do not contain components of high environmental concern. These discharges, which are monitored in accordance with existing procedures to ensure applicable project standards are met, will be rapidly diluted and are all assessed as having a minor impact upon biological receptors in the water column.

Seabed disturbance associated with anchor handling during positioning of the mobile drilling rig will cause temporary disturbance to the surface layers of the sediment. The assessment concluded that benthic communities in the area are not, however, sensitive to this form of disturbance and the impact was therefore assessed as negligible.

For all predrill phase environmental impacts assessed it has been concluded that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures and no additional mitigation is required.

E.7.2 Construction, Installation, Hook-Up and Commissioning

Table E.3 summarises the interactions assessed for the construction, hook-up and commissioning phase, and the results of the impact assessment for each interaction.

Table E.3 Summary of Construction, Installation, Hook-Up and Commissioning Residual Environmental Impacts

	Event	Receptor	Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from yard generators and engines	Onshore communities (people) Birds	Medium	Medium	**Moderate Negative**
	Emissions from onshore platform generator commissioning		Medium	Medium	**Moderate Negative**
	Emissions from support vessel engines		Medium	Low	**Minor Negative**
Onshore Noise	Noise from construction yard plant	Onshore communities (people) Birds	Medium	Medium	**Moderate Negative**
	Noise from onshore platform generator commissioning		Medium	Medium	**Moderate Negative**
Marine Environment	Underwater noise from jacket foundation piling and vessel movements	Seals and fish	Medium	Low	**Minor Negative**
	Cooling water discharge from onshore commissioning of topside	Seals and fish Zooplankton Phytoplankton	Medium	Low	**Minor Negative**
	Pipeline hydrotest discharge		Medium	Low	**Minor Negative**
	Discharge of oil line wye spool water		Low	Low	**Negligible**
	Support vessel ballast water discharge		Medium	Low	**Minor Negative**
	Support vessel treated black water discharge		Medium	Low	**Minor Negative**
	Support vessel grey water discharge		Medium	Low	**Minor Negative**
	Support vessel drainage discharge		Medium	Low	**Minor Negative**
	Jacket foundation pile cement discharge	Benthic Invertebrates	Low	Low	**Negligible**
	Seabed disturbance from anchor handling and pipe-lay		Low	Low	**Negligible**

During the construction phase, impacts to onshore communities and birds from atmospheric emissions and noise arising from construction yard plant operation and onshore generator commissioning were modelled based on planned activities and were assessed as having moderate impact.

Underwater noise sources include jacket piling activities and movement of vessels used during platform and pipeline installation. Piling activities will generate the greatest sound volume but the sound will occur intermittently and over a short period. Vessel noise will be more persistent but will be at a much lower level than piling noise. Underwater noise modelling, undertaken to determine the extent of the noise impacts, coupled with an assessment of the associated avoidance behaviour reactions recorded in fish and seal populations, demonstrated that the activities would result in a minor impact.

During onshore commissioning of the platform generators, it will be necessary to operate a temporary cooling water system that will abstract water from and discharge to the construction yard harbour. This water will be at a higher temperature than the receiving waters and will contain neutralised disinfectant at trace concentrations. Similar discharges have been modelled and subject to environmental assessment during previous ACG projects and on the basis of those assessments and the existing controls and monitoring in place, the discharge was assessed as having a minor impact to biological receptors.

During offshore installation, hook-up and commissioning, the largest total volume of discharge to the marine environment will be associated with hydrotesting the oil and gas infield pipelines which connect the platform to the main ACG pipeline network pipelines and the produced and injection water infield pipelines. These discharges (comprising seawater dosed with dye and chemicals to prevent corrosion and biological growth) will take place intermittently over approximately one year and at different depths. Individual events have been evaluated to have a minor impact and, given the spatial and temporal distribution of the discharges, the overall impact was also assessed as minor to biological receptors. Additional measures to monitor and control hydrotest discharges will comprise:

- Preparation and maintenance of a hydrotest management plan, which will include a regularly updated schedule of hydrotest events together with a detailed set of commissioning procedures;
- Recording of chemical dosage rates and water flow rates during all pipeline hydrotest activities;
- Recording of the volume of treated water released during each hydrotest discharge event; and
- Preparation of laboratory samples, which will be stored onshore under simulated pipeline conditions and periodically subject to chemical analysis and toxicity testing in order to measure the rate of chemical degradation and associated toxicity reduction

Based on previous ACG experience, these measures are considered to provide effective and practicable monitoring and assurance during hydrotesting and are designed to ensure that the impact to the marine environment is of no more than minor significance.

The impacts of jacket foundation cementing discharges and physical disturbance associated with anchor handling upon benthic invertebrates will be similar to those evaluated for the predrill programme and were assessed as minor.

Aqueous discharges (ballast water, grey water, black water and drainage) will also be similar in magnitude and impact to those for the predrill programme and were assessed as having a minor impact upon biological receptors.

A small volume of water (approximately 65m^3) with a low level of residual hydrocarbon (less than 100ppm) may be released to sea during hydrotesting of the wye section that will connect the COP oil export pipeline to the DWG oil export pipeline. This volume will be released at the seabed and will dilute and disperse rapidly. The impact upon biological receptors was assessed to be negligible.

Overall, the majority of residual impacts were assessed as minor or negligible. The only moderate impacts were those arising from air emissions and noise associated with construction yard activity and onshore platform commissioning. These activities will not however, result in the exceedence of ambient air quality or noise standards for the protection of human health. Community liaison and engagement, similar to that undertaken for the previous ACG projects, will be a key element throughout the construction phase to ensure these impacts are minimised. Construction activities will be managed in accordance with previously established practice and AzSPU procedures and impacts are considered to be controlled and mitigated to an acceptable level.

E.7.3 Operations

Table E.4 summarises the interactions assessed for the operations phase, and the results of the impact assessment for each interaction.

Table E.4 Summary of Operations Residual Environmental Impacts

	Event	Receptor	Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from offshore platform power generation and non-routine flaring	Onshore communities (people) Birds	Medium	Low	**Minor Negative**
	Emissions from support vessel engines		Medium	Low	**Minor Negative**
	Emissions from onshore combustion plant and flaring		Medium	(Humans) Medium	**Moderate Negative**
				(Biological /Ecological) Low	**Minor Negative**
Marine Environment	Underwater noise from drilling, hammering and vessel movements	Seals and fish	Medium	Low	**Minor Negative**
	Platform drilling discharges	Seals and fish Zooplankton Phytoplankton Benthic Invertebrates	Medium	Low	**Minor Negative**
	Platform pigging discharges (produced water and injection water infield pipelines)		Medium	Low	**Minor Negative**
	Platform cement discharge	Benthic Invertebrates	Medium	Low	**Minor Negative**
	Platform non routine produced water discharge	Seals and fish Zooplankton Phytoplankton	Medium	Low	**Minor Negative**
	Platform water intake and cooling water discharge		Medium	Low	**Minor Negative**
	Support vessel ballast water discharge		Medium	Low	**Minor Negative**
	Platform and support vessel treated black water discharge		Medium	Low	**Minor Negative**
	Platform and support vessel grey water discharge		Medium	Low	**Minor Negative**
	Platform and support vessel galley waste discharge		Medium	Low	**Minor Negative**
	Platform and support vessel drainage discharge		Medium	Low	**Minor Negative**

The majority of operational interactions are similar to those already considered for predrill and construction activities. Each interaction was assessed based on event magnitude and receptor sensitivity and the impact significance found to be the same as for the previous phases. Events include offshore emissions, underwater noise, drilling discharges (water based mud and cuttings discharge), cement discharge, cooling water discharge and aqueous discharges (i.e. ballast water, black water, grey water, galley waste, drainage). Only air emissions (onshore plant and flaring) were assessed as having a moderate impact. Emissions from onshore plant and flaring associated with the COP will not however, result in exceedences of internationally recognised ambient air quality standards for the protection of health at onshore receptors.

During routine operations, produced water will be reinjected into the reservoir. Discharge of produced water which meets applicable project standards will only occur due to failure of the reinjection system or if produced water is incompatible with seawater that is injected into the reservoir for pressure maintenance purposes. Pigging (i.e. cleaning of the produced water and injection water pipelines) is planned to occur once a week and discharge of pigging fluids will be of short duration (i.e. hours).

Produced water and pigging fluids have been the subject of chemical analysis, toxicity testing and dispersion modelling. The results of these studies have been used to estimate the degree of dilution required to reach a "no effect" level and the size of the dispersion plume within which such dilution would occur. Both types of discharge will be intermittent and of short duration (i.e. hours) and the plumes will dissipate within a few hours of the end of each discharge event. Based on the modelling conducted the volume of seawater potentially affected by these discharges is limited to a narrow plume of less than 600m in length. Based on the sensitivity of the receptors in the water column to the event and its limited magnitude, produced water and pigging fluid discharges were assessed as having a minor impact upon biological receptors.

Overall, the majority of residual impacts from operations are assessed as minor or negligible (with the exception of onshore air emissions). The expected moderate negative impact associated with onshore operations at the Sangachal Terminal will also be mitigated through existing community liaison and engagement supported by the IEMP ambient monitoring undertaken in and around the Terminal. All activities will be managed in accordance with previously established practice and AzSPU procedures and impacts are considered to be controlled and mitigated to an acceptable level.

E.8 Cumulative, Transboundary and Accidental Events

Cumulative impacts, potential transboundary impacts and the impacts of accidental events associated with the COP were also assessed. The routine and non-routine discharges to sea from the COP will be, as with other ACG projects, of limited impact. It was concluded that each discharge will make a small incremental contribution to the ACG total but the platform discharges will be isolated from each other and the total itself represents a very small fraction of the assimilative capacity of the Contract Area. Consequently, it is considered that these discharges represent a sustainable situation and it is predicted that there will be no measurable deterioration of the marine environment attributable to ACG operations.

For both onshore and offshore activities, the volumes of atmospheric emissions released (including visible particulates) due to the COP are expected to result in very small increases in pollutant concentrations in the atmosphere and in any washout from rainfall, which will not be discernable to biological/ecological receptors. SO_2 emissions are minimised through the planned use of low sulphur diesel and preferential use of gas as a fuel for the operation of the WC-PDQ platform and are expected to disperse rapidly due to appropriate equipment design and fuel use. Contribution of COP SO_2 emissions to acid rain generation is therefore expected to be insignificant.

It was estimated that 97% (5,995,000 tonnes) of the COP GHG emissions (comprising carbon dioxide and methane) will be generated from the operational phase activities onshore and offshore. The annual contribution of COP in the year 2020 to the predicted national Azerbaijan forecast[1] was estimated to be approximately 0.5%.

Energy efficiency and GHG reduction was a key aspect taken into account during the development of the COP design, contributing to the selection of the electric drive concept with all power to the platform, including the gas export compressors, being provided by the main power generation turbines. Analysis demonstrated that this technology selection resulted in a saving of approximately 300,000 tonnes of CO_2 emissions across the project's lifetime, when compared to direct drive gas turbine technology. This is a more than 40% reduction.

A review and assessment of accidental events was carried out as part of the COP ESIA. This considered a number of accidental events scenarios that included well blowout and pipeline failure as well as lower magnitude events (e.g. spills). Modelling was undertaken to illustrate the expected behaviour of an oil spill for the blowout and pipeline rupture scenarios for COP. The results were similar to those obtained within previous ACG ESIAs as the COP crude oil is expected to be more persistent than Azeri oil but less persistent than the Chirag oil.

A platform blowout or major pipeline rupture are the only events with the potential to become regional transboundary events. The precise nature of the impact would depend on the

[1] First National Communication of Azerbaijan on Climate Change, May 23 2000.

prevailing weather conditions at the time of the spill, the time required for deploying spill response measures and their effectiveness.

BP, as operator of AIOC, has developed and maintains a range of Oil Spill Response Plans (OSRP) in place for its offshore and onshore operations in Azerbaijan. These plans encompass all phases of ACG development and establish the notification, response and followup actions that must be implemented should an accidental event occur. In addition BP has developed a system to manage pipeline integrity across the ACG pipeline network including monitoring and auditing procedures.

Analysis of onshore construction and offshore operation spill data focused on classifying the root causes, types, and quantities of spills. The principal outcome of this analysis was to identify the areas for improvement in equipment specification, training, operating procedures and maintenance procedures to be implemented for the COP. The established procedures for spill recording, investigation and corrective action will also be maintained.

The ESIA predicts that accidental events will be low in frequency, given the preventative measures in place, and if they do occur will be discrete (i.e. have a very low likelihood of overlapping in time and space). With the exception of a major loss of oil containment (i.e., blowout or pipeline rupture) they are also not persistent and such events will, therefore, have no cumulative impact.

E.9 Environmental and Social Management

Each phase of the COP will be subject to formal environmental and social (E&S) management planning under the framework of the integrated AzSPU HSSE Management System.

During the predrill and construction, installation and HUC phases the key contractor companies will be required, under the terms of their contracts, to develop and implement E&S Management Systems that align with the BP expectations and are bridged to the AzSPU HSSE Management System.

Once the WC-PDQ platform is "hydrocarbon live" it will become an operational facility, managed directly by AzSPU. External certification of the platform to ISO 14001 (the leading international standard on environmental management) within 12 months of becoming operational is a BP requirement.

The environmental and social management process during all phases of the COP will benefit from accumulated experience and 'lessons learned' from executing the three previous ACG projects. Major benefits of previous project experience include the development of:

- Effective and reliable procedures for on-site segregation and management of waste;
- A non-hazardous landfill site designed and constructed to EU standards; and
- An effective process for identifying and utilising opportunities for waste recovery and recycling.

E.10 Conclusions

The COP has benefited, to a considerable extent, from the experience gained by AIOC in designing, constructing, installing and operating the ACG Phase 1, 2 and 3 facilities. The basic design concept has been well-tested and proven and over five years of environmental monitoring have demonstrated that the basic design concept is environmentally sound. Nevertheless, the COP has identified opportunities for improvement, most notably the selection of an electric drive concept that substantially reduces emissions and a more reliable sewage treatment plant. COP is committed to implementing these during project execution.

The COP will also benefit from the fact that the predrilling, construction and installation teams now have extensive practical experience in offshore ACG activities and that these teams can execute the planned activities reliably.

The environmental management process is underpinned by the IEMP. Since 2004, this programme has focused on establishing and executing a regular and structured programme of ambient environmental monitoring around planned, new and operating installations (onshore and offshore). By 2008, all the ACG Phase 1, 2 and 3 installations were operational and the focus of the IEMP is now shifting towards integration of operational monitoring. Increasingly, the IEMP will concentrate on the results of discharge/emission sampling and analysis from operational installations with the aim of confirming design performance and of identifying deviations in over time to minimise adverse effects.

In conclusion, the COP is based on proven design concepts and engineering standards and has benefited from lessons learned during previous ACG projects. These previous projects have been the subject of extensive environmental monitoring and the results of this monitoring provide confidence that the environmental impact of the COP design will be acceptable and effectively controlled.

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Units and Abbreviations

Units

B	Billion
barg	1 bar (gauge) = 14.5 psi
bbl	Barrel (6.2898 barrels = 1 m^3)
bpd	Barrels per day
Bq/kg	Bequerels per kilogram (measure of radioactivity)
Bstb	Billion standard barrels
cm	Centimetre
cm^3	Cubic centimetre
cm/year	Centimetres per year
dB	Decibel
dB (A)	A weighted unit of sound intensity weighted in favour of frequencies audible to the human ear
dBht(species)	A metric for estimating the behavioural effects of noise on marine species
dB L_{AEQ}	Sound pressure level
dB re. 1 µPa	Decibels relative to one micropascal
g	Grams
ha	Hectare
hr	Hour
H_s	Significant wave height
Hz	Hertz (Measure of frequency)
K	One thousand (e.g. 500K = 500,000)
keV	Kiloelectron volt (one thousand electron volts)
kg	Kilograms
km	Kilometre
km^2	Square kilometre
kNm^3	Thousand cubic metre at normal conditions
kW	Kilowatts
LC_{50}	Lethal Concentration 50. The concentration of a chemical which kills 50% of a sample population.
l	Litres
l/hr	Litres per hour
m	Metres
M	Million
m TVD BRT	Depth in Metres (True Vertical Depth) (Below the Rotary Table)
m/hour	Metres per hour
m/s	Metres per second
m^2	Square metres
m^3	Cubic metres
m^3/day	Cubic metres per day
m^3/hour	Cubic metres per hour
mbbl	Thousand barrels
mbgl	Meters below ground level
mbpd	Thousand barrels per day
mbwd	Thousand barrels of water per day
mbwpd	Thousand barrels of water per day
Mbopd	Thousand barrels of oil per day
µ	Microns
µm	Micrometers
µg	Micrograms
µg/g	Micrograms per gram
µg/m^3	Micrograms per cubic meter
µg/l	Micrograms per litre
µPa	Micro Pascal
mg	Milligrams
mg/l	Milligrams per litre
mg/m^3	Milligrams per cubic metre

mg/Nm^3	Milligrams per cubic meter (at normal conditions)
ml	Millilitres
mm	Millimetres
mm/day	Millimetres per day
mm/hr	Millimetres per hour
mm/month	Millimetres per month
MMscf	Million standard cubic feet
MMscfd	Million standard cubic feet per day
MMBtu	Million British thermal units
MMscf	Million standard cubic feet
MMscfd	Million standard cubic feet per day
MMstb	Million standard barrels
m/s	Metres per second
Mstb/day	Thousand barrels per day
Mstbd	Thousand barrels per day
MW	Megawatt
pH	$-\log_{10} [H^+]$ (Measure of acidity or alkalinity)
PM_{10}	Particulate matter measuring 10µm in diameter
ppb	Parts per billion
ppbv	Parts per billion by volume
ppm	Parts per million
ppmv	Parts per million by volume
PSI	Pounds per square inch
lb/MMscf	Pounds of water per million standard cubic feet
1Q	Quarter one (of year)
s	Second
scf	Standard cubic feet
scf/bbl	Standard Cubic Feet per Barrel
Sm^3	Standard cubic metres
Sm^3/hr	Standard cubic metres per hour
ktonne	Thousand tonnes
t	Tonnes
t/day	Metric tonnes per day
US$	US dollars
US$M	US dollars (Millions)
yr	Year
"	Inches
%	Percent
%v	Percentage by volume
%w	Percentage by weight
%ile	Percentile
˚C	Degrees centigrade
~	Approximately
>	Greater than
+/-	Plus/minus
<	Less than

Chemicals Elements and Compounds

^{241}Am	Americium
As	Arsenic
Ba	Barium
BCM	Bromochloromethane
BTEX	Benzene, toluene, ethylbenzene, xylene
Cd	Cadmium
CFC	Chlorofluorocarbon
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2 Eq	Carbon dioxide equivalent
Cr	Chromium
^{137}Cs	Caesium
Cu	Copper
Fe	Iron
H_2S	Hydrogen Sulphide
HCFC	Hydrochloroflurocarbon
HFCs	Hydrofluorocarbons
Hg	Mercury
HNO_3	Nitric Acid
KCl	Potassium Chloride
KOH	Potassium Hydroxide
MEG	Mono Ethylene Glycol
N_2	Nitrogen
N_2O	Nitrous Oxide
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NPD	Naphthalenes, phenanthrenes and dibenzothiophenes
PAH	Polycyclic aromatic hydrocarbons
Pb	Lead
^{210}Pb	Radioactive form of lead
PCB	Polychlorinated biphenyls
PFCs	Perfluorocarbons
PHB	Pre Hydrated Bentonite
Ra	Radium
SOx	Sulphur Oxides
SO_2	Sulphur Dioxide
TEG	Tri-ethylene Glycol
THPS	Tetrakyshydroxymethyl phosphonium sulphate
Zn	Zinc

Abbreviations

ACG	Azeri - Chirag - Gunashli
ADMS3	Atmospheric Dispersion Modelling System Version 3
ADR	European Agreement concerning International Carriage of Dangerous Goods by Road
AERMOD	A Computer programme that models air dispersion
AFFF	Aqueous Film Forming Foam
AFS	Anti Fouling Systems
AIOC	Azerbaijan International Operating Company
AMEA	Academy of Sciences of Azerbaijan
ANAS	Azerbaijan National Academy of Sciences
API	American Petroleum Institute
AQS	Air Quality Standard
ARB	Azerbaijan Red Data Book
ASA	Applied Science Associates

ASY	Azerbaijan Statistical Yearbook
ATA	Amec-Tekfen-Azfen
AZN	Azerbaijan Manat
AzSPU	Azeri Strategic Performance Unit
BAT	Best Available Technology
BDJF	Baku Deep Water Jacket Factory
BOD	Biological Oxygen Demand
BOP	Blow Out Preventer
BP	British Petroleum
BPEO	Best Practicable Environmental Option
BS	British Standard
BTC	Baku-Tbilisi-Ceyhan
BU	Business Unit
C&WP / CWP	Compression and Water Injection Platform
c.	Approximately
ca.	Circa (English word used with dates meaning about or approximately)
CA	Central Azeri
CAPEX	Capital expenditure
CBD	Convention of Biological Diversity
CCGT	Combined Cycle Gas Turbine
CD	Compact Disk
CDWG	Chirag/Deep Water Gunashli
CERC	Cambridge Environmental Research Consultants
CHARM	Chemical Hazard Assessment and Risk Management
CHP	Combined Heat and Power
CIA	Central Intelligence Agency
CISS	Caspian International Seal Survey
CITES	Convention on the International Trade of Endangered Species
CMC	Contracts Management Committee
COD	Chemical Oxygen Demand
COE	Council of Europe
COP	Chirag Oil Project
CRI	Cuttings Reinjection
CSC	Caspian Shipyard Company
CTD	Conductivity - Temperature - Depth
CVP	Capital Value Process
CWAA	Central Waste Accumulation Area
DBA	Derrick Barge Azerbaijan
DC/ AC	Direct Current/ Alternating Current
DES	Drilling Equipment Set
DHFC	Down Hole Flow Control
DLE	Dry Low Emission
DLN	Dry Low NOx
DPCU	Dew Point Control Unit
DPS	Diverse Path Shutdown System
DQ	Drilling and Quarters Platform
DRA	Drag Reducing Agent
DSM	Drilling Support Module
DST	Drill Stem Test
DSV	Dive Support Vessel
DTM	Digital Terrain Model
DUQ	Drilling, Utilities and Quarters
DWG	Deep Water Gunashli
DWG-PCWU	Deep Water Gunashli Production, Compression, Water Injection & Utilities
DWG-PDQ	Deep Water Gunashli Production, Drilling & Quarters
E	East
E&P Forum	Exploration and Production Forum
EA	East Azeri
EC	Effective Concentration

EC_{50}	The statistical estimate of the toxicant concentration that has an adverse effect on 50% of the test organisms after a specific exposure time.
EGC	Export Gas Compressors
EIA	Environmental Impact Assessment
EIMP	Environmental Impact Management Process
EMS	Environmental Management System
EMTAG	Environmental Monitoring Technical Advisory Group
ENP	European Neighbourhood Policy
ENVIID	Environmental Issues Identification
EOP	Early Oil Project
EPR	Environmental Performance Requirements
EQS	Environmental Quality Standard
ERD	Extended Reach
ES	Environmental Statement
ESC	Environmental Sub-Committee
ESIA	Environmental and Socio-Economic Impact Assessment
ESD	Emergency Shut Down
ESMS	Environmental and Social Management System
ESS	Expandable Sand Screen
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FDI	Foreign Direct Investment
FEED	Front End Engineering Design
FFD	Full Field Development
FGC	Flash Gas Compressors
FOC	Foreign Oil Company
GDP	Gross Domestic Product
GDP	Group Defined Practice
GHG	Greenhouse Gases
GMT	Greenwich Mean Time
GWP	Global Warming Potential
HOCNS	Harmonised Offshore Chemical Notification
HP	High Pressure
HPU	Hydraulic pumping unit
HRSG	Heat Recovery Stream Generators
HSE	Health, Safety & Environment
HSSE	Health, Safety, Security and Environment
HVAC	Heating, Ventilation and Air-Conditioning
HUC	Hook-Up and Commissioning
IADC	International Association of Drilling Contractors
IAGC	International Association of Geophysical Contractors
IBC	Intermediate Bulk Container (container for hazardous materials)
IC	Internal Combustion
IDP	Internally Displaced Persons
IEEM	Institute for Ecology and Environmental Management
IEMP	Integrated Environmental Monitoring Programme
IFC	International Finance Corporation
IMO	International Maritime Organisation
ISO	International Organisation for Standardisation
ISPM	International Standards of Phytosanitary Measures
ITD	Indirect Thermal Desorption
ITT	Invitation to Tender
IUCN	International Union for the Conservation of Nature
KO	Knock-out
KPI	Key Performance Indicator
KW_{elec}	Kilowatts of Electricity
Laeq	Equivalent average sound level
LAO	Linear alpha olefin
LC_{50}	Lethal Concentration 50%
LCM	Lost Circulation Mud

LCV	Level Control Valve
Leq (L_{Aeq})	equivalent continuous noise level
LMO	Living Modified Organisms
LP	Low Pressure
LQ	Living Quarters
LTMOBM	Low Toxicity Mineral Oil Based Mud
MARPOL	International Convention for the Pollution of Prevention by Ships, 1973, as modified by the Protocol of 1978
MED	Ministry of Economic Development
MEL	Maximum Exposure Level
MENR	Ministry of Ecology and Natural Resources
MEPC	Marine Environmental Protection Committee
MES	Ministry of Emergency Situations
MODU	Mobile Offshore Drilling Unit
MOL	Main Oil Line
MPC	Maximum Permissible Concentration
MPE	Maximum Permissible Emissions
MPN	Most Probable Number
MRS	Mud Recovery System
MSD	Marine Sanitation Device
MSDS	Material Safety Data Sheet
MSL	Mean Sea Level
MTAG	Manufacturing Advisory Group
MW	Megawatt
$MW_{elec.}$	Megawatts of electrical energy
$MW_{heating}$	Megawatts of heating energy
MW_{mech}	Megawatts of mechanical energy
NA	Not Applicable
N	North
NBSAP	National Biodiversity Strategy and Action Plan
NDT	Non Destructive Testing
NE	North East
NER	Northern Export Route
NETCEN	National Environmental Technology Centre
NGO	Non Governmental Organisation
NMVOC	Non-methane Volatile Organic Compounds
Non-GHG	Non Greenhouse Gases
NORM	Naturally Occurring Radioactive Material
NR	Non Routine
NRC	National Research Council
NREP	Northern Route of Export Pipeline
NNE	North northeast
NW	Northwest
NWBM	Non Water Based Mud
OBM	Oil Based Mud
OCNS	Offshore Chemical Notification Scheme
ODS	Oxygen Depleting Substances
OECD	Organisation for Economic Co-operation and Development
OGP	International Association of Oil and Gas Producers
OHGP	Open Hole Gravel Packs
OOIP	Original Oil in Place
OPEX	Operating expenditure
OSCE	Organisation for Security and Co-operation in Europe
OSCP	Oil Spill Contingency Plan
OSIS	Oil Spill Information System
OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment of the North East Atlantic
PCA	Partnership and Cooperation Agreement
PCDP	Public Consultation and Disclosure Plan
PCWU	Production, Compression, Water Injection and Utilities

PDQ	Production, Drilling and Quarters
PDUQ	Production, Drilling, Utilities and Quarters platform
PGP	Power Generation Package
PGU	Power Generation Unit
PIMS	Pipeline Integrity Management System
PLONOR	Presenting Little Or No Risk to the Environment
PM	Particulate Matter
POB	Persons on Board
PPAH	Pollution Prevention and Abatement Handbook
PPE	Personal Protective Equipment
PR	Performance Requirements
PSA	Production Sharing Agreement
PSS	Process Shutdown System
PW	Produced Water
PWD	Produced Water Disposal
PWT	Produced Water Treatment
QA	Quality Assurance
R	Routine
RAM	Reliability, Availability and Maintainability
RMG	Research and Monitoring Group
RO	Reverse Osmosis
ROP	Rate of penetration
ROV	Remotely operated vehicle
ROW	Right of Way
RTL	Reservoir Technical Limit
S	South
SBM	Synthetic Based Mud
SCP	South Caucasus Pipeline
SCS	Solids Circulation System
SD	Shah Deniz
SDII	Shah Deniz Phase 2
SE	Southeast
SEE	State Ecological Expertise
SOCAR	State Oil Company of the Azerbaijan Republic
SOFAZ	State Oil Fund of Azerbaijan
SPS	Shelfprojectsroi
SSC	State Statistical Committee
SSI	Subsea Injection
SST	Sea Surface Temperature
STB-01	Name of a transportation and installation barge
SW	Southwest
THC	Total Hydrocarbon Content
TOC	Total Organic Carbon
TPAO	Turkish Petroleum Corporation
TSS	Total Suspended Solids
TVD BRT	True Vertical Depth Below Rotary Table
UCM	Unresolved complex mixture
UK	United Kingdom
UKOOA	United Kingdom Offshore Operators Association
UN	United Nations
UNOCAL	Union Oil Company of California
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Food Programme
UNIDO	United Nations Industrial Development Organization
URS	URS Corporation Ltd
USCG	United States Coast Guard

US EPA	United States Environmental Protection Agency
VET	Vocal, Educational and Training
VIEC	Vessel Internal Electrostatic Coalescers
VOC	Volatile Organic Compound
W	West
WA	West Azeri
WB	World Bank
WBM	Water Based Mud
WC	West Chirag
WC-PDQ	West Chirag Production, Drilling and Quarters
WER	Western Export Route
WHO	World Health Organisation
WI	Water Injection
WIO	Water In Oil
WREP	Western Route Export Pipeline

Glossary

Aarhus Convention
An international legal agreement which promotes access to information, public participation in decision making and access to justice in environmental matters.

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

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

Ambient Levels
Sharing the same physical and/or chemical properties as the immediate surroundings.

Amine Sweetening
Group of processes that use aqueous solutions of various alkanolamines (commonly referred to simply as amines) to remove hydrogen sulphide (H_2S) and carbon dioxide (CO_2) from gases.

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

Anode
A positively charged electrode (associated with a battery, electronic device or electrical equipment).

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

Annulus
The space between the drill string and the well wall, or casing strings or between casing and the production tubing.

Anti-foulant
Chemicals that are added to fluids, which inhibit fouling of plant or vessels by organisms.

Anthropogenic
Relating to humans.

Aquifer
An underground formation of rock saturated with water.

Aromatic Hydrocarbons
Hydrocarbons which include cyclic conjugated carbon atoms such as benzene, toluene, xylene etc.

Arthropod
Invertebrates with an exoskeleton, jointed legs and a segmented body. Usually in marine biology terms comprising crustacea and insect larva.

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

Audiogram
A noise graph showing absolute threshold for pure tones as a function of frequency.

Azerbaijan Manat (AZN)
Currency of Azerbaijan.

Azeris or Azerbaijanis
People of the Republic of Azerbaijan.

Azores High
A permanent high atmospheric pressure area above the subtropical and tropic regions in the Atlantic Ocean in the Northern hemisphere.

Bacillarhiophytes
Also known as diatoms, a phylum of Algae. Single celled marine or freshwater organisms that have cell walls and consist of two overlapping halves. Past deposition of these has resulted in diatomaceous earth and oil deposits.

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

Barite
A very heavy substance used as a main component of drilling mud to increase its density (mud weight). Main constituent of barite is the chemical element barium.

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

Base Case Design
Project design as described and assessed within the ESIA.

Basel Convention
An international legal agreement that primarily deals with transboundary hazardous waste movement and other hazardous waste management.

Bathymetry
The measurement of the depth of water bodies, particularly of oceans and seas.

Beached Oil
The portion of an oil spill that reaches the shore.

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

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

Best Practicable Environmental Option (BPEO)
A set of procedures to evaluate the environmental implications of a project's options to determine the most benefits or least damage to the environment, at an acceptable cost.

Biocides
A chemical agent that can be added to fluids for the purpose of selectively preventing or limiting the growth of bacteria and other organisms.

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

Biodiversity
The number of plant and animal species in a given area.

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

Biomass
The total mass of living matter within a given quantity.

Biota
The plant and animal life of a particular region.

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

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

Birth Rate
Childbirth per 1,000 people per year.

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

Black Water
Wastewater containing fecal matter and urine.

Blowout
Uncontrolled or uncontrollable release of downhole pressure upward through the wellbore or casing.

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

Borehole
A hole in the ground made by drilling; the uncased drill hole from the surface to the bottom of the well.

Bund
Containment around a storage tank to contain the contents in case of rupture or spillage.

Buy Back
A system to allow the separation of fuel from a gas export line, when fuel gas is unavailable on the platform.

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

Casing
The steel piping used to line a well for protection against collapse of the well borehole and unwanted leakage into or from the surrounding formation.

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

Cement
A powdery, viscous substance, capable of forming elastic mass when mixing with water, which consequently hardens..

Chemical Oxygen Demand (COD)
The amount of oxygen consumed within a solution. It is used to indirectly measure the amount of organic compounds in water.

Chemiluminescence
The emission of light with limited emission of heat (luminescence), as the result of a chemical reaction.

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

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

Coliform
Of or relating to the bacteria that commonly inhabit the intestines/colons of humans and other vertebrates.

Commissioning
Preparatory work comprising system testing of the platform process systems, prior to full production.

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

Completion
See well completion.

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

Compression
The raising of pressure within a substance.

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

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

Conductor Section Hammering
Driving of the conductor section into the subsurface by repeated blows, usually using hydraulic hammering equipment

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

Consultation
A process of obtaining views and input from stakeholders.

Continental Plate
A tectonic plate that forms part of one of the Earth's continents.

Continental Slope
Connects the continental shelf and the oceanic crust and is part of the continental margin.

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

Convergent Plate Boundary
An actively deforming region where two (or more) tectonic plates or fragments of lithosphere move toward one another and collide.

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

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

Corrosion inhibitors
Chemicals which reduce the rate of corrosion on metal.

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

Crustacea
Class of invertebrate animals of arthropoda type, includes various familiar animals, such as crabs, lobsters, crayfish, shrimp, krill and barnacles.

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

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

Cuttings
The fragments of rock dislodged by the drill bit and brought to the surface in the mud. Can be re-injected into substratum via a well.

Dada Gorgud
The semi-submersible mobile drilling rig used to drill predrill wells.

Daphnia
Small planktonic invertebrate, cladoceran, varying in length from 0.2 to 5 mm.

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

Decommissioning
Shutdown and dismantling of any facilities.

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

Dehydration
Removal of water .

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

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

Descalers
Substances added to remove solids such as calcium carbonates and sulphates deposited on the drill pipe and casing.

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

Dew point
The temperature to which a given parcel of air must be cooled, at constant pressure, for water vapour to condense into water.

Disclosure
Release of ESIA information into the public domain.

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

Domestic waste
Solid waste, composed of garbage and rubbish, which normally originates from a residence/living quarters.

Down Hole
Area within the drilled bore of an oil well.

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

Drill bit
A drilling tool used to cut through rock.

Drilled Cuttings
Small fragments of rock produced as the result of drilling that are brought to the surface by the flow of the drilling mud as it is circulated.

Drill Stem Test
The assembled drill pipe in the well which serves to rotate the bit, to convey drilling mud or cement down the well and to flow fluids to the surface.

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

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

Early Oil Project
The first large-scale oil project in the Caspian Sea. It commenced in 1994 and involved a consortium of companies who invested to extract oil from the Azeri, Chirag and Guneshli wells.

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

Effluent
Waste products emitted as a liquid by an operation or process.

Emergency / Abnormal Activity
An unplanned activity e.g. due to equipment failure, loss of containment, operator error, unexpected well conditions or design error.

Emulsion
A mixture of two or more immiscible liquids, with one being dispersed in another.

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

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

Environment for Europe
A partnership of member states, including Azerbaijan, and other organisations within the UNECE region.

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

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

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

Environmental Impact Management Process
A full life-cycle process that seeks to identify and understand a project's environmental impacts, to avoid, minimise, mitigate and remediate the impacts.

Environmental Management System
A system established to plan, manage and document an organisation's activities and processes and resultant environmental impacts.

Environmental Quality Standard (EQS)
A value, generally defined by regulation, which specifies the maximum permissible concentration of a potentially hazardous chemical in an environmental sample, generally of gas or liquid.

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

Environmental Statement
Formal document required to present the findings of an ESIA process for a proposed project.

Ephemeral
Something living or lasting for a brief time.

Espoo Convention
A regional legal agreement to promote environmentally sound and sustainable economic development through the application of ESIA.

Exploration Well
A well drilled in search of an undiscovered reservoir or to greatly extend the limits of a known reservoir.

Fertility Rate
The average number of children that would be born to a woman in a certain area over her lifetime.

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

Fixed Exchange Rate
A type of exchange rate regime wherein a currency's value is matched to the value of another single currency or to a basket of other currencies, or to another measure of value, such as gold.

Flaring
Controlled disposal of surplus combustible hydrocarbons by igniting their vapours.

Flash
The sudden release of gases and/or vapours due to an instantaneous reduction in temperature and/or pressure.

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

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

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

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

Foreign Direct Investment
The establishment of an enterprise by a foreigner. Also used as a measure of foreign ownership of productive assets.

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

Fugitive Emissions
Unintended escape/leakage of gas and liquids from equipment and pipework.

Galley Waste
Organic food waste originating from the platform galley or kitchen.

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

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

Gas Reinjection
Re-injection of gas into a reservoir, in order to increase pressure and thus increase/induce further oil/gas flow.

Gastropod
Any of the various molluscs of the class Gastropoda such as the snail.

Geohazard
Geological state that represents or has the potential to develop further into a situation leading to damage or uncontrolled risk.

Glutaraldehyde
A colourless liquid with a pungent odour used for industrial water treatment and as a chemical preservative.

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

Greenhouse Gases (GHG)
Atmospheric gases considered to contribute to the greenhouse effect by absorbing and emitting radiation, including carbon dioxide, water vapour and methane.

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

Grout
A material that is used for filling voids and sealing joints.

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

Harmful Substances
Those substances that are identified as marine pollutants in the IMDG Code.

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

Heavy Metals
A subset of elements that exhibit metallic properties, and which include the transition metals and a number of metalloids, lanthanoids, and actinides.

Helideck
A helicopter landing surface on a drilling platform.

Holoplankton
Permanent members of the plankton species, excluding temporary larval forms of fish and benthos.

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

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

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

Inhibited Seawater
Seawater which is chemically treated to reduce potential corrosion and biofouling.

Inert Gas
Chemically unreactive gases used to flood compartments in a vessel or platform when there is fire or imminent danger of fire.

Injection Well
A well used to introduce fluids into a reservoir, usually leading to enhanced recovery.

International Finance Corporation
Organisation that is a member of the World Bank, and promotes sustainable private sector investment in developing countries.

Internationally Displaced Persons
People who are forced to flee their homes, but unlike refugees, remain within their country’s borders.

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

ISO 14001
An evolving series of generic environmental management system standards developed by the International Standards Organisation that provides business management with a structure for managing environmental impacts.

Isopod
A type of peracarid crustacean.

Jacket
The structure of an offshore steel, piled platform, which supports the topside facilities.

Kiloelectron volt
Common unit of energy used in physics. It is the amount of kinetic energy an unbound electron gains when it accelerates through and electrostatic potential difference of one thousand volts.

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

Law on Normative-Legal Acts
Azerbaijani legislation that stipulates that acts in force prior to independence, not subsequently cancelled or contradictory to the Constitution, remain in force.

Law on the Protection of the Environment
Azerbaijani legislation that addresses use of natural resources, the rights and responsibilities of the State and its citizens, ecological requirements for economic activities, ecological emergencies and disaster zones, etc.

Lift Gas
Gas sourced from the export stream to be delivered to the wellhead to maximise well productivity.

Likelihood
The possibility that an activity or effect will occur.

Linear Alpha Olefins
Chemical compounds found within some drilling mud. Olefins or alkenes have a chemical formula C_xH_{2x} and are industrially important.

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

Long Chain Diamine
A type of polymer (molecule with repeating structural units) with a ‘long’ chemical structure.

Macrobenthos or Macrofauna
Organisms that live on/in sediment at the bottom of a water column. Relatively larger than other benthos with a size range of approximately 20 cm to 0.5 mm.

Macroeconomic
The overall aspects and workings of a national economy, (e.g. gross domestic product, inflation, unemployment statistics etc.).

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

Maximum Permissible Level
An amount, usually a combination of time and concentration, beyond which any exposure of humans to a chemical or physical agent in their immediate environment is unsafe.

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

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

Microplate
Any small lithospheric (Earth’s crust and upper mantle) plate.

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

Milli Mejlis
Azerbaijan Parliament.

Mitigation
The measures put forward to prevent, reduce and where possible, offset any adverse environmental or socio-economic effects.

Module
A separate section or box-like compartment of the topside of a platform, as far as possible self-contained, designed to be connected to other modules offshore.

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

Nagorno-Karabakh
A landlocked region in the South Caucasus which is mostly mountainous and afforested. It is within the national boundary of Azerbaijan, but governed by the internationally unrecognised Nagorno-Karabakh Republic.

Naturally Occurring Radioactive Material (NORM)
A substance containing barium sulphate arising through the production process, which originates in subsurface formations. May be hazardous through inhalation and ingestion.

Neutralised Seawater
A process to chemically alter seawater to make its pH level nearer neutral, to enhance its effectiveness for drilling mud.

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

Non Routine Activity
An activity that occurs when plant / vessels or equipment is operated not as specified within the Base Case but in a previously planned manner, e.g. flaring when platform equipment is undergoing planned maintenance in line with known maintenance strategy, discharge of produced water when the produced water reinjection system is unavailable.

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

Oceanography
The study of the ocean, including marine ecosystems, ocean currents, waves, and physical and chemical changes.

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

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

Overpressure
Subsurface pressure that is abnormally high, exceeding hydrostatic pressure at a given depth.

Oxygenated Water
Water with high amounts of dissolved oxygen.

Particulates
Tiny particles of solid or liquid suspended in a gas or liquid.

Per Capita Income
Means how much each individual receives, in monetary terms, of the yearly income generated in the country.

Performance Requirements
The criteria BP shall meet to achieve a constant delivery of environmental performance.

Pipelay Barge
A vessel designed for welding together pipelines and laying them on the seabed.

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

Producer Well
A drilled hole through which oil and gas is extracted.

Productive Zone
Most populated zone of the ocean (usually the top layer).

Phytoplankton
Microscopic photosynthetic organisms which float or drift in the surface waters of seas and lakes, e.g. diatoms, dinoflagellates.

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

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

Pilot Hole
A smaller hole drilled into a material prior to a larger hole being drilled, widening the hole to the desired width.

Pipe Dope
Lubricating grease which seals pipe joints to prevent damage to threads.

Pipeline Tie-in
The connection of two or more pipelines, usually by a wye piece.

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

Photovolatic
Application of solar cells for energy by converting solar energy (sunlight, including ultra violet radiation) directly into electricity.

Phytosanitary Measures
Measures to protect the health of plants.

Plankton
Tiny plants (phytoplankton) and animals (zooplankton) that drift in the surface waters of seas and lakes. They are of high ecological importance as they provide a source of food to larger marine organisms such as fish.

Platform
One of the various types of offshore structures.

Plug
To seal a well or part of a well with cement.

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

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

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

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

Pour Point
The lowest temperature at which a liquid will pour or flow under prescribed conditions. It is a rough indication of the lowest temperature at which oil is readily pumpable.

Predrill
Drilling activities taking place to accelerate early production once offshore facilities are in place.

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

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

Production
The full-scale extraction of hydrocarbon reserves.

Production Sharing Agreement (PSA)
Type of contract signed between a government and a resource extraction company (or group of companies).

Public Participation
Process where the affected public are informed about the planned activities.

Pupping
The period when seals are giving birth to their young.

RAMSAR Convention
An international legal agreement that provides designations to sites that are considered internationally important in terms of birds.

Reactive formations
A group of subterranean formations which are sensitive to water, and may cause instability during drilling.

Receptor
The aspect of the environment (air, water, ecosystem, human, fauna, etc.) that is affected by/interacts with an environmental or socio-economic impact.

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

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

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

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

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

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

Resilience
A measure of how a biological, ecological or human receptor is affected by an identified stressor.

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

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

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

Riser
A pipe through which fluids flow upwards.

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

Routine Activity
An activity that occurs during routine operations when plant / vessels or equipment is operating as specified within the design base case e.g. operation of the flare in pilot mode, operation of the platform sewage treatment plant or drains as designed.

Sail-away
The process of transporting equipment from onshore to its offshore location by vessel.

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

Scale Inhibitor
Substances added to minimise deposition of solids such as calcium carbonates and sulphates in equipment, pipework or casings.

Scoping
Early stage in the EIA process which appraises the likely key issues requiring detailed assessment.

Screening
The process by which it is decided if an EIA is required to be carried out for a project.

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

Sediment
Any particular matter that transported by fluid flow and subsequently deposited.

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

Sensitivity
The recovery rate of flora or fauna from significant disturbance or degradation.

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

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

Siberian High
A collection of cold or very cold air that collects on the Eurasian terrain for much of the year, and causes a high pressure atmospheric system affecting weather patterns.

Significant Wave Height
The average wave height (trough to crest) of the 1/3 largest waves.

Slurry
A mix of cement and water used in cementing.

Solids Circulation System
A device that separates SBM/LTMOBM from cuttings via a series of shale shakers, a vacuum degasser and centrifuges.

South Asian Low
A semi-permanent area of low pressure which influences the weather patterns in South Asia.

Stakeholder
A person, group and/or organisation with an interest in a project.

Static Equilibrium Flotation
When all the forces on a floating body are at rest and the total force is permanently zero.

Stinger
A support boom that extends outwards from the stern of a lay-barge and used to lay pipes.

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

Stockholm Convention
An international legal agreement requiring Governments to reduce the release of persistent organic pollutants.

Storm Surge
An offshore rise in water level associated with a low pressure weather system. Usually caused by strong winds pushing the surface of the water body.

Strata
Distinct, usually parallel beds of rock.

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

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

Surfactant
An additive that reduces surface tension e.g. a detergent or emulsifier.

Swaging
A technique for joining mechanical fittings (by squeezing) onto tubes.

Swim Bladder
Buoyancy organ possessed by most bony fish.

Taxon
Plural -Taxa. A taxonomic category or group, used to classify organisms.

Template
The structural framework within which subsea wellheads are grouped.

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

Thermocline
Temperature differential in the water.

Topside
Part of a rig which includes the upper deck, mezzanine deck, cellar deck and underdeck.

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

Total original oil in place
The estimated amount of oil in an oil reservoir, including both producible and non-producible oil.

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

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

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

Transboundary impact
An impact which crosses any boundaries between two geopolitical boundaries (i.e. a border).

Turbidity
The cloudiness or haziness of a fluid caused by individual particles. It is used as a test of water quality.

Ullage
Capacity within a system or container.

Umbilical
Tube or line that connects the subsurface to the surface of the sea.

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

Venting
The release of gases to the atmosphere without burning.

Vienna Convention
An international legal agreement regarding the protection of the Ozone Layer.

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

Wadi
An Arabic term, traditionally referring to a valley or dry riverbed.

Wastewater
Water contaminated with domestic and production wastes.

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

Water Injection/Water Reinjection
The injection of water into a reservoir or well.

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

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

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

Well Completion
The work of preparing a newly drilled well for production.

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

Well Testing
Testing of a well to estimate expected well productivity. Testing in a production well also monitors the effects of cumulative production on the formation.

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

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

World Heritage Site
A site (such as a forest, mountain, lake, desert, monument, building, complex, or city) that is on the list that is maintained by the international World Heritage Programme administered by the UNESCO World Heritage Committee, composed of 21 state parties[1] which are elected by their General Assembly for a four-year term.[2] A World Heritage Site is a place of either cultural or physical significance.

Zonal Isolation
Separation of oil arising from different sub-surface formations.

Zooplankton
Plankton that consists of animals such as corals and jellyfish, usually small and often microscopic.

1. Introduction

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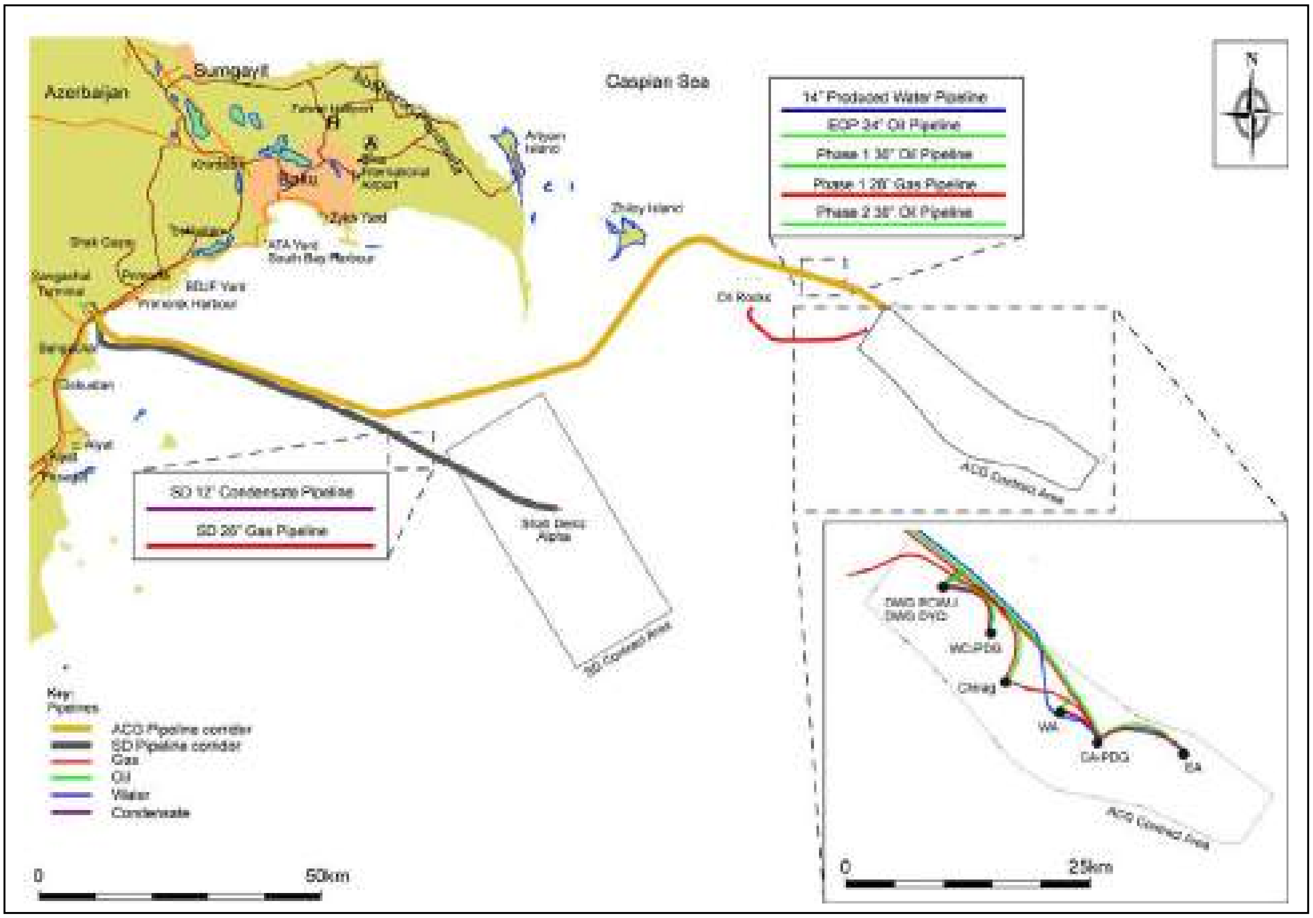
1.1 Introduction

This Environmental and Socio-Economic Impact Assessment (ESIA) has been prepared for the Azerbaijan International Operating Company (AIOC) proposed Chirag Oil Project (COP) in the Azerbaijani sector of the Caspian Sea. The project aims to install additional wells to develop approximately 330MMstb of incremental resources in the Chirag Deep Water Gunashli (CDWG) area of the Azeri Chirag Gunashli (ACG) Contract Area (see Figure 1.1).

Figure 1.1 Location of Azeri Chirag Gunashli Contract Area



The ESIA has been conducted in accordance with the legal requirements of Azerbaijan as well as BP Azerbaijan's Health, Safety, Security and Environment (HSSE) Policy as described in Chapter 2: Policy, Regulatory and Administrative Framework. The scope and assessment methodologies used in this ESIA have been informed through a consultation process, as described in Chapter 8: Consultation and Disclosure. Stakeholders consulted have included, among others, the Azerbaijan Ministry of Ecology and Natural Resources (MENR), the State Oil Company of the Azerbaijan Republic (SOCAR), National Academy of Sciences of Azerbaijan (AMEA), BP Operational Azeri Strategic Performance Unit (AzSPU) representatives and the COP Design Team.

1.2 AIOC Oil and Gas Caspian Developments

1.2.1 ACG Production Sharing Agreement

The ACG Production Sharing Agreement (PSA) was signed in September 1994 between SOCAR and a consortium of Foreign Oil Companies (FOC). The PSA passed into the Azerbaijan law in December 1994 and grants the consortium the rights to develop and manage hydrocarbon reserves within the "Contract Area" of the ACG Field over a period of 30 years. The FOC established the AIOC to conduct petroleum operations under the PSA on its behalf. In July 1999, BP was appointed Operator of the PSA on behalf of AIOC member companies. The participating interests of AIOC members and SOCAR are as follows:

- BP: 34.14%
- Unocal: 10.28%
- SOCAR: 10.00%
- Statoil: 8.56%
- Exxon Azerbaijan Ltd: 8.00%
- TPAO: 6.75%
- Devon: 5.63%
- ITOCHU: 3.92%
- Delta Hess: 2.72%
- Inpex: 10.0%

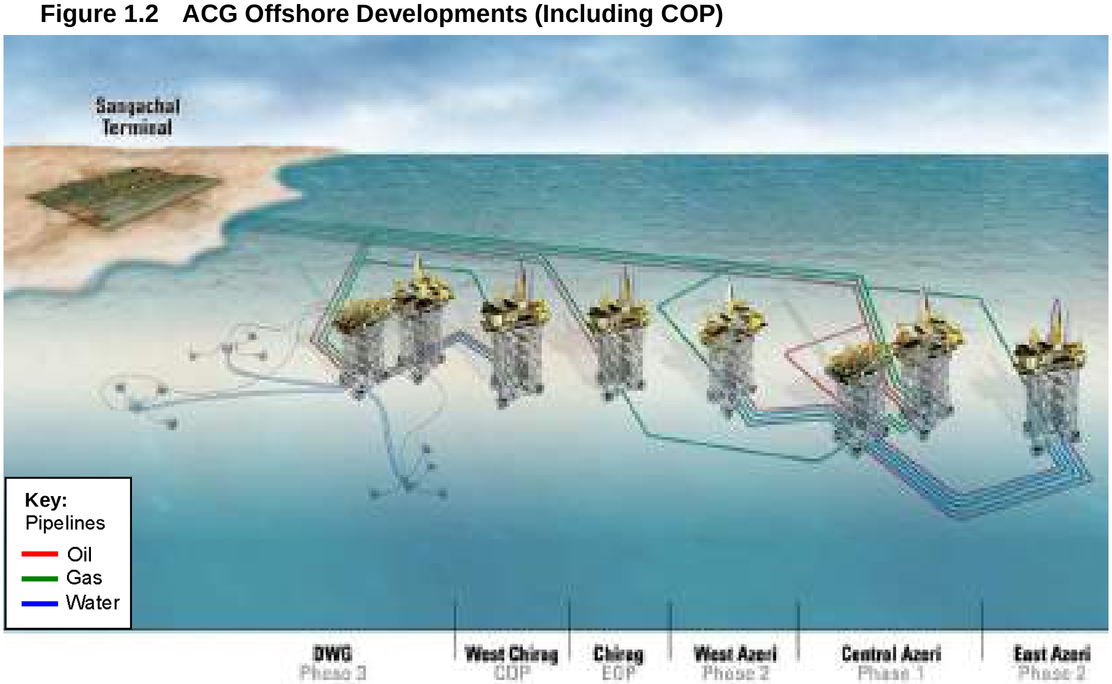
1.2.2 ACG Contract Area and Field Development

The ACG Contract Area covers approximately 432km^2 and lies approximately 120km east of Baku, the Azerbaijan capital. Development of the Contract Area is being pursued in phases and to date has included:

- Early Oil Project (EOP);
- ACG Phase 1;
- ACG Phase 2; and
- ACG Phase 3.

Figure 1.2 illustrates the offshore facilities associated with these phases.

Figure 1.2 ACG Offshore Developments (Including COP)



1.2.2.1 Early Oil Project

The EOP commenced production in 1997 and is currently producing approximately 100,000 bpd. The EOP offshore facilities are located within the Chirag portion of the ACG Contract Area. The facilities include:

- Chirag-1 PDQ platform;
- 24" (inch) oil pipeline from Chirag-1 platform to Sangachal Terminal; and
- 16" gas pipeline from Chirag-1 platform to the SOCAR Oil Rocks facility.

The project included the construction of an oil receiving facility near Sangachal south of Baku, referred to as the Sangachal Terminal. Following the installation of ACG Phase 1 an 18" gas pipeline was installed connecting the Chirag-1 platform to the Central Azeri (CA) platform. Currently the Chirag-1 platform has 21 wells in operation.

1.2.2.2 ACG Phase 1

The ACG Phase 1 development is located in the central part of the Azeri Contract Area and commenced production in February 2005. The CA facilities include:

- A Production Drilling & Quarters (PDQ) platform bridge-linked to a Compression and Water Injection (C&WP) platform;
- 30" oil pipeline from CA to Sangachal Terminal; and
- 28" gas pipeline from CA to Sangachal Terminal.

The project included the expansion of Sangachal Terminal for the installation of additional oil receiving and stabilisation facilities. The CA facilities are currently producing around 190,000 bpd.

1.2.2.3 ACG Phase 2

ACG Phase 2 offshore facilities include two Production, Drilling, Utilities & Quarters (PDUQ) platforms located to the West and East of the CA platforms referred to as the West Azeri (WA) and East Azeri (EA) platforms, respectively. The project included expansion of the Phase 1 C&WP facilities and infield pipelines were installed to provide the Phase 2 WA and EA platforms with water reinjection and gas reinjection facilities. The C&WP platform also provides both the WA and EA platforms with gas transfer facilities to Sangachal Terminal. Oil is exported from the two platforms via tie-ins to the Phase 1 30" marine oil pipeline to Sangachal Terminal.

The Phase 2 development also included installation of additional oil processing facilities at Sangachal Terminal.

The WA platform commenced production in January 2006 and is currently producing around 270,000 bpd. The EA platform commenced production in October 2006 and is currently producing around 145,000 bpd.

1.2.2.4 ACG Phase 3

The Phase 3 development is located in the Deep Water Gunashli (DWG) sector of the ACG Contract Area. Phase 3 facilities include:

- A Drilling, Utilities and Quarters (DUQ) platform, bridge-linked to a Production, Compression, Water Injection and Utilities (PCWU) platform;
- Tie-ins connecting the platforms to the 30" marine oil pipeline to Sangachal Terminal; and
- A tie-in connecting the Phase 3 facilities to the 28" marine gas pipeline to Sangachal Terminal.

ACG Phase 3 includes three sub-sea water injection wells designed to maintain reservoir pressure. The project also included the expansion of processing facilities at Sangachal Terminal. Phase 3 integration with other ACG offshore facilities is limited to the marine export pipeline ties-ins.

The DWG DUQ commenced oil and gas production in May 2008 and is currently producing around 120,000 bpd.

1.2.2.5 Produced Water Disposal

Oil produced from the ACG field contains a percentage of water, referred to as "produced water". Ninety-five percent (95%) of produced water is removed at the platforms and is re-injected into the reservoir to maintain reservoir pressure to aid production. The remaining 5% by volume water-in-oil is transported to the onshore Sangachal Terminal with the oil. At the Terminal the oil-water stream is separated to meet the water-in-oil specification required for delivery of oil to the oil export pipelines.

The Produced Water Disposal (PWD) project includes onshore facilities to treat separated water to a standard suitable for transfer back offshore via a dedicated marine pipeline to the CA C&WP platform for reinjection into the ACG reservoir for reservoir pressure maintenance.

The PWD project commenced operation in the fourth quarter of 2008.

1.2.3 Shah Deniz Gas Export Project

The Shah Deniz gas / condensate field lies approximately 100km south east of Baku and 55km southeast of the ACG Field (Refer to Figure 1.1). Full Field Development (FFD) of the Shah Deniz Field is being pursued in stages. The Shah Deniz Stage 1 development is located in the north eastern portion of the field and commenced production in the first quarter of 2007. The development included:

- A fixed platform with drilling and processing facilities limited to primary separation of gas and liquids; and
- Two marine export pipelines to transport gas and condensate to onshore reception, gas-processing and condensate facilities located adjacent to and integrated with the ACG Sangachal Terminal.

1.2.4 Export Pipelines

Oil is exported from Sangachal Terminal following stabilisation. Gas is similarly exported from the Terminal following dehydration, by three main export pipelines:

- The Baku-Tblisi-Ceyhan (BTC) Pipeline transports oil from Sangachal Terminal through Azerbaijan, Georgia and Turkey to the Ceyhan Terminal located on the Turkish coast of the Mediterranean Sea. From Ceyhan the oil is distributed to international markets. The pipeline covers a distance of 1,768km and has eight pump stations along the route with the head pump station installed at Sangachal Terminal.
- The Western Route Export pipeline is 833km in length and transports oil from the Sangachal Terminal to the Supsa Terminal located on Georgia's Black Sea coast.
- The South Caucasus Pipeline (SCP) transports gas from the Sangachal Terminal to Azerbaijan and Georgia. It became operational late 2006 and in July 2007 began transporting gas to Turkey from the Shah Deniz Stage 1 project. The SCP is 691km in length and runs parallel to the BTC Pipeline to the Turkish border where it is linked with the Turkish gas distribution network.

1.3 COP Overview

The COP offshore facilities, designed to process up to 185,000bpd, include a single fixed PDQ platform (denoted WC-PDQ) located between the Chirag-1 and DWG platforms in the CDWG area of the ACG Field. The platform will be partially integrated via infield pipelines with the nearby DWG-PCWU platform (5km to the west) for produced water disposal and provision of injection water. Infield marine pipelines will also be installed to tie-in the WC-PDQ platform to the existing Phase 2 30" oil pipeline and the Phase 1 28" gas pipeline to transport hydrocarbons to the onshore Sangachal Terminal.

The COP will not require any additional facilities at the Sangachal Terminal as it will make use of the existing "ullage" (capacity) within the ACG Phase 1, 2 and 3 onshore processing facilities.

1.4 COP Environment and Socio-economic Impact Assessment

1.4.1 Objectives

The overall objective of the ESIA process for the COP is to ensure that any adverse environmental or socio-economic impacts arising from proposed project activities are identified and where possible, eliminated or minimised through early recognition of and response to the issues.

The purpose of the ESIA is to:

- Ensure that environmental and socio-economic considerations are integrated into project design and planning and project construction and operation activities;
- Ensure that previous experience from ACG Phases 1, 2 and 3 is acknowledged and where appropriate, integrated into the project design;
- Ensure that environmental and socio-economic impacts are identified, quantified and assessed and appropriate mitigation measures proposed;
- Ensure that a high standard of environmental performance is planned and achieved for the project;
- Ensure that legal, operator and PSA Partner policy requirements and expectations are addressed;
- Consult with project stakeholders throughout the project and address their concerns; and
- Demonstrate that the project will be implemented with due regard to environmental and socio-economic considerations.

The impact assessment process considers all phases of the COP, from construction, installation, hook-up and commissioning through to operation. Project activity and potential receptor interactions are evaluated against existing environmental and socio-economic conditions and sensitivities, and the potential impacts are ranked. The assessment of potential impacts takes account of existing and planned controls and monitoring and mitigation measures developed as part of earlier ACG phases and those specific to the COP.

1.4.2 Structure and ESIA Team

The COP ESIA structure and summary of content is presented in Table 1.1.

Table 1.1 Structures and Content of the ESIA

Section	Content
Executive Summary	A summary of the ESIA
Units and Abbreviations	A list of the units and abbreviations used in the ESIA
Glossary	A glossary of terms
1. Introduction	A general introduction to the COP in the context of other projects underway or proposed for the region, the objectives of the assessment, and the report structure of the ESIA
2. Policy, Regulatory and Administrative Framework	A summary of the composition and HSE policies of the project proponent, the HSE requirements set out in the ACG PSA, relevant international and national environmental standards and guidelines.
3. Impact Assessment Methodology	A description of the methods used to conduct the ESIA
4. Options Assessed	A description of the alternative concept options assessed for the COP
5. Project Description	A detailed description of the COP
6. Environmental Description	A description of the environmental baseline conditions in the vicinity of the COP activities
7. Socio-Economic Description	A description of the socio-economic baseline conditions in the vicinity of the COP activities
8. Consultation and Disclosure	An overview of the consultation undertaken during the ESIA programme and the issues and concerns raised
9. Predrill Environmental Impact Assessment, Monitoring & Mitigation	An assessment of the potential environmental impacts associated with the predrill phase of the COP
10. Construction, Installation, Hook Up and Commissioning Environmental Impact Assessment, Monitoring & Mitigation	An assessment of the potential environmental impacts associated with the construction, installation, hook up and commissioning phase of the COP
11. Operations Environmental Impact Assessment, Monitoring & Mitigation	An assessment of the potential environmental impacts associated with the operational phase of the COP
12. Socio Economic Impact Assessment, Monitoring & Mitigation	An assessment of the potential socio-economic impacts associated with the COP
13. Cumulative and Transboundary Impacts and Accidental Events	An assessment of the potential cumulative and transboundary impacts and accidental events associated with the COP
14. Environmental and Social Management	A summary of the environmental and social management system associated with the COP
15. Residual Impacts and Conclusions	A summary of the residual impacts and conclusions arising from the ESIA process
Appendices	Supporting technical information

Table 1.2 presents the COP ESIA Team.

Table 1.2 COP ESIA Team

Team Member	Role
URS	ESIA Project Manager and Lead Authors
	Onshore Air Dispersion & Noise Assessment
	Underwater Noise Assessment
BMT	Marine Discharge Modelling
Granherne	Offshore Air Dispersion Assessment
Mehman M. Akhundov	Local Fish Specialist
Tariel Eybatov	Local Caspian Seal Specialist
Ilyas Babayev	Local Bird Specialist
ECS	Marine Ecology Specialist
Urkhan Alakbarov	Local Socio Economic Specialist
Alun Lewis	Oil Spill Specialist
BP	ACG Contract Area PSA Operator on behalf of AIOC

2 Policy, Regulatory and Administrative Framework

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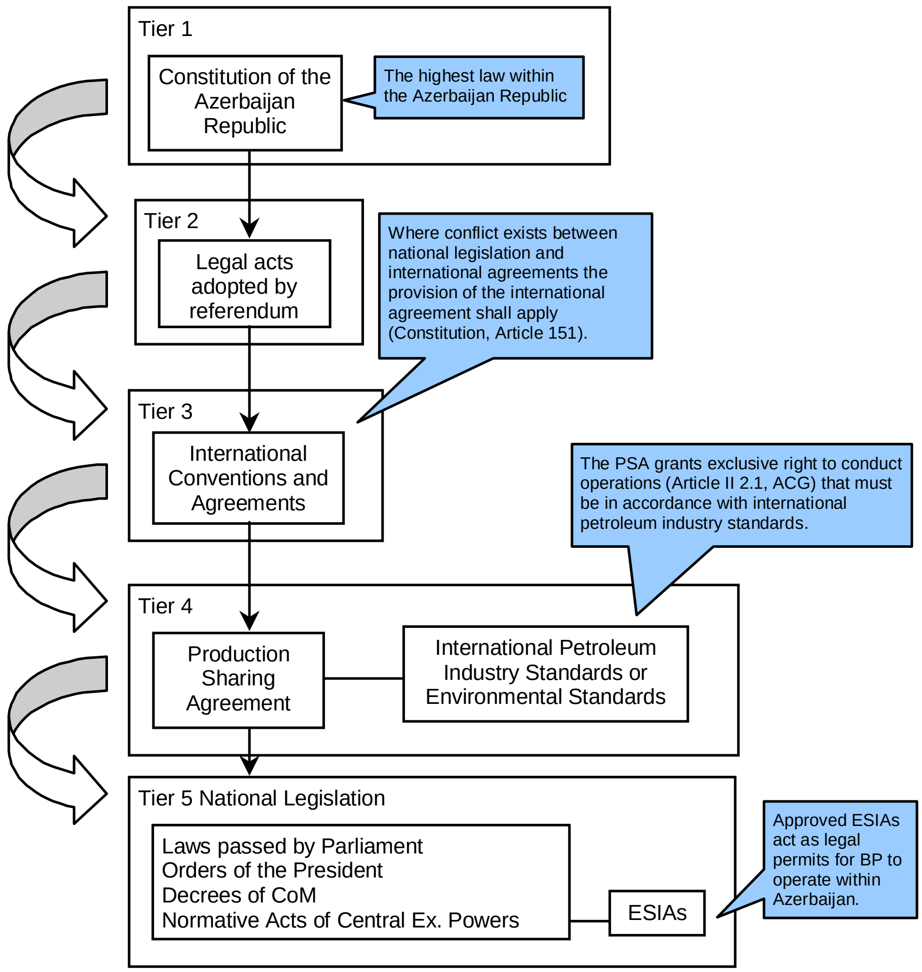
2.1 Introduction

The Chirag Oil Project (COP) will be undertaken in accordance with the Production Sharing Agreement (PSA), applicable requirements of international conventions ratified by the Azerbaijan government, International Petroleum Industry Standards and Practices, applicable national legislation and BP's Health Safety Security and Environment (HSSE) Policy. The legislative framework governing the COP is illustrated in Figure 2.1.

Figure 2.1 Azerbaijan Legal Hierarchy



2.2 Regulatory Agencies

The Ministry of Ecology and Natural Resources (MENR) has primary responsibility for environmental regulation. The MENR's statutes were adopted by presidential decree in 2001, making this body responsible for:

- Development of draft environmental legislation for submission to the Azerbaijan Parliament (Milli Mejlis);
- Implementation of environmental policy;
- Enforcement of standards and requirements for environmental protection;
- Suspension or termination of activities not meeting set standards;
- Advising on environmental issues;
- Expert review and approval of environmental documentation, including ESIA; and

- Implementation of the requirements set out in international conventions ratified by the Azerbaijan Republic (within its competence).

Other ministries and committees have functions that relate to environmental regulation including:

- **Ministry of Emergency Situations (MES)** - responsible for the management of natural disasters and industrial accidents and the implementation of safety rules in construction, mining and industry. MES (along with the State Oil Company of the Azerbaijan Republic (SOCAR), MENR and other appropriate Ministries) require prompt notification in the event of an emergency, or accident;
- **Ministry of Health** - state institution controlling the sanitary-epidemiological situation in the country and regulation of health protection in the work place;
- **Ministry of Fuel and Energy** - responsible for oil and gas activities, the sale of oil and gas products, and the efficient utilisation of Azerbaijan's energy resources;
- **Melioration Water and Utilities Open Joint Stock Company** - monitors water use, issues water abstraction permits for surface waters and imposes payments for water use; and
- **State Committee for Construction and Architecture** - regulates engineering surveys, and the implementation of design and construction rules and standards.

SOCAR is obligated under Article III, Clause 3.2 of the Azeri Chirag Gunashli (ACG) PSA to provide assistance to the Contractor in obtaining, *"any necessary Government approvals and any other approvals from relevant Azerbaijan authorities, agencies and/or organisations"*.

2.3 The Constitution

The Constitution is the highest law in the country. The following Articles help determine the applicability of national and international requirements to the COP:

- **Article 148.II** - International agreements acceded to by the Azerbaijan Republic become an integral part of the legislative system of Azerbaijan; and
- **Article 151** - If any conflicts arise between the normative-legal acts which constitute the legislative system of Azerbaijan (except for the Constitution and the acts adopted via referendum) and the international agreements acceded to by the Azerbaijan Republic, the provisions of the international agreements shall apply.

The Constitution (Article 39) also provides the right to all to live in a healthy environment; to have access to information on the state of the environment, and to obtain compensation for damage to person or property arising from a violation of environmental legislation.

2.4 Production Sharing Agreement

The ACG PSA is the legally binding agreement for the joint development and production sharing of the Azeri and Chirag fields and the deep-water portion of the Gunashli field in the Azerbaijan sector of the Caspian Sea. This agreement, between SOCAR and Azerbaijan International Operating Company (AIOC) shareholder parties (Contractor Parties) was enacted into Azerbaijan law in 1994 and applies to all phases of the COP Project. Under the terms of the PSA, AIOC, acting on behalf of Contractor Parties, has the right, for the entire term of the PSA, to develop and produce hydrocarbons from the ACG offshore fields. The PSA states that the conduct of operations should be undertaken with respect to the general environment, other natural resources and property, with the order of priority being the protection of life, environment and property.

Article 26.1 of the PSA states:

"Contractor shall conduct the Petroleum Operations in a diligent, safe and efficient manner in accordance with generally accepted international Petroleum industry standards."

Article 26.3 of the PSA requires AIOC to:

"comply with the present and future Azerbaijani laws or regulations of general applicability with respect to public health, safety and protection and restoration of the environment to the extent that such laws and regulations are no more stringent than the then current international petroleum standards and practices".

The requirement to prepare environmental documentation, including an Environmental Impact Assessment of any new facilities is also a condition of Appendix IX Section II B of the PSA.

The specific environmental standards that must be met throughout the life of the PSA are stipulated in Appendix IX of the PSA (Appendix 2A).

2.5 International and Regional Environmental Conventions

Since its independence, Azerbaijan has sought to reform the policy, legal and institutional framework that it inherited from the former Soviet Union in order to move towards a modern market oriented economy. Accordingly, in recent years, the Azerbaijan Government has engaged in international and regional processes to support this objective. International and regional conventions currently in force in Azerbaijan relevant to the scope of this ESIA are described below in Tables 2.1 and 2.2.

Table 2.1 Summary of International Conventions

Convention	Purpose	Status
UN Framework Convention on Climate Change	To collate information on greenhouse gas emissions and cooperate in planning	Azerbaijan not formally required to meet specific reduction targets
Bern Convention	Conservation of wild flora and fauna and their natural habitats	In force in Azerbaijan since 2002
Basel Convention	Primarily deals with transboundary hazardous waste movement	Azerbaijan acceded in 2001
RAMSAR Convention	Protection of wetlands of international importance	Azerbaijan signed convention in 2001.
Stockholm Convention on Persistent Organic Pollutants	Reduction in releases of dioxins, furans, hexachlorobenzene and PCBs with the aim of minimization or elimination	Azerbaijan acceded in 2004
Vienna Convention on the Protection of the Ozone Layer	Framework for directing international effort to protect the ozone layer, including legally binding requirements limiting the production and use of ozone depleting substances as defined in the Montreal Protocol to the Convention	Azerbaijan acceded in 1996
Convention on Biological Diversity	Conservation of biological diversity including the sustainable use of its components and the fair and equitable sharing of benefits	Azerbaijan became party to the Convention in 2000
World Heritage Convention	Defines natural or cultural sites that may be considered for inclusion on the World Heritage List	At the time of writing, two sites in Azerbaijan are on the List
International Plant Protection Convention	A treaty to prevent the spread and introduction of pests of plants and plant products and to promote measures for their control	Entered into force in Azerbaijan in 2000
Convention to Combat Desertification	To combat desertification and mitigate the effects of drought	Entered force in Azerbaijan in 1998
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Controls trade in selected species of plant and animals	Entered into force in Azerbaijan in 1999
International Maritime Organisation	The principal IMO conventions relevant to this ESIA are: MARPOL – Annexes I-VI covering the control of discharges and emissions from vessels London Convention – the prevention of marine pollution by dumping of wastes and other matter Antifouling Systems Convention Ballast Water and Sediments Convention	Entered into force in Azerbaijan in 2004 At the time of writing, Azerbaijan is not a signatory to the protocol to the Convention Not ratified by Azerbaijan at the time of writing (entered into force in 2008 for the countries that had ratified it) Not ratified by Azerbaijan at the time of writing (and not yet entered into force for the countries that have ratified it)

Table 2.2 Summary of Regional Conventions

Convention	Purpose	Status
Aarhus Convention*	To guarantee the rights of access to information, public participation in decision-making and access to justice in environmental matters	Azerbaijan acceded in 2000
Espoo Convention*	To promote environmentally sound and sustainable development through the application of EISA, especially as a preventive measure against transboundary environmental degradation.	Azerbaijan acceded in 1999. At the time of writing, Azerbaijan had not signed a related protocol on Strategic Environmental Assessment
Convention on the Protection and Use of Transboundary Watercourses and International Lakes*	To prevent, control or reduce and transboundary impact resulting from the pollution of transboundary waters by human activity	Azerbaijan acceded in 2002
Protocol on Water and Health*	To protect human health and well-being by better water management and by preventing, controlling and reducing water-related diseases	Azerbaijan acceded in 2003
Geneva Convention on Long-range Transboundary Air Pollution*	Provides a framework for controlling and reducing transboundary air pollution	Entered into force in Azerbaijan in 2002. Has been extended by 8 protocols, none of which at the time of writing have been ratified by Azerbaijan
Convention on the Transboundary Effects of Industrial Accidents*	To prevent industrial accidents that may have transboundary effects and to prepare for and respond to such events	Azerbaijan acceded in 2004
International Carriage of Dangerous Goods by Road*	Provides requirements for the packaging and labelling of dangerous goods and the construction, equipment and operations of transportation vehicles. Annexes provide detailed technical requirements	Entered into force in Azerbaijan in 2000
Tehran- Caspian Framework Convention	Ratified by all 5 littoral states and entered into force in 2006. Requires member states to take a number of generic measures to control pollution of the Caspian Sea. Four protocols have been drafted which will, when adopted, form the basis for national legislation and regulations	Convention is ratified, but protocols are at the time of writing still in draft form and do not therefore at present provide a binding basis for the development of legislation

* A UNECE agreement; Azerbaijan became a member of the UNECE in 1993. The major aim of the UNECE is to promote pan-european integration through the establishment of norms, standards and conventions

2.6 National Environmental Legislation

The Law on Normative-Legal Acts stipulates that acts in force prior to independence, that were not subsequently cancelled and that do not contradict the Constitution, remain in force. This results in a transitional legislative structure that combines soviet era and post soviet era regulations. The on-going transition process is being supported through a Partnership and Cooperation Agreement (PCA) between Azerbaijan and the European Union (which has been in force since 1999), (See Section 8.1).

The Government has committed to a process to align national environmental legislation with the principles of internationally recognised legislation, based on EU environmental legislation. As this process is on-going, the COP Project will comply with the intent of current national legal requirements where those requirements are consistent with the provisions of the PSA and do not contradict or are otherwise incompatible with international petroleum industry standards and practice.

The framework for national environmental legislation in Azerbaijan is provided by the Law on the Protection of the Environment (1999), which addresses the following issues:

- The rights and responsibilities of the State, the citizens, public associations and local authorities;
- The use of natural resources;
- Monitoring, standardisation and certification;
- Economic regulation of environmental protection;
- State Ecological Expertise (SEE);
- Ecological requirements for economic activities;
- Education, scientific research, statistics and information;
- Ecological emergencies and ecological disaster zones;
- Control of environmental protection;
- Ecological auditing;
- Responsibility for the violation of environmental legislation; and
- International cooperation.

According to Article 54.2 of the Law on Protection of the Environment, EIAs are subject to SEE, which means that the environmental authority (MENR) is responsible for the review and approval of EIA reports submitted by developers. The Law establishes the basis for the SEE procedure, which can be seen as a “stand-alone” check of compliance of the proposed project with the relevant environmental standards (e.g. for pollution levels, discharges and noise). In addition the law determines that projects cannot be implemented without a positive SEE resolution.

The SEE approach is based on Soviet approval and planning processes requiring state authorities to formally verify all submitted developments for their potential environmental impacts. Current internationally recognised practice emphasises a proportionate, consultative and publicly accountable approach to assessing impacts.

Table 2.3 Key National Environmental and Social Laws[1]

Subject	Title	Date	Description / Relevance to COP ESIA
General	Law of Azerbaijan Republic on the Protection of the Environment No. 678-IQ	08/06/1999 (last amendment 30/03/2001)	Establishes the main environmental protection principles and the rights and obligations of the State, public associations and citizens regarding environmental protection. Described above.
	Law of Azerbaijan Republic on Ecological Safety No. 677-IQ	08/06/1999	One of two keystone laws of the country's environmental legislation (along with the *Law on the Protection of the Environment*). Its purpose is to establish a legal basis for the protection of life and health, society, the environment, including atmospheric air, space, water bodies, mineral resources, natural landscapes, plants and animals from natural and anthropogenic dangers. The Law assigns the rights and responsibilities of the State, citizens and public associations in ecological safety, including information and liability. The Law also deals with the regulation of economic activity, territorial zoning and the alleviation of the consequences of environmental disasters.
Ecosystems	Law of the Azerbaijan Republic on Specially Protected Natural Territories and Objects No. 840-IQ	24/03/2000	Determines the legal basis for protected natural areas and objects in Azerbaijan.
	Law of Azerbaijan Republic on Fauna No. 675-IQ	04/06/1999	Defines the animal world, property rights over fauna and legal relationships between parties. It also describes issues of State inventory and monitoring, and economic and punitive regulations.
Water	Water Code of Azerbaijan Republic (approved by Law No. 418-IQ)	26/12/1997	Regulates the use of water bodies, sets property rights and covers issues of inventory and monitoring. The Code regulates the use of water bodies for drinking and service water and for medical treatment, spas, recreation and sports, agricultural needs, industrial needs and hydro energy, transport, fishing and hunting, discharge of waste water, fire protection and specially protected water bodies. It provides for zoning, maximum allowable concentrations of harmful substances and basic rules of conduct for industry.
	Law of the Azerbaijan Republic on Water Supply and Wastewater No. 723-1Q	28/10/1999	Applicability limited to onshore operations. Restricts industrial waste releases into the sewage system; requires segregation of stormwater and industrial wastes from sewage, and requires legal entities to acquire permissions to operate sewage plant.
	Rules of Referral of Specially Protected Water Objects to Individual Categories, Cabinet of Ministers Decree No. 77	01/05/2000	The Caspian Sea is a specially protected water body. This resolution requires special permits for disposal if there are no other options for wastewater discharge. The resolution allows for restrictions to be placed on the use of specially protected water bodies, and for further development of regulations related to these water bodies. It requires consent from MENR for activities that modify the natural conditions of specially protected water bodies, and includes provisions for permitting of any discharges to water that cannot be avoided. There are also special requirements for the protection of water bodies designated for recreational or sports use (which includes the Caspian).

[1] This table is compiled from a variety of sources including: United Nations 2004, Environmental Performance Reviews Series No. 19 – Azerbaijan; Currie & Brown, 2008, Integrated Solid Waste Management System for the Absheron Peninsula Project, and Popov 2005, Azerbaijan Urban Environmental Profile (an ADB Publication).

Subject	Title	Date	Description / Relevance to COP ESIA
	Rules for Protection of Surface Waters from Waste Water Pollution, State Committee of Ecology Decree No. 1	04/01/1994	Under this legislation the *Permitted Norms of Harmful Impact Upon Water Bodies of Importance to Fisheries* require discharges to meet several specified standards for designated water bodies in terms of suspended solids; floating matter; colour, smell and taste; temperature; dissolved oxygen; pH; BOD and poisonous substances. Limits are based on Soviet era standards and are to be achieved at the boundary of the facility (specific "sanitary protection zone limits") rather than "end-of-pipe" limits. End of pipe limits are defined in facility-specific "eco-passports" and are established with the intent to ensure compliance with applicable ambient standards.
Air	Law of Azerbaijan Republic on Air Protection No. 109-IIQ	27/03/2001	Establishes the legal basis for the protection of air, thus implementing the constitutional right of the population to live in a healthy environment. It stipulates the rights and obligations of the authorities, legal and physical persons and NGOs in this respect, sets general requirements for air protection during economic activities, establishes norms for mitigating physical and chemical impacts to the atmosphere, establishes rules for the State inventory of harmful emissions and their sources and introduces general categories of breaches of the Law that will trigger punitive measures.
	Methodology to Define Facilities' Hazards Categories Subject to Hazardous Substance Emissions Levels and Need to Develop Projects' Maximum Permissible Emissions (MPEs).	04/09/1990	Under this methodology the maximum permissible concentrations of harmful substances and their hazard classes are provided. Limits are based on Soviet era standards.
Waste	Law of Azerbaijan Republic on Industrial and Domestic Waste No. 514-IQ	30/06/1998	Describes State policy in environmental protection from industrial and household waste including harmful gases, waste water and radioactive waste. It defines the rights and responsibilities of the State and other entities, sets requirements for the design and construction of waste-treatment installations, licensing of waste generating activities, and for the storage and transport of waste (including transboundary transportation). The Law also encourages the introduction of technologies for the minimisation of waste generation by industrial enterprises. There is a general description of responses to infringements. This law is specified by Resolutions of the Cabinet of Ministers on the rules of certification of hazardous wastes, state strategy on management of hazardous wastes in Azerbaijan and by Instructions on the Inventorisation Rules and Classification System of the Wastes generated by Industrial Processes and In the Field of Services approved by the MENR.
Subsurface	Law of the Azerbaijan Republic on Subsurface Resources No. 439-IQ	13/02/1998	Regulates the exploitation, rational use, safety and protection of subsurface resources and the Azerbaijani sector of the Caspian Sea. The Law lays down the principal property rights and responsibilities of users. It puts certain restrictions on the use of mineral resources, based on environmental protection considerations, public health and economic interests.
Information	Law of the Azerbaijan Republic on Access to Environmental Information No. 270-IIQ	12/03/2002	Establishes the classification of environmental information. If information is not explicitly classified "for restricted use" then it is available to the public. Procedures for the application of restrictions are described. Law aims to incorporate the provisions of the Aarhus Convention (ratified by Azerbaijan in 1999) into Azeri Law.
Community heath & safety	Law on Sanitary-Epidemiological Services (authorized by Presidential Decree No. 371)	10/11/1992	Establishes sanitary and epidemiological requirements for industrial entities to be met at design, construction and operational stages, and for other economic activities. Aims to protect the health of the population. It addresses the rights of citizens to live in a safe environment and to receive full and free information on sanitary-epidemic conditions, the environment and public health.

Subject	Title	Date	Description / Relevance to COP ESIA
	Law of the Azerbaijan Republic on Protection of Public Health No. 360-IQ	26/06/1997	Sets out the basic principles of public health protection and the health care system. The Law assigns liability for harmful impact on public health, stipulating that damage to health that results from a polluted environment shall be compensated by the entity or person that caused the damage.
	Law of the Azerbaijan Republic on Public Radiation Safety No. 423-IQ	30/12/1997	Includes requirements for ensuring radiation safety in industrial entities. The Law establishes the main principles of government policy on radiation safety, as well as environmental norms protecting the safety of employees and populations in areas potentially affected by the use of radioactive sources. The Law provides for compensation for damage to health, property and life during accidents.
Liability	Law on Azerbaijan Republic on Mandatory Environmental Insurance No. 271	12/03/2002	Identifies requirements for the mandatory insurance of civil liability for damage caused to life, health, property and the environment resulting from accidental environmental pollution.
Permitting	A System of Standards for the Environment Protection and Improvement of Natural Resources Utilisation. Industrial Enterprise Ecological Certificate Fundamental Regulations, GOST 17.0.0.04-90	01/07/1990	The MENR issues ecological documents on the impact on the environment of potentially polluting enterprises. The documents include maximum allowable emissions, maximum allowable discharges, and an "ecological passport." The last item is specific to countries of the Former Soviet Union and contains a broad profile of an enterprise's environmental impacts, including resource consumption, waste management, recycling, and the effectiveness of pollution treatment. Enterprises develop the draft passport themselves and send it to MENR for approval.

2.6.1 National EIA Guidance

Guidance on the EIA process in Azerbaijan is provided in the Handbook for the Environmental Impact Assessment Process in Azerbaijan. The handbook introduces the main principles of the 'western'-type EIA process and details:

- The EIA process, i.e. the sequence of events and the roles and responsibilities of applicants and Government institutions;
- The purpose and scope of the EIA document;
- Public participation in the process;
- Environmental review decision (following its submission to the MENR, the ESIA document is reviewed for up to three months by an expert panel); and
- The appeal process.

A summary of the guidance provided in the handbook is given in Table 2.4 below.

The approval of an EIA by the MENR establishes the compliance framework, including the environmental and social standards that an organisation should adhere to.

Table 2.4 Summary of Guidance on the EIA Process in Azerbaijan[2]

Screening	The developer is required to submit an Application (containing basic information on the proposal) to MENR to determine whether an EIA is required.
Scoping	Requirement for a Scoping Meeting to be attended by the developer, experts and concerned members of the public, and aimed at reaching a consensus on the scope of the EIA.
Project Description	Full description of technological process and analysis of what is being proposed in terms of planning, pre-feasibility, construction and operation.
Environmental Studies	Requirement to describe fully the baseline environment at the site and elsewhere, if likely to be affected by the proposal. The environment must be described in terms of its various components – physical, ecological and social.
Consideration of Alternatives	No requirement to discuss project alternatives and their potential impacts (including the so-called "do-nothing" alternative), except for the description of alternative technologies.
Impact Assessment and Mitigation	Requirement to identify all impacts (direct and indirect, onsite and offsite, acute and chronic, one-off and cumulative, transient and irreversible). Each impact must be evaluated according to its significance and severity and mitigation measures provided to avoid, reduce, or compensate for these impacts.
Public Participation	Requirement to inform the affected public about the planned activities twice: when the application is submitted to the MENR for the preliminary assessment and during the EIA process. The developer is expected to involve the affected public in discussions on the proposal.
Monitoring	The developer is responsible for continuous compliance with the conditions of the EIA approval through a monitoring programme. The MENR undertakes inspections of the implementation of activities in order to verify the accuracy and reliability of the developer's monitoring data. The developer is responsible for notifying the MENR and taking necessary measures in case the monitoring reveals inconsistencies with the conditions of the EIA approval.

[2] Source: based on a review of the EIA Handbook and "EIA in the New Oil and Gas Projects in Azerbaijan", Parviz, 2005.

2.7 Regional Processes

2.7.1 European Union

EU relations with Azerbaijan are governed primarily by the EU-Azerbaijan Partnership and Cooperation Agreement (PCA) and the European Neighbourhood Policy (ENP).

The PCA entered into force in 1999, under Article 43:

"The Republic of Azerbaijan should endeavour to ensure that its legislation will be gradually made compatible with that of the Community".

As part of the PCA an EU assessment of Azerbaijan's environmental legislation against EU Directives identified a number of recommendations for the approximation of national legislation with EU Directives[3]. Based on this, a draft national programme was developed that emphasises a flexible approach to amending national legislation to take account of institutional capacity and cost[4].

Following the enlargement of the European Union, the EU launched the ENP and Azerbaijan became part of this policy in 2004. The current National Indicative Programme for implementing the ENP[5] includes a commitment to support legislative reform in the environmental sector, including:

- Approximation of Azerbaijan's environmental legislation and standards with the EU's;
- Strengthening of management capacity through integrated environmental authorisation;
- Improved procedures and structures for environmental impact assessment; and
- Development of sectoral environmental plans (waste and water management, air pollution, etc.)

2.7.2 Environment for Europe

Environment for Europe[6] is a partnership of member states, including Azerbaijan, and other organisations within the UNECE region. Under the auspices of the Environment for Europe a series of ministerial conferences on the environment have been held that have resulted in the establishment of the UNECE conventions described in Section 2.5.

2.8 International Petroleum Industry Standards and Practices

ACG related activities are required to comply with national legislation where it is no more stringent than "the then current international petroleum industry standards and practice (ACG PSA, Art. 26.3). Consideration of relevant international industry standards is therefore an important element in determining the applicability or otherwise of national legislation. Industry standards including those of the International Association of Oil and Gas Producers (OGP), the International Association of Geophysical Contractors (IAGC) and the International Association of Drilling Contractors (IADC) were specifically mentioned in the ACG PSA.

2.9 BP Requirements

The BP Environmental Group Defined Practice (GDP) includes minimum requirements that are applicable to the COP Project. There are two components of environmental practice applicable to the COP Project; the Environmental Impact Management Process (EIMP) and the Performance Requirements (PR). The latter are a comprehensive set of environmental

[3] Mammadov, A. & Apruzzi, F. (2004) Support for the Implementation of the Partnership Cooperation Agreement between EU-Azerbaijan. Scoreboard Report on Environment and Utilisation of Natural Resources. Report prepared for TACIS.
[4] SOFRECO (undated) Support for the Implementation of the PCA between EU-Azerbaijan, Draft Programme of legal Approximation.
[5] NIP (2007) European Neighbourhood and Partnership Instrument, Azerbaijan National Indicative Programme.
[6] UNECE (2008) Environment for Europe (http://www.unece.org/env/efe/welcome.html)

standards and the minimum requirements therein are in accordance with international petroleum industry standards as required by the ACG PSA.

2.9.1 EIMP

EIMP seeks to identify and understand the project's environmental impacts. The project uses this information to avoid, minimise, mitigate and remediate the impacts. EIMP is a full life-cycle process and comprises:

1. Screening and categorisation
2. Environmental assessment
3. Consultation and disclosure
4. Compliance
5. Resourcing and contracting
6. Residual impacts
7. Environmental management system
8. Assurance and lessons learnt
9. Reporting

2.9.2 PR

The PR define the criteria BP shall meet to achieve a consistent delivery of environmental performance and are to be considered at all stages in the Environmental Impact Management Process.

PR-1 Air quality
PR-2 Community disturbance
PR-3 Cultural property
PR-4 Drilling, completions and workover wastes and discharges
PR-5 Energy efficiency
PR-6 Environmental liability prevention
PR-7 Flaring and venting
PR-8 Marine mammals
PR-9 Ozone Depleting Substances
PR-10 Physical and ecological impacts
PR-11 Waste management
PR-12 Water management

2.10 COP Project Standards

Throughout the previous ACG Phases project standards have been agreed with the MENR on a project specific basis. The standards have taken into account Azerbaijan's environmental legislation and regulation, which is currently in a transitional stage, as well as international standards, such as those mandated by the EU. This process has enabled MENR to assess, approve or modify the mitigation, controls and standards proposed by the project in liaison with BP.

This approach has also been adopted for the COP ESIA. Existing controls associated with COP events are summarised within the impact assessments chapters of this ESIA (Chapters 9-11). These controls comprise mitigation and monitoring inherent in the project design including the relevant environmental performance standards (refer to Chapter 9, Table 9.4, Chapter 10, Table 10.3 and Chapter11, Table 11.3).

3 Impact Assessment Methodology

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3.1 Introduction

This Chapter presents a description of the Environmental and Socio-Economic Impact Assessment (ESIA) process adopted for the Chirag Oil Project (COP) and the methodology used to assess impact significance.

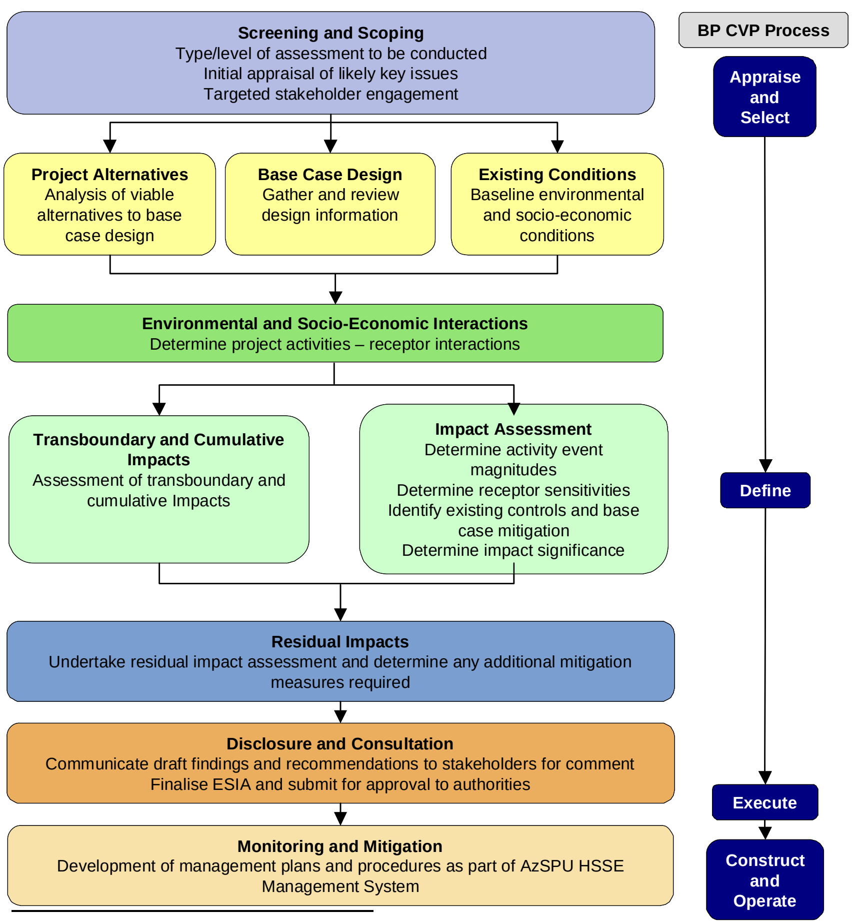
3.2 ESIA Process

The ESIA process constitutes a systematic approach to the evaluation of a project and its associated activities throughout the project lifecycle from pre-construction, to construction and through to operation. The process includes:

- Screening and Scoping;
- Project Alternatives and Base Case Design;
- Existing Environmental and Socio-Economic Conditions;
- Impact Significance Assessment;
- Mitigation and Monitoring;
- Residual Impacts; and
- Disclosure.

The ESIA also includes stakeholder consultation that identifies the views and opinions of potentially affected people and other interested parties. Stakeholder feedback is used to focus the impact assessment and, where appropriate, influence project design and execution. The ESIA process is integrated with the BP Capital Value Process (CVP) as illustrated in Figure 3.1[1].

Figure 3.1 The ESIA Process



1 Refer to Chapter 4 Section 4.1 for further details regarding the BP CVP

3.2.1 Screening

Screening is the first step in the ESIA process. It confirms the need (or otherwise) for an ESIA by appraising the type of project and its associated activities throughout its lifecycle in the context of its biophysical, socio-economic, policy and regulatory environments.

Given the location, scale and planned activities associated with the COP, AIOC and the Ministry of Ecology and Natural Resources (MENR) concluded that the project should be subject to an ESIA, and the ESIA should take account of applicable national and international legislation, AIOC PSA and BP standards as detailed in Chapter 2: Policy, Regulatory and Administrative Framework.

3.2.2 Scoping

Scoping is a high level assessment of anticipated “interactions” between project activities and environment ‘receptors’. Its purpose is to focus the ESIA on key issues and eliminate certain activities from the full impact assessment process based on their limited potential to result in discernable impacts. To arrive at a conclusion to “scope out” an activity/event, a mixture of expert scientific judgement based on prior experience of similar activities and events and, in some instances, scoping level quantification/numerical analysis (e.g. emission and discharge inventories and generic modelling) is used.

The scope of the COP ESIA has been determined, in part, from the experience gained during construction and operation of previous ACG phases (i.e. Phases 1, 2, and 3), in relation to both routine and non-routine activities (e.g. discharges during start up, maintenance and process upset conditions). Non-routine activities were not fully captured in the ESIA for these earlier developments (see Section 3.2.2.1). In addition, stakeholders’ concerns that were raised during the construction and operation of these prior ACG projects have been highlighted for consideration in the COP ESIA. COP ESIA Scoping consultation has included:

- Liaison with the Onshore and Offshore Azerbaijan Strategic Performance Unit (AzSPU) Operations Teams and contractors associated with the construction phase of the ACG Phase 1, 2 and 3 projects;
- Review of existing environmental and socio-economic data and reports relevant to the COP;
- Liaison with the COP Design Team to gather design data and to formulate an understanding of the COP and its integration with existing operational ACG assets; and
- Consultation with external stakeholders including the local community, academics, the MENR and Non Governmental Organisations (NGO).

Based on the findings and results of these reviews, investigations and consultations, the COP ESIA Team identified:

- Potential project related environmental and socio-economic impacts based on likely interactions between COP project activities (as known during the BP CVP Select design stage) and environmental receptors; and
- Gaps where the extent, depth and/or quality of environmental, socio-economic and/or technical data is insufficient for the COP ESIA process, thus identifying additional work to complete the ESIA.

3.2.2.1 Lessons Learnt From Previous ACG Project ESIA

As part of the COP ESIA scoping phase, key issues and lessons learned during the production and following the approval of previous ACG Project ESIAs as well as during the subsequent construction, installation, commissioning and operation of ACG Project facilities were identified. Table 3.1 provides a summary and details how the lessons have been implemented for the COP.

Table 3.1 Summary of Lessons Learnt in Relation to Previous ACG Project Phases and Related ESIA

Aspect	Issue	Lesson Implementation
Project Description	Not all emissions and discharges were fully captured in previous project phase ESIAs – in particular those relating to onshore and offshore commissioning	A comprehensive review of all discharges, based on previous project experience, has been carried out for the COP ESIA to ensure that they are properly identified, quantified, assessed and mitigated. Regular reviews with the design team has been undertaken to ensure that there are no gaps.
	Design changes during late ESIA phase and construction phase not all fully registered and tracked	A tracking system to capture all design changes with environmental aspects has been established for the COP, to ensure that the approval status of the final design is unambiguous
	Ongoing options assessment post ESIA not fully registered and tracked	The COP tracking system will also ensure that any changes to the perceived viability of selected options are captured and that alternatives undergo a timely assessment and consultation process as detailed in the COP ESIA Management of Change Process[2].
Options assessed	During previous projects, it was not always possible to implement the intended commissioning options, with the consequence that additional discharges had to be negotiated at short notice with the regulators	Whether selected commissioning options do or do not involve discharge, the alternatives should the selected option become unavailable have been thoroughly considered by the COP ESIA, and the potential impacts of the alternatives have been assessed.
Impact assessment methodology	Previous ESIAs used a generic, qualitative approach to impact assessment, which did not generate easily-tested predictions of impact	The COP ESIA impact assessment methodology takes a more quantitative approach, based largely on the data accumulated from previous projects, existing operations, and the AzSPU Integrated Environmental Monitoring Programme. In particular, impacts have been assessed with specific reference to the information available on actual receptors (Refer to Sections 3.2.4 and 3.2.5).
Mitigation and Monitoring	Interpretation of ambient environmental monitoring data has in the past been constrained by a lack of detailed information on the composition chemistry of discharges to sea.	In order to enhance understanding and interpretation of impacts, a process of systematic operational discharge monitoring will be initiated for the COP which will be incorporated within the Integrated Environmental Monitoring Programme (IEMP) for existing operations in future years. The IEMP is designed to provide a consistent set of environmental data, including monitoring at platforms (to directly identify impacts) and at a regional level (to quantify natural variability and trends)[3]. In respect of COP commissioning discharges, a sampling and analysis assurance programme based on that developed during commissioning of pipelines and injection facilities for the Deep Water Guneshli (ACG Phase 3) platforms will be agreed with the MENR.
	Impact assessment and associated mitigation for previous project phases were often based on estimates, in the absence of available verified data (e.g. with respect to water production rates). Experience has shown that these estimates are not always accurate.	During the execution phase, COP will continue to monitor available data from existing operations, to test the ESIA estimates in instances where a change in predicted values could occur, and will revise impact assessment and mitigation measures where necessary as detailed in the COP ESIA Management of Change Process[2].

[2] Refer to Chapter 5 Section 5.11
[3] Refer to Chapter 6 for IEMP details

3.2.3 Project Alternatives and Base Case Design

3.2.3.1 Project Alternatives

The initial step in defining a project is to identify, at a conceptual level, viable alternatives to the project so that a Base Case Design may be realised. Consideration of project alternatives occurs at two levels:

- To the development as a whole, including the "no development" option, and
- Engineering alternatives within the selected project's concept design definition.

Project alternatives were defined during the early conceptual design (CVP Appraise stage) of the COP and were compared on financial, logistical, technical design, safety, environmental and socio-economic criteria. The alternative that represented the best balance in regards all criteria was taken forward into the front end engineering design stage and subsequent detailed design stage (CVP Select and Define stages).

Chapter 4: Options Assessed presents a summary of the alternative designs considered and engineering options evaluated for the COP.

3.2.3.2 COP Design

The COP ESIA Team worked with the COP Engineering, Construction and Operations Teams to gather and interpret relevant information for the ESIA. This dialogue between the teams identified where additional project design definition, in terms of existing controls and additional mitigation measures, was required in the COP Base Case Design to minimise impacts. Opportunities identified for environmental and socio-economic enhancements were considered by the teams and incorporated into the Base Case Design where appropriate and practicable.

The COP Base Case Design, on which the COP impact assessment is based, is presented in Chapter 5: Project Description.

3.2.4 Existing Conditions

In order to identify potential impact to receptors, an understanding of the existing conditions was established prior to execution of project activities. The COP ESIA Scoping exercise determined that the project will likely result in impacts on the following receptor groups:

- Biological/Ecological; and
- Socio-Economic/Human.

A review of existing onshore and offshore baseline data, covering a period from 1995 to 2007, and including results of ACG monitoring programmes, was undertaken to identify the existing conditions within the COP area. A benthic survey had been conducted at the proposed COP location in 2003, and discussion with MENR led to the agreement to carry out a limited supplementary survey in 2009[4], with the primary aim of identifying and quantifying any significant changes in the characteristics of the benthic habitat. As the COP scope does not include any Sangachal Terminal construction work and BP has completed numerous environmental surveys and continues to undertake routine monitoring work around the Terminal, additional surveys specific to the COP at Sangachal were not considered necessary.

Chapter 6: Environmental Description and Chapter 7: Socio-Economic Description describe the existing environments based on a review of existing data.

[4] Subsequent to the submission of this ESIA

3.2.5 Impact Significance Assessment

An impact, as defined by ISO14001:2004 is:

"Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's environmental aspects (activities, products or services)".

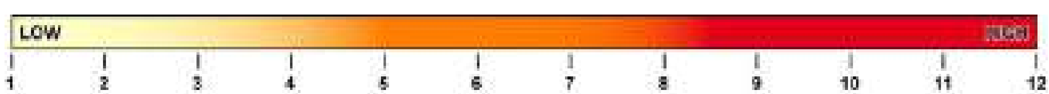
Where project activity – environmental receptor interactions occur, an impact is defined. The ESIA process ranks impacts according to their "significance" determined by considering project activity "event magnitude" and "receptor sensitivity". Determining event magnitude requires the identification and quantification (as far as practical) of the sources of potential environmental and social effects from routine and non-routine project activities. Determining receptor sensitivity requires an understanding of the biophysical environment.

3.2.5.1 Method for Determining Event Magnitude

Event magnitude is determined based on the following parameters, which are equally weighted and are each assigned a rating of "1", "2", or "3":

- **Extent / Scale**: Events range from those affecting an area of up to 500m from the source (1); to those affecting an area greater than 500m and up to 1km from the source (2); to those affecting an area of greater than 1km from the source (3).
- **Frequency**: Events range from those occurring once (1); to those occurring up to 50 times (2); to those occurring more than 50 times or continuously (3).
- **Duration**: Events range from those occurring for less than 24 hours (1); to those occurring for more than 24 hours and up to one week (2); to those occurring for periods longer than one week (3).
- **Intensity**: Concentration of an emission or discharge with respect to standards of acceptability that include applicable legislation and international guidance, its toxicity or potential for bioaccumulation, and its likely persistence in the environment. Ranges from a low intensity event (1), to a moderate intensity event (2) to a high intensity event (3).

Overall event magnitude is then scored on a spectrum from low (1) to high (12) by adding the individual parameter scores:



Resulting individual ratings are summed to give the overall event magnitude ranking. Table 3.2 presents the score ranges for magnitude rankings of "Low", "Medium" and "High".

Table 3.2 Event Magnitude Rankings

Event Magnitude	Score (Summed Parameter Rankings)
Low	4
Medium	5-8
High	9-12

3.2.5.2 Method for Determining Receptor Sensitivity

Receptor sensitivity is determined based on the following parameters, which are equally weighted and are each assigned a rating of ”1”, ”2”, or ”3”:

- **Biological/Ecological Receptors:**
  - ***Resilience (to the identified stressor)***: Ranges from species or community unaffected or marginally affected (1); to probability of species undergoing moderate but sustainable change which stabilises under constant presence of impact source, with ecological functionality maintained (2); to probability for substantial loss of ecological functionality (e.g. loss of species in key groups, substantially lower abundance and diversity) (3).
  - ***Presence***: Routine, regular or reliably predictable presence of any species which is, in reverse order, a unique, threatened or protected species (3), to regionally rare or largely confined to COP area or sensitive to industry emissions /disturbances (2); to a species which is none of the above and is therefore assessed at the community level only (1).

- **Human Receptor:**
  - ***Presence:*** Ranges from people being uncommon in the geographical area of anticipated impact (1); to people being present some of the time (e.g. commercial property) (2); to people being permanently present (e.g. residential property) in the geographical area of anticipated impact (3).
  - ***Resilience (to the identified stressor):*** Ranges from people being least vulnerable to change or disturbance (i.e. ambient conditions (air quality, noise) are well below applicable legislation and international guidance) (1); to quite vulnerable to change or disturbance (i.e. ambient conditions (air quality, noise) are below adopted standards) (2); to the most vulnerable groups (i.e. ambient conditions (air quality, noise) are at or above adopted standards) (3).

Overall receptor sensitivity is then scored on a spectrum from low (1) to high (6) by adding the individual parameter scores:

Table 3.3 presents the score ranges for sensitivity rankings of ”Low”, ”Medium” and ”High”’.

Table 3.3 Biological/Ecological and Human Receptor Sensitivity Rankings

Receptor Sensitivity	Score (Summed Parameter Rankings)
Low	2
Medium	3-4
High	5-6

3.2.5.3 Method for Determining Impact Significance

Impact significance, as a function of event magnitude and receptor sensitivity is subsequently ranked as “Negligible”, “Minor”, “Moderate” or “Major” as presented in Table 3.4 below.

Table 3.4 Impact Significance

		Receptor Sensitivity		
		Low	**Medium**	**High**
Event Magnitude	**Low**	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Major

Any impact classified as "major" is considered to be significant and where the impact is negative, requires additional mitigation. Impacts of negligible, minor or moderate significance are considered as being mitigated as far as practicable and necessary, and therefore, do not warrant further mitigation[5].

3.3 Transboundary and Cumulative Impacts

Transboundary impacts are impacts that occur outside the jurisdictional borders of a project's host country. Potential COP transboundary impacts are considered to include:

- Social and economic issues surrounding the sourcing of labour, goods and services from the international market;
- GHG emissions to air; and
- Discharges to the marine environment.

Cumulative impacts arise from:

- Interactions between separate project-related residual impacts; and
- Interactions between project-related residual impacts in combination with impacts from other projects and their associated activities.

These can be either additive or synergistic effects, which result in a larger (in terms of extent or duration) or different (dependant on impact interaction) impacts when compared to project-related residual impacts alone.

At the time of writing there were no reasonably foreseeable new projects proposed in the ACG Contract Area and no new projects at or in the vicinity of the Sangachal Terminal which are sufficiently defined and for which there is sufficient data available for a quantitative impact assessment to be undertaken.

For the COP ESIA, potential cumulative impacts are therefore considered to include:

- Physical presence of multiple ACG offshore installations;
- Cumulative discharges from the COP and other ACG offshore installations; and
- Cumulative emissions from COP activities and from other ACG facilities.

[5] The methodology described in this chapter is focused on the evaluation of potentially significant negative impacts. Assessment of positive impacts resulting from the COP, primarily associated with employment and economic benefits, along with relevant enhancement measures is presented in Chapter 12 of this ESIA.

3.4 Mitigation and Monitoring

The iterative and integrated nature of the ESIA and project design processes means that the majority of proposed additional mitigation measures and strategies have been incorporated into the Base Case Design. These measures / strategies have included mitigation measures and ongoing commitments as previously adopted by other ACG projects and which are of relevance to the COP. These include monitoring and reporting commitments, for, for example, emissions and discharges, as well as policies and procedures that form part of the AzSPU Environmental Management System.

4 Options Assessed

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4.1 Introduction

The objective of the Chirag Oil Project (COP) is to increase the oil production and recovery from the Azeri-Chirag-Gunashli (ACG) Contract Area. It is expected that approximately 5.4 billion standard barrels of oil (Bstb) can be recovered during the life of the Production Sharing Agreement (PSA) (up to the year 2024) from the Pereriv and Balakhany reservoirs within the ACG Contract Area.

The scope of the COP includes:

- Fabrication, assembly and installation of offshore facilities;
- Drilling wells to target the Pereriv and Balakhany reservoirs;
- Tie-ins to the existing offshore marine pipeline infrastructure; and
- Transport of hydrocarbon products to the existing onshore Sangachal Terminal.

Offshore export pipelines and receiving/processing systems at Sangachal Terminal are expected to have sufficient levels of unutilised oil, gas and produced water handling capacity in 2013 when the COP offshore facilities are commissioned. There has, therefore, not been a requirement to consider additional subsea export pipelines or expansion at Sangachal Terminal at any stage of the COP option selection process.

ACG Phases 1, 2 and 3 were built using a successful standardised design principle, incorporating environmental improvements to reduce emissions and discharges to the environment and utilising in-country construction facilities wherever possible. The starting point for the COP offshore facilities was, therefore, to follow this approach where feasible but incorporating key learnings from the existing platforms to improve design, where appropriate.

Options assessed for the COP have focused on:

- The selection of a suitable location within the ACG Contract Area for the offshore facilities to exploit the Pereriv and Balakhany reservoirs;
- Platform design and the extent of integration with existing ACG offshore facilities;
- Efficiency and performance improvements offered by technology alternatives; and
- Maximising in-country fabrication of offshore facilities.

Those design options previously considered throughout the development of the ACG Phase 1, 2 and 3 Projects have also been assessed.

The option of not developing the COP offshore facilities has also been recognised and considered. A decision not to proceed would, however, result in a reduction of potential oil revenues to the Azerbaijan government with a resultant inability to deliver the associated benefits to the Azerbaijan economy. Pursuing the COP will result in employment creation for national citizens during both the construction phase and operational phase of the development as well as increased use of local facilities, infrastructure and suppliers. The option of not proceeding was therefore disregarded when considered against these socio-economic benefits[1].

The development of the COP design has been undertaken within BP's Capital Value Process (CVP). The CVP consists of a number of decision stage gates that all major project development decisions must pass through. The CVP approach ensures consistency across all major projects within BP's portfolio. Figure 4.1 illustrates the CVP.

[1] Chapter 12: Socio Economic Impact Assessment presents the expected socio-economic impacts of the project in full.

Figure 4.1 BP Capital Value Process

Appraise:

- Determine project feasibility & alignment with business strategy;
- Understand project drivers; and
- Identify viable opportunities to pursue.

COP: Jan 07 to Sept 07

Select:

- Perform technical definition and evaluation of prioritised project options;
- Develop initial cost and schedule estimates for the options;
- Compare options by focusing on uncertainties, risks, flexibility and associated economic criteria;
- Recommend preferred option and further develop technical definition, cost schedule and production estimates.

COP: Oct 07 to Oct 08

Define:

- Develop the selected option to an appropriate level of detailed technical definition and planning required to freeze the scope of the project; and
- Confirm cost, schedule and production estimates.

Execute:

- Produce an operating asset consistent with scope, cost and schedule, including;
- Detailed engineering;
- Procurement;
- Follow-on engineering;
- Site support; and
- Project management services.

Operate:

- Evaluate asset to ensure performance is to specification including;
- Feedback of facilities availability; and
- Production performance.

As Figure 4.1 demonstrates, conceptual design options are analysed in terms of their feasibility during the Appraise stage of the CVP. Recommended design options then pass onto the Select stage during which the preferred option for development is further studied and selected. During the Define stage, the scope of the preferred option is more fully defined and final design decisions are made.

Throughout the CVP to date, environmental evaluation of the project options has been undertaken alongside technical and economic evaluation and consultation with stakeholders including SOCAR and AIOC partners[2]. Initial environmental evaluation undertaken during Appraise involves project screening to determine likely potential impacts and the requirement for / scope of an ESIA based on early project concepts. Chapter 3: Impact Assessment Methodology describes the process and the outcome of the COP screening process in full[3].

The following sub-sections present a summary of the main decisions made during the Appraise and Select stages of the CVP. The End of Select COP Base Case Design is described in detail in Chapter 5: Project Description of this ESIA.

4.2 Appraise Stage

Aside from commercial and business strategy issues, identification of a suitable location for the COP offshore development was the key issue considered during Appraise. The following were taken into account:

- Available reservoir resources across the ACG Contract Area;
- Bathymetry, seabed and subsea geotechnical characteristics including location of geo-hazards (e.g. mud volcanoes and shallow gas); and
- Drilling radii and the potential to reduce the requirement for Extended Reach (ERD) Wells.

[2] Chapter 8: Consultation and Disclosure provides details of the consultation undertaken and proposed specifically with regard to the COP ESIA

[3] Chapter 3 Figure 3.1 illustrates how COP ESIA process was integrated into the CVP

4.2.1 Reservoir Resource

Reservoir simulations and analytical techniques were used to identify the best areas of the reservoir for further development. Three locations were considered:

- **West Chirag:** Located in the Chirag/Deep Water Gunashli (CDWG) field of the ACG Contract Area between the existing Chirag-1 and DWG platforms;
- **North Azeri:** Located in the north of the Contract Area in the Azeri field between the Central Azeri (CA) and East Azeri (EA) platforms; and
- **South Azeri:** Located between the CA and EA platforms to the south of the Contract Area.

The analysis undertaken considered the total incremental oil recovery in each location to the end of the PSA period (2024). Table 4.1 summarises the results obtained[4].

Table 4.1 Incremental Oil Recovery for West Chirag and North/South Azeri Options

	Unit	West Chirag	North / South Azeri*
End PSA Incremental Oil Recovery:	MMstb	347	270

* Note: The North and South Azeri locations were modelled as a single location in the Azeri field assuming the same reservoirs exploited and same number of wells.

The analysis shows that the total incremental oil recovery was greater for the West Chirag option. This better performance was attributable to the following:

- The Azeri field (where North/South Azeri locations are situated) is more developed in the higher quality reservoirs than the CDWG field (where the West Chirag location is situated)- the Azeri field has three drilling centres (i.e. EA, CA and WA) currently in place, whereas CDWG only has two (i.e. Chirag-1 and DWG); and
- The reservoirs are of better quality in the CDWG field than the Azeri field translating into more resources per well, a longer plateau and a slower production decline post plateau.

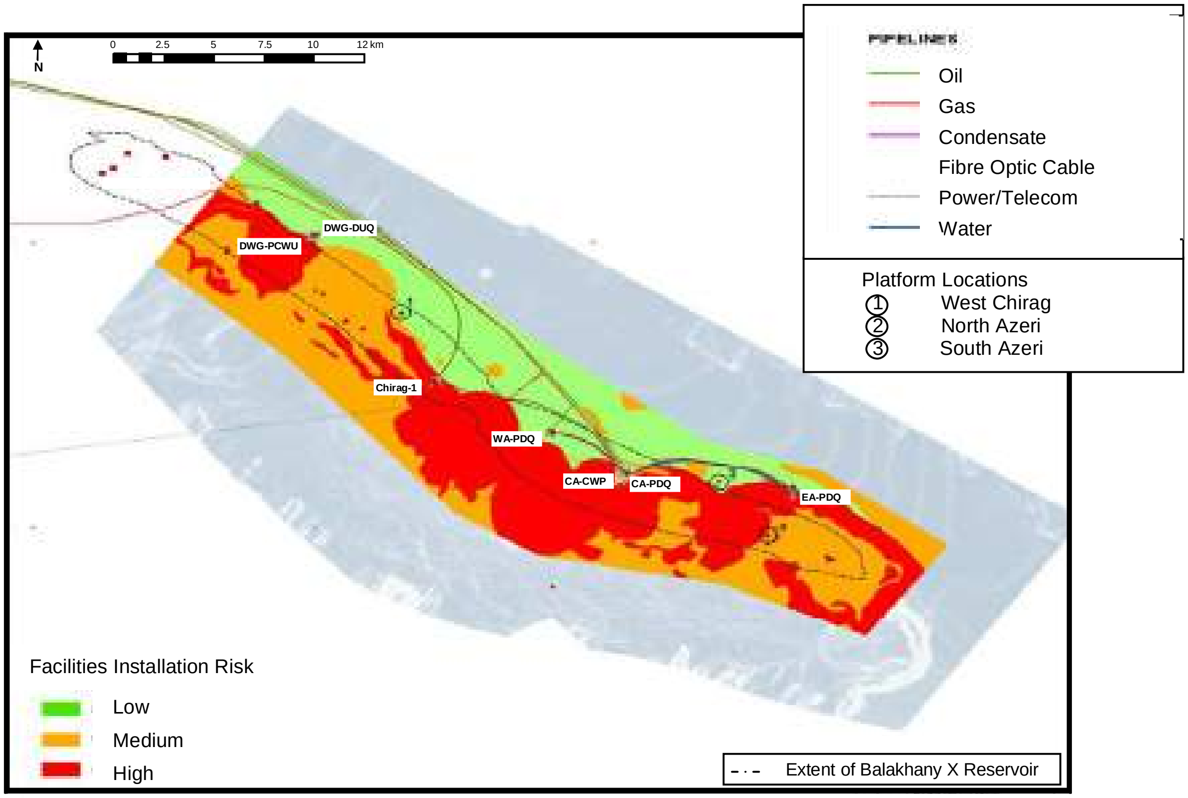
4.2.2 Bathymetry and Hazard Mapping

Existing bathymetric data for the three potential platform locations was reviewed. The water depths obtained from the data imply that a one piece jacket installation would be possible at the West Chirag and North Azeri locations (depths of approximately 170m and 150m respectively) but a two piece jacket installation would be required at the South Azeri location (depth of approximately 250m).

Available information regarding geohazards such as mud volcanoes and shallow gas across the Contract Area was used to determine whether the locations were in areas of low, medium or high risk. Figure 4.2 presents a simplified version of the mapping used and shows the location of the three platform locations considered. Both the West Chirag and North Azeri locations are situated in areas of “low risk” whereas the South Azeri location is situated in an area of “medium risk”.

[4] At this early stage, 20 Balakhany and 7 Pereriv producer wells were assumed. The drilling plan subsequently evolved during Select and Define and the targets optimised.

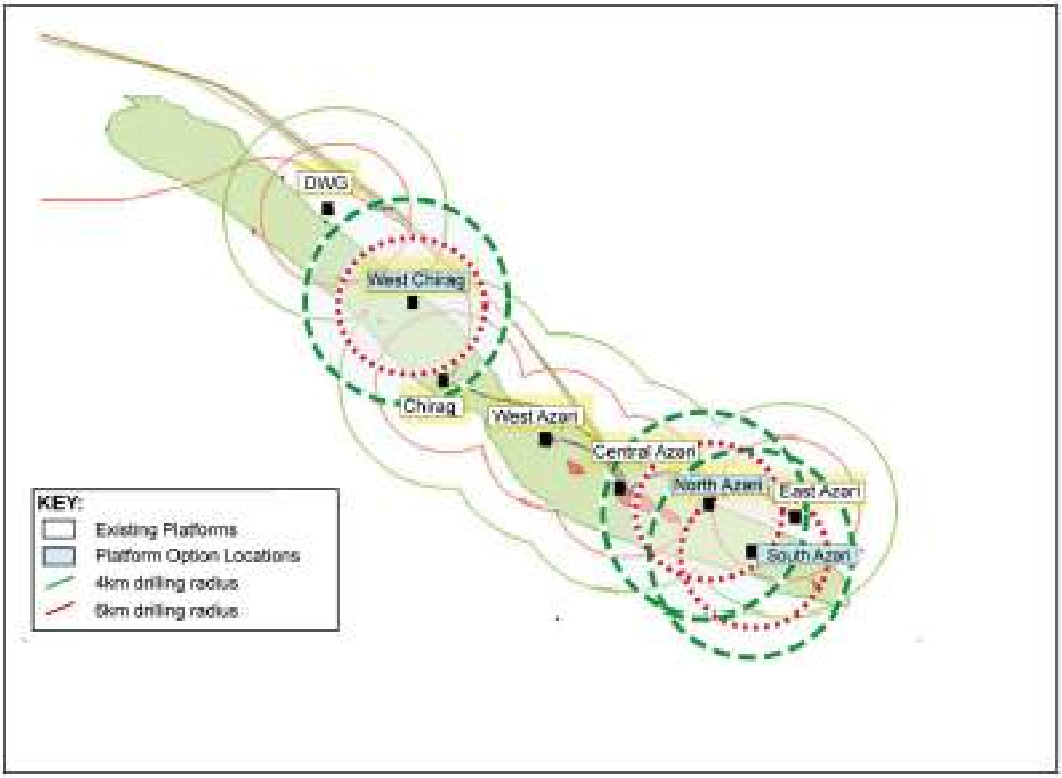
Figure 4.2 Installation Risk Mapping Across the ACG Contract Area



4.2.3 Extended Reach Wells

One of the criteria used in selecting the platform location was the associated reduction in Extended Reach Drilling (ERD) Wells. Figure 4.3 shows the drilling radii of 4km (in red) and 6km (in green) from the West Chirag and North/South Azeri locations. The potential locations for the new platforms were selected to be approximately midway between the current platform locations thereby reducing the length of wells required to access both the Pereriv and Balakhany reservoirs. Currently ERD (defined as having a step-out in excess of 4km) are being drilled from the EA platform to the south flank of the Azeri field and have contributed to a low well drilling rate. It was estimated that there could be 15 fewer ERD and/or sidetracks required for the Pereriv and Balakhany reservoirs if a new platform is installed in the West Chirag location and seven fewer ERD with a new platform in the North or South Azeri locations.

Figure 4.3 Platform Option Locations and Drilling Radii from Each Location Option



4.2.4 Location Selection and Environmental Issues

Based on the reservoir resources, water depth and hazard mapping and the potential reduction available in ERD wells, West Chirag was identified as the optimal COP location[5]. The potential environmental benefits of this location include:

- Reduction in materials required for jacket construction (as compared to South Azeri location where a two stage jacket would be required) and associated reduction in potential construction waste, emissions and discharges;
- Reduction in the quantity of cuttings generated due to a reduction in ERD wells that generate more cuttings; and
- Lower risk of accidental events, spills and discharges associated with geohazards as compared to South Azeri location.

4.2.5 Well Drilling Options

The number of wells drilled per year is a critical project driver from a schedule and economic feasibility perspective. The principle of predrilling a number of wells, as adopted for the previous ACG Phases, was incorporated in the COP Base Case during the Appraise stage. If predrilling were not to be performed the duration required for production ramp-up would be dramatically increased, resulting in a large reduction in the economic reasons for executing the project. If this were the case it is likely that the project would not proceed and the benefits associated with the project for all of the stakeholders would be lost. The number of predrill wells to ensure economic feasibility was determined with reference to the optimal project drilling and completion rate[6].

[5] Further analysis was undertaken during Select based on existing bathymetric and shallow seismic data from earlier studies and a completed seabed survey conducted during June / July 2008 to confirm the precise location for the offshore facilities.
[6] Refer to Section 4.3.2.3 for predrill/platform drilling discharge options assessed.

4.2.6 Platform Design Options

During Appraise, it was determined that the new offshore production facilities would comprise either a single platform or twin, bridge linked platforms to provide:

- Living quarters;
- Drilling rig;
- 48 well slots for production, water injection and cuttings reinjection wells;
- Oil production and separation systems;
- Oil pumping facilities for exporting oil to Sangachal Terminal via tie-ins to the existing 30" marine pipelines;
- Gas dehydration unit;
- Produced water treatment system suitable for treating produced water for downhole disposal / reservoir waterflood; and
- Utility and ancillary systems necessary to support the safe operation of the production facility.

In addition, the following would either need to be accommodated on the new platform(s) or provided through integration with another ACG facility or facilities:

- Gas compression system exporting associated gas to Sangachal Terminal via a tie-in to the existing 28" marine pipeline;
- Water injection system utilising treated produced water and treated seawater; and
- Power generation to provide electrical power for the total platform(s) demand.

In keeping with the ACG standardisation principle, design case types were identified based on single and twin platform configurations analogous to the existing EA and DWG platforms respectively, centred at the West Chirag location. The case types considered were:

- **Case 1:** Single platform integrated with existing ACG offshore facilities (e.g. for provision of injection water, export gas compression); and
- **Case 2:** Twin platforms with ACG integration limited to subsea export pipeline tie-ins.

These case types were carried forward to the Select stage for more detailed analysis.

4.3 Select Stage

During Select, options assessment focused on the following:

- The number of COP platforms, extent of integration with existing ACG facilities and efficiency and performance improvements associated with alternatives to ACG standardised technology; and
- The extent of fabrication and assembly works that could be undertaken at the existing in-country construction yards.

4.3.1 Select Stage Platform Design Options

4.3.1.1 Stand Alone and Fully Integrated Platform Concepts

At the end of the Appraise stage, the principle platform design concepts taken into Select were:

- Stand alone twin platform concept (analogous to DWG facilities):
  - Based on two bridge-linked platforms, identical to the Drilling, Utilities and Quarters (DUQ) and Production, Compression, Water injection and Utilities (PCWU) platforms. This concept would provide all of its own processing capacity, including injection water, produced water handling, gas export utilities

and power generation. Oil and gas would be exported via tie-ins to the existing marine export oil and gas pipelines to Sangachal Terminal.

- Fully integrated single platform concept (analogous to EA facility):
  - Based on a single Production, Drilling and Quarters (PDQ) platform, with produced gas sent for processing on DWG-PCWU. This concept would require an additional export gas compressor to be installed on DWG-PCWU platform. The new platform would also be integrated with DWG-PCWU for handling of produced water and provision of water injection services. The option of integrating the power generation and distribution facilities with those on DWG-PCWU was also considered.

A Preliminary Environmental Impact Identification (ENVIID) was conducted during the Select stage to determine whether these design concepts could be differentiated in terms of their potential environmental benefits. Issues considered included:

- **Power Generation:** Potential for efficiencies with an integrated single platform;
- **Energy Efficiency:** Considering life of field energy requirements;
- **Construction:** Significant reduction in material use, construction waste and construction emissions for a single platform;
- **Energy Usage:** Reduction in energy used for transportation, installation, hook up and commissioning of a single platform;
- **Produced Water:** Potential reduction in produced water discharged (particularly during start up) with a single integrated platform assuming existing ullage on DWG-PCWU is used; and
- **Pigging Discharges:** Increased pigging discharges associated with a single platform as produced water / injection water pipelines required for integration with DWG-PCWU, would need to be pigged periodically.

4.3.1.2 Partially Integrated Single Platform Concept

A variation to the fully integrated single platform concept was also considered, which consisted of a single platform with its own gas turbine driven gas export compression facility but with water injection support from DWG-PCWU. The advantages of this partially integrated design were:

- Gas could be directly exported to Sangachal Terminal via the existing 28" marine gas export pipeline thereby avoiding the need for gas tie-ins to DWG-PCWU;
- Independent power generator and hence no dependency on another installation for power, improving reliability and reducing down time;
- A water injection system will not be required on the platform, saving weight, space and additional power generation capacity as well as making use of available capacity in the water injection system on DWG-PCWU; and
- Construction and installation of the single platform will use significantly less raw materials, generate less waste, emissions and discharges than a twin platform concept.

An energy efficiency study was undertaken during Select, considering total energy use as a percentage of the total energy associated with the exported products. This study assessed the fully and partially integrated single platform options. The results demonstrated very little difference between the two options; cumulative energy efficiencies of 1.52%[7] (fully integrated concept) and 1.60% (partially integrated concept) were calculated.

The main disadvantage of the partially integrated single platform option was the weight of the topside. Assuming power generation and gas compression systems analogous to those across the existing ACG facilities, the topsides would be heavier than any other ACG design to date and too heavy to be installed in one operation with the existing transportation barge. Up to two modules would be required to be lifted and installed onto the topside offshore, increasing the project hook up and commissioning duration and the risks associated with

[7] Energy Efficiency was calculated as the proportion of energy consumed expressed as a percentage of the total energy exported by the platform.

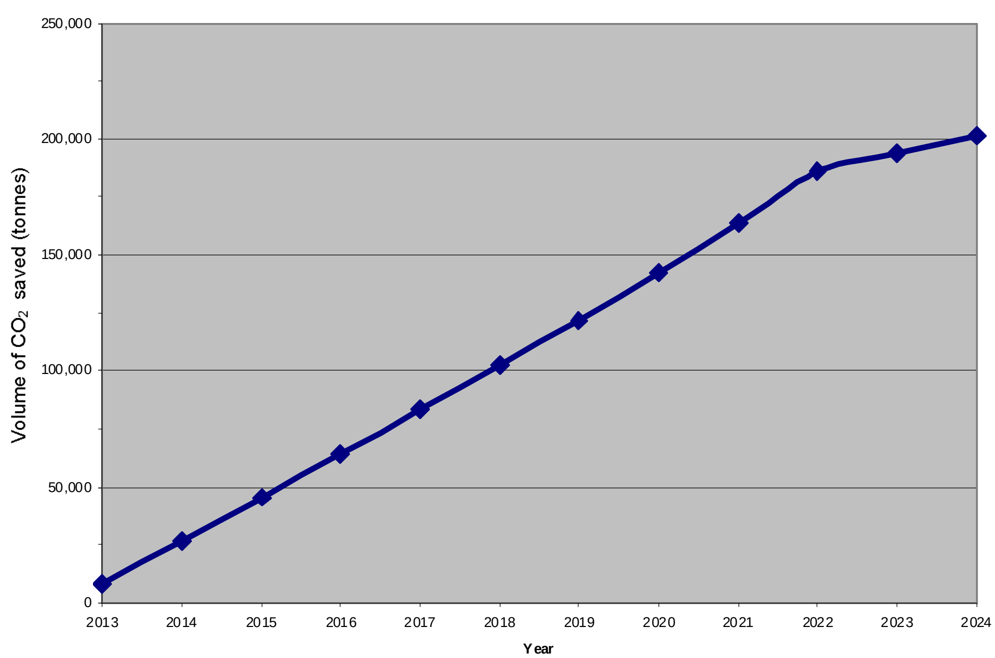
transportation and installation. The additional weight of the topside would also require a larger jacket, increasing material use, construction emissions discharges and waste and increasing the construction schedule.

The energy efficiency study considered an alternative to the partially integrated platform concept whereby the gas turbine direct drives for gas export compression were replaced with electric motor drives and the onboard main power generation capacity was increased. The benefits of this all-electric concept are:

- Improved topsides weight distribution (centre of gravity) such that, following upgrade, the existing transportation barge can be used to install the topside in one operation eliminating the need for offshore modular lifts;
- The electric motors, which are proven technology, are easier and quicker to start than gas turbine direct drives and require less maintenance - the increased availability has the effect of significantly reducing expected non-routine flaring due to process upsets and maintenance. Calculations demonstrated that the all-electric drive partially integrated single platform concept has the potential to reduce flaring across the PSA period by up to 40% compared to the gas turbine direct drive equivalent;
- Better matching of compressor load requirements over the life of the PSA resulting in improved energy efficiency); and
- Increased reliability also implies reduction in safety risk and potential for accidental events.

The reduction in annual CO_2 emissions achieved by the all-electric drive concept compared to stand alone gas turbine direct drives for the export gas compressors is shown in Figure 4.4. The difference in CO_2 savings between the two options in 2023 and 2024 is due to the reduced gas export in this period, resulting in one less compressor required for gas export for both options. This results in a more significant drop in emissions for the standard design (gas turbine drivers) configuration as one less gas turbine is running. Although the relative CO_2 savings between the standard design and the alternative concept (electric deck) reduce in 2023 and 2024 the alternative concept option still results in lower overall emissions during these two years of reduced production.

Figure 4.4 Cumulative Reduction in CO_2 Emissions for the All-Electric Drive Single Platform Concept versus GT Direct Drives for Export Gas Compression



At the end of Select the all-electric partially integrated single platform option, denoted the West Chirag Production, Drilling and Quarters (WC-PDQ) platform, was adopted as the COP Base Case for subsequent development in Define.

4.3.2 Lessons Learnt and Previous ACG Options Appraisal

During previous phases of ACG a significant amount of work was undertaken to assess the viability of options that would reduce emissions to air/water and improve the energy efficiency or overall environmental performance of the facilities.

Some options were discounted based on space, weight, technological challenges or adverse economics. Similarly, some options were shown to improve environmental performance whilst fulfilling the weight and space restrictions of the offshore environment. A summary of the lessons learnt from previous phases is provided within the sections below.

4.3.2.1 Discounted Options

The COP was able to use research from earlier phases to ensure options that were previously discounted for technological, economic or practicality reasons were not considered in the design. A review of previously considered options was undertaken during the early stages of the project to reassess viability and to confirm that such options were still not viable.

The reader is referred to the Phase II ESIA for a full description of options and the advantages/disadvantages of each, however, a summary is provided below detailing previous considerations and why they were found to not be viable.

Discounted Options for Reducing or Eliminating Emissions from Combustion

- **CO_2 Recovery & Sequestration**. The principle would be to capture the CO_2 emissions from combustion sources (gas turbines primarily) and dispose to sub-surface. This was not adopted due to weight of the equipment required to capture and dispose of the CO_2, safety aspects, technological novelty and adverse economics.

- **Solar Thermal and Solar Photovoltaic Power Generation**. The use of solar thermal or solar photovoltaic technology could help to reduce combustion emissions by supplementing the energy requirements of the topsides. This option is technically impractical and would not be able to make a significant contribution to the energy requirement of the topsides without the presence of impractically large solar collection areas. Additionally, this option was not found to be economically viable.

- **Wind Power Generation**. Wind power could help to reduce the combustion emissions by supplementing energy requirements for the topsides. This option was found to have limited application offshore, represent a safety risk (due to rotating blades) and exhibit adverse economics.

- **Wave Power**. Wave driven power generators could help to reduce combustion emissions on the topsides. However, the Caspian Sea is a low wave energy environment and therefore this option was not considered practical.

- **Centralised Onshore Power Generation**. This option would consist of a centralised power generation scheme onshore (Sangachal) and subsequent transmission via sub-sea cable network to the offshore platforms. This option would not eliminate the production of combustion emissions but would help to reduce such emissions through increased efficiency of power generation. However, calculations for previous phases demonstrated the CO_2 saving to be only marginal. This option was not adopted in previous phases due to size and weight concerns as high voltage DC/AC converter modules would be required on the offshore platforms. Additionally, this option suffered from unfavourable economics.

- **Combined Heat & Power Offshore and Combined Cycled Power Generation Offshore.** There is no significant requirement for heating on the offshore platforms, as such, this option was not considered further in previous phases. The same limitation applies to the WC-PDQ topside and therefore was not considered a viable option.

- **Low NOx Gas Turbine Offshore**. In previous phases, dry low NOx turbine technology was considered for the offshore platforms. Such technology can achieve around a 90% reduction of NO_X emissions. The technology was rejected previously due to the requirement of dual fuel machines offshore (dual fuel turbines are required to enable power generation using diesel fuel when fuel gas is not available) for which low NO_X was not available, and general operating problems that can occur such as 'flame-out' and the general robustness of the technology. The issue was re-visited for COP to identify whether such technology had improved, particularly in terms of reliability, and to identify whether there could be advantages in employing such technology. To this end, a review of current low NO_X technology and operational feedback and predictive modelling undertaken to identify whether normal combustion emissions from gas turbines on the WC-PDQ platform could have an adverse environmental impact. The decision was made that low NO_X technology should not be employed for the WC-PDQ topside for the following reasons:
  - There is a need for a dual fuel (gas and diesel) capability for the WC-PDQ turbines and there are currently no low NO_X burners available on the market for dual fuel turbines (Rolls Royce have recently withdrawn this option).
  - Low NO_X burners respond poorly to changes in fuel gas composition (trip) which can occur more frequently offshore.
  - Low NO_X burners respond poorly to sudden changes in load (trip) which also occurs more frequently offshore.
  - Low NO_X burner turbines produce more emissions than normal turbines when under low loads which will occur offshore during early years.
  - The main reason for low NO_X burners being installed on turbines is to protect the health of local populations who are living nearby. High NO_X levels can cause breathing difficulties and long term health effects. The WC-PDQ platform is not positioned in the vicinity of any local populations and the air dispersion modelling study undertaken demonstrated that even without low NO_X burners there are no concerns regarding harmful NO_X levels, or concentrations above regulatory limits either offshore or onshore.

- **Offshore fuel gas H_2S removal using either zinc oxide absorption or by amine sweetening and sulphur recovery.** Air dispersion modelling studies demonstrated that the concentration of SO_2 in emissions had little impact on air quality around the greater Baku area and therefore there is no requirement for the removal of H_2S in fuel gas. In addition H_2S or SO_2 removal has been shown in previous phases to be either expensive or consist of large heavy plant (depending on the technology used for removal) meaning that it was not practicable for application in the offshore environment.

Flaring

- **Offshore Flare Gas Recovery**. Flare gas recovery systems enable the recovery of hydrocarbon vapours from the flare system and their return to the upstream process during normal purging and low flow conditions. In the absence of fuel gas, purge gas would need to be inert gas. This would increase the size and weight of equipment on the topsides, both for generating inert gas and for compressing recovered hydrocarbon vapours back into the process. The size and weight issues have resulted in flare gas recovery options offshore being discounted in previous phases. The same reasons for discounting this technology are applicable to the WC-PDQ topside.

- **Non-Continuously Lit Pilot Ignition Systems**. A non-continuously lit pilot would eliminate the requirement for continuously lit flare tips, thereby reducing emissions. The systems evaluated previously were not considered viable due to reliability issues associated with electronic ignition of the flare, or due to adverse economics.

Discharges to Sea

- **Air Cooling**. Previous projects had considered the possibility of cooling the platform using air in order to eliminate or reduce the need to abstract (and discharge) seawater. However this was deemed to be impossible to implement due to the combination of cooling demand, limited availability and restrictions on weight allowance. As such, the most efficient method of cooling was concluded to be the seawater lift system currently employed on all the offshore platforms.

4.3.2.2 Adopted Options

The environmental options assessment undertaken during previous phases identified a number of features that improved environmental performance of the platforms whilst fulfilling the weight and space restrictions of the offshore environment. Such features were incorporated into previous designs and were included as part of the WC-PDQ platform base case design from early stages of development. A summary of these environmental performance features are as follows.

Emissions to Air

- **Electric Flash Gas Compression**. Two flash gas compression trains (2 x 50% configuration) have been selected as the system configuration for the WC-PDQ topside. This continues the same configuration as used in previous phases. This configuration provides higher availability than a single train to process the full gas inventory and consequently provides a reduction in gas flaring should a compressor suffer downtime.

- **Flare Gas Metering**. Although the rate of gas purge in the flare systems is calculated during design, the valve and metering system allows the volume of purge gas to be proactively controlled, thereby allowing the volume flared to be optimised i.e. the minimum flared while still maintaining safe conditions. A needle valve is in place to throttle flare gas into the flare header. Metering is also provided to measure the amount of gas flared during upset conditions.

- **Gas Dehydration Off-Gas Disposal via Flaring**. This achieves a reduction of greenhouse gas emissions by combusting the methane in off-gas (into carbon dioxide and water), rather than emit non-combusted product into the atmosphere (which has higher greenhouse gas properties than CO_2). This design feature was adopted in previous phases and continued in the COP design.

- **Fugitive Emissions**. The project shall achieve a reduction in fugitive emissions by incorporating the following aspects into the design.
    - Reduced number of valves, flanges, connections and intrusive instrumentation;
    - Use of high efficiency dry gas seals on flash gas and export gas compressors;
    - Closed drains for drainage of the hydrocarbon system; and
    - All process vents piped to flare.

Emissions to Water

- **Produced Water Disposal** – Re-Injection. This is a long term solution for disposal of produced water and minimises discharges into the Caspian Sea. Treated produced water will only be discharged overboard due to a downtime event such as an emergency, accident or mechanical failure (Refer to Chapter 5 Section 5.84)
- **Copper-Chlorine Seawater Anti-fouling System**. Typical seawater anti-fouling systems utilise a hypochlorite generator to dose incoming seawater for anti-fouling control. The copper-chlorine system employed during previous phases, and included on the WC-PDQ topside, uses the application of direct current electrolysis to produce copper and chlorine at low concentrations. This results in significantly lower concentrations of chlorine discharged into the Caspian over the lifetime of the project from the seawater system.

<u>Ozone Depleting Chemicals</u>

- **Fire Fighting Systems**. No halon fire suppressants will be used in fire fighting systems. As used in previous projects, deluge/water mist and Niagara 3-3 Foam will be the primary methods of fire fighting. Niagara foam is based on natural protein foaming agent and contains no harmful synthetic detergents, glycol ethers, alkyl phenol ethoxylates (APE), totyltriazoles or complexing agents. It is biodegradable and virtually non-toxic to aquatic organisms.

- **Refrigerants**. Refrigeration or HVAC systems on the WC-PDQ will not utilise HCFC and CFC gases.

4.3.2.3 Mud and Cuttings

During the ACG Phase 1 project a Best Practicable Environmental Option (BPEO) assessment was undertaken considering the handling and disposal of water based and non-water based mud and cuttings from drilling operations. The options evaluated for non-water based mud (NWBM) included:

- The collection of mud and cuttings and ship to shore for disposal; and
- Re-injection offshore.

The assessment concluded that the BPEO was that NWBM and cuttings should be re-injected offshore. Cuttings generated prior to the installation of a cuttings re-injection well (e.g. during predrilling programme with a mobile drilling unit) or when the cutting re-injection system is not available should be contained and shipped to shore for treatment and disposal. This approach has been adopted across ACG Phases 1, 2 and 3. No routine discharge of NWBM and cuttings is a requirement of the PSA. It was determined that the cuttings reinjection (CRI) well would be partially drilled during predrilling and completed later by the WC-PDQ platform rig once the latter has commenced operations. The CRI well could be completed by the MODU, however, the MODU vessels available are not equipped with any of the major process and pumping equipment required to allow it to prepare cuttings for re-injection or systems to reinject the cuttings into the CRI well. Therefore NWBM and cuttings will be recovered and shipped to shore during predrilling.

The BPEO assessment of water based mud (WBM) and cuttings considered the following options:

- Discharge to sea;
- Collection of cuttings and ship to shore for treatment and disposal; and
- Re-injection off shore.

Based on the expected low levels of environmental toxicity of the chemicals in the WBM and the localised impact of solids deposition, which will occur near to the discharge point, it was concluded that WBM and cuttings, which meet the relevant project standards, would be discharged to the marine environment. This approach has been adopted across ACG Phases 1, 2 and 3.

Monitoring of the benthic environment and water column in the vicinity of the existing ACG platforms and across the ACG Contract Area is reported in Chapter 6 of this ESIA. The monitoring demonstrates no appreciable impact to the marine environment associated with discharge of WBM and cuttings. Discharge of WBM and cuttings (in accordance with relevant project standards) to the marine environment has therefore, been incorporated into the COP Base Case Design.

4.3.2.4 Pipeline Commissioning Discharges

The process of constructing subsea pipelines involves flooding them with water to facilitate construction and pressure testing. To prevent corrosion, the seawater used to flood the pipelines must be chemically treated to remove oxygen and inhibit the activity of bacteria; a dye is added to the water to provide a method of identifying leakage during pressure testing. On completion of construction and before a pipeline is used for its intended purpose, the treated water must be removed from the pipeline system.

Options to eliminate or reduce the use of chemicals during pipeline commissioning were considered and are summarised in Table 4.2.

Table 4.2 Options Considered to Reduce Chemical Use During Pipeline Commissioning

No.	Option	Applicability Yes / No	Reason for Unsuitability
1	Reduce biocide dosage	No	There is uncertainty in the duration that water will be present in the pipelines. The biocide dosage must ensure concentrations are sufficient to control biological growth for between 6 and 24 months.
2	Use no chemical additives and use Intrinsically Clean Water	No	This option does not treat the biological systems that will be present in the pipeline prior to flooding and the level of confidence that the pipeline will be protected from corrosion is uncertain.
3	Use air or inert gas for pressure testing	No	The risks to personnel and equipment are significantly higher when pressure testing with gas as the amount of energy stored in a pressurised gas, and released, in the event of a failure are far higher.
4	Recycling	No	Due to the planning constraints, the requirement to minimise disturbance to existing operational facilities and the lack of interconnectivity between the pipelines there are no opportunities to reuse the water from one pipeline and another.
5	Subsurface reinjection	No	The injection water quality, required to maintain well functionality, excludes this option.
6	Contain and ship to shore	No	Due to the space and weight constraints on the existing DWG-PCWU and WC-PDQ platform there is no opportunity to contain these large volumes of treated seawater on production facilities. The storage of the volumes of treated water required for this operation would require an additional vessel. The additional vessel would have to be a `tanker type` vessel as construction and pipelay vessels do not have the levels of tankerage that would be required. Having `tanker type` vessel to collect water from a subsea pipeline would present significant risk and technical challenges, for example tankers do not normally have systems or ROV equipment required to support this type of operation where a hose may be connected to a subsea pipeline.
7	Send to terminal	Partially used	Sangachal Terminal have indicated that the maximum water slug size received and processed is 1,000m^3. Where practical returning commission fluids to the Terminal forms part of the methodologies

The selected option is therefore to use chemically-treated seawater to flood and hydrotest the pipelines and to discharge this water to sea in cases where it cannot be sent to the Terminal (for instance, because of the volume or location of the event)[8].

The chemicals added to the hydrotest seawater will comprise a tracer dye, an oxygen scavenger and a biocide. All three chemicals have been extensively used in previous ACG hydrotesting activities and have been:

- The subject of extensive field and laboratory studies; and
- Extensively reviewed and approved by the MENR.

[8] Refer to Chapter 5 Section 5.5

The tracer dye and oxygen scavenger are of very low toxicity and the previous ACG-MENR evaluation process concluded that they would have no environmental impact. The biocide was selected because it rapidly hydrolyses (both in the pipeline and following discharge) to harmless components. Laboratory and field studies have shown that the toxicity of the biocide is reduced by more than 90% during the expected period it is in a pipeline; this reduction in toxicity, combined with low persistence following discharge, ensures that the environmental effects of discharging hydrotest water to sea are minimised.

4.4 Define Stage

During the Define stage of the CVP, the project scope, cost and schedule will be finalised. The main aspects being considered during Define are:

- **Power Generation:** Review and update of the COP Base Case power demand requirements;
- **Flaring:** Review of potential COP flaring expected based on updated reservoir information and flaring across the ACG field to date;
- **Sewage Treatment System:** Selection of the preferred sewage treatment system for the WC-PDQ platform. As part of the COP engineering design process a team was established to complete a comprehensive review of sewage treatment technology. The team included an external consultant who specialises in sewage treatment systems and technology. The review considered the problems with the existing ACG platform treatment plants to ensure that any technology selected for the West Chirag PDQ will not have the same compliance, operability and reliability issues. The review included an assessment of the ability to comply with applicable discharge standards, the operability and reliability of the plant, sludge generation and handling, space and weight restrictions and maintenance requirements. From this review a decision was taken to include membrane filtration technology for the treatment of black water on the WC-PDQ platform. The vendor selection process and compliance assurance process is ongoing;
- **Waste Minimisation and reduction:** Review of waste minimisation and reduction opportunities will be pursued at three levels:

  – **Design Stage:** Reviewing the specification for all material acquisition that generates waste, and assessing the opportunity to reduce waste at source. To date a key focus area has been assessment of options to reduce waste from painting activities. The COP will benefit from work undertaken during the ACG Project, that resulted in the acceptance of low VOC paints, as well reductions in the quantities of paint required for the jacket following a review of the corrosion protection requirements.

    A review of COP paint usage included challenging the need to paint the jacket and exposed topside surfaces as well as consideration of alternative corrosion protection coatings. Alternative corrosion protection options that would preclude the use of paint, such as increasing the wall thickness of the steel or installing sufficient sacrificial anodes on the jacket were rejected due to the weight limitations of the installation barge STB1 and safety issues associated with using divers to install sufficient sacrificial anodes once the jacket is installed. Alternative corrosion painting systems were considered, such as thermal aluminium systems, however the application systems are not flexible enough for jacket fabrication.

    Opportunities do exist to reduce paint waste during construction by developing good paint shop work practices and reviewing procurement options, these opportunities will be pursued with the construction contractors.

  – **Construction Stage:** Use construction contracts to encourage contractors to minimise the generation of waste. The main fabrication and installation contractors will be required to develop waste minimisation plans and key performance indicators that will focus on promoting efficient resource usage and reporting performance against waste minimisation targets. Site based initiatives, to increase the segregation of waste to maximise recycling will be developed including workforce training and awareness schemes, as well as measures to reduce vehicle movements will be developed once the construction contractors have been selected.

  - **Service procurement:** Local recycling services will be actively sought to maximise the potential for recycling material as close as possible to the point of generation.

- **Sand Treatment:** Consideration of sand treatment packages that will improve performance compared to the existing packages on the operating ACG offshore facilities. Due to sand being wetted with oil and solidifying at low temperatures, current packages perform below expectations, resulting in potential damage to platform process equipment and the increased likelihood of equipment/platform shutdown. To improve performance the project is working with vendors to determine alternative designs using data and samples collected across the ACG field and test rig trials.

Should any of these studies result in a change to the COP Base Case design as assessed within this ESIA, the COP Management of Change Process will be followed as detailed within Chapter 5 Section 5.11.

5. Project Description

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5.1 Introduction

This Chapter of the Environmental and Socio-economic Impact Assessment (ESIA) describes the construction and operational activities associated with the Chirag Oil Project (COP). The description presents the technical design basis for the project facilities and associated planned activities for the following project phases:

- Offshore predrilling;
- Onshore construction and commissioning of offshore facilities;
- Infield pipeline installation, tie-in and commissioning;
- Platform installation, hook up and commissioning;
- Platform drilling;
- Offshore operations and production; and
- Decommissioning of offshore facilities.

Estimated emissions, discharges and wastes from the COP are presented for each project phase; emission estimate assumptions are provided in full within Appendix 5A.

This Chapter provides the basis for the ESIA as presented in Chapters 9-13 and was prepared during the 'Define' stage of the project. During subsequent stages of the COP, there may be a need to change a design element. The COP Management of Change Process that will be followed should this be necessary is presented in Section 5.11 of this Chapter.

The Base Case design of the COP includes:

- West Chirag Production, Drilling and Quarters (WC-PDQ) platform;
- Infield subsea pipelines to tie the WC-PDQ platform into the existing Azeri Chirag Gunashli (ACG) pipeline infrastructure to transport hydrocarbon products to the Sangachal Terminal for processing to export specification; and
- Infield pipelines for:
  - Produced water transfer from the WC-PDQ platform to Deep Water Gunashli Production, Compression, Water Injection and Utilities (DWG-PCWU) platform; and
  - Provision of injection water to the WC-PDQ platform from the DWG-PCWU platform.

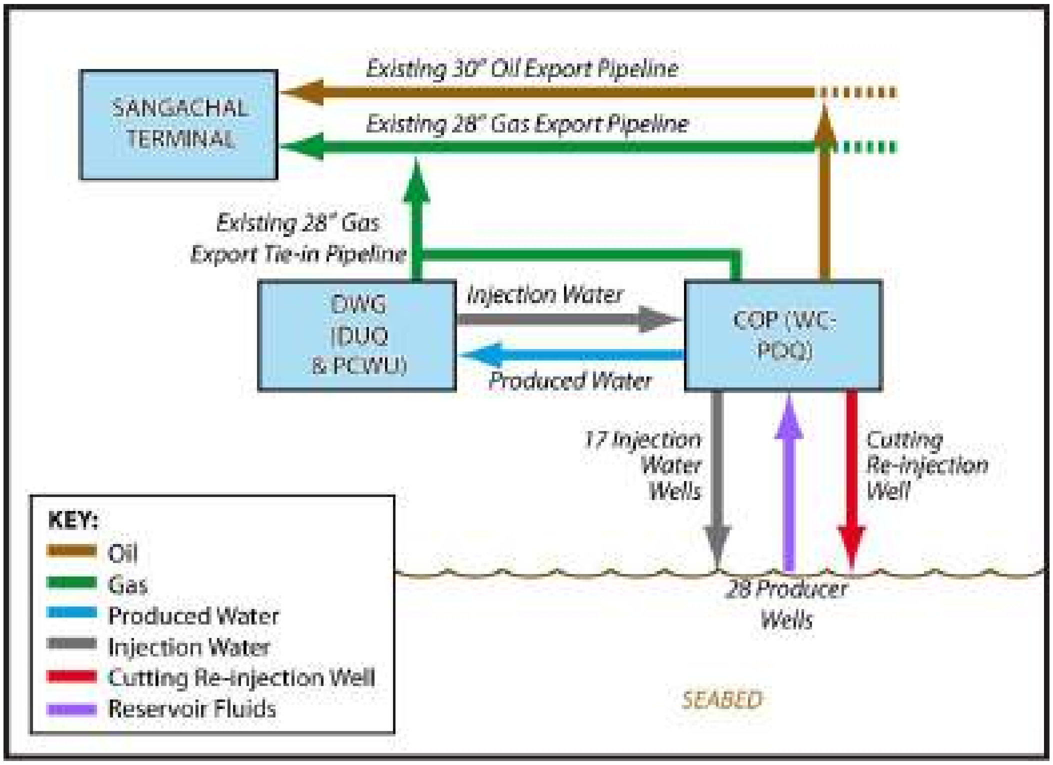
Up to 28 producer wells, 17 water injection wells and 1 cutting reinjection (CRI) well are planned for the COP. While no subsea water injection wells will be drilled, space will be provided on the WC-PDQ platform to allow tie-in to a future subsea water injection system at a later date, if required.[1]

The COP will make use of existing capacity/ullage within the Sangachal Terminal processing facilities and no new infrastructure or Terminal expansion will be required.

Figure 5.1 presents an overview of the COP and the associated tie-ins to the existing ACG facilities and infrastructure.

[1] Subsea water injection wells would allow more producer wells to be drilled. These are not part of the COP Base Case.

Figure 5.1 Overview of Chirag Oil Project



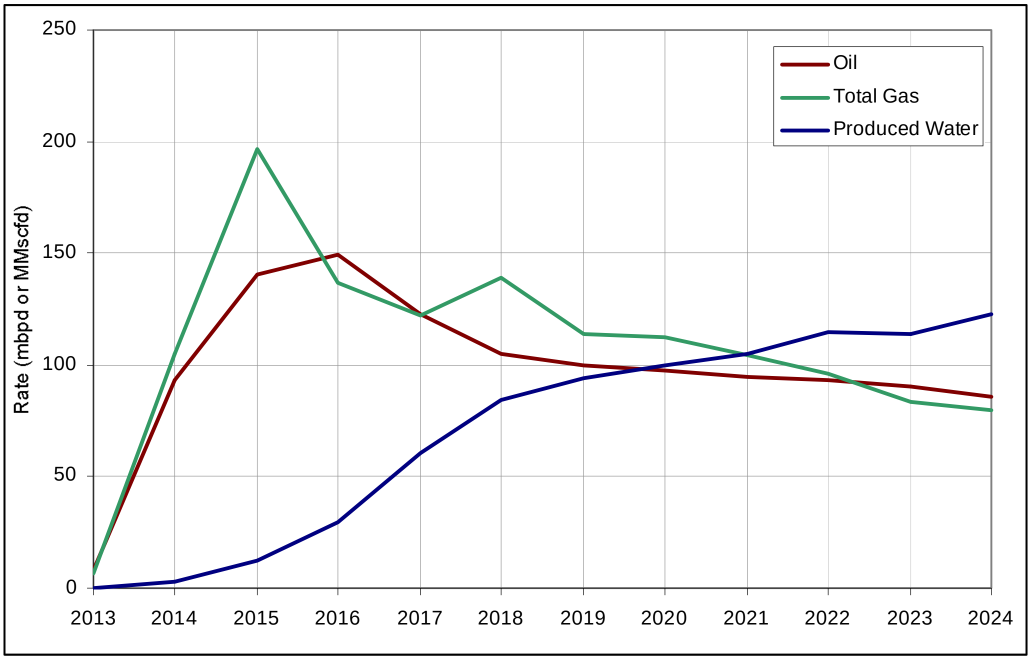
Planned first oil for the COP is late 2013 with peak production anticipated in 2015. The ACG field, comprising 5 Pereriv (A, B, C, D, E) and 4 Balakhany (VII/VIII/IX/X) reservoirs, contains "total-original-oil-in-place" of 16.2 billion standard barrels (Bstb). The COP aims to develop the Balakhany reserves and accelerate recovery of the Pereriv resources in the Chirag-Deep Water Guneshli (CDWG) area of the ACG field. The COP offshore facilities have been designed to process up to:

- 185 thousand barrels per day (Mbpd)) oil;
- 290 million standard cubic feet per day (MMscfd) gas[2]; and
- 120 thousand barrels per day (Mbwd) of produced water.

Figure 5.2 illustrates the estimated COP oil, produced water and total gas production profile over the Production Sharing Agreement (PSA) period.

[2] Including 80MMscfd lift gas and fuel gas

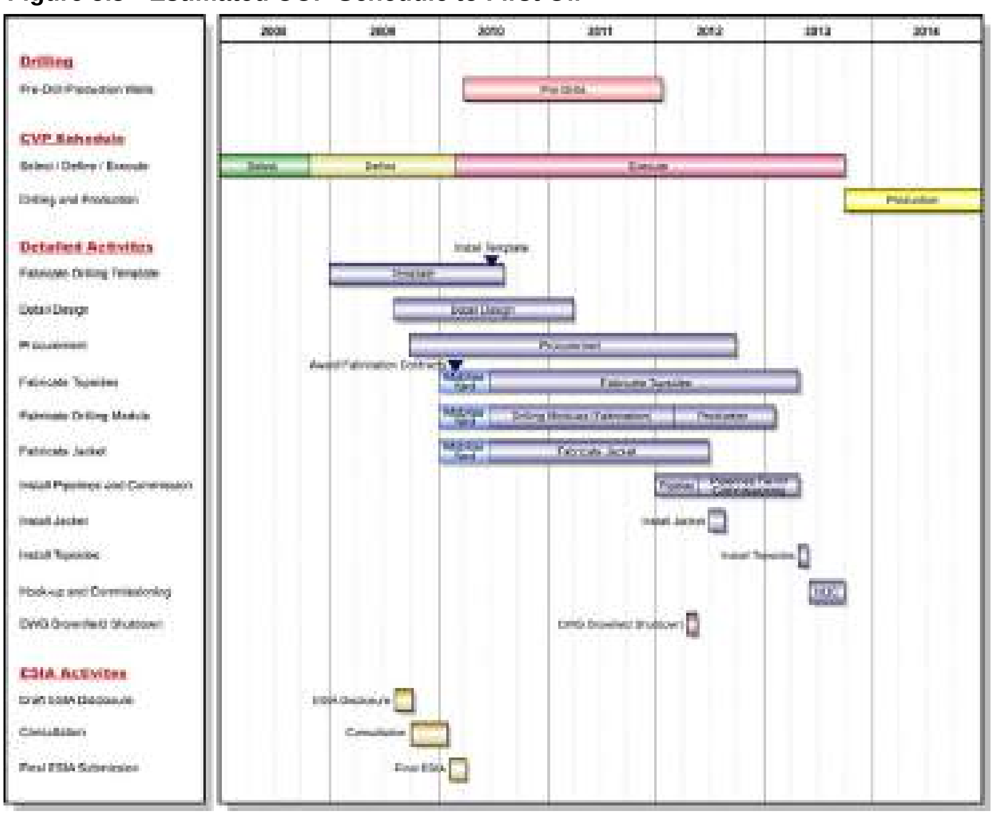
Figure 5.2 Estimated COP Production Profiles Across the PSA Period



5.2 COP Schedule

Key COP milestones are shown in Figure 5.3. The milestones are based on the best available knowledge at the time of writing. The timing for each will be finalised prior to the end of the Define stage of the BP Capital Value Process (CVP).

Figure 5.3 Estimated COP Schedule to First Oil



The following sections discuss key activities associated with each phase of the project.

5.3 Predrilling

The purpose of predrilling is to accelerate early production once the platform is in place. It is planned that up to 20 wells (16 producer wells, 3 water injection wells and 1 cuttings reinjection well) will be predrilled, using a Mobile Offshore Drilling Unit (MODU), prior to the installation of the WC-PDQ platform. It is anticipated that the wells will be drilled using the "Dada Gorgud" semi-submersible rig. This rig has been used for all of AIOC's predrilling activities in the ACG Contract Area (Figure 5.4).

Figure 5.4 Dada Gorgud Semi-Submersible Rig

5.3.1 MODU (Predrilled) Well Design

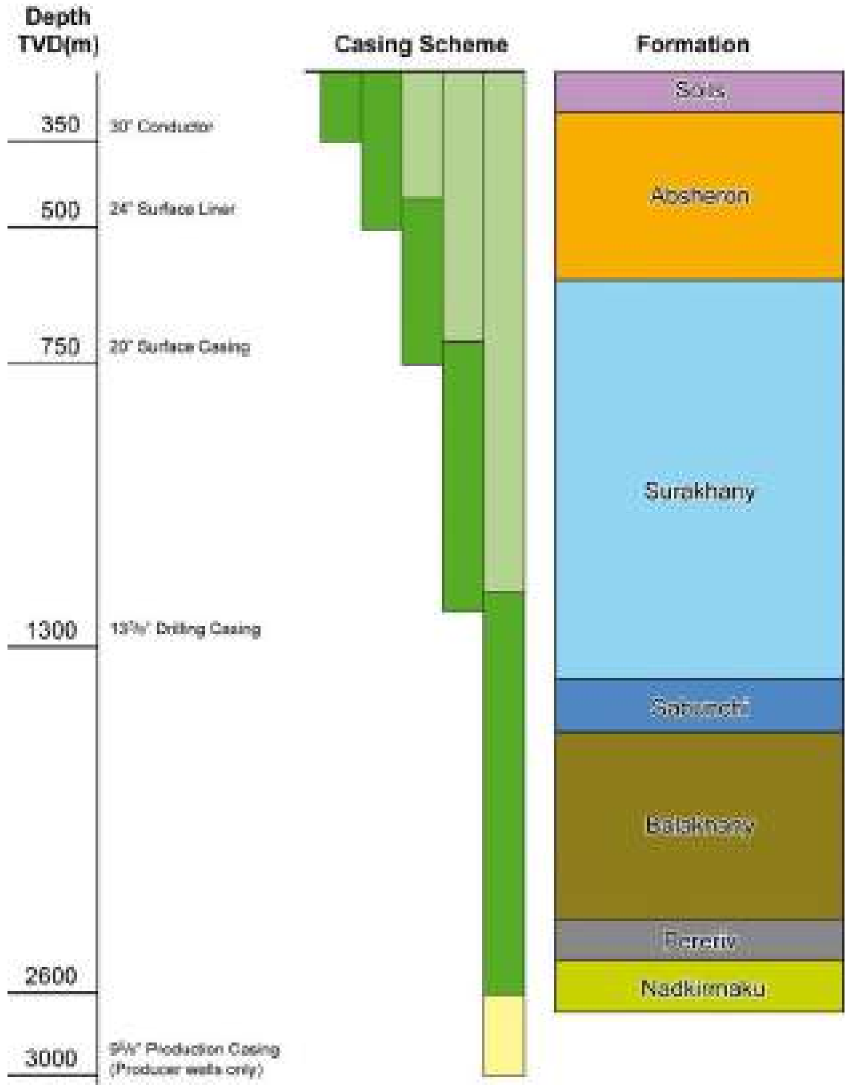
The generic predrill well design is presented in Table 5.1 and illustrated in Figure 5.5. The casing design for the COP wells will be similar to the current designs used on the Pereriv wells in the ACG field. As was required for the Central and West Azeri wells, the drilling studies undertaken as part of the COP design evolution have demonstrated that a 24" casing liner may be required to minimise risk associated with shallow seabed instability.

Table 5.1 Generic COP Predrill Well Design

Hole Size (Drill Bit Diameter)	Casing Outer Dimension	Description	Setting Depth (m TVD BRT[1])	Drilling Mud System	Disposal Route of Drilling Muds
36"	30"	Conductor	+/- 350	Seawater & gel sweeps	Discharge to sea
28"	24"	Drilling Liner	+/- 500	WBM[2]	Discharge to sea
26"	20"	Surface	+/- 750	WBM	Discharge to sea
16"	$13^{3}/_{8}$"	Intermediate	+/- 1,300	SBM[3] or LTMOBM[4]	Ship to Shore
12¼"	$9^{5}/_{8}$"	Production	Top Reservoir (2,600 - 3,000)	SBM or LTMOBM	Ship to Shore

1 m TVD BRT: True Vertical Depth Below Rotary Table in metres.
2 WBM: Water Based Mud.
3 SBM: Synthetic Based Mud.
4 LTMOBM: Low Toxicity Mineral Oil Based Mud.

Figure 5.5 Generic Predrill Well Design



Note: Target formation for CRI well will be the Sabunchi formation.

5.3.2 MODU Drilling Activities

5.3.2.1 Drilling Template and Foundation Pin Piles

To control the horizontal positioning of the predrill wells, a drilling template comprising 20 “slots” (i.e. wellhead receptacles) will be lifted into position by the Derrick Barge Azerbaijan (DBA), lowered onto the seabed and levelled using a hydraulic system. Following installation of the drilling template, four 96” diameter 110m length pin piles will be driven into the seabed using an underwater hydraulic hammer. These pin piles will form the temporary foundation support for the WC-PDQ jacket when it is installed (see Section 5.6.2). The construction and installation activities associated with the template and pin piles are described in full within the COP Fabrication and Installation of the Drilling Template Environmental Technical Note submitted in April 2009.

5.3.2.2 MODU Positioning

The MODU will be moved into place above the drilling template by up to 3 vessels (each with up to 15 Persons on Board (POB). Anchoring of the MODU is expected to result in the following seabed disturbances:

- **Anchor setting:** 8 anchors, 5m wide and 200m long seabed disturbance; and
- **Anchor chains:** 8 chains, 2m wide and up to 300m long seabed disturbance.

The total area of seabed likely to be affected is therefore approximately 12,800m^2.

The positioning and set up of the MODU is expected to take up to 3 days and a further 3 days to demobilise the rig at the end of the drilling programme. A mandatory 500m exclusion zone will be established around the rig for the duration of the predrilling programme.

5.3.2.3 Pilot Hole

Before commencing predrilling, it is planned that 1 pilot hole will be drilled to determine whether any high-pressure shallow gas zones are present in the area. The pilot hole will be drilled to a depth of approximately 1,000m using a seawater system and gel sweeps[3] of equivalent specification and environmental performance as used for previous ACG pilot holes[4]. It is predicted that approximately 60m^3 of cuttings will be forced out of the hole and these will be directly discharged to the seabed over approximately 8 hours. The hole will subsequently be drilled and cased section by section as part of the predrilling programme as described in Section 5.3.2.4 below.

5.3.2.4 MODU Drilling of Predrill Wells

Prior to any drilling activities, the rig crew will apply pipe dope to the drilling equipment joints to prevent thread damage. Pipe dope is a lubricating grease which seals the joints to stop them rubbing and wearing. It is anticipated that BESTOLIFE 3010 Ultra (OCNS Category E) or a similar heavy metal free dope will be used for this purpose.

All well-bore sections will be drilled using drilling fluids/drilling muds, the primary role of which is to:

- Maintain down-hole pressure to prevent formation fluids entering the well bore;
- Remove drill cuttings generated by the drill bit as it bores through the rock strata and transport these to the surface;
- Lubricate and provide cooling to the drill bit and the drill string; and
- Seal the wall of the well-bore in order to provide stabilisation.

Drilling mud for the predrill programme will be routinely prepared on shore and supplied to the MODU via hose connections from supply vessels. The mud pumping system and connections between the MODU and supply vessels are designed to avoid discharges to the marine environment during mud transfer.

Conductor Sections

Drilling fluids for the 36” conductor sections will comprise a seawater and gel sweeps system of equivalent specification and environmental performance as used for previous ACG conductor section drilling fluid systems, which will be pumped down the drill string, forcing the

[3] Worst case chemical use for pilot hole drilling is expected to be similar to estimated use for the 36” hole sections. Refer to Tables 5.2 and 5.5 for chemical composition and estimated volumes.
[4] The COP Management of Change Process (Section 5.11) will be followed should alternative project chemicals be required

cuttings up the hole and onto the seabed[5]. Table 5.2 presents the expected composition of the conductor section drilling chemicals and the estimated use per hole.

Table 5.2 Estimated Use of Drilling Chemicals Per Hole – 36" Conductor Section

Chemical[1]	Composition	Function	Estimated Use per Hole (tonnes)[2]	Hazard Category[3]
Bentonite	Clay Ore	Viscosifier and removal of cuttings	20	E
Sodium Bicarbonate	Sodium Bicarbonate	pH treatment and calcium ion separation	1	E
Fluorescent Dye	Fluorescein	Cement tracer	0.1	GOLD

1 Refer to Appendix 5C for further details of regarding composition and function of COP chemicals with potential for discharge
2 Volumes will depend on the actual subsurface conditions encountered as such these volumes are best estimates based on previous experience.
3 Two methods of hazard assessment are used in accordance with internationally recognised practice - CHARM and Non CHARM. The CHARM Model is used to calculate the ratio of predicted exposure concentration against no effect concentration (PEC:NEC) and is expressed as a Hazard Quotient. Hazard Quotients are assigned to 1 of 6 categories and "GOLD" is the least hazardous category. Those chemicals that cannot be modelled by CHARM are assigned to a category (A to E) based on toxicity assessment, biodegradation and bioaccumulation potential. Category E is the least harmful category. Source: CEFAS, Offshore Chemical Notification Scheme - Ranked Lists of Notified Chemicals, Updated February 2009. Refer to Appendix 5D for further details regarding determination of chemical hazard categories.

Drilling Liner and Surface Holes

The 28" and 26" drilling liner and surface hole sections will be drilled using a water based mud (WBM). It is proposed to use an Ultradril mud of the same specification and environmental performance as used for previous ACG wells (refer to Chapter 9 for environmental performance/toxicity details). If there is a requirement to change the drilling mud composition or to select a different drilling mud for commercial or technical reasons, the COP Management of Change Process (see Section 5.11) will be followed.

Table 5.3 presents the expected composition of the drilling liner and surface hole drilling mud (assuming use of an Ultradril mud) and the estimated volume per hole.

Table 5.3 Estimated Use of WBM (Ultradril) Per Hole - 28" and 26" Hole Sections

Chemical[1]	Composition	Function	Estimated Use per Hole (tonnes)[2]	Hazard Category[3]
Barite	Barium sulphate ore	Weighting agent	200	E
Bentonite	Clay ore	Viscosifier and removal of cuttings	20	E
KCL	Potassium chloride	Borehole stabiliser	15	E
Ultrahib	Polyether amine	Stabiliser / Shale Inhibitor	3	GOLD
Polypac	Polyanionic cellulose	Encapsulater	0.3	E
Flo-Trol	Cellulose polymer/ Modified starch	Fluid loss control and reduces the risk of drill string sticking	0.3	E
Duovis	Bio-polymer	Viscosifier	0.5	GOLD
UltraFree	Synthetic Alyphatic Hydrocarbon	Lubricant, prevents bit balling	2	GOLD
Ultracap	Polymer	Encapsulator	1	GOLD
Sodium Bicarbonate	Sodium bicarbonate	pH treatment and calcium ion separation	1	E
Citric acid	Citric acid	pH treatment and calcium ion separation	3	E

Notes as per Table 5.2

The WBM and cuttings from the 28" and 26" hole sections will be returned to the MODU using a submerged Mud Recovery pumping System (MRS) located at the subsea wellhead. The mud and cuttings will then be treated in a solids control unit, separating mud from the cuttings onboard the MODU. Recovered WBM will be reused whenever possible. It is planned to discharge the cuttings to the sea via the MODU cuttings caisson at 11m below the sea surface, in accordance with applicable PSA standards[6]. If cuttings accumulate on the seabed

[5] The COP Management of Change Process (Section 5.11) will be followed should alternative project chemicals be required
[6] There shall be no discharge of drill cuttings or drilling fluids if the maximum chloride concentration of the drilling fluid system is greater than 4 times the ambient concentration of the receiving water.

to a degree where they could interfere with jacket installation, a hose will be used to discharge cuttings away from the template and jacket location.

Where practicable, residual WBM from the surface hole casing or left in the MODU mud system at the end of the drilling section will be recovered and shipped to shore for re-use or disposal. Where this is not practicable, residual WBM (up to approximately 160 tonnes per hole) will be discharged to sea in accordance with the applicable PSA requirements[4].

Intermediate and Production Hole Sections

To improve well bore stability, ensure appropriate lubrication, optimise compatibility with deeper well formations and minimise the risk of stuck pipe, it will be necessary to change to a SBM or LTMOBM for the lower 16" and $12^1/_4$" well sections. The use of a SBM or LTMOBM will be dependent on the actual well conditions encountered during drilling operations. Table 5.4 presents the typical composition and estimated volumes expected to be used per hole.

Table 5.4 Estimated Use of SBM/LTMOBM Per Hole - 16" and 12 ¼" Holes

Chemical[1]	Composition	Function	Estimated Use per Hole (tonnes)[2]	Hazard Category[3]
Chemicals Common to both SBM and LTMOBM				
Barite	Barium sulphate ore	Weighting agent	200	E
Bentone/truvis	Organoclay	Viscosifier and removal of cuttings	4	E
Calcium Chloride	Calcium chloride	Borehole stabiliser	12	E
Ecotrol	Polymer	Fluid loss control and reduces the risk of drill string sticking	1	E
Lime	Calcium hydroxide	Alkalinity, calcium ion treatment	10	E
Chemicals within SBM Only				
Novamull	Emulsifier	Emulsifier	10	C
Novawet	Surfactant	Wetting agent	2	C
Chemicals within LTMOBM Only				
Versamul	Emulsifier	Emulsifier	10	B
Versawet	Surfactant	Wetting agent	2	E

Notes as per Table 5.2

It is proposed to use LTMOBM and/or SBM of the same specification as used for previous ACG wells[7].

Following installation of the surface casing (see Section 5.3.2.5), the blow-out preventer (BOP) and marine riser will be deployed for drilling the intermediate and production hole sections. The riser allows mud and cuttings to be returned to the MODU. Onboard the MODU, mud and cuttings will pass through the MODU Solids Circulation System (SCS) that separates SBM/LTMOBM from cuttings via a series of shale shakers, a vacuum degasser and centrifuges, which, in turn, separate increasingly smaller cutting particles from the SBM/LTMOBM Separated SBM/LTMOBM will be reused either on the MODU or transported to an operating platform for use where practicable. Unused separated SBM/LTMOBM will be returned to shore for disposal or recycling. SBM/LTMOBM associated drill cuttings will be contained in dedicated cuttings skips on the rig deck for subsequent transfer either:

- To an operating platform for reinjection (where practicable); or
- To shore for treatment and final disposal.

It is not planned to release any SBM or LTMOBM or associated cuttings into the marine environment.

[7] The COP Management of Change Process (Section 5.11) will be followed should alternative project chemicals be required

Summary of Mud and Cuttings

Table 5.5 presents the estimated quantities of waste drilling fluids and cuttings for each hole section and the planned disposal route.

Table 5.5 Estimated MODU Well Cuttings and Mud Volumes per Hole Section

Hole Size (Drill Bit Diameter)	Description	Estimated Quantity of Cuttings per Well (tonnes)	Estimated Quantity of Drilling Fluids per Well (tonnes)[1]	Drilling Fluid/ Mud System	Cuttings and Mud Disposal	Duration of Discharge per Well (hours)
36"	Conductor	230	250	Seawater and gel sweeps	At seabed	8
28" & 26"	Drilling Liner and Surface Holes	155	340	WBM	To sea via caisson or hose. Mud recovery system utilised to recover muds from cuttings	30
	Residual Mud	-	160		To sea via caisson or hose. Worst case discharged when WBM cannot be recovered or recycled	4
16" & 12¼"	Intermediate and Production Holes	600	450	SBM/ LTMOBM	Reinjection at operational platform (where practicable) or shipped to shore	Discharge not planned

1 Total estimated fluid volume including chemicals and seawater/drill water.

5.3.2.5 Casing and Cementing

Once each hole section is drilled, a steel casing string will be installed and cemented into place. The casing provides structural strength for the well, protecting it from weak or unstable formations and is cemented into place by pumping cement slurry into the well bore. The cement passes around the open lower end of the casing and into the annulus between the casing outer wall and the host rock formation in the case of the top-hole conductor. For subsequent casings, the cement passes between the casing outer wall and inner wall of the previous casing. For each casing string, some loss of cement to the seafloor usually occurs due to the need to slightly overfill the annulus to complete the casing cementing[8]. Table 5.6 below presents the expected chemical constituents of the cement, the expected usage per hole and estimates of the worst case volume discharged to the seafloor[9].

Table 5.6 Estimated Usage of Well Cement Per Constituent

Additive[1]	Hazard Category[3]	36" Hole Casing		28" & 26" Hole Casing		16" & 12¼" Hole Casing	
		Estimated Use per Hole (tonnes)[2]	Worst Case Discharged (tonnes)[2]	Estimated Use per Hole (tonnes)[2]	Worst Case Discharged (tonnes)[2]	Estimated Use per Hole (tonnes)[2]	Worst Case Discharged (tonnes)[2]
Class G cement	E	63	6.3	105	4.4	57	0.7
Barite	Gold	1.9	1.9	6.3	6.3	9.4	trace
Cement chemicals							
D175 Antifoam	Gold	0.1	0.1	0.2	<0.1	0.1	trace
D185 Dispersant	Gold	0.3	<0.1	0	0	0	trace
D500 Gasblok LT	Gold	3.6	0.3	8.3	0.6	0	trace
D077 Liquid Acc. ($CaCl_2$)	E	1.1	0.1	0	0	0.1	trace
D075 Extender	E	0.2	0.1	0.3	<0.1	1.3	trace
D182 Mudpush II	Gold	0.1	0.1	0.1	0.1	0.2	trace
F103 Ezeflo	Gold	0	0	0	0	0.6	trace

Notes as per Table 5.2

8 Cement losses are estimated to occur over approximately 1 hour per hole.
9 The COP Management of Change Process (Section 5.11) will be followed should alternative chemicals be required.

It is expected that, as a worst case, approximately 22 tonnes of cement per well will be discharged, comprising approximately 12 tonnes Class G cement, eight tonnes barite and the remainder cement chemicals of low toxicity (Hazard Category E and Gold).

At the end of cementing each casing string, up to 0.7 tonnes of cement (comprising Class G cement, barite and cement chemicals) could remain in the MODU cement system. Where it is not technically practicable or safe to recover excess cement remaining in the cement system, it will be mixed with seawater and discharged to the seabed over approximately one hour via the cement system hoses. It is not planned to discharge any dry cement to the marine environment.

The volume of cement used to cement each casing is calculated prior to the start of the activity. Sufficient cement is used to ensure that the casing is cemented securely and necessary formations isolated so that this safety and production critical activity is completed effectively while minimising excess cement discharges to the sea.

5.3.2.6 Drilling Hazards

Based on prior experience and current reservoir knowledge, there are a number of potential hazards that may be encountered during predrilling operations including:

- **Shallow Gas:** Potentially between the surface and 16” hole sections (this is generally identified during pilot hole drilling);
- **Reactive Formations:** Below the 16” hole section; and
- **Overpressure:** At the 12¼” hole section, causing differential sticking and fluid losses to the subsurface formations.

A number of contingency chemicals will be retained for use in the event that hazards are encountered during drilling. Table 5.7 lists the chemicals intended to be stored on the rig and used during lower hole drilling in the event of contingencies[10]. By definition the use of contingency chemicals cannot be predicted with accuracy, although their use will be minimised to the extent practicable in accordance with operational needs. Contingency chemicals used will be recovered with the OBM/LTMOBM and shipped to shore for disposal. It is not planned to discharge contingency chemicals to the marine environment.

Table 5.7 Estimated Usage of Drilling Contingency Chemicals

Chemical[1]	Function	Estimated use per Hole (tonnes)[2]	Hazard Category[3]
G-Seal	Stress cage application	13	E
Durcal 130	Stress cage application	13	E
Safecarb Z3	Stress cage application	7	E
Safecarb Z4	Stress cage application	7	E
Starcarb	Calcium carbonate – LCM	5	E
Nutplug	LCM /Cement scouring pill	1	E
From-A-Squeeze	LCM	3	E
M-I-X II	LCM	4	E
Guar Gum	Gel sweeps	4	E

Notes as per Table 5.2

5.3.2.7 Well Clean Up

Clean up of the predrill wells will be achieved by circulating a number of fluid slugs or “pills” to the well. Their function is to remove any remaining mud and cuttings and, where the reservoir is already drilled, ready the sand face for production once the platform is in position and the well completed.

[10] The COP Management of Change Process (Section 5.11) will be followed should alternative project chemicals be required.

Table 5.8 details the chemicals and fluids planned to be stored on the rig and used for well clean up[11].

Table 5.8 Estimated Well Clean Up Chemicals

Chemical/Fluid[1]	Function	Estimated Use per Well (tonnes)[2]	Hazard Category[3]
Transition Pill			
1.46 SG Brine	Weighted circulation fluid	12.5	N/A
SAFE-VIS LE (@7ppb)	Viscosifier	0.2	E
SAFE-SOLV E	Surfactant	0.9	GOLD
SAFE-SURF E	Viscosifier	0.6	GOLD
Sodium Bromide	Brine additive	0.75	E
Hydroxyethylcellulose (HEC) Pill			
1.46 SG Brine	Weighted circulation fluid	35.0	N/A
Drill water	Circulation fluid	6.0	N/A
SAFE-VIS LE (@7ppb)	Viscosifier	0.8	E
CCT®3000D Hi-Vis Pill			
1.46 SG Brine	Weighted circulation fluid	13.0	N/A
Drill water	Circulation fluid	3.5	N/A
CCT®3000D	Detergent	2.5	D
FLOVIS PLUS	Viscosifier	0.1	GOLD
CCT®3000D Wash Pill			
1.46 SG Brine	Weighted circulation fluid	22.0	N/A
Drill water	Circulation fluid	8.0	N/A
CCT®3000D	Detergent	4.0	D
Casing Tail Spacer			
1.46 SG Brine	Weighted circulation fluid	7.0	N/A
Drill water	Circulation fluid	4.0	N/A
FLOVIS PLUS	Viscosifier	0.05	GOLD

Notes as per Table 5.2

It is planned that clean up chemicals will be circulated back to MODU, reused and recycled where practicable, and shipped to shore for disposal. It is not planned to discharge clean up chemicals or fluids to the marine environment.

5.3.2.8 Well Testing

Drill stem testing of predrill wells will be undertaken by exception only with well test proposals reviewed and challenged through existing BP internal processes. Well tests comprise flowing of formation fluids to the surface where pressure, temperature and flow rate measurements are made to evaluate well performance characteristics. The hydrocarbons are sampled and analysed with the remaining fluids sent to flare. The COP Base Case assumes well testing of two wells as a worst case, with up to 4,000 barrels of oil and 360 tonnes of gas flared per well[12]. A burner, designed to achieve high burning efficiencies and fallout free and smokeless combustion of the liquid hydrocarbons produced, will be used during well testing.

5.3.2.9 Template Well Suspension

Once predrilling, casing, cementing, clean up and any well tests are complete, the wells will be temporarily suspended by filling them with inhibited seawater, which will protect the well from any pressurised formations. Table 5.24 (see Section 5.7.3 below) presents the expected chemical constituents of the suspension fluid.

The wells will then be closed with a mechanical plug and a corrosion cap installed on the subsea well-head following retrieval of the riser system. The purpose of the cap is to seal the well until the WC-PDQ platform is in place and the wells can be re-entered for completion. It is

[11] The COP Management of Change Process (Section 5.11) will be followed should alternative chemicals be required.
[12] Assumes gas-to-oil ratio of 1250 scf/bbl

not planned to re-enter any wells from the MODU unless there is an emergency event (such as hydrogen sulphide (H_2S) presence in the well).

5.3.3 MODU Logistics and Utilities

To support the predrilling described above, a variety of utilities and support activities will be required. These are detailed in Table 5.9 below.

Table 5.9 Summary of the MODU Utilities and Support Activities

Utility/Support Activity	Description
MODU Power Generation	• Main Power provided by 4 Wartsila 12V 22DB diesel generators (developing 2183hp or 1627kW at 1000rpm) • Twin diesel cement pumping units rated at 2 x 224kW • Emergency diesel generator rated at 635kW
MODU and Support Vessels Grey Water and Sanitary Waste	• MODU grey water discharged to sea (without treatment) as long as no floating matter or visible sheen is observable. • Sewage systems[13] designed to treat black water to applicable MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards[a] • Sewage sludge shipped to shore for disposal
MODU and Support Vessels Galley Waste	• MODU maceration unit designed to treat food wastes to applicable MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standard[b] prior to discharge • Vessel maceration units designed to treat food wastes to applicable MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standards[b] prior to discharge. Non food galley waste generated by the support vessels will be collected and transported onshore for disposal via authorised contractors
MODU Seawater/Cooling Water Systems	• Seawater used onboard within: - Engine and compressor systems (for cooling); - Desalination unit; and - Sanitary system. • Two seawater service pumps (one operating at a time) designed to lift approximately $575m^3$/hr via caisson 9m below sea level • Biocide dosing system designed to dose pump reservoirs with biocide DA at rate of $1cm^3$ added 3 times a minute • Cooling system: - Designed to discharge up to $575m^3$/hr via caisson 1m above sea level ; and - Design and operation reviewed and confirmed that the temperature at the edge of the cooling water mixing zone (assumed to be 100m from the discharge point) will be no greater than 3 degrees more than the ambient water temperature[c].
MODU Drainage	Drainage routes: • Deck drainage and wash water discharged to sea [d] • Deck runoff including WBM spills collected via rig floor drains and recycled to mud system or if not possible for technical reasons, diluted and discharged to sea (>60cm from sea surface) in accordance with applicable requirements [e]. • Deck drainage including LTMOBM, SBM, oil/diesel/cement spills and bilge water tank contents collected in waste tank and shipped to shore
MODU Desalination Unit	• Unit produces freshwater from lifted seawater by reverse osmosis for sanitary and galley use • Designed to discharge approximately $2,000m^3$/day saline water at approximately 5°C above ambient temperature and twice the salinity of the receiving waters
MODU Ballast System	• Ballasting, using untreated seawater, undertaken daily to maintain stability of Dada Gorgud for effective drilling • The ballast system is designed so that oil and chemicals do not come into contact with ballast water
Support Vessels	• Vessels: - Supply drilling mud, diesel and other consumables to the MODU - Ship solid and liquid wastes (including lower hole cuttings) to shore for treatment/disposal • Up to 7 support vessel movements (up to 15 POB) required per week through predrilling
Support Vessel Drainage	• Deck drainage and wash water discharged to sea [d] • Oily bilge water tank sludges, untreated oily water and waste oil shipped to shore
Crew Change	• 5 return vessel trips per week for personnel transfer[f] • Helicopters may be used for some crew changes.

a 5 day BOD of less than 50mg/l, suspended solids of less than 50mg/l (in lab) or 100mg/l (on board) and coliform 250MPN (most probable number) per 100ml. Residual chlorine as low as practicable.
b Macerated to particle size less than 25mm.
c The COP Management of Change Process (Section 5.11) will be followed should any change to the design or operation of the cooling water system be required.
d Deck drainage and wash water may be discharged as long as no visible sheen is observable.
e There shall be no discharge of drill cuttings or drilling fluids if the maximum chloride concentration of the drilling fluid system is greater than 4 times the ambient concentration of the receiving water.
f Vessel trips may be shared with other AzSPU Offshore installations.

[13] The MODU sewage treatment system comprises a Hamworthy Membrane Bioreactor installed in July 2006

It is anticipated that 120 workers will be onboard the Dada Gorgud during the 22 month predrill programme.

5.3.4 Predrilling – Emissions, Discharges and Waste

5.3.4.1 Summary of Emissions to Atmosphere

Table 5.10 summarises the greenhouse gas (GHG) (i.e. CO_2 and CH_4[14]) and non GHG emissions predicted for predrilling. Key sources include:

- MODU engines and generators;
- Crew change helicopters/vessels;
- MODU support/supply vessel engines; and
- Non routine flaring associated with possible well testing.

Table 5.10 Estimated GHG and Non GHG Emissions Associated with Routine and Non Routine COP Predrill Activities

	MODU Rig Transfer	Power Generation	Crew Change	Support Vessels	Well Test Flaring	TOTAL
CO_2 (k tonnes)	0.3	19.0	0.5	12.7	8.5	**41.1**
CO (tonnes)	1	93	1	32	41	**168**
NO_x (tonnes)	6	353	2	234	8	**603**
SO_x (tonnes)	1	24	1	32	0	**58**
CH_4 (tonnes)	0	1	0	1	83	**85**
NMVOC (tonnes)	0	0	0	10	54	**64**
GHG (k tonnes)	0.3	19.0	0.5	12.7	10.3	**42.9**

See Appendix 5A for detailed emission estimate assumptions.

5.3.4.2 Summary of Discharges to Sea

Table 5.11 provides a summary of estimated routine and non routine drilling fluid, cuttings and cement discharges to sea across the predrilling programme associated with planned activities. A maximum of 20 predrilled wells is assumed.

Table 5.11 Estimated Drilling Fluids and Cement Discharges to Sea Associated with COP Predrill Activities

Discharge	R /NR*	Frequency	Location	Estimated Volume (tonnes)	Discharge Composition
Seawater, gel sweeps and cuttings	R	During pilot and top hole drilling	Seabed	4,830 (cuttings) 5,250 (seawater and gel sweeps)	Refer to Tables 5.2 and 5.5
WBM and cuttings	R	During surface hole drilling	To sea (via cuttings caisson)	3,100 (cuttings) 6,800 (WBM)	Refer to Tables 5.3 and 5.5
Cement and cement chemicals	R	During each casing cementing	Seabed	440	Refer to Table 5.6
Residual WBM	NR	At end of surface hole drilling (if WBM cannot be recovered / recycled)	To sea (via cuttings caisson)	3,200	Refer to Tables 5.3 and 5.5
Excess cement and cement chemicals	NR	At the end of each casing section (if excess cement cannot be recovered)	Seabed	45	Refer to Section 5.3.2.5

* R – Routine, NR – Non Routine

[14] To convert to CO_2 equivalent the predicted volume of CH_4 is multiplied by a global warming potential of 21.

Planned discharges associated with cooling water, desalination unit returns, treated black water and grey water, drainage, ballasting and galley waste from the MODU and support vessels are described in Table 5.9 above.

5.3.4.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non hazardous and hazardous waste generated during the predrill programme are provided in Table 5.12. Waste quantities have been estimated based on operational data from the drilling programmes of the previous ACG Phases, assuming that a maximum of 20 wells will be predrilled over a 22 month period.

Solid and liquid waste generated will be shipped to shore and managed in accordance with the Waste Management principles detailed in Chapter 14.

Table 5.12 Estimated Hazardous and Non Hazardous Waste Associated with Predrilling Activities[1]

Type	Waste Category[2]	Sub Category	Estimated Volume (tonnes)
Non hazardous waste	Non hazardous non recyclable waste	General waste	285
		Food/galley waste	
	Recyclable waste	Cooking oil	95
		Electrical cable	
		Paper and card	
		Plastics	
		Scrap metal and wood	
		Total (Non hazardous)	**380**
Hazardous waste	Solid hazardous waste	Batteries	210
		Drum/cans	
		Cement	
		Clinical waste	
		Oil filter parts	
		Oily rags	
		Paint cans contaminated with uncured paint	
	Non-water based drill cuttings[3]	-	21,000
	Used drilling fluids	-	1,020
	Hazardous liquid waste	Acids and alkalis	430
		Antifreeze	
		Chemicals	
		Fuel oil	
		Grease	
		Oil	
		Paint	
		Paint sludge	
		Solvents and thinners	
		Photographic developing fluids	
		Oily and contaminated water	
		Total (Hazardous)	**22,660**

1 Treatment and disposal routes are detailed in Section 5.12.2.
2 Estimates include key waste types. Minor non hazardous wastes including used tyres, toner cartridges and intermediate bulk containers are excluded.
3 Includes associated mud, which is not separated on board the MODU.

5.4 Onshore Construction and Commissioning of Offshore Facilities

5.4.1 Introduction

Fabrication of the jacket, topside and drilling facilities will be performed in Azerbaijan. The tender process for the selection of the construction contractors is planned for completion by the first quarter of 2010. It has been assumed for the purposes of this ESIA, that a combination of the following construction yards may be used:

- **Baku Deep Water Jacket Factory (BDJF) yard[15]:** Used extensively during the ACG Projects. It is planned that the jacket will be constructed at the BDJF yard;
- **Zykh yard:** Used during the Shah Deniz Project; and
- **Construction yards located on the western fringe of the Bibi Heybet oil field:** Either in the South Dock[16] or the yard previously used to construct the ACG DWG-PCWU and Central Azeri Compression and Water Injection (CA-CWP) offshore facilities[17].

The location of these yards is described in Chapter 6: Environmental Description.

5.4.2 Upgrade Works and Yard Reactivation

COP construction activities will require a number of minor upgrade works to be undertaken at the selected construction yards. The scope of the upgrades is dependant on which elements of jacket, topside and drilling facilities construction are undertaken at each yard. Potential upgrade scopes include:

- New steel rolling equipment for jacket fabrication;
- Extensions of the yard real estate to allow for equipment storage and fabrication;
- Ground improvement work to increase the weight bearing capacity – e.g. piling work, backfilling and ground compaction;
- Electrical system upgrades; and
- New or refurbishments of the existing site support facilities, electrical systems, material storage areas and waste handling facilities.

In addition to yard upgrades, the STB-01 topside transport and jacket launch barge will be strengthened to increase its topside transport capacity during 2011. Work to upgrade the STB-01 will take place at the quayside of the selected construction yard and is expected to include:

- Addition of external sponsons in the stern area to increase the vessel's stability; and
- Strengthening the internal and external structure with steel.

The DBA crane vessel will be reactivated ahead of drilling template activities. Potential modifications may be undertaken prior to mobilisation for jacket and topside installation activities.

The pipelay barge will undergo a condition survey prior to mobilisation to determine the requirement for any upgrade works. No major upgrade works to the barge are expected.

15 Referred to in previous ACG Project ESIAs as Shelfprojectsroi (SPS).
16 Operated by the Caspian Shipyard Company (CSC).
17 Operated by Amec-Tekfen-Azfen (ATA).

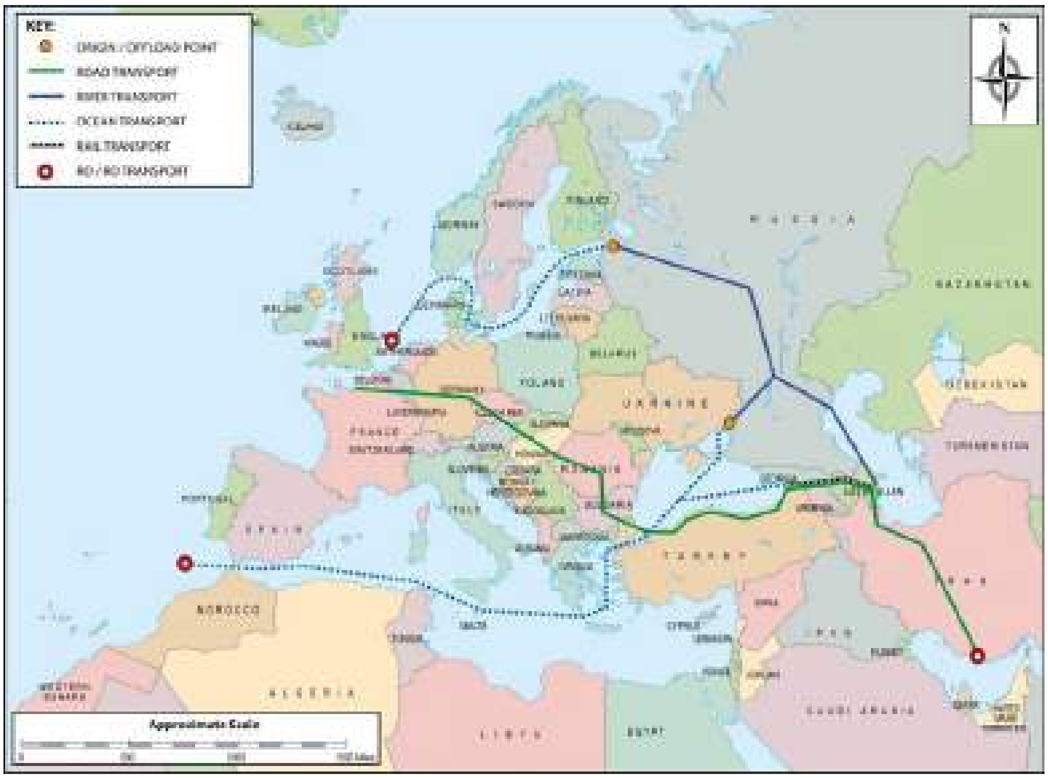
5.4.3 Materials Transportation

Materials and prefabricated components/modules will arrive at the construction sites by road, rail, sea and air using the transportation routes established for the previous ACG Project construction programmes.

Goods arriving via sea can travel by two main routes. From the Mediterranean and Black Sea, vessels must pass through the Don-Volga canal system. Cargoes following the Baltic Sea route, would be transhipped at St. Petersburg and travel along the Baltic-Volga system. These routes are not available during the ice season (November - April).

Rail links are available from Poti in Georgia and Riga in Latvia. Deliveries by road from Europe would be through Turkey and Georgia and via Iran. Figure 5.6 illustrates potential transport routes.

Figure 5.6 Import Routes to Azerbaijan



While available transport routes can be identified, the likely use of each and what will be transported cannot be determined with any certainty until the procurement strategy and award of construction contracts has been made.

5.4.4 Jacket and Piles

The COP jacket, an 8 legged, braced, steel structure, will support the topside and will be designed for installation over the drilling template. The jacket structure will be approximately 185m tall, extending approximately 15m above the sea surface. The top of the jacket will be a “twin tower” configuration to enable “float over” installation of the topside deck. The design of the base will incorporate 3 pile sleeves at each of the 4 corners into which the 12 foundation piles will be driven.[18]

[18] Refer to Appendix 5E for the WC-PDQ platform seismic design details.

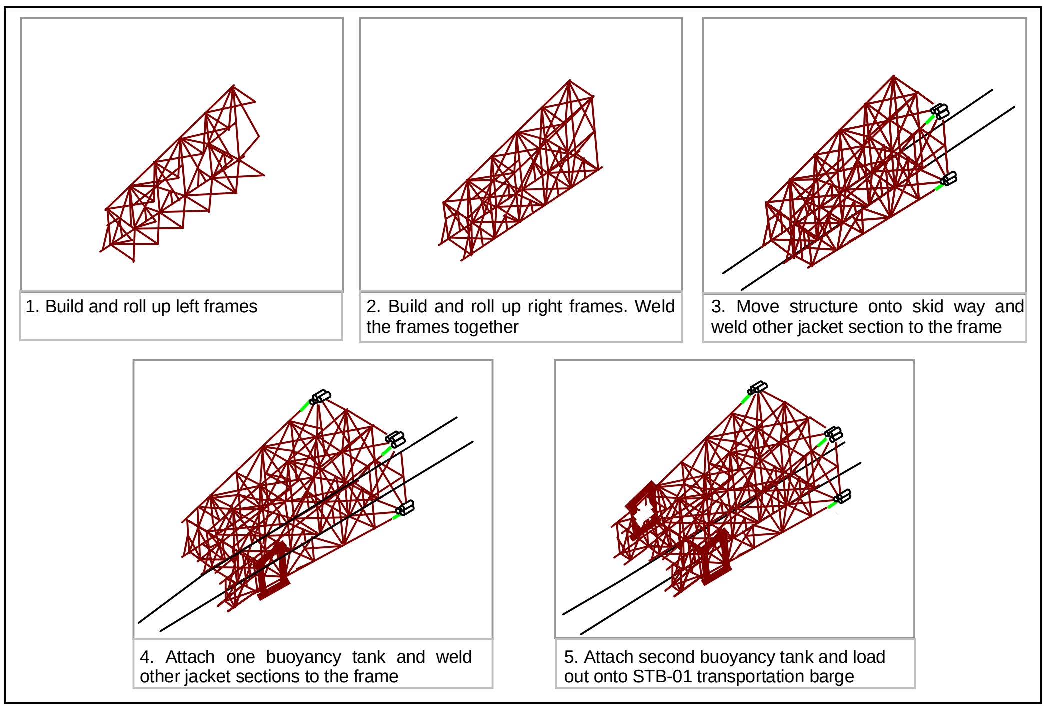
To construct the jacket, steel plate received at the fabrication yard, will be cut and shaped as required and then welded together with any prefabricated elements that are not constructed in country, to form the various sectional pieces. Section and weld joints will be integrity tested using Non Destructive Testing (NDT) prior to grit blasting in preparation for painting.

The majority of grit blasting and anti corrosion painting of jacket and pile components will be undertaken in a paint shop with a fume extraction and grit recovery system in place. Grit blasting and anti corrosion painting of sections which are too large are to be accommodated within a paint shop will be undertaken within a temporary enclosure. Waste grit and paint will be collected and disposed of in accordance with the Waste Management Process (see Chapter 14). Cathodic protection will be provided by zinc-aluminium sacrificial anodes. The jacket sections will then be transferred to the assembly skidway, where they will be crane lifted into position and welded to other jacket sections to form the complete structure.

Two buoyancy tanks will be placed on either side of the jacket (see Section 5.6.2 below). The current plan is to reuse the ACG Phase 2 tanks, which will be cleaned and integrity checked using an inert gas and potentially a helium tracer prior to use. Figure 5.7 shows the various stages of jacket fabrication.

The 12 foundation piles (each 96” diameter and approximately 130m in length) will be assembled, inspected and tested at the construction yard in a similar manner to the jacket.

Figure 5.7 Jacket Fabrication Process



5.4.5 Drilling Modules

Unlike previous ACG projects, the COP drilling module elements will be constructed in country. The Drilling Support Module (DSM), Drilling Derrick and Drilling Equipment Set (DES), will be constructed up to mechanical completion over approximately 16 months at the selected drilling module construction yard. Activities will predominantly include cutting, shaping, erecting and welding of steel, pipefitting, grit blasting and painting of steel and pipework in dedicated paint shops. Once mechanical completion has been achieved, the DSM and DES will be transported for installation on the topside. Depending on the construction yard selected, the drilling module elements may be moved to the topside yard by crane or loaded onto a barge and transported by sea over approximately 3 days. Onshore testing (including onshore test drilling), pre-commissioning and operator training of the drilling module is expected to take approximately 8 months.

5.4.6 Topside

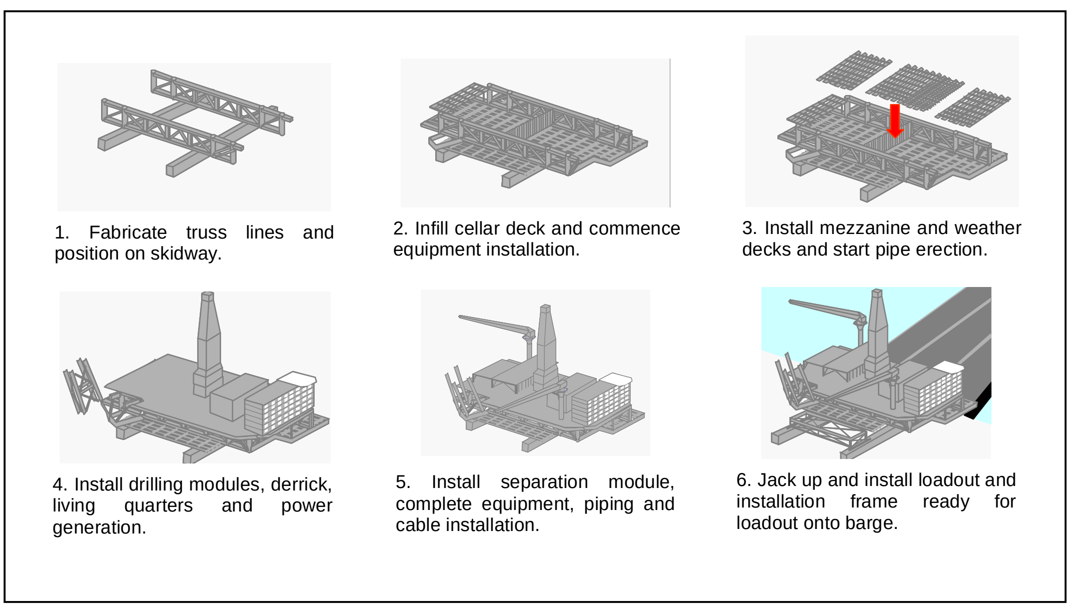
The COP topside will be a steel structure erected from steel girders, steel stanchions, trusses and cross beams, which form and enclose decks and modules. Equipment, both electrical and mechanical will be installed into the topside modules. The topside will comprise a number of decks including an upper deck, weather deck, mezzanine deck, cellar deck and under deck. These will support the following:

- Living Quarters;
- Power Generation Skids;
- Drilling Support Module;
- DES;
- Separation System;
- Gas Compressor Systems;
- Pig Launchers;
- Manifold;
- Flare Boom;
- Main Oil Line Pump;
- Wellbay Module;
- Equipment Room;
- Switchroom Module; and
- Utility Systems.

The main topside structure and decks will be fabricated at the selected topside construction yard. Prefabricated and imported components and modules will either be transported from international fabrication yards or fabricated in other Baku construction yards.

Steel plate will be cut, shaped and welded to form the topside structural elements. The sections will then be grit blasted and painted with anti-corrosion paint. Prefabricated utility and process equipment will be lifted into place using cranes, installed into the structural frame, secured and then fitted with power and piping connections as required. A single flare boom structure for the offshore platform, comprising a steel lattice frame structure, will be attached to the integrated deck in the construction yard. All deck frame and component weld joints will be tested using NDT methods. Figure 5.8 shows the general topside construction approach.

Figure 5.8 Topside Construction Process



1. Fabricate truss lines and position on skidway.

2. Infill cellar deck and commence equipment installation.

3. Install mezzanine and weather decks and start pipe erection.

4. Install drilling modules, derrick, living quarters and power generation.

5. Install separation module, complete equipment, piping and cable installation.

6. Jack up and install loadout and installation frame ready for loadout onto barge.

5.4.7 Testing and Pre-Commissioning

The topside module elements including processing equipment and utilities will be tested onshore and where practicable, pre-commissioned. Testing will include hydrotesting of pipework and/or pressurised gas tests (using nitrogen with a 1% helium trace for detection). Onshore hydrotesting of the topside will be performed using potable water (where practicable) or seawater dosed with sodium hypochlorite (a sterilising agent) at a concentration of 2 mg/l. On completion of the pressure test, the water will be reused where possible. If the water cannot be reused on site, it will be neutralised and discharged to the site sewer network or used for dust suppression on site (if required).

5.4.8 Topside Commissioning

All topside utilities will be fully commissioned at the construction yard over an approximate 10 month period.

Partial commissioning (comprising system testing) of the platform process systems will also be undertaken where possible, including:

- The fuel gas system;
- The Main Oil Line (MOL) pumps;
- The flare system;
- The flash gas compression system;
- The export gas compression system;
- Chemical systems;
- The produced water system; and
- Sand separation units.

These systems will be fully commissioned once in place offshore.

5.4.8.1 Seawater System

During onshore commissioning, seawater will be supplied to the topside via a temporary seawater lift system from the quayside. The seawater system will be designed to operate at a flow rate of approximately 575m^3/hr for a period of up to 6 months and will be of a similar design to that approved for previous ACG projects. Seawater will be abstracted from the construction yard quayside and discharged back to the sea after use. The design and operation of the seawater/cooling water system has been reviewed and confirmed that the temperature at the edge of the cooling water mixing zone (assumed to be 100m from the discharge point) will be no greater than 3 degrees more than the ambient water temperature[19].

As mentioned above, the seawater system will be designed to incorporate continuous dosing of sodium hypochlorite at a concentration of 2mg/l. The dose rate will be controlled and checked. Prior to discharging the cooling water, a neutralising agent will be added to reduce the chlorine concentration to a safe level (i.e. to <1mg/l residual chlorine).

5.4.8.2 Freshwater System

The freshwater supply system, with a total volume of approximately 120m^3, is planned to be filled with freshwater dosed with sodium hypochlorite. To ensure that the entire system is adequately sterilised, approximately 2 - 3m^3 will be expelled via taps and drains, collected and analysed. The system will be sealed once it is confirmed that the target concentration of hypochlorite has been achieved throughout the system.

After sterilisation, the contents of the system will be neutralised and discharged with the cooling water to the Caspian Sea.

[19] The COP Management of Change Process (Section 5.11) will be followed should any change to the design or operation of the cooling water system be required.

5.4.8.3 Diesel Users

The main platform power generation system comprises 3 RB211 generators. Onshore commissioning of the generators using diesel is planned to include:

- Each generator run separately and intermittently for a week, for up to 8 hours a day at a maximum load of approximately 26%; and
- 3 synchronisation tests of 8 hour duration, running 2 of the 3 generators together at a maximum load of approximately 26%.

During commissioning of the compression system and topside utilities, the intention is to run the platform generators separately and intermittently for approximately 6 months. The emergency generator and platform pedestal cranes are also planned to be commissioned onshore.

5.4.9 Load Out and Sail-away

When completed, the jacket and topside will be loaded onto the upgraded STB-01 barge for transportation to the WC-PDQ platform location.

The jacket will be manoeuvred onto the STB-01 barge and sea fastened by welding members from the jacket to the barge deck. The barge will be ballasted and trimmed to sea-tow condition. The transportation barge will be assisted by 3 attendant support vessels during sail-away. Figure 5.9 shows the DWG-DUQ jacket on the transportation barge ready for sail-away.

Figure 5.9 DWG-DUQ Jacket During Loadout

The topside will be installed with a loadout and installation frame, which can then be moved onto the STB-01 barge. As for the jacket, the barge will be assisted by 3 support vessels during sail-away. Figure 5.10 shows the East Azeri (EA) platform topside on the transportation barge.

Figure 5.10 EA Platform Topside Onboard STB-01 Barge

The jacket piles will be transported to site by “wet float”, that is, towed in the water behind a support or supply vessel.

5.4.10 Onshore Construction and Commissioning – Emissions, Discharges and Waste

5.4.10.1 Summary of Emissions to Atmosphere

Table 5.13 summarises the GHG (i.e. CO_2 and CH_4) and non GHG emissions predicted to be generated during onshore construction and commissioning from key sources which include:

- Construction yard engines and generators (including plant, cranes and on site vehicles);
- Volatile materials used during construction (e.g. paint and solvents);
- Temporary generators (during commissioning);
- Platform crane and emergency generators (during commissioning); and
- Platform main generators (during commissioning).

Table 5.13 Estimated GHG and Non GHG Emissions Associated with Routine and Non Routine COP Onshore Construction and Commissioning Activities

	Jacket Construction	Topside Construction and Commissioning	Drilling Module Construction	TOTAL
CO_2 (k tonnes)	15	30	14	**59**
CO (tonnes)	55	68	48	**171**
NO_x (tonnes)	220	310	191	**721**
SO_2 (tonnes)	19	48	16	**83**
CH_4 (Tonnes)	1	1	1	**3**
NMVOC (tonnes)	18	25	14	**57**
GHG (k tonnes)	15	30	14	**59**

See Appendix 5A for detailed emission estimate assumptions.

5.4.10.2 Summary of Discharges to Sea

Planned routine discharges to the sea during COP onshore construction and commissioning will be associated with the cooling water system. In total, approximately 575m^3/hr of neutralised seawater is estimated to be discharged to sea during the 6 month commissioning period (See Section 5.4.8.2).

At the construction yards there will be 3 categories of drainage water:

- Black and grey water – black and grey water generated at the construction yard(s) will be collected in on site sewer pipes and sumps and then either transferred by road tanker or by sewer pipes to a municipal sewage treatment plant for treatment and disposal. If the construction yard has an operational sewage treatment plant that discharges treated effluent to the environment, the yard operator will be responsible for agreeing the discharge standard with the MENR and maintaining the discharge permit conditions stipulated by the MENR;
- Hazardous area drainage – drainage water from areas in the construction yard(s) in which hazardous materials are stored, routinely used and drainage water is generated (e.g. mechanical workshops and bunded chemical storage areas), will be contained and collected from site via vacuum tanker and delivered to an appropriate licensed waste management contractor, in accordance with the site waste management procedure[20]; and

[20] For discussion regarding spills refer to Chapter 13.

- Storm/rain water drainage - uncontaminated rainwater will be discharged directly to the onshore or marine environment to prevent flooding and ponding of water on site.

5.4.10.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non hazardous and hazardous waste that will be generated during onshore construction and commissioning are provided in Table 5.14. These have been estimated based on the waste records for construction of the previous ACG Phase platforms, taking into account the increased scope of onshore construction associated with the COP.

Solid and liquid waste generated will be shipped to shore and managed in accordance with the Waste Management principles detailed in Chapter 14.

Table 5.14 Estimated Hazardous and Non Hazardous Waste Associated with Onshore Construction and Commissioning Activities[1]

Type	Waste Category[2]	Sub Category	Estimated Volume (tonnes)
Non hazardous waste	Non hazardous non recyclable waste	General waste	20,470
		Food/galley waste	
	Recyclable waste	Cooking oil	16,555
		Electrical cable	
		Uncontaminated blasting grit	
		Paper and card	
		Plastics	
		Scrap metal and wood	
		Total (Non hazardous)	**37,025**
Hazardous waste	Solid hazardous waste	Batteries	515
		Drum/cans	
		Cement	
		Sand and soil	
		Contaminated grit	
		Clinical waste	
		Oil filter parts	
		Oily soil	
		Sand and sludges	
		Oily rags	
		Paint cans contaminated with uncured paint	
	Hazardous liquid waste	Acids and alkalis	8,255
		Antifreeze	
		Chemicals	
		Fuel oil	
		Grease	
		Oil	
		Paint	
		Paint sludge	
		Solvents and thinners	
		Photographic developing fluids	
		Oily and contaminated water	
		Total (Hazardous)	**8,770**

1 Treatment and disposal routes are detailed in Section 5.12.2.
2 Estimates include key waste types. Minor non hazardous wastes including used tyres, toner cartridges and intermediate bulk containers are excluded.

5.5 Infield Pipeline Installation, Tie-in and Commissioning

To enable oil to be exported from the WC-PDQ platform, an infield pipeline will be installed to connect the platform via a subsea wye piece tie-in to the existing 30" diameter oil export pipeline from the DWG-PCWU platform. This pipeline connects into the existing Phase 2 main export pipeline running from the CA facilities to Sangachal terminal. For gas export from the WC-PDQ platform, a 14" diameter infield pipeline will be installed, connecting the WC-PDQ platform to the 28" gas export pipeline at the DWG-PCWU platform. This pipeline enables gas export from the DWG-PCWU platform to the main 28" Phase 1 main gas export pipeline from the CA facilities to Sangachal terminal. Infield produced water and injection water pipelines, which will run parallel to the 14" infield gas pipeline, will be installed between the WC-PDQ and DWG-PCWU platforms. COP infield pipeline dimensions as currently planned are presented in Table 5.15.

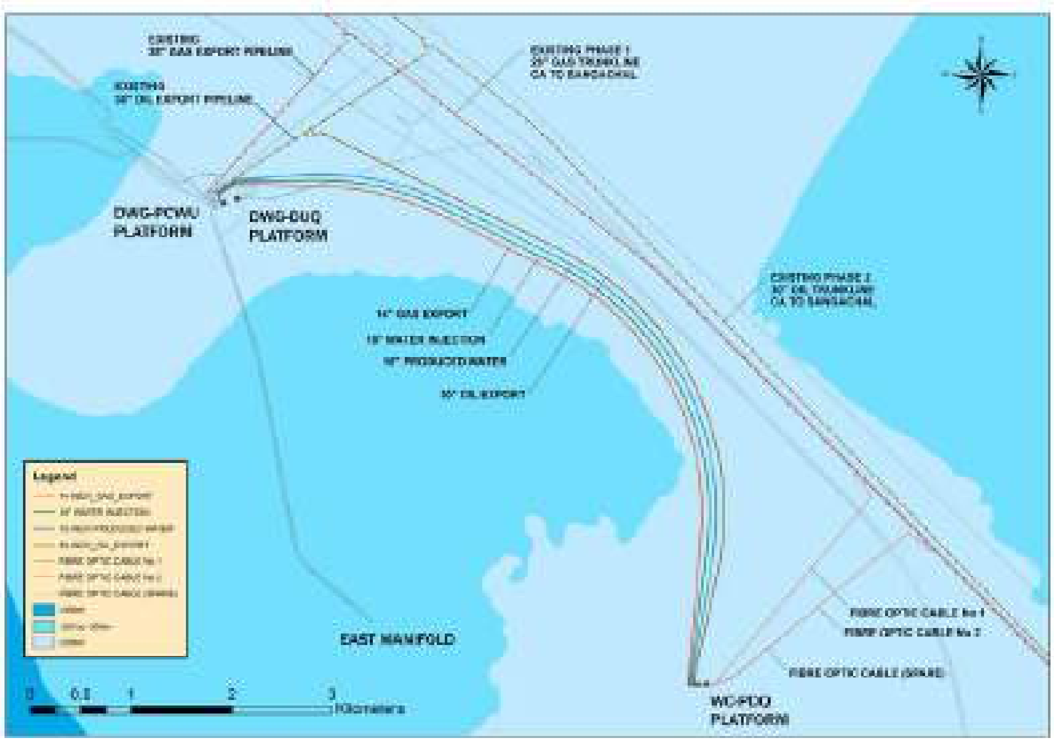
Table 5.15 COP Infield Pipelines

Infield Pipeline	Inside Diameter (mm)	Length (km)
30" oil pipeline	720	7.62
14" gas pipeline	330	8.05
16" produced water pipeline	378	8.18
18" injection water pipeline	382	8.22

The COP oil export pipeline is currently planned to tie into a new wye piece, located approximately 2km north east of the DWG facilities and installed for the COP. Figure 5.11 illustrates the current scope and location of the COP infield pipeline works.

The design and exact routing of COP infield pipelines is ongoing through the 'Define' stage And route optimisation may result in a reduction in infield pipeline lengths. The Base Case design, installation and pipeline hydrotesting (including estimated volumes of hydrotest water discharged), described in Sections 5.5.2 to 5.5.6, are considered to represent the worst case for the purposes of this environmental assessment.

Figure 5.11 Proposed COP Infield Pipelines



5.5.1 COP Pipeline Integrity and Design

The COP infield pipeline design and materials will be consistent with that used for the previous ACG Projects. The pipelines will be constructed of carbon steel and will be designed to ensure that they are suitable for the environmental conditions including seawater properties and geo-hazards.

All the pipelines will be protected by a high integrity 3-layer polyolefin anti-corrosion coating, together with a sacrificial anode cathodic protection system. In addition, corrosion-inhibiting chemicals will be added to the hydrocarbon product before it passes through the pipeline to minimise internal corrosion.

The pipelines will be designed to be stable under 100 year extreme environmental conditions. The oil, gas and produced water pipelines will be provided with a reinforced concrete weight coating with a minimum thickness of 40mm to provide the required level of negative buoyancy. The concrete weight coating also affords protection from the mechanical impact of a dropped object or hooking anchor. The 18" water injection pipeline will be stable on the seabed without concrete coating due to the high pipeline wall thickness.

The infield gas, produced water and injection water pipelines between the WC-PDQ and DWG-PCWU platforms are planned to be routed along a common corridor, which minimises possible interference from anchoring vessels and the risk of damage due to dropped objects. The oil pipeline also follows the same route corridor for the majority of its length. Where an infield pipeline is planned to cross an existing pipeline(s), the intention is to construct crossing structures to ensure permanent separation between the pipelines.

In addition to the passive protection measures integrated into the COP pipelines design described above, pipeline integrity systems will also include the following measures

- Monitoring (pressure, flow and fluid contaminant concentrations);
- Corrosion protection;
- Inspection;
- Emergency response;
- Management of change (e.g. pipeline system modifications); and
- Assurance.

These form part of the existing Offshore Operations Pipeline Integrity Management System (PIMS) (refer to Chapter 13).

5.5.2 Pipeline Installation

It is planned to use the pipelay barge "Israfil Guseinov" for the infield pipeline installation works. The installation methodology will be consistent with the previous ACG Projects.

On the lay-barge, each pipe section will be welded to the preceding one and the welded joints will be visually inspected and integrity tested using NDT techniques. The weld area will then be field-coated for protection with anti-corrosion material. The pipeline will be progressively deployed from the stern of the lay-barge via the "stinger", a support boom that extends outwards from the stern of the barge.

The pipe-laying operation will be continuous with the barge moving progressively forward as sections of the pipe are welded, inspected, coated on board and then deployed to the seabed. The barge will be held in position by anchors. As pipe-laying proceeds, the anchors will be periodically moved by 2 anchor handling support vessels to pull the barge forward (with 1 more on standby). The distance of this will vary, but will typically be every 500m to 600m of pipeline length. The lateral anchor spread of the pipe-lay barge will typically be between 600m to 700m either side of the pipeline.

In areas of soft sediment, concrete mats may be laid from a Diving Support Vessel (DSV) to provide support for the infield pipelines.

Those pipelines susceptible to temperature related lateral buckling during operation will be laid in a "lazy-S" configuration to allow their compression forces to be safely dissipated. In this case, concrete sleepers will be laid on the seabed under the pipeline so that it can move laterally in a controlled manner.

Table 5.16 summarises the estimated number and function of the vessels that will support the COP pipeline installation activities.

Table 5.16 Pipelay Support Vessels

Vessel	Number	Function	POB
Pipelay barge	1	Pipelay	280
Anchor handling vessels	3	Positioning of pipelay barge and standby duty	15
Pipe supply vessels	4	Supplies pipe to the pipe-lay barge from the onshore pipe store	10
Pipelay barge support vessels	2	Tow pipeline barge and support functions	14
Survey vessel	1	Inspects laid pipeline	26
DSV	1	Diver support to survey vessel	

Table 5.17 summarises the pipelay barge and support vessel utilities.

Table 5.17 Pipelay Barge and Support Vessel Utilities

Utility	Description
Power Generation (Israfil Guseinov)	• The main power provided by 5 diesel generators rated at 1,150 kW each.
Sanitary Waste	• Sewage systems designed to treat black water to applicable MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards [a] • Sewage sludge shipped to shore for disposal
Galley Waste	• Vessel maceration units designed to treat food wastes to applicable MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standards[b] prior to discharge. Non food galley waste generated by the support vessels will be collected and transported onshore for disposal via authorised contractors
Drainage/Cooling Water	• Deck drainage and wash water discharged to sea [d] • Oily bilge water tank sludges, untreated oily water and waste oil shipped to shore

Notes as per Table 5.9

Offshore pipelay activities are scheduled to last approximately 3 months.

5.5.3 Pipeline Cleaning and Hydrotesting

Following installation and prior to tie-in, each pipeline will be cleaned, gauged and hydro-tested. Treated seawater, pumped from a support vessel, will push a pig train to a temporary subsea pig trap to clean and gauge the pipeline and remove construction debris. The pig train will be removed and test flanges installed at either end of the pipeline. Hydrotesting will then be undertaken by pumping treated seawater from a support vessel to raise the pressure in the pipeline and confirm that there are no leaks. Treated seawater from cleaning, gauging and hydrotesting each infield pipeline will be discharged to the sea. Following hydrotesting of the infield oil pipeline, a new wye section will be laid, cleaned, gauged and hydrotested using treated seawater, which will be discharged to sea. (refer to Section 5.5.5 for discharge volume estimates).

To prevent corrosion and inhibit bacteria growth, seawater used for cleaning and hydrotesting will be chemically treated. A dye will also be added to the water to provide a method of identifying leakage during hydrotesting. The following Base Case chemicals, at the indicated dosage rates, are currently planned to be used:

- 300ppm Troskil 88 (biocide)[21];
- 100ppm Tros TC 1000 (oxygen scavenger); and
- 100ppm Tros Seadye (dye).

In the event that different chemicals are required for commercial or technical reasons, the COP Management of Change Process (see Section 5.11) will be followed. The intent is to use chemicals no more toxic or persistent than the Base Case chemicals.

5.5.4 Oil Pipeline Wye Installation

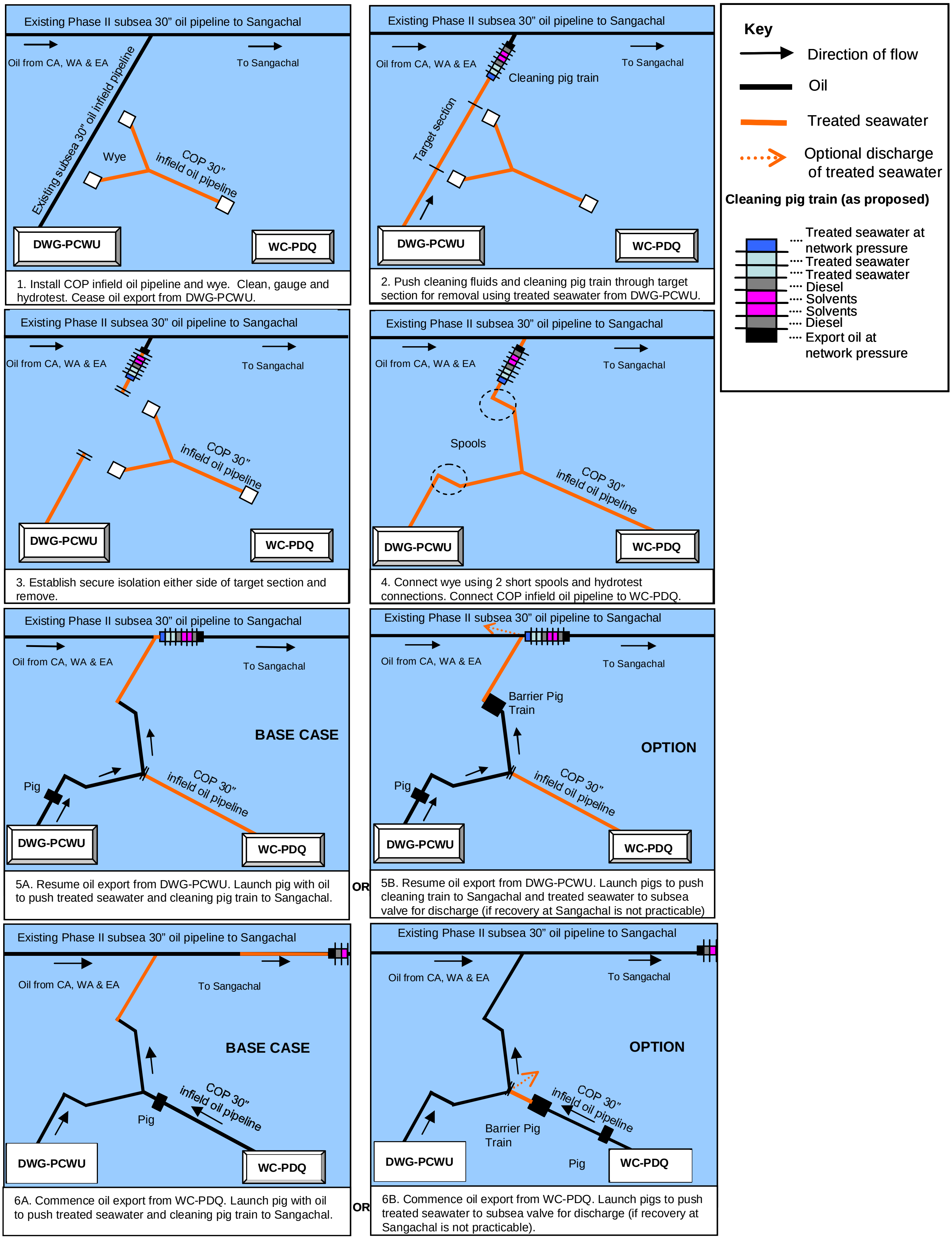
To tie in the COP infield oil pipeline, it is planned to remove a section of the DWG oil export pipeline and connect the new wye section (refer to Figure 5.12 illustrating the installation methodology). Cleaning fluids (including wax solvents and diesel) will be used to displace the oil and minimise the amount of oil remaining on the internal surfaces of the pipeline. The cleaning fluids, together with the cleaning pig train, will be propelled through the pipeline using treated seawater (see Section 5.5.3 above for proposed chemicals and dosage rates). On completion of cleaning operations, secure isolation will be established between the target section and the oil on the main oil export pipeline side of the target section; the isolation will be provided either via the subsea valves at the trunk line wye valves, or alternatively via a high integrity piggable pipeline isolation tool (such as a smart plug). Once isolation has been verified, a section of cleaned pipeline will be removed to allow the wye to be installed and connected using 2 short spool pieces (curved connecting sections of pipeline).

Once the wye has been connected, the spools and tie ins will be hydrotested with treated seawater to confirm the integrity of the connections. During hydrotesting of the tie ins, a small volume of treated seawater (approximately 65m^3) contaminated with residual hydrocarbons (approximately 100ppm) may be discharged to the marine environment. When pressure testing has been completed, the valves or isolation tool will be released and oil production from the DWG facilities will resume. Should a smart plug be used, this will be pushed along the main oil export pipeline to Sangachal Terminal by the oil export flow.

It is planned that the hydrotest and cleaning fluids from the target section cleaning activities will be displaced by the export oil flow and sent to Sangachal where they will be recovered and treated prior to disposal in accordance with Terminal procedures and permitting. If it is not practicable to recover the treated seawater (approximately 1,110m^3 contaminated with approximately 100ppm residual hydrocarbon), for technical or safety reasons, it will be discharged to sea.

[21] See Section 5.5.4 for dosing proposed during final produced water pipeline hydrotesting.

Figure 5.12 Oil Pipeline Wye Installation Methodology



5.5.5 Pipeline Tie-in, Testing and Dewatering

Tie-in spool pieces will be used to connect each newly constructed pipeline to further components of the overall pipeline system. The spool pieces will be filled with treated seawater (Section 5.5.3 above provides chemical dosing details), prior to being deployed for subsea installation.

COP Produced Water and Injection Water Infield Pipelines - will connect the WC-PDQ and DWG-PCWU platforms. The completed pipelines will be cleaned, gauged (using a pig train as described above) and leak tested using treated seawater. The injection water pipeline will then be dewatered and the treated seawater discharged to the marine environment. It is planned that the produced water pipeline hydrotest water will be discharged at a later date, prior to commencement of the produced water system on the WC-PDQ platform (see Section 5.8.7). As the biocide in the pipeline will degrade over time, to minimise potential biological growth, it is planned to increase biocide dosing to 1,000 ppm in the produced water pipeline during final hydrotesting. Should there be a requirement for technical reasons to retain treated water in the COP produced water and injection water infield pipelines beyond the period when the biocide and oxygen scavenger chemicals remain at their effective concentrations, the pipelines will be dewatered and refilled with treated water at the chemical dose levels provided in Section 5.5.3. It is planned that pigging using “intelligent pigs” which incorporate instrumentation to confirm pipeline integrity, of the completed pipelines will be undertaken following the commencement of their operation (refer to Section 5.8.7). If a requirement is identified to undertake intelligent pigging during pipeline commissioning activities, approximately 1,285m^3 and 1,185m^3 of treated seawater may be discharged to sea from the produced water and injection water pipelines respectively.

COP Infield Oil Pipeline - will connect the WC-PDQ platform to the existing DWG-PCWU infield pipeline via the newly installed wye (see Section 5.5.4 above). Once the pipeline between the new wye and WC-PDQ platform has been installed, the pipeline will be cleaned, gauged and leak tested using treated seawater. The treated seawater will be sent to the Terminal to be recovered and treated as produced water or, if this is not practicable for technical or safety reasons, discharged to sea. Should a requirement be identified to undertake intelligent pigging during pipeline commissioning activities, approximately 3.740m^3 of treated seawater may be discharged to sea.

COP Infield Gas Pipeline - will connect the WC-PDQ platform to the DWG-PCWU infield gas export pipeline. The completed pipeline will be cleaned, gauged (using a pig train as described above), leak tested using treated seawater and subsequently dewatered. Approximately 15m^3 of MEG dosed with 300ppm Troskil 88 (biocide) and 100ppm Tros TC 1000 (oxygen scavenger) may be used to condition the infield gas pipeline; the Base Case is to recover the conditioning fluids and ship to shore. If this is not practicable for technical or safety reasons they will be discharged to sea. Should a requirement be identified to undertake intelligent pigging during pipeline commissioning activities, approximately 865m^3 of treated seawater may be discharged to sea.

5.5.6 Summary of Pipeline Installation Discharges

Table 5.18 presents the expected volume and location of discharges associated with gauging, hydrotesting, tie-in, testing and dewatering of the infield COP pipelines, including potential discharges when recovery is not practicable for technical or safety reasons. The table includes estimated volumes should additional tests of the full length of the pipelines be required for safety reasons.

Table 5.18 Estimated Pipeline Gauging, Hydrotesting, Tie-in, Leak Tests and Dewatering Discharges

Pipeline	Activity	Discharge Location	Estimated Discharge Volume (m^3)	Total Estimated Discharge Volume (m^3)[3]
Gas Pipeline	Clean and gauge	Seabed	165	3,760 *(includes optional discharges)*
	Hydrotest	Surface	20	
	Tie-ins at WC-PDQ SSIV (Pipeline)	Seabed	25	
	Tie-ins at WC-PDQ SSIV (Spool)			
	Tie-ins at WC-PDQ (Riser)			
	Tie-ins at PCWU			
	Final gauging connected system	45-50m below surface	2,670	
	Leak test			
	Valve leak test			
	Dewater pipeline following full length test[1]			
	Option: If recovery is not practicable: Condition pipeline using MEG		15	
	Option Intelligent pigging		865	
Oil Pipeline	Clean and gauge pipeline and wye	Seabed	725	17,986 *(includes optional discharges)*
	Hydrotest pipeline and wye	Surface	65	
	Option: If recovery is not practicable: Treated seawater from DWG-PCWU target section (discharge includes 100ppm hydrocarbons).	Seabed	1,110	
	Tie-ins at wye (pipeline)	Seabed	3,760	
	Tie-ins at wye (spool)			
	Tie-ins at WC-PDQ (pipeline & riser)			
	Tie-ins at check valve (spool)			
	Final gauging connected system			
	Leak test	45-50m below surface	65	
	Valve leak test	Surface	1	
	Tie-ins at wye (spool)	Seabed	5	
	Tie-ins at wye (spool - DWG-PCWU) (discharge includes 100ppm hydrocarbons).		65	
	Leak test	45-50m below surface	85	
	Leak test topsides pipework			
	Option: If recovery is not practicable: Dewater pipeline following full length test[1]	Seabed	8,365	
	Option Intelligent pigging		3,740	
Injection Water	Clean and gauge	Seabed	230	5,135 *(includes optional discharges)*
	Hydrotest	Surface	25	
	Tie-ins at WC-PDQ	Seabed	5	
	Tie-ins at DWG-PCWU			
	Final gauging connected system	45-50m below surface	3,690	
	Leak test			
	Leak test topsides pipework			
	Dewater pipeline following full length test[1]			
	Option Intelligent pigging		1,185	
Produced Water	Clean and gauge	Seabed	245	5,555 *(includes optional discharges)*
	Hydrotest	Surface	25	
	Tie-ins at WC-PDQ	Seabed	5	
	Tie-ins at DWG-PCWU			
	Final gauging connected system	45-50m below surface	3,995	
	Leak test			
	Leak test topsides pipework			
	Dewater pipeline following full length test[1,2]			
	Option Intelligent pigging		1,285	

1 Includes estimated volume should additional testing be necessary.
2 The produced water pipeline will be dewatered prior to commencement of the produced water system on the WC-PDQ platform (refer to Section 5.8.7.1)

Tie-in, testing and dewatering activities (except for the produced water pipeline) are expected to be undertaken over a 12 month period, assisted by up to 5 support vessels.

5.5.7 Pipeline Installation, Tie-in and Commissioning – Emissions, Discharges and Waste

5.5.7.1 Summary of Emissions to Atmosphere

Table 5.19 summarises the GHG (i.e. CO_2 and CH_4) and non GHG emissions predicted to be generated during pipeline installation, tie-in and commissioning from key sources which include:

- Pipelay barge and support vessel engines and generators; and
- Commissioning vessel engines.

Table 5.19 Estimated GHG and non GHG Emissions Associated with Routine and Non Routine Pipeline Installation, Tie-in and Commissioning Activities

	Installation	Commissioning	TOTAL
CO_2 (k tonne)	40.5	31.5	72
CO (tonnes)	181	79	260
NO_x (tonnes)	1,333	584	1,917
SO_x (tonnes)	181	79	260
CH_4 (tonnes)	6	3	9
NMVOC (tonnes)	54	24	78
GHG (k tonnes)	41	32	73

See Appendix 5A for detailed emission estimate assumptions.

5.5.7.2 Summary of Discharges to Sea

Routine and non routine discharges to the sea during pipeline installation, tie-in and commissioning comprise:

- Pipeline cleaning and hydrotest fluids (refer to Section 5.5.6 above); and
- Pipelay and support vessel discharges as described within Table 5.17.

5.5.7.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non hazardous and hazardous waste that will be generated during the pipeline and platform installation, tie-in and commissioning programme are provided in Section 5.6.7.3 Table 5.23.

5.6 Platform Installation, Hook Up and Commissioning

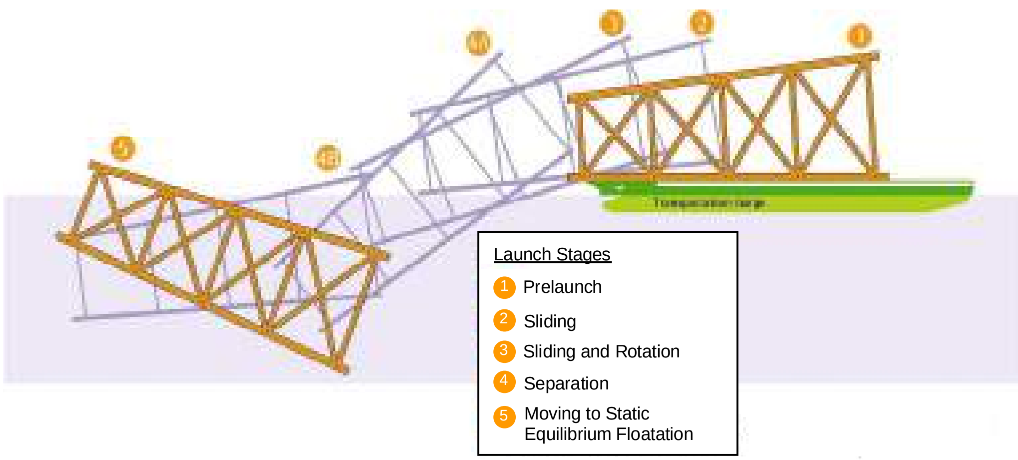
5.6.1 Pre Installation Survey

Prior to any installation works, a seabed survey will be undertaken using a remotely operated vehicle (ROV), controlled from a support vessel. This will confirm that there are no obstacles present in the platform location. While not expected, if any obstacles are present they will be removed using a DSV.

5.6.2 Jacket

Installation of the COP jacket, scheduled to take approximately 45 days, will follow similar methods as employed for the previous ACG projects. The process followed to unload and position the jacket is shown in Figure 5.13. Ballasting and use of the jacket buoyancy tanks will allow the jacket to be accurately positioned over the drilling template.

Figure 5.13 Jacket Installation



Once in position, the jacket will be attached to the anchored DBA crane[22] and set down onto the pre-installed pin piles. Hydraulic gripper jacks will secure the jacket until permanent piling is completed.

The buoyancy tanks will be removed by a combination of seawater ballasting and lifting with the DBA crane, then drained and towed back to the onshore fabrication site for reuse.

12 main foundation piles will secure the jacket. The piles will be driven using an underwater hydraulic hammer and grouted to the jacket pile sleeves. Grout will be supplied via flexible hoses from the DBA to the grout manifold panel located on the side of the jacket; and pumped down into the annulus between the pile and pile sleeve. A passive mechanical seal will ensure that the grout material is retained inside the pile sleeve annulus. A high strength cement will be used for the grout operation. Discharge of excess cement will be minimised as far as possible. However, approximately 50m^3 of excess cement may be discharged as the grouting operation is completed.

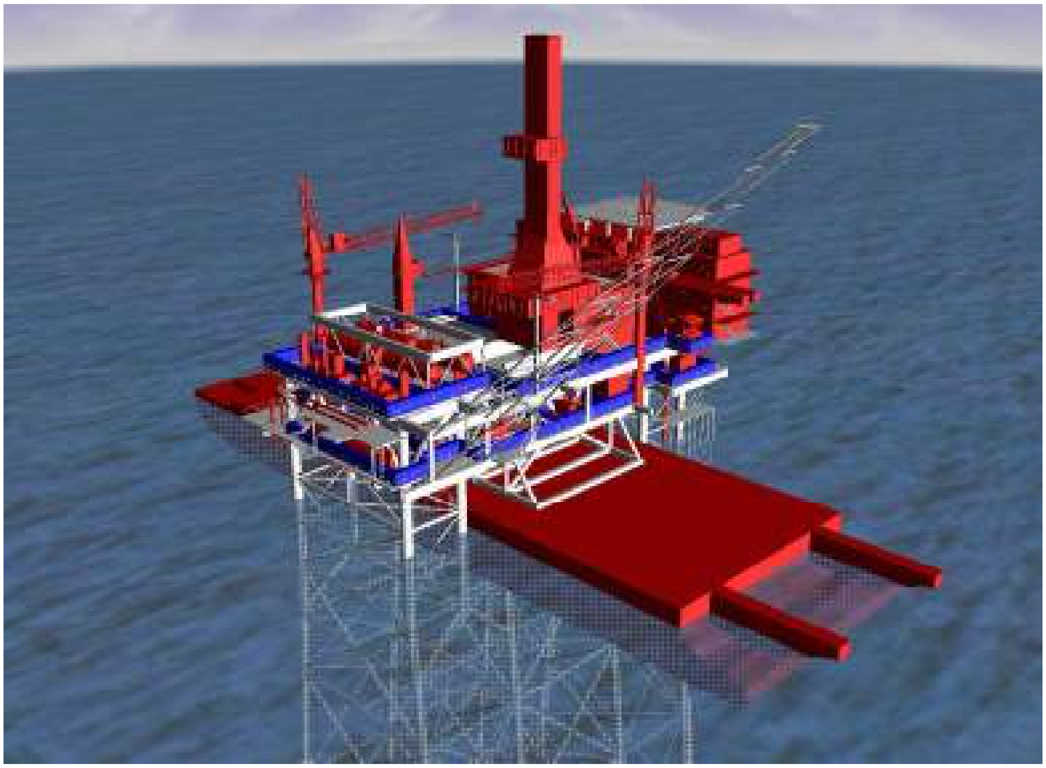
5.6.3 Topside

The topside is designed for the "float-over" method of installation, as employed for the previous ACG Phases. The STB-01 transportation barge is manoeuvred between the two jacket towers such that the topsides are positioned above their intended installation position on the jacket as illustrated in Figure 5.14. The mating operation (i.e. the process of connecting the topside to the jacket) is executed by ballasting the barge such that the topside

[22] The DBA anchoring system comprises 8 anchors each attached to electrically driven hydraulic mooring winches. Up to 3 vessels are planned to assist with DBA anchor handling during jacket and topside installation.

engages with shock absorbers in the jacket legs and the load is transferred. Sand jacks are then used to lower the topside until steel faces mate and are ready for welding. It is estimated that approximately 35m^3 of sand will be released from the 8 sand jacks during this process and discharged to the sea. Topside installation is scheduled to take approximately 2 days.

Figure 5.14 Topsides "Float-Over" Installation Method



5.6.4 Topside Hook Up and Commissioning

Once the topside is installed, a number of offshore hook up activities will need to be completed on the topside prior to start up. These will include:

- Installation of the WC-PDQ firewater and seawater lift pumps and caissons;
- Installation of the hazardous open drains caisson pump;
- Installation of the buy back valve control system[23];
- Tie-ins to all risers; and
- Connection of all umbilicals (including subsea cabling).

During installation of the buy back valve control system, it is not planned to discharge any hydraulic fluids, however approximately 0.1 litres of water/glycol based fluids of the same specification and environmental performance as used for previous ACG hydraulic control systems may be discharged to the marine environment.

Commissioning will commence with living quarters and utility systems including the main power generators. The systems will then be started up, allowing workers to inhabit the platform during commissioning and start up of the process facilities.

The current Base Case assumes that power during commissioning (until first oil) will be provided by the main platform generators, using fuel gas received from the "buy back system"[24] from the 28" marine export gas pipeline (through a connection near to CA).

[23] Refer to Section 5.8.6.3 for further details
[24] See Section 5.8.6.1

Alternatively, if not feasible for technical or safety reasons, four 1MW temporary diesel generators may be used for approximately 5 months through the commissioning period.

Commissioning of the deluge and foam systems is predicted to result in approximately 200 litres of seawater and approximately 20 litres of aqueous film forming foam (AFFF) (mixed with 140m^3 of seawater) discharged via the WC-PDQ open drains caisson to the sea at 49.5m below sea level .

5.6.5 DWG-PCWU Brownfield Works

Brownfield works on the DWG-PCWU platform will comprise the following:

- Installation of a riser ladder (which will be floated out) that includes risers for the produced water coming to the DWG-PCWU platform from the WC-PDQ platform and the injection water transported from DWG-PCWU to the COP water injection wells;
- Installation of a produced water pig receiver/launcher and injection water pig launcher/receiver;
- Tie-in to the injection water and produced water systems on the DWG-PCWU platform;
- All piping and control systems for the required piping runs; and
- Installation of a hazardous open drains line to cover the areas where the additional equipment is installed.

Up to 50 days of diving works using a DSV will be required to install and secure the risers and frames to the DWG-PCWU jacket. Some of this work can take place when the PCWU platform is operational. However, it is expected that a shutdown of the DWG-PCWU platform of approximately 28 days will be required to complete the critical installation works. Once the shutdown procedure and programme are finalised for the DWG-PCWU platform to enable tie in to the COP platform, the potential implications of shutdown on the environmental impacts predicted for the original DWG-PCWU platform design will be considered. The results of this review will be communicated to the MENR.

Once installed and tied into the risers, the infield produced water and injection water pipelines will be hydrotested as described in Section 5.5.5 above.

Testing and commissioning of the pigging equipment and water systems' controls will be undertaken. This equipment will be commissioned using the power generation and utility systems in place on the DWG-PCWU platform and will not require any temporary equipment.

5.6.6 Installation, Hook Up and Commissioning Vessels

Table 5.20 summarises the estimated numbers and period of use of the vessels that will support the COP platform installation, hook up and commissioning (HUC) activities and the DWG-PCWU platform brownfield works. The actual duration of the offshore installation work will be dependant on weather and other factors.

Table 5.20 Installation, Hook Up and Commissioning Vessels (Including DWG-PCWU Platform Brownfield Works)

Vessel	Jacket Installation			Topside Installation			WC-PDQ Commissioning and DWG-PCWU Brownfield Works		
	No.	Duration (Days)	POB	No.	Duration (Days)	POB	No.	Duration (Days)	POB
DBA	1	45	160	1	2	70	1	21	160
Support vessel	3	45	4	4	2	15	2	180	15
STB-01	1	45	9	1	2	9			
DSV	1	1	26				1	50	1

Note: The DBA will be used to accommodate personnel for up to 3 weeks during platform HUC.

Table 5.21 summarises the vessel utilities.

Table 5.21 Installation, Hook Up and Commissioning Vessel Utilities

Utility	Description
Sanitary Waste	• Sewage systems designed to treat black water to applicable MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards[a] • Sewage sludge shipped to shore for disposal
Galley Waste	• Vessel maceration units designed to treat food wastes to applicable MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standards[b] prior to discharge. Non food galley waste generated by the support vessels will be collected and transported onshore for disposal via authorised contractors
Drainage/Cooling Water	• Deck drainage and wash water discharged to sea[d] • Oily bilge water tank sludges, untreated oily water and waste oil shipped to shore

Notes as per Table 5.9

It is planned that crew changes will be by helicopter or by vessel through the installation, hook up and commissioning COP phase.

5.6.7 Platform Installation, Hook Up and Commissioning – Emissions, Discharges and Waste

5.6.7.1 Summary of Emissions to Atmosphere

Table 5.22 summarises the GHG (i.e. CO_2 and CH_4) and non GHG routine emissions predicted to be generated during platform installation, hook up and commissioning from key sources[25] which include:

- Jacket installation vessel engines and generators;
- Topside installation vessel engines and generators; and
- Support vessels engines (Hook up and transport of DWG-PCWU equipment).

Table 5.22 Predicted GHG and Non GHG Emissions Associated with Routine Installation, Hook Up and Commissioning Activities

	Jacket Installation	Topside Installation	Hook Up Vessels	DWG Vessels	TOTAL
CO_2 (k tonnes)	4.8	0.3	2.9	0.02	**8.0**
CO (tonnes)	12	1	7	0	**20**
NO_x (tonnes)	88	5	54	0	**147**
SO_x (tonnes)	12	1	7	0	**20**
CH_4 (tonnes)	0	0	0	0	**0**
NMVOC (tonnes)	4	0	2	0	**6**
GHG (k tonnes)	4.8	0.3	2.9	0.02	**8.0**

See Appendix 5A for detailed emission estimate assumptions.

[25] Emissions and discharges associated with commissioning and start up activities on the platform (including crew transfer) are included within Sections 5.8.9.1 and 5.8.9.2 respectively.

5.6.7.2 Summary of Discharges to Sea

Routine discharges to the sea during platform installation, hook up and commissioning comprise:

- Ballast water during jacket installation (refer to Section 5.6.2);
- Minor cement losses during jacket grouting (refer to Section 5.6.2);
- Sand from topside jacking activities (refer to Section 5.6.3);
- Seawater and AFFF from deluge and foam system testing (refer to Section 5.6.4); and
- Installation and support vessel discharges as described within Table 5.21[25].

5.6.7.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non hazardous and hazardous waste that will be generated during the pipeline and platform installation, hook up and commissioning programmes are provided in Table 5.23. These have been calculated using operational data gained during the previous ACG Phases.

Solid and liquid waste generated will be shipped to shore and managed in accordance with the Waste Management principles detailed in Chapter 14.

Table 5.23 Estimated Hazardous and Non Hazardous Waste Associated with Pipeline and Platform Installation, Hook Up and Commissioning Activities[1]

Type	Waste Category[2]	Sub Category	Estimated Volume (tonnes)
Non hazardous waste	Non hazardous non recyclable waste	General waste	3,000
		Food/galley waste	
	Recyclable waste	Cooking oil	765
		Electrical cable	
		Paper and card	
		Plastics	
		Scrap metal and wood	
		Total (Non hazardous)	**3,765**
Hazardous waste	Solid hazardous waste	Batteries	90
		Drum/cans	
		Cement	
		Clinical waste	
		Oil filter parts	
		Sand and sludges	
		Oily rags	
		Paint cans contaminated with uncured paint	
	Hazardous liquid waste	Acids and alkalis	4,335
		Antifreeze	
		Chemicals	
		Fuel oil	
		Grease	
		Oil	
		Paint	
		Paint sludge	
		Solvents and thinners	
		Photographic developing fluids	
		Oily and contaminated water	
		Total (Hazardous)	**4,425**

1 Treatment and disposal routes are detailed in Section 5.12.2.
2 Estimates include key waste types. Minor non hazardous wastes including used tyres, toner cartridges and intermediate bulk containers are excluded.

5.7 Platform Drilling

5.7.1 Introduction

The COP Base Case assumes the following well requirements:

- 28 production wells (targeting the Pereriv and Balakhany reservoirs);
- 17 water injection wells; and
- 1 cuttings reinjection (CRI) well.

Up to 20 of these wells (16 producer wells, 3 water injection wells and the CRI well) are planned to be predrilled using a MODU as described in Section 5.3 above. Platform drilling operations will commence with re-entry and tie-back of the predrill wells to the production facilities. The Base Case incorporates two spare well slots in the platform design, future use of these is not currently defined.

The platform well designs will be the same as the predrill wells, with additional reservoir penetration achieved in the future through sidetracking. The objective of the COP is to target the Balakhany and Pereriv reservoirs, which underlay the ACG Contract Area[26].

Following the tie-back of the predrilled wells, it is anticipated that platform drilling will commence in 2015 and will continue through to 2023. It is estimated that an average annual drill rate of 3.6 wells/year can be achieved, with each well taking approximately 40 days to drill and approximately 40 days to complete. Sidetrack drilling operations and well workover (i.e. well maintenance/remedial works) will be undertaken as per drilling requirements once the drilling programme is finalised.

5.7.2 Platform Drilling Facilities

Drilling facilities will comprise the DES and DSM. The DES will be a moveable rig, which can be positioned, by means of hydraulic rams, over each of the drilling slots. It will comprise the following principal equipment items:

- Drilling equipment and pipe handling systems;
- Power swivel;
- Mast/Derrick;
- Draw works;
- Well control system;
- Solids control system;
- Drilling waste management system, including the CRI system;
- Ship-to-shore system;
- Drilled cuttings containment system; and
- Rig skidding system.

The DSM is a fixed unit, which is used for the storage and mixing of mud, cement and other chemicals necessary to support drilling. The module comprises the following principal equipment items:

- Pipe rack and lay-down area;
- Low and high pressure mud systems;
- Mud chemical stores;
- Fluid and dry bulk stores;
- Mud mixing;
- Cementer Unit;
- 3 x cement powder storage tanks;
- Hazardous stores; and
- Forklift.

[26] The depth of water at the drilling location is 169m.

Power will be supplied to the drilling facilities by the main platform generators (see Section 5.8.6.4) and, when required, by the platform emergency power generators.

5.7.3 Predrill Well Tie-in and Re-entry

Conductors on the platform will be installed into each predrilled well, which will then be connected to the production manifolds. Following the removal of the mechanical plug and suspension fluids, viscous sweeps will be circulated within the well.

Table 5.24 presents the expected suspension fluids that will be displaced per well re-entry and the volume of viscous sweeps chemicals used per well.[27]. The suspension fluid and sweeps associated with predrill well re-entry will be sent to the CRI well, when available. Prior to the CRI well being tied-back and when it is not available, suspension fluids and sweeps will be recovered and shipped to shore. It is not planned to discharge suspension fluids and associated viscous sweeps.

Table 5.24 Estimated Suspension Fluid Chemicals and Viscous Sweeps

Chemical/Fluid[1]	Function	Estimated Use per Well (tonnes)[2]	Hazard Category[3]
Suspension Fluids			
M-I Cide / Glutaraldehyde	Biocide	0.6	E/GOLD
OS1-L	Oxygen Scavenger	0.4	E
Safe-Cor	Corrosion Inhibitor	2.5	E
Viscous Sweeps			
Freshwater	Circulation fluid	120	N/A
Bentonite	Viscosifier	11	E
Guar Gum	Viscosifier	2	E
Gluteraldehyde	Biocide	0.1	GOLD

Notes as per Table 5.2

Completion of the predrill wells to achieve first oil will comprise drilling of the 8½” reservoir hole, the installation of downhole sand control systems, described in Section 5.7.8, and installation of the upper completion system.

5.7.4 Platform Well Design

Table 5.25 below summarises the platform well design, the drilling mud system for each hole section and the respective disposal or discharge route.

[27] The COP Management of Change Process (Section 5.11) will be followed should alternative chemicals be required.

Table 5.25 Generic COP Well Design

Hole Size (Drill Bit Diameter)	Casing Outer Dimension	Description	Setting Depth (m TVD BRT[1])	Drilling Mud System	Disposal Route of Drilling Muds/Cuttings
N/A	30"	Conductor	+/- 350	-	-
28"	24"	Drilling Liner	+/- 500	WBM[2]	Discharge to sea via cuttings caisson
26"	20"	Surface	+/- 750	WBM	Discharge to sea via cuttings caisson
16"	$13^3/_8$"	Intermediate	+/- 1300	SBM[3] or LTMOBM[4]	CRI or shipped to shore
12¼"	$9^5/_8$"	Production	Top Reservoir (2,600 – 3,000)	SBM or LTMOBM	CRI or shipped to shore
8½"	NA	-	200 - 600m in length	SBM or LTMOBM	CRI or shipped to shore

See notes of Table 5.1.

Unlike the predrill wells, the platform well **30" conductor** will self penetrate and be driven by hydraulic hammer into the seabed. No drilling will be required.

28"/26" Hole Section - will be drilled with WBM as per the predrill wells (see Section 5.3.2.4 and Table 5.3 for estimated chemical use)[28].

The resulting cuttings, diluted to ensure a chloride concentration in accordance with PSA requirements for the drilling mud system, will be discharged from the platform cuttings caisson at a depth of 136m below the sea surface . As with the predrill programme, WBM will be reused wherever possible. Excess WBM will be disposed of via the CRI well or, if this is not available, diluted to ensure a chloride concentration in accordance with PSA requirements, and discharged to sea.

16", 12¼" and 8½" Hole Sections - will be drilled from the platform with LTMOBM or SBM as described for the predrill well (see Table 5.4)[25]. Mud and cuttings from these hole sections will be returned to the platform topside, separated and the mud reused wherever possible. Cuttings will be re-injected into the CRI well with mud that it is not practicable to separate and/or reuse. When the CRI well is not available, cuttings and mud for disposal will be containerised and either transported to another operational platform for reinjection or shipped to shore for treatment.

Table 5.26 below summarises the expected volumes of mud and cuttings generated per well and the preferred disposal route.

Table 5.26 Estimated Platform Well Cuttings and Mud Volumes per Hole Section

Hole Size (Drill Bit Diameter)	Description	Quantity of Cuttings per Well (tonnes)	Quantity of Drilling Fluids Associated with Cuttings per Well (tonnes)	Drilling Fluid / Mud System	Cuttings and Mud Disposal	Duration of Discharge per Well (hours)
28" & 26"	Drilling Liner and Surface Holes	155	340	WBM	To sea via caisson at -136m. Mud recovery system utilised to recover muds from cuttings. CRI preferred option for excess/residual mud	30
16", 12¼" and 8½"	Intermediate and Production Holes	675	550	SBM /LTMOBM	CRI or shipped to shore	N/A

1 Total estimated fluid volume including chemicals and seawater/drill water.
2 The estimated water based mud and cuttings volumes, calculated from historic ACG drilling discharge records, make allowance for the slight increase in measured depth associated with deviated wells.

[28] Chemicals used will be of the equivalent specification and environmental performance as used for previous ACG wells. Alternatives will be selected in accordance with the COP Management of Change Process (see Section 5.11).

A total of approximately 18 tonnes of residual WBM per well, diluted to achieve the PSA chloride standard, may be discharged should recovery/reuse or reinjection not be possible.

5.7.5 Cuttings Treatment and Disposal

Mud and cuttings from both the surface and lower holes will be returned to the platform. Each will pass through a shale shaker screen system to separate and recover the muds from the cuttings. The WBM cuttings will be discharged to the platform cuttings caisson and the mud stored for reuse. The SBM/LTMOBM cuttings will be routinely treated for reinjection as described below.

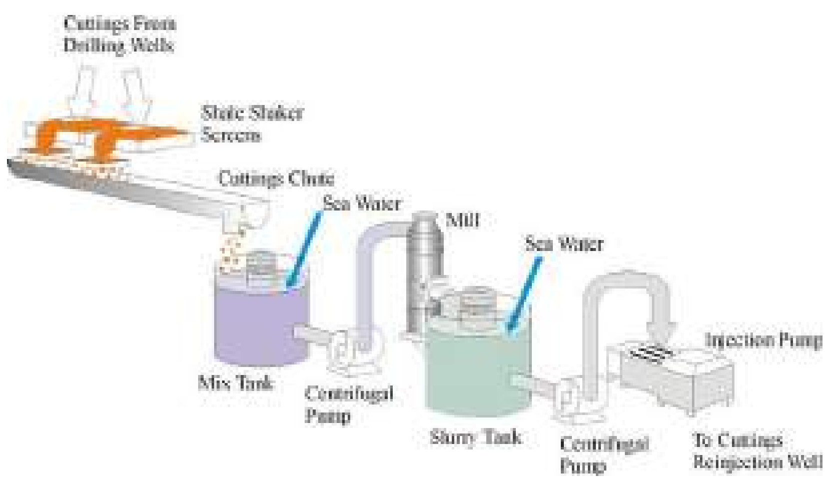
5.7.5.1 Cuttings Reinjection

In addition to used SBM and/or LTMOBM mud and cuttings, contaminated WBMs, used contingency and well clean up chemicals, predrill and batch suspension fluids, produced sand from the processing facilities, sewage sludge and waste streams previously approved by the MENR for offshore reinjection, may also be sent to the CRI well for disposal[29].

Figure 5.15 below illustrates the cuttings reinjection process.

After separation by the shale shaker screens, the cuttings will be mixed with seawater and the resulting slurry milled. The slurry, injected with a viscosifier, oxygen scavenger and biocide, will then be pumped downhole into the CRI well either continuously or in batches. The slurry enters sub surface fractures created by injecting high pressure water into the well. The fracture characteristics are controlled by the flowrate, pressure and properties of the slurry. Injection rates and batch sizes will vary across the PSA period[30].

Figure 5.15 Cuttings Reinjection Process



5.7.5.2 Cuttings Reinjection Well Design

The COP CRI well location, design and operation has been based on the findings of two major studies,[31,32] which include detailed analysis and consideration of the following:

- Estimating the total volume of drilling and completion wastes expected from the proposed development;
- Assessing the technical and environmental suitability of overburden formations for burial of waste. This includes an understanding of stress and permeability barriers in the target formation that provide containment to ensure the waste domain does not

[29] Refer to Appendix 5B for previously approved waste streams.
[30] See ACG Phase 1 and 3 ESIAs for a full description of the cuttings reinjection process.
[31] Subsurface Burial of Well Construction Wastes from the DWG field Development, Gidatec Ltd., March 2005
[32] Disposal of Drill Cuttings from the Azeri Field Development: A Re-Injection Feasibility Study, BP Sunbury report UTG/245/01, May 2001

grow upward to surface, into shallow faulted zones or over-pressured zones. Similarly, this assessment ensures that the waste domain does not grow downwards into reservoirs or deeper over-pressured zones;

- Numerical simulation of the injection process to define the geometry of the waste domain and the limit for the volume of waste that can be buried safely in the targeted formation. This includes numerical simulation of fracture development and containment over time which requires understanding of the overall subsurface stress state;
- Estimation of surface injection pressures and slurry re-injection rates required to sustain the burial operation, plus possible constraints in achieving these parameters;
- Examination of any constraints on subsurface re-injection posed by nearby wells and stratigraphic features, such as faults, abnormally pressured formations, mud volcanoes or offset wells, which have potential to cause communication paths to surface;
- Identification of any operational and environmental issues affecting the overall success of the re-injection operation; and
- Departure of the CRI well design required from normal ACG well design to prevent pressure-up of drill-through intervals.

Compliance with these findings and BP's internal CRI well policy[33], has formed the basis of design for the COP CRI well. In addition to initial well design, the two studies consider well-life through operations, surveillance, well workover and well abandonment.

The preferred location for the COP CRI well is away from the crest and on the north-eastern flank of the anticline structure in the base of the Surakhany formation. This is because there is little risk of the disposal fractures intersecting any of the COP production and water injection wells and also prevents pressurisation of drill-through zones for the COP wells. Additionally, there are some overlying sand/silts that provide redundant capacity in the event that fracture containment is breached.

The top of the Surakhany formation, marked by a 3m-thick cap-rock of gypsum, is composed predominately of yellowish-brown and gray-green claystone with thin beds of gypsum and anhydrite and fine-grained argillaceous sandstone. In addition, subordinate halite has been noted from traces found in claystone cuttings in association with the evaporite-sandstone beds. The claystone is moderately calcareous and dolomitic, with occasional thin dolostone stringers found in conjunction with gypsum beds. The lower part of the section consists of olive-gray to yellowish-brown claystone with thin interbedded gray-white siltstones and sandstones that increase in frequency to the base of the formation, making the lower Surakhany suitable as the disposal target.

Cuttings/slurry capacity determination is based on specific well conditions as drilled, which is a function of formation porosity and thickness characteristics. Should the COP CRI well fail to provide the required performance or capacity or otherwise fails during service there is sufficient appropriately located volume within the Surakhany formation within the drilling radius of the COP platform for an additional CRI well to be located. This is not part of the current Base Case design.

All ACG CRI wells are designed with the casing shoes located to provide redundant isolation between the injection interval and the overlying formations. Cement bond logs are run in CRI wells to ensure annular integrity.

During well operation, injection pressure trends are monitored to detect any significant deviation from the fracture growth behaviour predicted by the fracture modelling work. This would provide early indication of any fracture containment barrier being breached. Annulus pressures are continuously monitored to ensure that the mechanical integrity of the wellbore is being maintained. All CRI wells are fitted with downhole pressure and temperature gauges which provide data from just above the depth of formation injection. These gauges are used for Pressure Fall-Off testing which provide additional information regarding fracture growth and containment which can be used to calibrate the fracture models.

[33] BP DCRI Manual, BP Intranet: http://ut.bp.web.bp.com/drillcuttingreinjection/.

5.7.6 Conductor Suspension

During drilling operations, it is expected that a number of the platform wells will be suspended with brine suspension fluids (as used for existing ACG projects) after the 30” conductor has been installed; and then re-entered at a later date in the drilling programme.

The preferred option for disposing of conductor suspension fluids when the wells are re-entered will be to recover and inject via the CRI well or, if this is unavailable, to ship to shore. It is not planned to discharge conductor suspension fluids to sea.

5.7.7 Well Completion Activities

5.7.7.1 Casing and Cementing

As for the predrill wells, different hole sections will be cased and the casing cemented into place. Cement slurry from the WC-PDQ platform will be pumped between the casing outer wall and the host rock formation via hosing. It is expected that the cement formulation used for predrilling will also be used for platform well casing.

Where it is not technically practicable or safe to recover excess cement remaining in the cement system following casing, it will be mixed with seawater and discharged to the seabed over approximately one hour via the cement system hoses. It is not planned to discharge any dry cement to the marine environment.

The volume of cement used to cement each casing is calculated prior to the start of the activity. Sufficient cement is used to ensure that the casing is cemented securely and necessary formations isolated so that this safety and production critical activity is completed effectively while minimising excess cement discharges to the sea. Releases of cement during platform drilling are anticipated to be slightly less than during predrill (refer to Section 5.3.2.5) as the conductor section will be driven and will not be cemented into place. It is expected that, as a worst case, approximately 13 tonnes of cement per well will be discharged, comprising approximately 5 tonnes Class G cement, 6.5 tonnes barite and the remainder cement chemicals of low toxicity (Hazard Category E and Gold) (Refer to Table 5.6) Releases of excess cement at the end of casing cementing, when it is not technically practicable or safe to recover excess cement remaining in the cement system, will be comparable to predrill releases (refer to Section 5.3.2.5).

To minimise potential gas leakage from wells due to inadequate cementing of the casing annuli (as occurred historically at the CA facilities), the following measures have been adopted:

- The cement units have been designed to improve the reliability and accuracy of the system that controls the supply of the cement additives;
- Solids control capability has been improved to ensure that the drilling fluid is maintained within specification; and
- It is planned to spend additional time executing the cement programme and ensuring quality control. New cement techniques may be considered (e.g. two-stage cementation) and cement bond logs will be run after all critical cement jobs so that the quality of the cement can be verified.

5.7.7.2 Well Clean Up

Following cementing, as for the predrill wells, a number of clean up chemicals will be circulated to the wells. Estimated chemicals and usage is provided in Table 5.8.[34]. Clean up fluids will be recovered and injected via the CRI well or, if this is unavailable, shipped to shore.

5.7.8 Sand Control

Without a form of sand control, the wells would accumulate considerable quantities of sand thereby adversely affecting production. It is expected that both Open Hole Gravel Pack (OHGP) and Expandable Sand Screen (ESS) sand control will be used depending on the well characteristics. In both cases, a well screen is installed in the open-hole-producing zone of the well. OHGP involves gravel packing the annular space between the screens and wellbore. This has the disadvantage of reducing the wellbore inside diameter due to the packing. The expandable sand screen option maintains the wellbore diameter and allows zonal isolation between oil arising from different formations.

5.7.9 Contingency Chemicals

Potential hazards during platform drilling include shallow gas, reactive formation and overpressure as discussed in Section 5.3.2.6. By definition, the use of contingency chemicals cannot be predicted with accuracy. Indicative information on the use of contingency chemicals for predrilling, provided previously in Table 5.7, is also applicable for platform drilling[26]. Contingency chemicals, if required, will be recovered and disposed of with the SBM/LTMOBM and cuttings, either to the CRI well (preferred option) or, if this is unavailable, shipped to shore.

5.7.10 Platform Drilling – Emissions, Discharges and Waste

Emissions, discharges and waste associated with all platform operations including drilling are provided in Section 5.8.9.

[34] The COP Management of Change Process (Section 5.11) will be followed should alternative chemicals be required.

5.8 Offshore Operations and Production

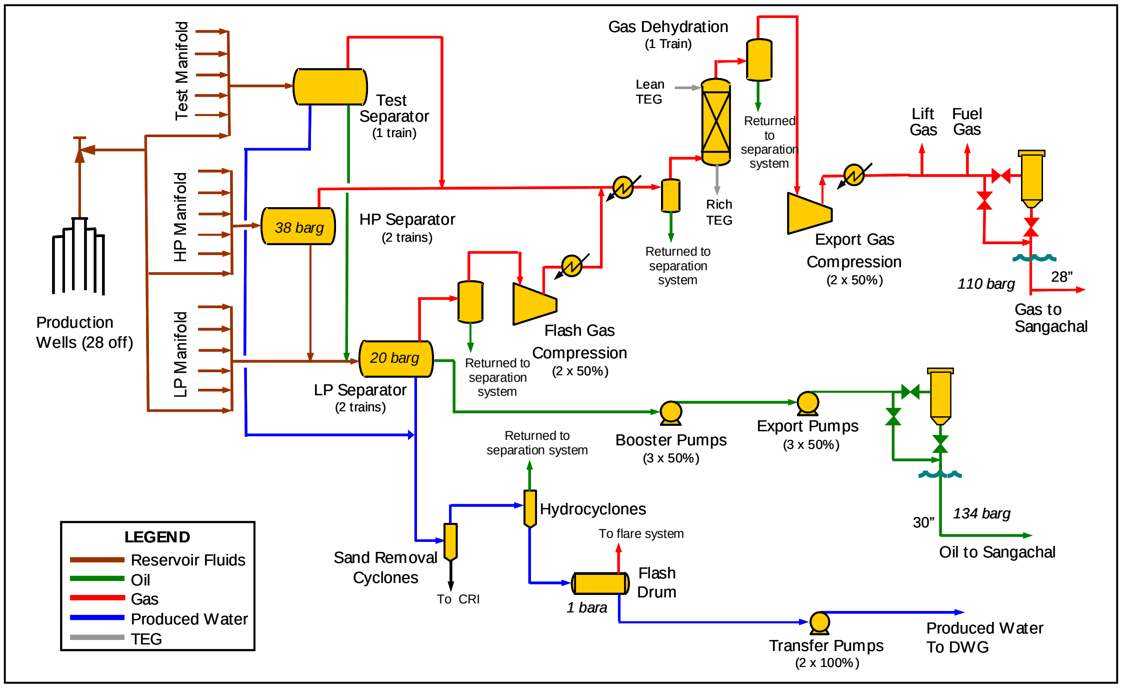
5.8.1 Overview

Key production activities that will be undertaken on the WC-PDQ platform will include:

- Produced hydrocarbon separation;
- Gas processing;
- Oil and gas export;
- Well testing;
- Produced water treatment;
- Water injection; and
- Utilities to support these processes.

Figure 5.16 shows a simplified flow diagram of the platform processes.

Figure 5.16 WC-PDQ Process Schematic



The principal processes and support utilities for the COP are described below.

5.8.2 Separation System

Well fluids will be transferred from producing wells to the platform via flow-lines, which tie into either the high pressure (HP) or low pressure (LP) production manifold of the platform. From the manifolds, the fluids will be sent to the separation trains where gas, oil and produced water separation will be carried out.

Each separation train will comprise an HP separator, which will receive well fluids from the HP production manifold and a downstream LP separator, which will receive fluids from the HP separator and from the LP production manifold. The HP separator is designed to permit 2 phase separation of gas from liquids at a pressure of 38 bar gauge (barg). The LP separator is designed to permit further separation of the gas, at a pressure of 20 barg and separation of the oil from the produced water. The LP separator is designed to achieve a partially stabilised oil product, exported to the Sangachal Terminal from the platform via the Main Oil Line (MOL) pumps, with a maximum oil-in-water content of less than 8% by volume.

When testing wells, reservoir fluids will be sent to an additional test manifold and separator. The test separator will be sized to accommodate the maximum expected operational flows from any one well and will be capable of operating as a production separator in the event that the HP separator is unavailable (e.g. due to maintenance).

5.8.3 Gas Processing and Export

Flash gas from the LP separator will be compressed by 2 electric motor driven flash gas compressors to 38 barg, cooled and combined with the gas from the HP separator. The combined gas stream will then be cooled and passed to the gas dehydration package.

The gas dehydration package will comprise an inlet scrubber, glycol contactor and glycol regeneration package. The system is designed to reduce the water content of the combined separator flash gas stream to 4 lb/MMscf. The purpose of the dehydration process is to prevent hydrate formation and corrosion within the export gas pipeline.

The combined gas stream passes through the glycol contactor, where it is scrubbed by a recirculating solution of lean tri-ethylene glycol (TEG). The TEG absorbs the water within the gas stream and some heavy gaseous hydrocarbons. The rich (i.e. water and hydrocarbon saturated) TEG is then sent to the glycol regeneration package where it is heated to release the absorbed compounds. The regenerator off gas (i.e. gas released during heating) is cooled to condense the water present. The residual gaseous hydrocarbon and the condensed water streams are sent to the LP flare header. The regenerated glycol is recirculated back to the contactor.

The dehydrated gas stream will be compressed to export pressure of 112 barg using 2 centrifugal electrically driven Export Gas Compressors (EGC). Prior to export, a portion of the gas will be taken for use on the platform as lift and fuel gas (refer to Sections 5.8.6.1 and 5.8.6.2 below).

5.8.4 Produced Water

During early field life the produced water portion of the reservoir fluids will be small and will be transported onshore with the oil. Once the water portion in the COP LP separators exceeds 5% it will be separated from the reservoir fluids on the platform, treated and, under normal conditions, pumped to the DWG re-injection system. Recovered produced water from the LP separators will be desanded and sent to the produced water treatment package. This will include sand cyclones, oil hydrocyclones and a produced water degassing drum. The treatment package will be designed to:

- De-oil the produced water to an oil-in-water concentration of 42 mg/l as a daily maximum and 29 mg/l as a monthly average (as defined by EPA method 1664A); and
- De-gas the cleaned water.

Hydrocarbons from the degassing drum will be sent to the flare system and flared. Separated oil will be returned to the LP separators via the reject oil pumps. The cleaned and degassed produced water will be pumped by the produced water transfer pumps to the injection water system on the DWG-PCWU platform, via the produced water pipeline. Figure 5.2 presents the estimated produced water profile across the PSA period.

Discharge of produced water, treated to the applicable oil-in-water standards (42 mg/l as a daily maximum and 29 mg/l as a monthly average), will only occur:

- If the volume of produced water exceeds that required for reservoir pressure maintenance; or
- Due to a downtime event such as an emergency, accident or mechanical failure; or

- If standard compatibility testing demonstrates that produced water and Caspian seawater are not compatible[35].

Experience to date from the ACG Contract Area has shown the most likely scenario for discharge is due to plant upsets. For the COP this would be due primarily to failure of:

- the WC-PDQ platform produced water transfer pumps; or
- the DWG platform injection water pumps.

To reduce these potential failures redundancy has been designed into the WC-PDQ and DWG platforms as follows:

- WC-PDQ produced water transfer pumps - the platform design incorporates two transfer pumps (1 spare), each of the two transfer pumps is capable of handling 100% of the forecasted maximum produced water flow rates, as if one pump fails the other pump can continue pumping water to DWG; and
- The DWG-PCWU injection water pumps - the three water injection pumps on the DWG-PCWU platform are individually capable of handling all the produced water from WC-PDQ even at maximum predicted produced water flows.

5.8.5 Water Injection

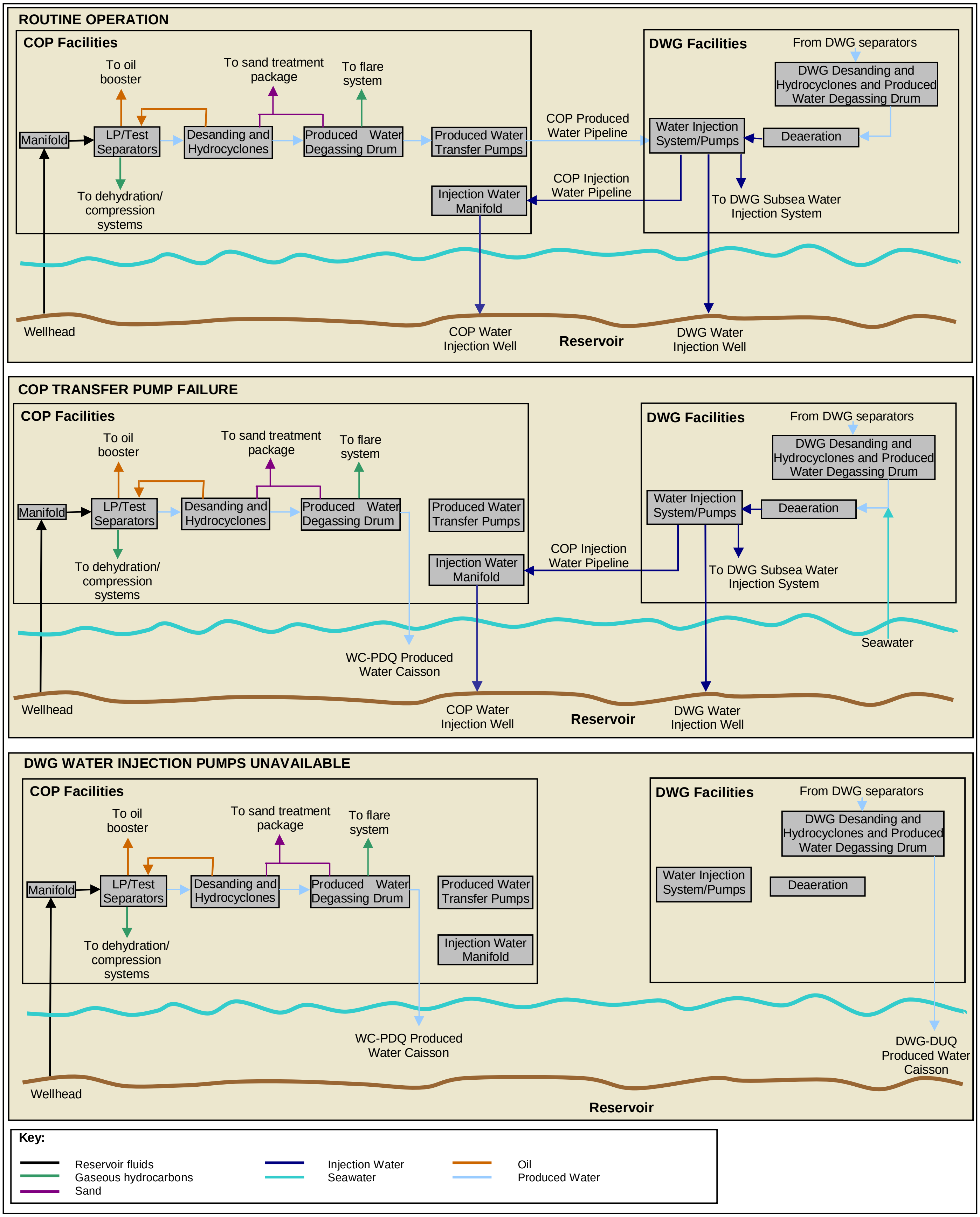
Produced water from the WC-PDQ platform will be co-mingled with DWG produced water and treated seawater (when there is insufficient produced water at DWG) and treated to meet the specifications established for the operation of the DWG-PCWU water injection system.

A portion of the injection water will be pumped back to the WC-PDQ platform and the remainder will routinely be sent to the DWG water injection wells and via the DWG subsea water injection system. Injection water received at the WC-PDQ platform will be supplied to the WC-PDQ injection water manifold and routed to the COP water injection wells. Under routine conditions, it is not planned that injection water will be discharged to sea from the WC-PDQ platform.

Figure 5.17 provides a simplified flow diagram showing produced water and injection water flows associated with the COP and DWG facilities during routine operation and during downtime events such as mechanical failure of the WC-PDQ platform produced water transfer pumps or mechanical failure associated with the DWG water injection pumps.

[35] The PSA requires that produced water is used for reservoir pressure maintenance as long as standard compatibility testing with Caspian Sea water demonstrates that no damage to the reservoir, resulting in a reduction in overall hydrocarbon recovery, would occur by mixing the two water streams.

Figure 5.17 Simplified Produced Water and Injection Water Flows



5.8.6 Platform Utilities

5.8.6.1 Fuel Gas

A portion of the gas abstracted from the reservoir will be used as fuel gas for the following:

- RB211 main gas turbine generators; and
- Purge and pilot within the HP and LP flare systems.

The gas, taken from the export gas stream, will be first passed through a knockout drum to remove any entrained liquids, through a heater and then filtered before being distributed to the platform users. The entrained liquids will be routed to the separators prior to export in the crude oil. In the event the separators are not available the system will be equipped with fuel gas condensate pumps, which will inject condensed liquid hydrocarbons to the MOL.

In the event that the export gas system is unavailable (e.g. due to maintenance, platform start up and plant and equipment upsets), a fuel gas "buy back" system will be provided to allow the import of fuel gas to the platform from the 28" marine gas export line, via a connection near to DWG-PCWU platform.

5.8.6.2 Lift Gas

The purpose of lift gas is to maximise well productivity. Lift gas will be sourced from the gas export stream, from where it will pass to the lift gas manifold before being delivered to the wellhead. The lift gas system will be sized to provide 80 MMscfd of gas, with a maximum lift gas flowrate per well of 6 MMscfd.

5.8.6.3 Hydraulic Valve Control System

The subsea gas "buy-back" valve on the 14" infield gas pipeline at the WC-PDQ platform will be controlled from the platform by a direct hydraulic closed loop control system. The control system will provide low pressure hydraulics from a dedicated hydraulic pumping unit (HPU) to the subsea valve via an umbilical. The umbilical contains hydraulic control lines and electrical cabling for instrumentation providing valve position status. During normal valve operations, the hydraulic fluid will be returned to the HPU via this closed loop system. It is not planned to discharge hydraulic fluid to the marine environment.

5.8.6.4 Power Generation

Power for the WC-PDQ platform will be provided by 3 identical Rolls Royce dual fuelled (fuel gas with diesel back up supply) RB211 gas turbine driven power generators. 2 of these turbines, each capable of providing 28.5MW of electrical power (based on ISO rating) will normally be operated simultaneously with the third turbine spared (e.g. used during maintenance work on the main turbines).

Emergency power will be provided for essential service by a 1.2 MW diesel generator.

5.8.6.5 Diesel System

The main platform diesel users comprise:

- Cranes;
- Emergency power generators;
- Main power generators (only when both the export fuel gas and "buy back" system is unavailable);
- Standby air compressor;
- Firewater pumps; and
- Lifeboats.

Diesel will be transferred from supply boats and offloaded onto the platform by hose, where it will be filtered and stored in the crane pedestals. When required, it will be pumped to the diesel users, via the diesel treatment package, which will remove small amounts of water and particulates that have contaminated the diesel during vessel transfer from the onshore diesel treatment facilities. All by-products generated from the diesel treatment system will be transferred to the non-hazardous open drains system (see Section 5.8.6.11 below).

5.8.6.6 Flare System

The platform will be fitted with an LP and HP flare system. Each of the systems is designed to collect gaseous releases from various sources around the platforms and convey them, via a header and flare drum, to a flare tip where the gas is burned and the products of combustion discharged to atmosphere.

Under routine operational conditions, flaring emissions will only be associated with the following:

- The glycol regeneration package, which will vent continuously into the LP flare header;
- The flare system, which will be continuously purged with fuel gas to prevent ingress of oxygen and the build-up of an explosive atmosphere; and
- The flare tip, which will be provided with a fuel gas-fired pilot light to ensure ignition of any gaseous releases.

During non routine conditions including start up, shutdown and equipment failure/maintenance, gaseous release from process equipment and utilities are directed to the flare for combustion as a safety measure. The COP Base Case assumes that up to 3% of total gas will be flared per annum, 2% of this total will be flared at the platform and the remainder at the Terminal.

Both the LP system and the HP system will share the same flare boom. The HP flare tip will be of a ‘smokeless design’.

5.8.6.7 Seawater System

Seawater will be required onboard the platform for a number of purposes including:

- Heating, Ventilation and Air Conditioning (HVAC);
- Living quarters ablutions;
- Drilling facilities;
- Freshwater maker;
- Fire water ring main pressurisation facility;
- Bio-fouling control unit;
- Sewage treatment system;
- Sand jetting system;
- Course filter backwash;
- Cooling for the cooling medium system; and
- Washdown facilities.

The seawater will be abstracted from 1 of the 3 vertical seawater lift pump caissons[36] at a depth of 105m beneath sea level. The maximum seawater abstraction design flow rate per pump will be approximately 1,500 m^3/hr. The design of the seawater intake caissons on the platform will incorporate a mesh of 200mm diameter.

Lifted seawater will be electrochlorinated in an antifouling package and dosed with 50 ppbv of chlorine and 5 ppbv copper; and then filtered to remove any particles that are above 150 microns in diameter. After use, part of the seawater (up to 3,000 m^3/hr) will be returned to the Caspian, via the seawater discharge caisson (at a depth of 45m below sea level). The design

[36] Internal diameter 1,060mm.

and operation of the seawater/cooling water system has been reviewed and confirmed that the temperature at the edge of the cooling water mixing zone (assumed to be 100m from the discharge point) will be no greater than 3 degrees more than the ambient water temperature[37]. Seawater forwarded to the drilling system will be mixed with the WBM and cuttings (see Section 5.7).

5.8.6.8 Cooling Medium System

The platform will be equipped with an indirect cooling medium system. The cooling medium (20% by weight MEG) will be cooled against seawater and will be circulated within a closed loop.

The main processes which require cooling include:

- Flash gas compressor;
- Export gas compressors;
- Flash gas compressor discharge coolers;
- HP gas cooler;
- Power generation turbine utilities;
- MOL booster pumps;
- MOL pumps;
- Glycol regeneration package;
- Air compressor package; and
- Export gas compressor after-cooler.

In the event that the cooling medium becomes degraded and requires replacement, the used cooling medium will be pumped from the system, containerised and shipped to shore for disposal. The system will then be recharged with fresh cooling medium. The same process will be adopted for any make-up required.

5.8.6.9 Fire Systems

The platform will be equipped with a firewater distribution system, which will be supplied by two diesel powered firewater pumps. The firewater pumps will be tested on a weekly basis for an hour with seawater circulated through the firewater system and discharged via the seawater discharge caisson.

A foam concentrate system will be provided in the separator module (where there is potential for hydrocarbon pool fires), which will enhance the effectiveness of the fire system's deluge water spray. A foam system will also be provided for the helideck. Following commissioning (see Section 5.6.4), foam may be discharged during emergency exercise drills (approximately every 4 months). Foam system chemicals of the same specification and environmental performance as those used in existing ACG platform foam systems will be stored on the platform for emergency use.[38]

5.8.6.10 Sand Separation System

The well completions will be designed to minimise sand production. Nevertheless, sand will be transported into the topside production facilities. As such, online sand removal will be required and will comprise sand jetting equipment. This will be internally fitted to process equipment such as the separators, produced water degassing drum and the closed drains drum to remove accumulated sand. Water will be injected into the equipment to generate a sand-water slurry. This slurry will then exit the vessel via dedicated nozzles and be routed to the sand treatment package.

[37] The COP Management of Change Process (Section 5.11) will be followed should any change to the design or operation of the cooling water system be required.
[38] The COP Management of Change Process (Section 5.11) will be followed should alternative chemicals be required.

The following equipment will incorporate online sand removal capabilities:

- HP separators;
- LP separators;
- Test separator;
- Produced water degassing drum and sand cyclones; and
- LP flare/closed drains drum.

Under routine conditions, treated produced water will be used for jetting. However, in the event that there is an insufficient volume of produced water available to fulfil this role, it is planned that deoxygenated seawater prepared and stored in the produced water degassing drum will be used instead[39].

Design of the sand treatment package is ongoing through the 'Define' stage (refer to Chapter 4 Section 4.4).

The COP Base Case assumes the package will be designed to remove oil to a nominal level of 1% by weight oil on sand. Cleaned produced sand will be turned into a slurry and transported to the CRI system, where it will be injected into the CRI well. The oily water mixture from the sand treatment package will be routed to the closed drains drum (see Section 5.8.6.11 below). In the event that the CRI system is unavailable, the sand slurry will be diverted to the sand bagging filter. The filtered slurry water from the bagging system will be sent to the hazardous area open drains system (see Section 5.8.6.11); and the sand, to the bagging area where it will be containerised for transportation to shore for disposal. There will be no planned overboard discharge of sand from the platform.

Sand removal systems for the LP flare/closed drains drum and the produced water degassing drum will incorporate a transport system for returning the sand to the sand treatment package. This is because their operating pressures are too low to enable free flow of removed sand to the sand treatment package.

5.8.6.11 Drainage System

Open Drains

The open drains system on the WC-PDQ platform will comprise two separate gathering systems: a hazardous area drains system and a non-hazardous area drains system (see Figure 5.18). These will be segregated.

The purpose of the non-hazardous open drains system is to provide drainage for rainwater, wash down water, spillages and equipment drains/leakages from all the deck levels in the non-hazardous area of the platform. The non-hazardous area open drains will be routed to the non-hazardous open drains tank and then to the drilling oily drains tank. Liquids from the oily drains tank will then be pumped to the CRI system. Non-hazardous area liquids will be discharged to sea via the open drains caisson, provided that no visible sheen is observable[40] if:

- The oily drains tank is unavailable;
- The oily drains tank overflows; or
- The CRI well is unavailable.

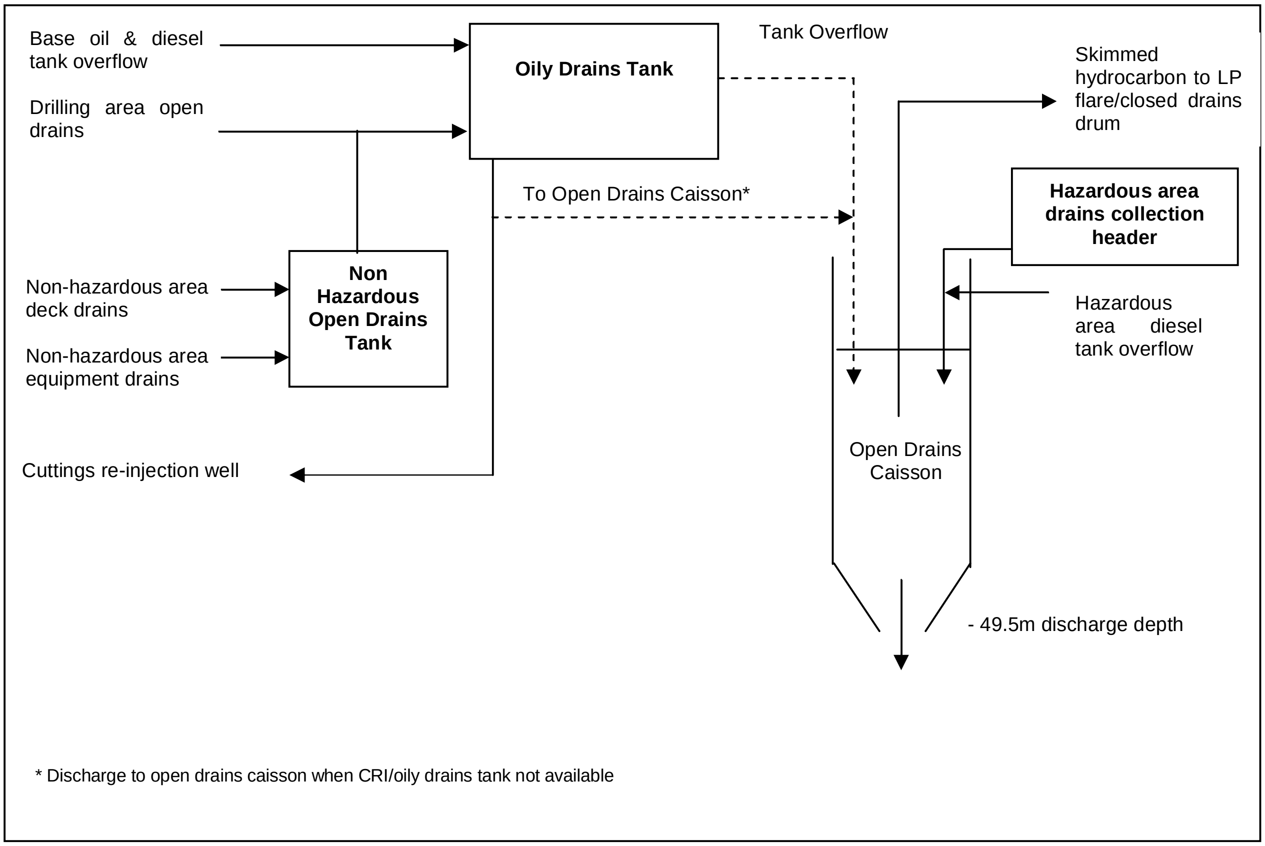
The purpose of the hazardous open drains system is to provide drainage for rainwater, wash down water, firewater deluge, spillages and equipment drains/leakages from all the deck levels in the hazardous area of the platform. The hazardous area open drains will be routed to the open drains caisson, which is designed to ensure that there is no visible sheen on the

[39] See Table 5.29 for chemical dosing rates of biocide and oxygen scavenger.
[40] The non hazardous area and hazardous area drains design is based on previous ACG platform designs and is determined by space and weight requirements as well as safety considerations.

sea surface, and discharged at a depth of 49.5m below sea level. Any oil in the open drains caisson will be routed to the LP flare/closed drains drum.

Helideck drains and deluge from deck drain boxes shall be routed directly overboard.

Figure 5.18 Open Drains System



Closed Drains

The function of the closed drains system is to collect hydrocarbon liquids/hazardous fluids from process equipment and instruments during maintenance operations. The contents of closed drain system on the WC-PDQ platform shall be collected, the gaseous phase routed to the LP flare drum and the liquid phase routed to the LP separators.

5.8.6.12 Instrument Air and Inert Gas System

The instrument air system will provide plant and instrument air for use in drilling, process and maintenance.

Inert gas (nitrogen) will be generated on demand by a membrane package using dry compressed air and a backup supply facility will be provided. Inert gas users include compressor seals, cooling medium expansion drum, methanol storage vessel blanketing and utility systems.

5.8.6.13 Freshwater

Freshwater will be produced on the WC-PDQ platform from seawater (taken from the seawater system) in the freshwater maker. There will also be a backup system whereby freshwater from supply boats is transferred to the freshwater tanks (via a filtration unit). The freshwater maker system will utilise a reverse osmosis (RO) process to desalinate seawater. Saline effluent from the freshwater maker will either:

- Be returned to the Caspian via the seawater or sewage discharge caissons; or
- Routed to the sewage treatment system and any unused saline effluent sent to the sewage caisson[41] .

The main uses of freshwater are expected to be:

- The living quarters;
- Drilling support module;
- Mechanical workshop/laboratory;
- Utility station/HP wash-down;
- Safety showers; and
- Initial fill and make-up of cooling medium system (along with MEG).

5.8.6.14 Black and Grey Water

Black water will be collected via the sewer system and treated in a sewage treatment package, sized to accommodate up to 265 POB and an average of 175 POB. The selection of the sewage treatment package is ongoing through the 'Define' stage (refer to Chapter 4 Section 4.4). It will be designed in accordance with PSA requirements such that effluent is treated to applicable standards prior to discharge via the platform sewage caisson (17m below sea level)[42] . The presence of surfactants in the sewage effluent has been considered during the selection process. The types of plant being considered ensure that a high proportion of the biodegradable surfactants present (greater than 90%) degrade prior to discharge of the treated effluent.

Grey water from the platform will be discharged to sea (without treatment) in accordance with applicable PSA requirements[43] via the sewage caisson, 17m below sea level.

5.8.6.15 Galley Waste

Organic food waste originating from the platform galley will be macerated to less than 25mm in accordance with MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships requirements and discharged to the sewage caisson.

5.8.6.16 Chemical Injection System

The production process requires the addition of certain chemicals to facilitate production, aid the separation process and protect process equipment from corrosion.

Table 5.27 presents a list of anticipated production chemical requirements to be stored on the platform along with the dosage range and injection points. The chemical systems will be continually evaluated and modified as necessary depending on specific operating conditions.

[41] Dependant on the selection of the sewage treatment system – refer to Section 5.8.6.14
[42] Sanitary waste may be discharged from a U.S. Coast Guard certified or equivalent Marine Sanitation Device (MSD) to meet USCG Type II standards of total suspended solids of 150mg/l and fecal coliforms of 200MPN (most probable number) per 100ml
[43] Domestic wastes and grey water may be discharged as long as no floating solids are observable. Monitoring of floating solids shall be accomplished during daylight by visual observation of the surface of the receiving water in the vicinity of the sanitary and domestic waste outfalls. Observations shall be made following either the morning or the midday meals and at a time during daylight and maximum estimated discharge.

Table 5.27 Anticipated Production Chemicals and Requirements

Chemical	Unit	Typical Dosage	Design Maximum Dosage	Dosage Basis[1]	Injection Mode[2]	Injection Points[3]	Chemical Present in Produced Water When Discharged
Antifoam	ppmv	13	25	Total production liquids	Continuous	- Inlet to each HP separator - Inlet to each LP separator - Inlet test separator	No[8]
Demulsifier[4]	ppmv	20	30	Total production liquids	Continuous	- Inlet to each HP separator - Inlet to each LP separator - Inlet test separator	No[8]
Scale inhibitor	ppmv	20	20	Produced Water rate	Continuous	- Individual wellheads - Inlet of produced water infield pipeline	Yes
Reverse Demulsifier	ppmv	10	20	Produced Water rate	Continuous	- Water outlet from each LP separator - Water outlet of test separator	Yes
Corrosion Inhibitor (Oil)	ppmv	30	30	Oil rate	Continuous	Suction of each oil export pump	No
Corrosion Inhibitor (Produced Water)	ppmv	30	30	Produced water rate	Continuous	Suction of each produced water transfer pump	No
Biocide	ppmv	500	500	Produced water rate	Batch[5]	Inlet of produced water degassing drum	No
Methanol (Gas Export)	l/MMscf	60	60	Export gas rate	Temporary	Gas export line[6]	No
Methanol (Well Equalisation)	l/hr	100	100	Absolute rate	Temporary	Wellheads	Possible (during start up)[7]
Methanol (Fuel Gas Import)	l/MMscf	48	48	Fuel gas rate	Temporary	Fuel gas import line	No
Oxygen Scavenger	ppmv	150	150	Equipment volume	Batch	- Produced water degassing drum - Cooling medium system	No
Corrosion Inhibitor (Export Gas)	l/MMscf	1	1	Export gas rate	Temporary	Gas export line	No

1 The rate or volume on which the dosage is base
2 Temporary = continuous injection for a short period, batch = single finite dos
3 Where more than one location is specified, operational experience will determine if single or multiple simultaneous injection is required.
4 Alternative demulsifier may be water based, whereas the "Base Case" conventional demulsifier will be hydrocarbon based. Injection of both demulsifiers may be required simultaneously.
5 Shock dosing for 6 hours per week. System designed such that dosing can be discontinued during discharge/pigging
6 Temporary injection only (during wet gas export operation). Dosing facility to be available for start up.
7 During production start up, methanol may be injected into a well with a high produced water content to inhibit the formation of hydrates and prevent blockages of process equipment and pipe work that could create emergency situations associated with over pressure events. Methanol would only be discharged in the event that produced water is discharged during this period, which is considered very unlikely.
8 Hydrocarbon based chemicals, which are expected to remain in the oil phase in the separators.

Water soluble production chemicals will normally be reinjected into the reservoir with the produced water. Table 5.27 indicates those production chemicals present in the event that produced water is discharged from the WC-PDQ platform or during planned produced water pipeline pigging (refer to Section 5.8.7.1 below). It is planned to use chemicals with comparable environmental performance to those previously approved for use on existing ACG Platforms[44].

[44] The COP Management of Change Process (Section 5.11) will be followed should alternative chemicals be required.

5.8.7 Pipeline Operations and Maintenance

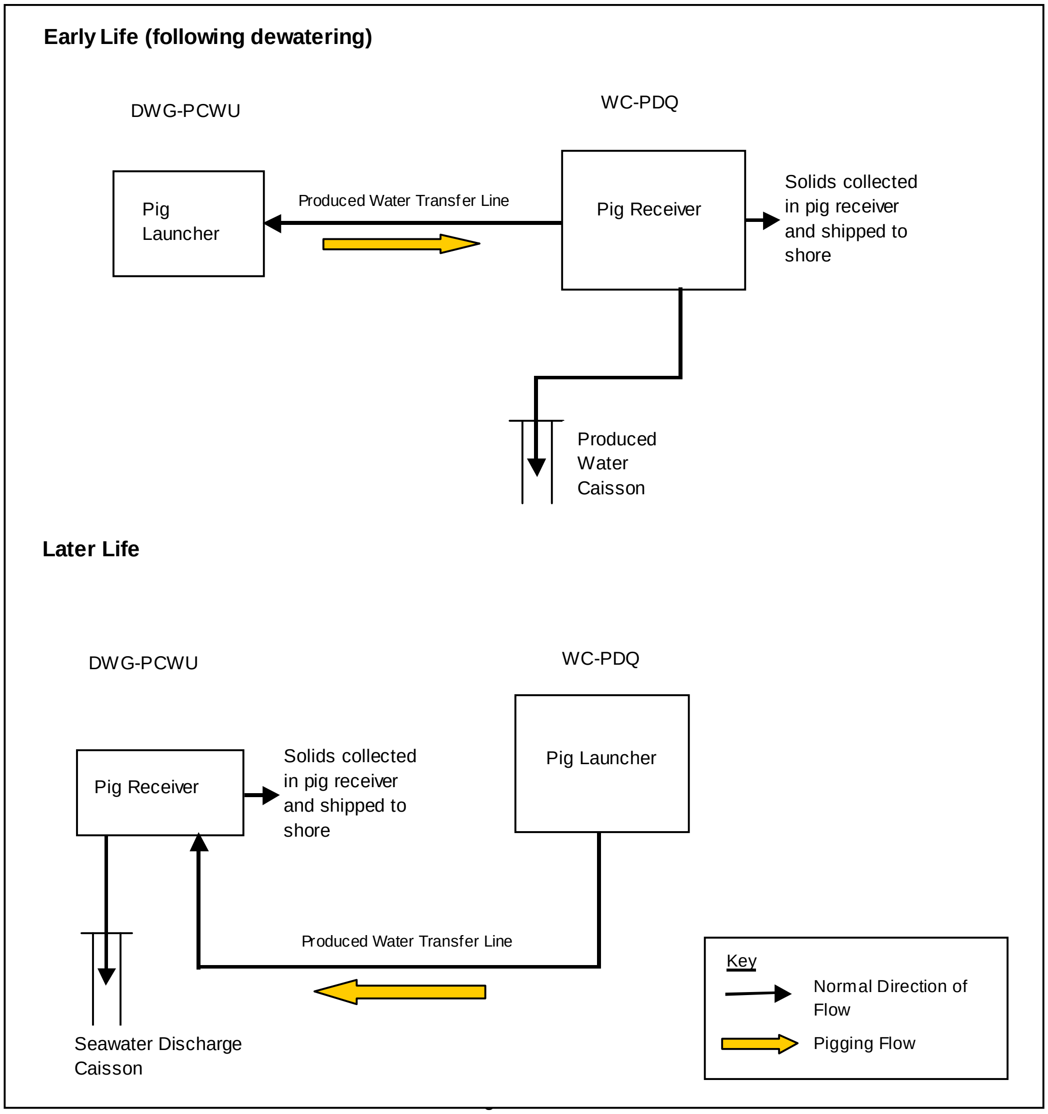
Maintenance of the produced water and injection water pipelines between the WC-PDQ and DWG-PCWU platforms will include periodic pigging to remove any scale and biological growth thereby controlling internal corrosion.

5.8.7.1 Produced Water Pipeline

During early field life, the produced water pipeline will be filled with treated seawater[45] and will be dewatered as the produced water volume in oil approaches approximately 5%. Section 5.5.4 above describes the dewatering, which will be counter to the normal direction of flow. It is planned that pigging and flushing will continue in this direction using produced water and/or treated seawater from the DWG facilities, until there is sufficient produced water flow from the WC-PDQ platform to drive a pig. Once there is sufficient produced water flow to drive a pig in the normal direction of flow, pigging will be undertaken from the WC-PDQ platform to the DWG-PCWU platform with pigging water discharged at the DWG-PCWU seawater discharge caisson. Solids from pigging collected in the DWG-PCWU pig receiver will be containerised and shipped to shore for disposal.

Figure 5.19 shows the pigging scheme for the produced water pipeline.

Figure 5.19 Pigging Operations – Infield Produced Water Pipeline



5.8.7.2 Injection Water Pipeline

The injection water pipeline will be pigged as required to maintain pipeline integrity. The pigging will be carried out from the DWG-PCWU platform to the WC-PDQ platform (i.e. the normal direction of flow) with pigging water discharged at the WC-PDQ produced water discharge caisson. Solids from pigging collected in the WC-PDQ pig receiver will be containerised and shipped to shore for disposal.

As the injection water discharged during pigging will be provided from DWG-PCWU the chemical composition will be determined by the DWG-PCWU planned dosing regime as detailed in Table 5.28.

Table 5.28 DWG-PCWU Injection Water Chemicals

Chemical	Typical Dosage (ppmv)	Design Maximum Dosage (ppmv)	DWG-PCWU Injection Points	Chemical Present in Pigging Water When Discharged
Calcium Nitrate (Souring Mitigation)	To WI: 57 To PW: 163	As "typical"	Upstream of the deaerators Upstream of the produced water pumps	Yes
Oxygen Scavenger (Water Injection)	5	10	Each deaerator system recycle loop.	Yes
Scale Inhibitor	30	30	Suction of each water injection pump.	Yes
Antifoam	1	2	Inlet of each deaerator	Yes
Biocide[1]	500	500	Inlet of each deaerator Exit of each deaerator	No[2]
Corrosion Inhibitor	30	30	Suction of each water injection pump	Yes

1 Batch dosed for 6 hours per week (period treatment)
2 The DWG-PCWU system is designed to enable biocide dosing to be discontinued during pigging/discharge.

Figure 5.20 shows the proposed injection water pigging scheme.

Figure 5.20 Pigging Operations – Injection Water Pipeline

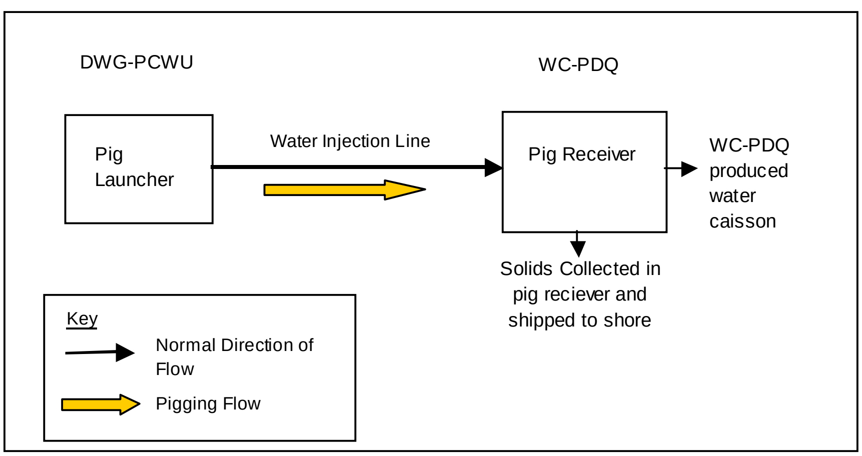


Table 5.29 below summarises the estimated produced water and injection water pipeline pigging volumes and locations of discharge.

Table 5.29 Summary of Produced Water and Injection Water Pipeline Pigging Volumes and Locations of Discharge

Pipeline	Volumes of Pigging Fluid per Pigging Event	Discharge Location		Frequency[46]	Chemicals Present in Discharged Pigging Fluid
		Fluids	Solids		
Produced water (Early Life)	$920m^3$	WC-PDQ produced water caisson	Collected in WC-PDQ pig receiver and shipped to shore	Once a week for approximately 6 months	Refer to Table 5.28
Produced water (Later Life)	$920m^3$	DWG-PCWU produced water caisson	Collected in DWG-PCWU pig receiver and shipped to shore	Once a week for approximately 9 years	Refer to Table 5.27
Injection water	$950m^3$	WC-PDQ produced water caisson	Collected in WC-PDQ pig receiver and shipped to shore	Once a week for approximately 11 years	Refer to Table 5.28

The contribution due to pigging of the COP produced water pipeline to the total volume of produced water discharge at DWG–PCWU will not result in the Phase III ESIA produced water discharge forecast being exceeded.

5.8.8 Supply and Logistics

Consumables such as mud, diesel, chemicals, water and supplies will be transported to the platform by vessels. During drilling operations, supplies will normally be delivered every 4 - 7 days. When there is no drilling, supply vessels will visit less frequently, normally every 10 - 14 days. Personnel will be transferred to the platform by vessels with up to 5 trips per week. Helicopters may be used for some crew changes. There will be no helicopter or vessel re-fuelling facilities on the platform.

5.8.9 Offshore Operations and Production – Emissions, Discharges and Waste

5.8.9.1 Summary of Emissions to Atmosphere

Table 5.30 shows the GHG (i.e. CO_2 and CH_4) and non GHG emissions predicted to be generated during COP start up and offshore production from key sources across the PSA period. These sources include:

- Main power generators;
- Emergency diesel generators;
- Firewater pump;
- Platform cranes; and
- Crew change helicopters/vessels and supply vessels;

In addition, predicted emissions associated with the following are included:

- Offshore flaring; and
- Commissioning and start up operations on the platform (2012 – 2013).

Table 5.30 Predicted GHG and non GHG Emissions Associated with Routine and Non Routine COP Offshore Operations and Production Activities

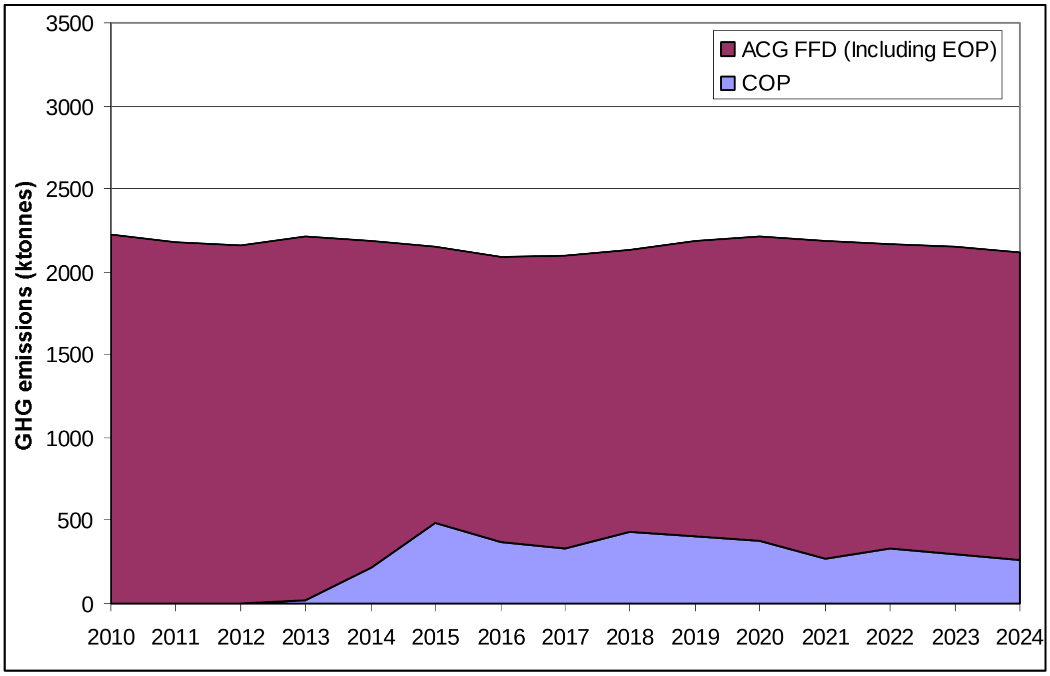
	CO_2 (ktonne)	CO (tonne)	NOx (tonne)	SO_2 (tonne)	CH_4 (tonne)	NMVOC (tonne)	GHG (ktonne)
TOTAL	**4,320**	**7,275**	**9,990**	**2,475**	**7,105**	**4,610**	**4,470**

See Appendix 5A for detailed emission estimate assumptions.

[46] It is expected that the frequency of pigging required may reduce over the PSA period. A worst case is presented for assessment.

Figure 5.21 presents the predicted GHG emissions associated with the COP over the PSA period in the context of ACG FFD.

Figure 5.21 Predicted GHG Emissions Associated with COP Offshore Operations and ACG FFD



COP offshore GHG emissions represent approximately 14% of all GHG emissions from ACG offshore facilities between 2013 and the end of the PSA period.

5.8.9.2 Summary of Discharges to Sea

Table 5.31 provides a summary of planned discharges to sea associated with COP platform drilling.

Table 5.31 Estimated Planned Discharges to Sea Associated with Routine and Non Routine Platform Drilling Activities

Discharge	R /NR*	Frequency	Location	Estimated Volume	Discharge Composition
WBM and cuttings	R	During surface hole drilling	To sea (via WC-PDQ cuttings caisson)	4,340 tonnes cuttings 9,520 tonnes WBM	Refer to Tables 5.3 and 5.26
Residual WBM	NR	At end of surface hole drilling (if WBM cannot be recovered/ recycled)		4,480 tonnes WBM	Refer to Section 5.7.4
Cement and cement chemicals	R	During each casing cementing	Seabed	320 tonnes	Refer to Section 5.3.2.5
Excess cement and cement chemicals	NR	At the end of each casing section (if excess cement cannot be recovered)		37 tonnes	Refer to Section 5.3.2.5
Predrill well suspension fluids and cement plugs	NR	During re-entry of predrill wells (if suspension fluids cannot be recovered)	Seabed	70 tonnes	Refer to Section 5.7.3

* R – Routine, NR – Non Routine

Other planned discharges to sea from COP offshore operations comprise:

- Platform cooling water (refer to Section 5.8.6.7);
- Platform drainage (refer to Section 5.8.6.11);
- Platform freshwater maker returns (refer to Section 5.8.6.13);
- Platform black and grey water (refer to Section 5.8.6.14);
- Platform galley waste (refer to Section 5.8.6.15); and
- Infield produced water and injection water pipeline pigging fluids (refer to Section 5.8.7).

It is estimated, based on 2% unavailability of the equipment used to inject produced water and assuming that under these conditions produced water will be discharged, the resultant discharge of produced water will be approximately 730M m^3 of produced water between 2014 and 2024 (refer to Section 5.8.4).

5.8.9.3 Summary of Hazardous and Non Hazardous Waste

The estimated quantities of non hazardous and hazardous waste that will be generated by the WC-PDQ operations during the PSA period are provided in Table 5.32. These have been estimated based on the waste records for the operational ACG platforms.

Solid and liquid waste generated will be shipped to shore and managed in accordance with the Waste Management principles detailed in Chapter 14.

Table 5.32 Estimated Hazardous and Non Hazardous Waste Associated with Offshore Drilling and Processing Activities[1]

Type	Waste Category[2]	Sub Category	Estimated Volume (tonnes)
Non hazardous waste	Non hazardous non recyclable waste	General waste	3,000
		Food/galley waste	
	Recyclable waste	Cooking oil	975
		Electrical cable	
		Paper and card	
		Plastics	
		Scrap metal and wood	
		Total (Non hazardous)	**3,975**
Hazardous waste	Solid hazardous waste	Batteries	1,765
		Drum/cans	
		Cement	
		Clinical waste	
		Oil filter parts	
		Sand and sludges	
		Oily rags	
		Paint cans contaminated with uncured paint	
	Non-water based drill cuttings[3]	-	6,125
	Used drilling fluids	-	17,350
	Hazardous liquid waste	Acids and alkalis	56,820
		Antifreeze	
		Chemicals	
		Fuel oil	
		Grease	
		Oil	
		Paint	
		Paint sludge	
		Solvents and thinners	
		Photographic developing fluids	
		Oily and contaminated water	
		Total (Hazardous)	**82,060**

1 Treatment and disposal routes are detailed in Section 5.12.2.
2 Estimates include key waste types. Minor non hazardous wastes including used tyres, toner cartridges and intermediate bulk containers are excluded.
3 Includes associated mud, which is not separated on board the platform.
4 Refer to Appendix 5F for details of sewage sludge estimate

5.9 Terminal

The partially stabilised oil and gas from the COP will be transported via the existing 30” oil and 28” gas subsea export pipelines to Sangachal Terminal for processing. Final processing to export specifications will be carried out in the existing ACG facilities onshore at Sangachal Terminal. There is sufficient capacity at Sangachal Terminal such that no upgrades or improvements are required for onshore processing of the COP produced fluids.

The existing ACG facilities at the Terminal comprise:

- Oil and gas reception facilities;
- 6 separation and stabilisation trains;
- 3 crude oil storage tanks;
- 2 dew point control units;
- 3 off spec crude oil tanks;
- Produced water storage tanks and treatment facilities;
- Open drains water tank;
- PSA1 Pump Head Station operated by BTC under the Export Business Unit (BU); and
- Standalone and back-up support and utility systems.

5.9.1 Oil Processing

Partially stabilised oil from the two 30” marine oil pipelines is fed to the 6 onshore processing trains. The oil is fed to the fired heater of each train where it is heated, before being degassed in a separator. The oil then flows into a low pressure separator where the pressure is reduced further to achieve the vapour pressure specification. Stabilised oil flows to an electrostatic coalescer where the water content is reduced to export specifications. Flash gas is compressed and co-mingled with the gas stream arriving from the 28” marine pipeline.

5.9.2 Gas Processing

Gas from the 28" marine pipeline (with water removed but containing residual hydrocarbons) will be co-mingled with flash gas from the oil stabilisation train and fed to the Dew Point Control Units (DPCUs). Here the gas is chilled using a propane refrigerant circuit to recover condensate and water from the gas. MEG is injected to prevent the formation of hydrates in the DPCU process. The residual gas is exported to the SOCAR pipeline. Recovered liquids are fed back into the process.

5.9.3 Produced Water

The produced water separated from the oil is pumped to produced water storage tanks. The treatment facilities enable the produced water from the storage tanks to be filtered and treated to remove oil and solids, cooled and chemically treated prior to export along the ACG produced water disposal pipeline for reinjection offshore at CA.

5.9.4 Terminal Operations – Emissions, Discharges and Waste

Additional emissions, discharges and waste arising at the Terminal due to COP Activities will be associated with incremental changes in the following:

- Load on fired heaters, dew point control units and turbines;
- Oil storage tank throughput;
- Non routine flaring; and
- Waste generated from routine operations (produced water treatment, pigging handling, canteen/camp activities).

Table 5.33 presents the predicted COP contribution to the GHG and non GHG emissions associated with Terminal operations (including fugitive emissions).

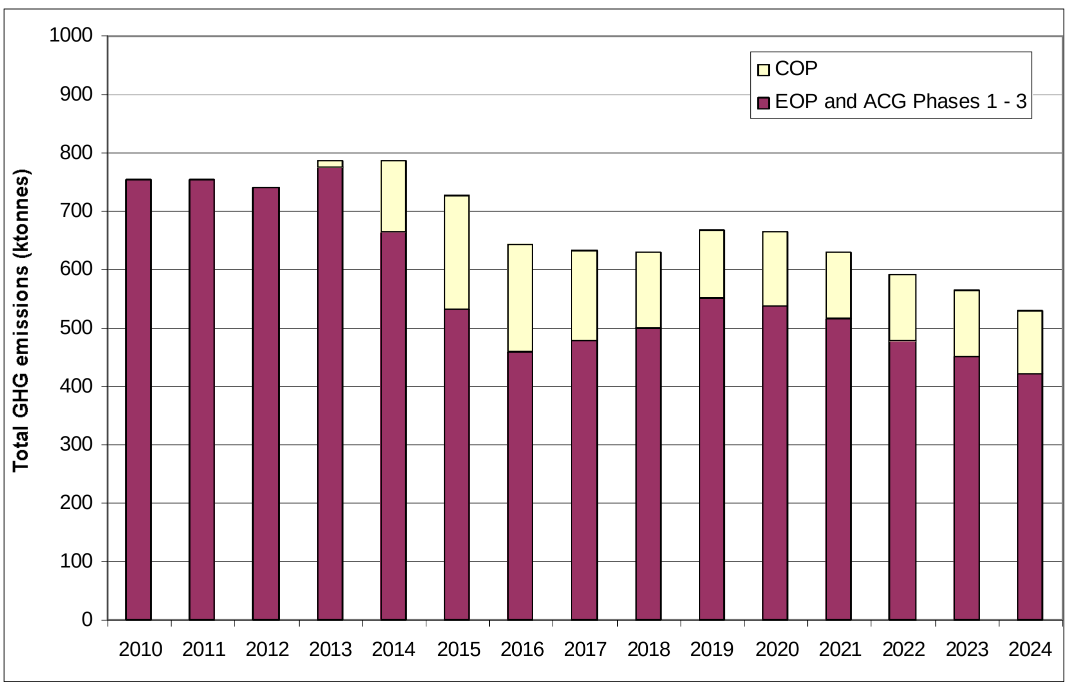
Table 5.33 Predicted GHG and non GHG Emissions Associated with Terminal Operations (COP Contribution)

	CO_2 (ktonne)	CO (tonne)	NOx (tonne)	SOx (tonne)	CH_4 (tonne)	NMVOC (tonne)	GHG (ktonne)
TOTAL	1,455	1,505	1,725	5	1,465	1,335	1,485

See Appendix 5A for detailed emission estimate assumptions.

Figure 5.22 shows the forecast GHG emissions for the Terminal associated with the EOP and ACG Phases 1-3 including the COP contribution.

Figure 5.22 Forecast EOP and ACG Phases 1 - 3 GHG Emissions Associated with Terminal Operations and COP Contribution



The figure indicates that emissions at the Terminal from the COP and existing ACG operations will not exceed the peak annual emissions volume forecast for EOP and ACG Phases 1 - 3. From first oil to the end of the PSA, COP is estimated to contribute to approximately 19% of emissions associated with the Terminal.

5.10 Decommissioning

In view of the operational lifetime of the COP development, it is not possible to provide a detailed methodology for the potential decommissioning of the offshore facility. In accordance with the PSA, AIOC will produce a field abandonment plan one year before 70% of the identified reserves have been produced.

5.11 Management of Change Process

During the 'Define', 'Execute' and 'Operate' stages of the COP, there may occasionally be a need to change a design element or a process. The COP intends to implement a formal process to manage and track any such changes, and to:

- Assess their potential consequences with respect to environmental and social impact; and
- In cases where a new or significantly increased impact is anticipated, to inform and consult with the MENR to ensure that any essential changes are implemented with the minimum practicable impact.

All proposed changes, whether to design or process, will be notified to the Project HSE team, who will review the proposals and assess their potential for creating environmental or social interactions.

Changes which do not alter existing interactions or impacts, or which give rise to no interactions or impacts, will be summarised and periodically notified to the MENR, but will not be considered to require additional approval. This category will include items such as minor modification of chemical and drilling fluid systems, where the modification involves substitution of a chemical with equal or less environmental impact than the original.

If internal review and assessment indicates that a new or significantly increased impact may occur, the following process will be applied:

- Categorisation of the impact using ESIA methodology;
- Assessment of the practicable mitigation measures;
- Selection and incorporation of mitigation measures; and
- Re-assessment of the impact with mitigation measures in place.

In practical terms, the changes that will require prior engagement and approval by the MENR are those that:

- Result in a discharge to the Caspian that is not described in the COP ESIA;
- Increase the quantity discharged as detailed in the COP ESIA by more than 20%[47,48];
- Result in the discharge of a chemical not referenced in the ESIA and not currently approved by the MENR for use in the same application by existing AzSPU operations; or
- Create or increase noise, light or other disturbance above applicable thresholds to human populations living in the vicinity of the COP activities.

Once the changes (and any appropriate mitigation) have been assessed as described above, a technical note will be submitted to the MENR describing the proposal and reporting the results of the revised impact evaluation. Where appropriate, this may include the results of environmental testing and modelling (e.g. chemical toxicity testing and dispersion modelling). Following submission of the technical note, the Project team will engage in meetings and

[47] For the discharges detailed in the ESIA, an increase of 20% in volume would result in a 3-4% increase in the linear dimension of the mixing zone. For instance, a mixing plume 100m by 20m by 20m would increase by less than 2m in each dimension. Taking into account the actual size of the predicted mixing zones, this magnitude of increase is considered to make no material difference to the physical extent of the impacts. In practical terms, this would apply to increases of more than 20% (the value was selected to be conservative).

[48] Unless increase is deemed to have no material effect on the associated impact(s).

communication with the MENR in order to secure formal approval. Once approved, each item will be added to a register of change. The register will include all changes, including those non-significant changes notified in periodic summaries, and will note any specific commitments or regulatory requirements associated with those changes.

5.12 Summary of Emissions and Waste

5.12.1 COP Emissions

Table 5.34 presents an estimate of the total GHG and non GHG emissions associated with COP, assuming operations continue until 2024.

Table 5.34 Estimated GHG and non GHG Emissions Associated with the COP

	Emissions to Atmosphere							
		Predrill	Onshore Construction and Commissioning	Pipeline Installation and Commissioning	Platform Installation and Commissioning	Offshore Operations	Onshore Operations	Total
CO_2	ktonnes	41	59	72	8	4,320	1,455	**5,955**
CO	tonnes	168	171	260	20	7,275	1,505	**9,400**
NO_x	tonnes	603	721	1,917	147	9,990	1,725	**15,103**
SO_x	tonnes	58	83	260	20	2,475	5	**2,901**
CH_4	tonnes	85	3	9	0	7,105	1,465	**8,667**
NMVOC	tonnes	64	57	78	6	4,610	1,335	**6,150**
GHG	ktonnes	43	59	73	8	4,470	1,485	**6,138**

See Appendix 5A for detailed emission estimate assumptions.

5.12.2 COP Hazardous and Non Hazardous Waste

Table 5.35 presents a summary of the expected hazardous and non hazardous waste generated by the COP, while Table 5.36 provides the subcategories of the waste listed in Table 5.35

Table 5.35 Estimated Hazardous and Non Hazardous Waste Associated with the COP[1]

Type	Waste Category[2]	Estimated Volume (tonnes)					
		Sub Category	Predrill	Onshore Construction & Commissioning	Installation and HUC	Offshore Operations	Total
Non hazardous waste	Non hazardous non recyclable waste	General Waste	285	20,470	3,000	3,000	**26,755**
		Food/galley waste					
	Recyclable waste	Cooking oil	95	16,555	765	975	**18,390**
		Electrical cable					
		Uncontaminated blasting grit					
		Paper and card					
		Plastics					
		Scrap metal					
		Wood					
	Total (Non hazardous)		**380**	**37,025**	**3,765**	**3,975**	**45,145**
Hazardous waste	Solid hazardous waste	Batteries	210	515	90	1,765	**2,580**
		Drum/cans					
		Cement					
		Sand and soil					
		Contaminated grit					
		Clinical waste					
		Oil filter parts					
		Oily soil					
		Sand and sludges					
		Oily rags					
		Paint cans contaminated with uncured paint					
	Non-water based associated drill cuttings[3]	-	21,000	-	-	6,125	**27,125**
	Used drilling fluids	-	1,020	-	-	17,350	**18,370**
	Hazardous liquid waste	Acids and alkalis	430	8,255	4,335	56,820	**69,840**
		Antifreeze					
		Chemicals					
		Fuel oil					
		Grease					
		Oil					
		Paint					
		Paint sludge					
		Solvents and thinners					
		Photographic developing fluids					
		Oily and contaminated water					
	Total (Hazardous)		**22,660**	**8,770**	**4,425**	**82,060**	**117,915**

1 Treatment and disposal routes are detailed in Table 5.36
2 Estimates include key waste types. Minor non hazardous wastes including used tyres, toner cartridges and intermediate bulk containers are excluded.
3 Includes associated mud, which is not separated on board the MODU/platform.

Table 5.36 Waste Subcategories

	Waste Container Type	Waste type
NON-HAZARDOUS WASTE	GENERAL WASTE	Ground sweepings (non-hazardous)
		Food and drink packaging
		Office kitchen waste
		Uncontaminated used PPE
		Welding flux slag
		Uncontaminated cotton rags
		Used welding rods / electrodes
		Grinding / abrasive discs
		Non-recyclable office paper
		Rubber (hoses, gloves, etc)
		Air filters (no oil contamination)
		Empty plastic bottles
		Green waste (cuttings, dead plant matter)
		Electrode packaging
		Shoe covers
		Glass (sheet and uncontaminated bottles) – to be packaged
		Composite electrical equipment (switches etc)
		Scrap electrical panels
		Uncontaminated soils (unsuitable for re-use)
		Aggregates (stones, concrete, asphalt etc)
		Textile sacks and ropes
		Insulation eg Rockwool (must be in sealed bags)
		Used ropes
		Empty plastic packaging
		Waste Blasting Grit/ Garnet (must be in sealed bags)
	METAL	General Metal Scrap
		Metal slag/ grindings
		Empty drums (uncontaminated)
		Chain cuts
		Empty clean metal buckets
		Nails
		Cable trays (stainless steel)
		Electrical cable cuts (aluminum & copper)
		Scrap metal lifting gear (no longer fit for use)
	WOOD	Pallets, boxes, packing material and timber
		Plywood cuts
		Broken wooden handles from tools & supports
		Cable drums and cables
	PAPER	Cardboard
		Paper
	PLASTIC	Plastic scaffolding sheets
		Broken safety glasses and helmets
		Plastic packaging material
		Plastic kitchen wastes – not contaminated with food
		Plastic pipe cuts and shavings – no hazardous residues
		Waste plastic stationery
	FOOD	Post consumer food waste
		Food processing and preparation waste
HAZARDOUS WASTE	SOLID OILY WASTE	Oily rags
		Oil filters
		Oily wood / wood shavings
		PPE contaminated with oil
		Oil Spill absorbents
		Any materials contaminated with oil
		Soil contaminated with oil (sealed in plastic bags)
	OILY WASTE CONTAINERS	Empty oil drums
		Empty plastic oil drums / cans
		Empty grease drums / tins
		Empty cooking oil drums / tins (metal & plastic)
	PAINT WASTE	Paint cans (100% dry / cured)
		Paint cans containing unused paint (solid)
		Discarded paint brushes (100% dry /cured)
	HAZARDOUS WASTE	Waste paint sludge
		Batteries & Accumulators
		Printer Cartridges
		Fluorescent tubes
		Tires (to be kept separately on pallets)

	Waste Container Type	Waste type
		Contaminated blasting grit (in plastic bags or dedicated skips)
		Glue tins / tubes – fully cured no wet glue
		Chemical contaminated rags, pads and sorbents
		Spray cans – punctured and depressurised
		Empty gas cylinders – fully emptied and depressurised
		Empty thinners tins
	MEDICAL WASTE	Glass sharps, needles and syringes (double bagged)
		Contaminated materials (binds, tissues, etc)
		Plastic and glass vials (dbl bagged)
		Other medical disposables
	DEAD BIRD / ANIMALS LIQUID WASTE – TANKS PROVIDED BY EXECPETION	Dead birds and animals(dedicated wheelie bins)
		Oily liquids – waste drums to be used
		Cooking oil – filtered
		Waste thinners – waste drums to be used, no solids
		Paint sludge – waste drums to be used

The planned destination of each COP waste stream is provided within Table 5.37. Waste management plans and procedures are detailed within Chapter 14.

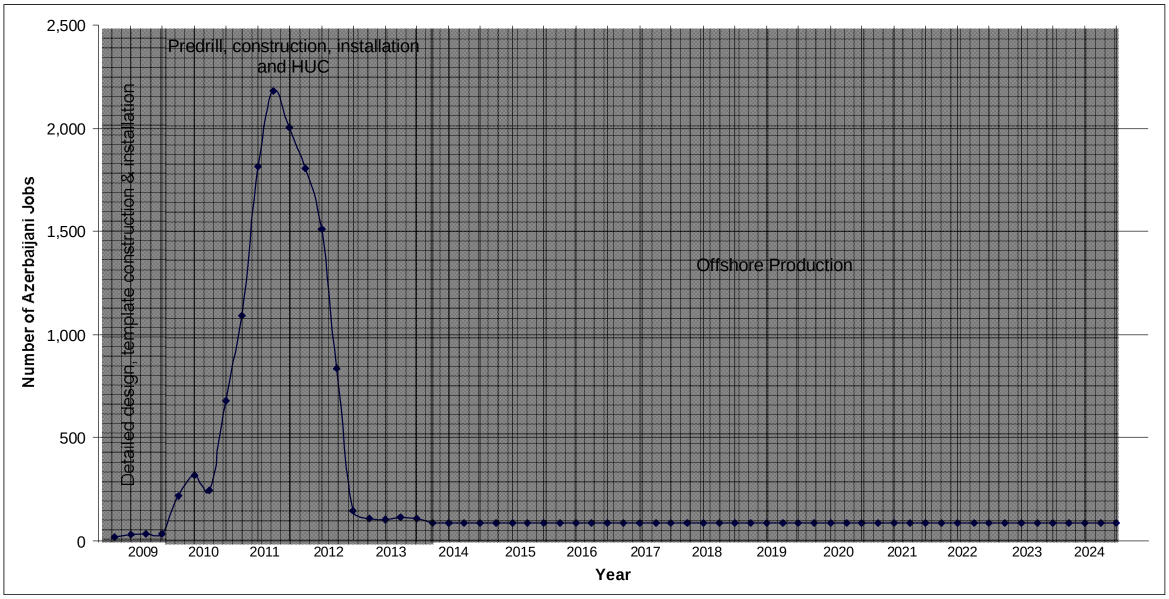
Table 5.37 Planned Destination of COP Waste Streams

Category	Sub Category	Destination
Non hazardous non recyclable waste	General Waste	Non-hazardous landfill – current facility has been designed and constructed to EU standards
	Food/galley waste	
Recyclable waste	Cooking oil	Recycling contractors – SOFAZ to receive revenue from waste with inherent remaining value e.g. steel
	Electrical cable	
	Uncontaminated blasting grit	
	Paper and card	
	Plastics	
	Scrap metal	
	Wood	
Solid hazardous waste	Batteries	Treatment/disposal by licensed AzSPU approved contractor or storage pending availability of appropriate contractor
	Drum/cans	
	Cement	
	Sand and soil	
	Contaminated grit	
	Clinical waste	
	Oil filter parts	
	Oily soil	
	Sand and sludges	
	Oily rags	
	Paint cans contaminated with uncured paint	
Non-water based drill cuttings	Drilling cuttings	Cuttings will be treated by the indirect thermal desorption unit at Serenga. Recovered mud will be reused and the process residuals stored until an AzSPU strategy of the long term reuse or disposal is agreed with the MENR
Hazardous liquid waste	Acids and alkalis	Treatment/disposal by licensed AzSPU approved contractor or storage pending availability of appropriate contractor
	Antifreeze	
	Chemicals	
	Fuel oil	
	Grease	
	Oil	
	Paint	
	Paint sludge	
	Solvents and thinners	
	Photographic developing fluids	
	Oily and contaminated water	

5.13 COP Employment

It is estimated that the COP employment will peak at approximately 2,200 in 2011, and that the workforce will exceed 1,000 for a period of approximately 18 months during predrill, construction, installation and HUC activities (see Figure 5.23)[49].

Figure 5.23 Estimated Number of Jobs for Azerbaijani Citizens Over the COP



[49] Refer to Chapter 12 for further details

6 Environmental Description

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6.1 Introduction

This Chapter describes the terrestrial and marine environments associated with the Chirag Oil Project (COP). Three geographic zones are defined:

- **Onshore:** Vicinity of the Sangachal Terminal and potential construction yards; and
- **Offshore:** ACG Contract Area and the vicinity of the West Chirag Production, Drilling and Quarters (WC-PDQ) platform location.

It is the preference of the COP to use existing, developed, brown-field sites for onshore construction activities. Candidate locations include the following established yards:

- Baku Deep Water Jacket Factory (BDJF) yard (formerly Shelfprojectsroi (SPS) yard);
- Zykh yard; and
- Construction yards adjacent to Bibi Heybet Oilfield including:
  - South Dock yard; and
  - the former Amec-Tekfen-Azfen (ATA) yard hereafter referred to as the Bibi Heybet construction yard.

Selection of the COP construction contractors and yards will be completed in 1Q 2010.

Figure 6.1 presents the key onshore and offshore locations associated with the COP.

6.2 Data Sources

AIOC has conducted a large number of surveys and investigations in relation to the ACG Contract Area and Sangachal Terminal environments. Table 6.1 lists the onshore, nearshore and offshore surveys and studies undertaken by AIOC since 1992 in the following areas:

- ACG Contract Area and the associated marine export pipeline Right of Way (ROW);
- Sangachal Bay; and
- Vicinity of the Sangachal Terminal and other ACG onshore facilities including the Logistics Supply Base (adjacent to the BDJF yard) and established construction yards.

Between 1994 and 2004 onshore surveys have focused on investigating baseline conditions for flora and fauna, air quality, noise and contamination in various project locations. As part of the Integrated Environmental Monitoring Programme (IEMP), data reporting since 2004 includes:

- Ambient air quality at selected receptors in the vicinity of the Terminal;
- Soil, groundwater and surface water conditions from boreholes and sampling points in the vicinity of the Terminal; and
- Ongoing overwintering birds survey in and around Sangachal Bay.

In 2003, a baseline benthic survey was conducted at the West Chirag location. The proposed position of the COP WC-PDQ platform lies within the boundaries of the 2003 West Chirag survey area. In July 2009 a limited benthic and sediment survey was carried out to extend the 2003 West Chirag survey area to the north east (NE).

Since 2004, offshore monitoring has been managed within the context of the IEMP, which has covered baseline surveys (for new ACG developments), operational platform surveys (as new installations start production), subsea pipeline surveys and regional “background” surveys to identify natural or large-scale trends for comparison against baseline and operational surveys.

A primary aim of the IEMP is to develop reliable and consistent time series data for each location or station array within a survey area. This approach enables long-term trends to be identified and minimises the risk of misinterpretation which can arise from simple “before and after” comparisons of data. In particular, it permits ecological changes, observed at a regional level, to be taken into account when interpreting the results of monitoring around ACG production platforms or other operational installations.

Under the AIOC Production Sharing Agreement (PSA), responsibility for the preparation and approval of the overall environmental monitoring programme rests with the Environmental Sub-Committee (ESC), which carries out an annual review of planned 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.

Figure 6.1 Key Onshore and Offshore Locations Associated with the COP

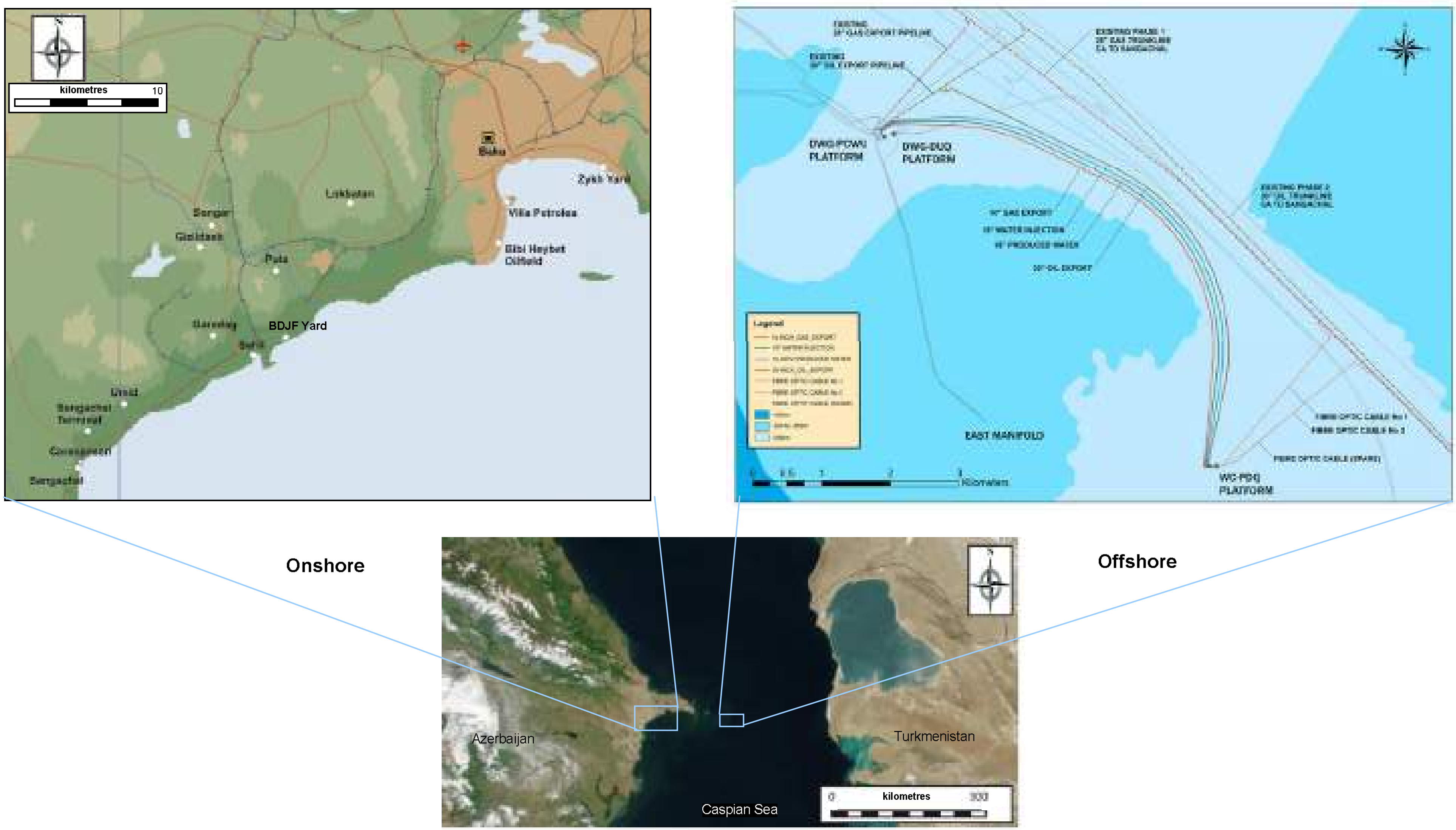


Table 6.1 Onshore, Nearshore and Offshore Surveys, 1992-2009

Date	Title of Survey
Marine Surveys	
1992	Pilot Environmental Survey, Chirag oilfield
1995	Environmental baseline study: Review of the existing scientific literature
1995	AIOC Offshore Environmental Baseline Survey 1995, September and December
1996	Pipeline Landfall Survey: Sediments and Macrobenthos
1996	AIOC Contract Area Long Term Monitoring Stations, 1996
1996	AIOC Appraisal Well 1 Pre and Post Appraisal Drilling Seabed Environmental Survey
1996	Sangachal Coastal Environmental Survey, 1996
1997	AIOC Appraisal Well 1 Pre and Post Appraisal Drilling Seabed Environmental Survey
1997	AIOC Appraisal Well GCA No. 3 GCA No. 4, Post Appraisal Drilling Surveys
1998	AIOC Chirag 1 Mid Drilling Environmental Survey, 1998
1998	AIOC Phase 1 Environmental Description, 1998 (draft)
1998	Phase 1 Platform 1a and 1b Environmental Baseline Surveys
1999	Review of AIOC Environmental Monitoring, 1999
1999–2001	Gunashli Field Fisheries Surveys
2000	Chirag 1 Post Saraline Survey, 2000
2000	GCA 5 and 6 Post Well Survey, 2000
2000	Chirag - Sangachal Sub-sea Pipeline Survey, 2000
2000	Sangachal Coastal Environmental Survey, 2000
2001	ACG Phase 1 ESIA Baseline Survey (Central Azeri)
2001	GCA7 Environmental Survey (ACG Phase 3 Offshore Area)
2000-2005	Sangachal Fisheries Monitoring Programme
2002	ACG Phase 2 Environmental Baseline Survey (East Azeri and West Azeri)
2003	West Chirag Environmental Baseline Survey
2004	ACG Contract Area Regional Benthic and Plankton Survey
2004	Chirag 1 Benthic Survey
2004	Central Azeri Benthic Survey
2005	ACG Regional Plankton Survey
2005	West Azeri Post-installation Benthic Survey
2006	East Azeri Post-installation Benthic Survey
2006	Chirag 1 Platform Benthic Survey
2006	ACG Regional Benthic Survey
2006	Sangachal Bay Benthic Survey
2006	ACG Pipeline Corridor Benthic and Plankton Survey
2007	West Azeri Platform Benthic Survey
2007	Deep Water Guneshli DUQ Post-installation Benthic Survey
2009	West Chirag Benthic and Sediment Composition Survey
Terrestrial Surveys	
1996	EOP Sangachal Terminal Survey
2001	Phase 1 Terrestrial Survey
2002	Phase 2 Terrestrial Survey
2002/2003	Overwintering Bird Survey, Absheron to Kura
2003	Sangachal Terminal Watershed Analysis
2003	Sangachal Wetlands Survey Summer/Autumn 2002
2004	BP Logistics Supply Base Development Project, Environmental and Socio-economic Impact Assessment, Draft Report
2004	Overwintering Bird Survey, Absheron to Kura
2004	Breeding Bird Monitoring Survey Sangachal
2004	Integrated Terrestrial Ecosystem Monitoring Survey - Spring
2004	Integrated Terrestrial Ecosystem Monitoring Survey - Autumn
2004	Winter Waterfowl Monitoring Study. Absheron to Kura
2005	Integrated Terrestrial Ecosystem Monitoring Survey - Spring
2005	Integrated Terrestrial Ecosystem Monitoring Survey - Autumn
2006	Sangachal Terminal Ambient Air Quality Monitoring
2006	Winter Waterfowl Monitoring Study. Absheron to Kura
2006	Sangachal Terminal Terrestrial Monitoring Survey - Spring
2006	Sangachal Terminal Terrestrial Monitoring Survey - Autumn
2006	Onshore Ambient Monitoring (Sangachal): Hydrology & Hydrogeology – Phase 1
2007	Sangachal Terminal Ambient Air Quality Monitoring
2007	Sangachal Terminal Terrestrial Monitoring Survey - Spring
2007	Sangachal Terminal Terrestrial Monitoring Survey - Autumn

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 occurred for hundreds of millions of years leading 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.

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[1]. Convergent plate movements are generally associated with relatively high levels of seismic activity and accompanied by earthquakes and volcanism.

Azerbaijan is known for its seismic activity, particularly in the Greater and Lesser Caucasus Mountains. Five earthquakes with a magnitude greater than 6.0 on the Richter scale have occurred since 1842 with the most recent, measuring 6.5, on 25th November 2000 with an epicentre 30km east-north east of Baku. More detailed information on the seismicity and tectonics of the area can be found in the ACG Phase 1 ESIA[2].

6.3.2 Climate

Climatic data, with the exception of wind data, for the period 1977 to 2000, has been collected from the meteorological station at Alyat located approximately 25km south of Sangachal. Wind data, for the period 1999 and 2001, has been recorded onshore at Baku Airport located approximately 45km northeast of Sangachal. Offshore wind data, for the year 2005, has been recorded at the Central Azeri (CA) and Chirag-1 platforms.

6.3.3 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 between 1977-2000 of 26.4°C. 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.

Offshore air temperatures show considerable seasonal variation in the Caspian area. In the summer, the southern Caspian Sea is influenced by the South Asian Low. Air temperatures peak in July and August with average temperatures of 27°C. During the winter pressures over the southern area of the Caspian Sea tend to be raised by local highs that form over the Armenian and Iranian highlands. Temperatures within the ACG Contract Area average around 5°C, but are known to occasionally fall below freezing[3].

6.3.4 Precipitation

The onshore Sangachal area is one of the driest in Azerbaijan. Based on data from Alyat meteorological station, mean annual rainfall over the period from 1977 to 2000 was 217mm. The highest monthly rainfalls are recorded in November, receiving an average of around 32mm/month with the drier periods occurring during July, receiving an average of 3mm/month. October to March is the period of greatest rainfall with intensities often exceeding 25 mm/day.

[1] Karabanov, Institute of Geology, *pers comm*.
[2] URS (2002)
[3] Ocean MetriX Ltd (2009)

Table 6.2 presents average monthly rainfall data from the Absheron Peninsula for 2000. The Absheron Peninsula experiences relatively dry summers with higher rainfall in the winter, spring and autumn months. Average annual rainfall varies between 200mm and 400mm. Rainfall in the ACG Contract Area is similar to that on the Absheron Peninsula.

Table 6.2 Absheron Peninsula 2000 Rainfall Data (mm)[4]

J	F	M	A	M	J	J	A	S	O	N	D	Total
46	20	34	18	45	20	2	15	45	64	44	33	386

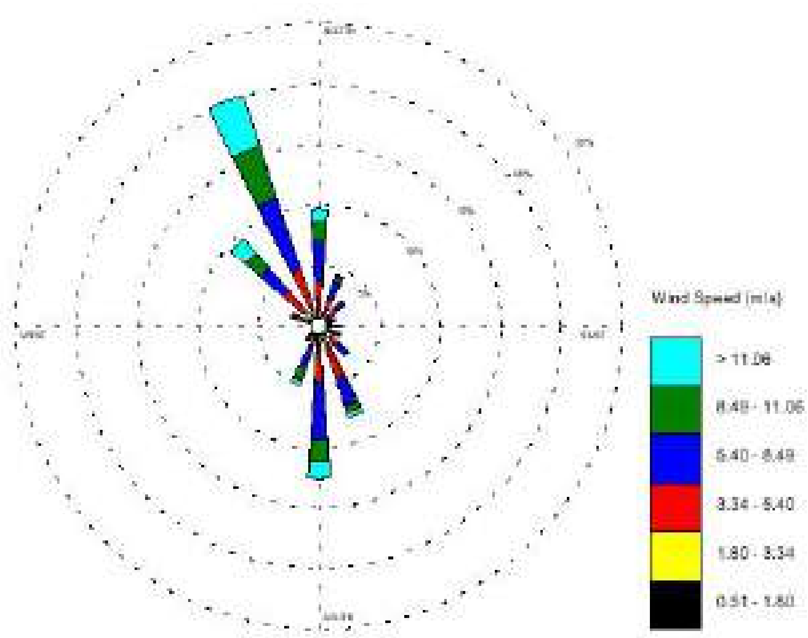
6.3.5 Wind

Onshore

The wind regime in Sangachal Bay is on the whole 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 then drops and becomes a stronger onshore wind as the land heats up. This thermal influence coupled with the meteorological dynamics of the region can result in strong winds occurring with little forewarning.

Figure 6.2 shows a wind rose compiled from data collected over the period between January 1999 and October 2001 at Baku Airport[5]. The predominant wind direction is north-northwesterly (i.e. blowing from land to sea) occurring approximately 20% of the year. Northwesterly, northerly and southerly winds account for approximately 30% to 40% of other winds. Wind speeds typically range from 0.5m/s to 14m/s with approximately 10% of winds being greater than 11m/s.

Figure 6.2 Annual Wind Rose for the Sangachal Area, 1999-2001



[4] Food and Agricultural Organisation of the United Nations (2001)
[5] The anemometer is located 10m above ground level

Offshore

Figure 6.3 presents a wind rose for offshore in the central Caspian Sea based on data recorded at the Chirag-1 and CA platforms for the year 2005[6]. The predominant wind direction is southerly (blowing from south to north), occurring for approximately 20% of the year with secondary winds from the north, northwest and northeast occurring 30% of the year.

Figure 6.3 Wind Rose for Offshore Central Caspian, 2005

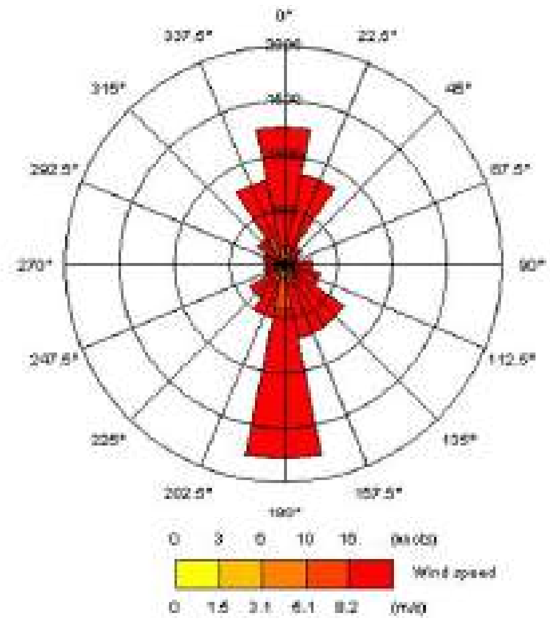
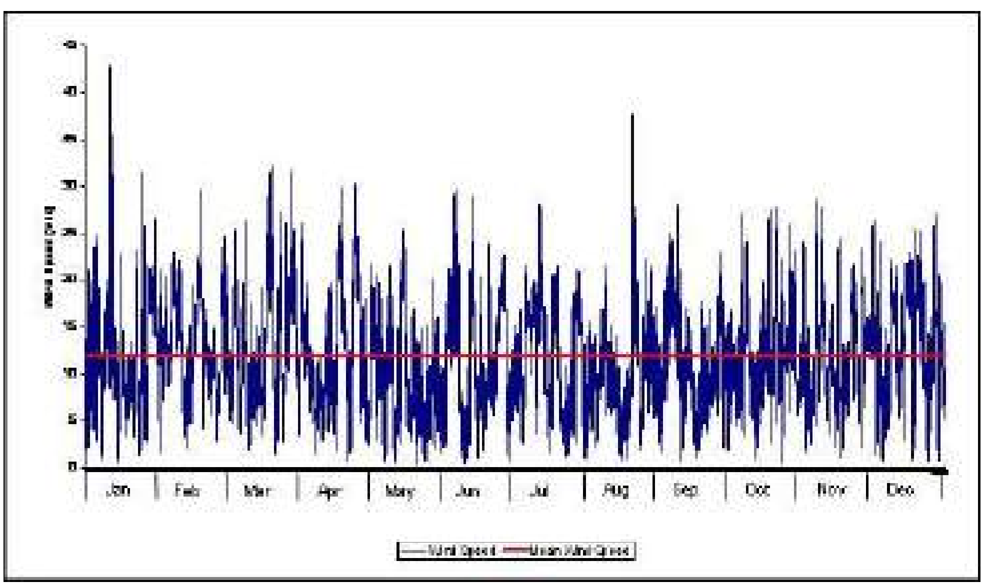


Figure 6.4 shows that the mean wind speed offshore was 12m/s in 2005. A maximum of 42.8m/s was reached in January. Wind speeds greater than 20m/s were experienced for approximately 10% of the time.

Figure 6.4 Wind Speeds for Offshore Central Caspian, 2005



[6] There are two anemometers on both the Chirag-1 and CA platforms – one on the drilling rig approximately 80m above sea level and one on the helideck approximately 50m above sea level.

6.4 Terrestrial and Coastal Environment

6.4.1 Setting

6.4.1.1 Sangachal Terminal

Sangachal 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 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 three main settlements in the vicinity of the Terminal (Figure 6.5) the largest being Sangachal Town located approximately 2.5km south. The Umid Settlement lies less than 1km to the east of the Terminal and Azim Kend is located approximately 2.7km to the southwest.

Umid and Sangachal are adjacent to the Baku-Alyat 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.

Figure 6.5 also shows the main drainage catchment areas surrounding the Terminal. Drainage from:

- Catchment areas 1-3 (the Shachkaiya Wadi and its western tributaries) flows to a culvert, which drains to the Caspian under a bridge beneath the railway and through a box culvert under the coastal highway.
- Catchment areas 4-7 flows from the slopes around Mt Qaraqush to the flood protection channel around the Terminal and from there drains to the Caspian via the Central Drainage outlet; a culvert under the highway and railway.
- Catchment area 8 flows directly to the Central Drainage outlet.
- Catchment area 9 (Wadi Umid) flows to the Caspian via a separate culvert under the highway and railway.

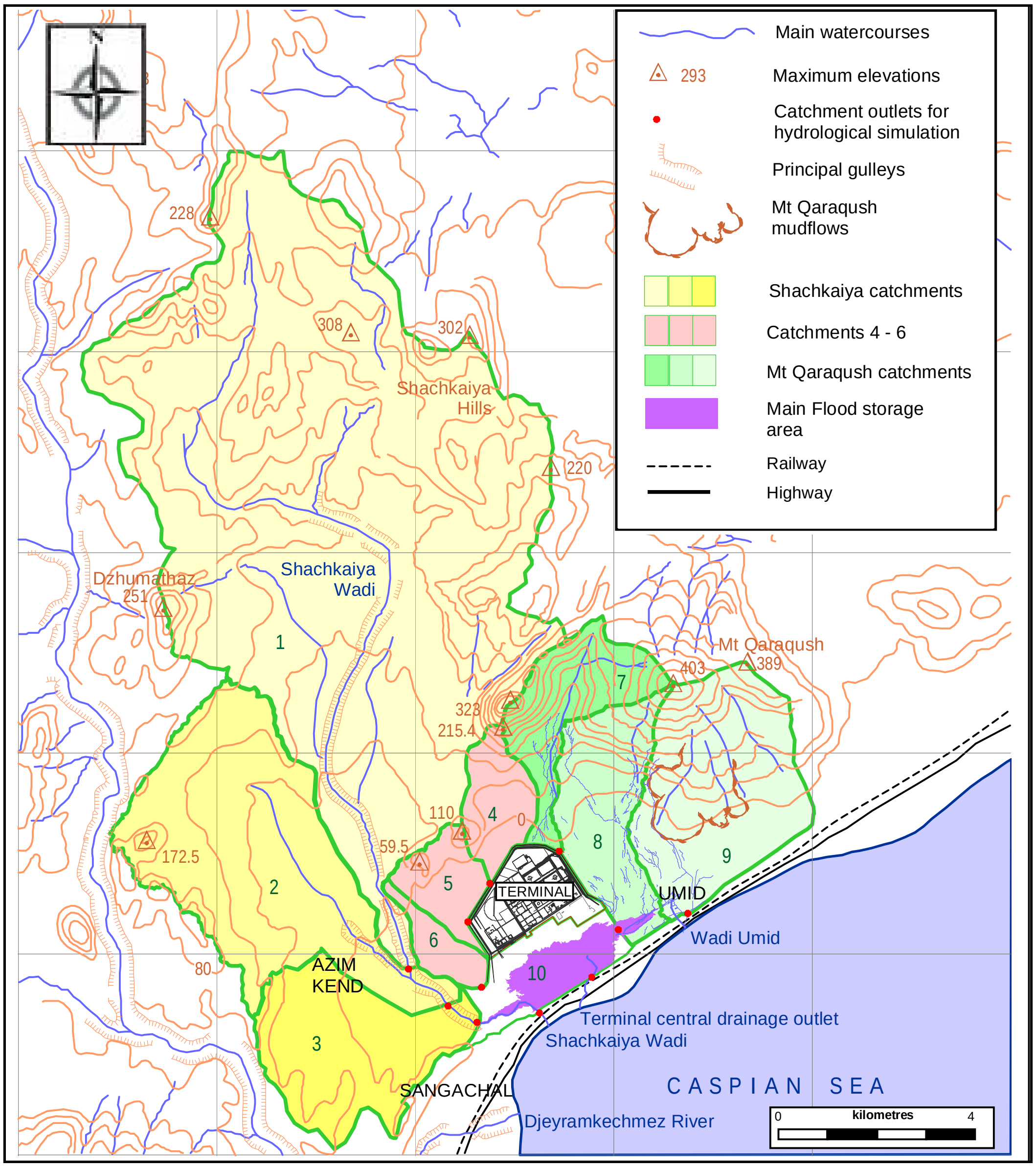
During periods of high flow there can be significant ponding of water in flood storage area 10 prior to discharge to the Caspian via the Central Drain outlet.

The Sangachal Wadi flows between the terminal and Sangachal settlement, and enters the Caspian Sea through the railway bridge and a box culvert beneath the coastal highway. This wadi, and the other smaller catchments, are ephemeral and only flow after heavy or prolonged rainfall.

The lower reaches of the Shachkaiya Wadi are usually wet and appear to have a small permanent water flow which sustains a significant area of reed and scrub vegetation. It is likely that this flow is a combination of ephemeral surface drainage from the Sangachal terminal and waste water streams from the Azim Kend and Sangachal settlements, possibly with some contribution from leaking water pipes.

The Central Drain also seems to carry a small but steady stream of water which seems to originate largely from treated sewage water discharges from the Sangachal terminal.

Figure 6.5 Sangachal Terminal and Key Features in the Surrounding Area



6.4.1.2 Construction Yards

The **BDJF Yard** lies approximately 20km southwest of Baku on the western coastline of the Caspian Sea. The site is approximately 1.5km^2 in size and bound to the north by vacant land, to the southeast by the Caspian Sea and to the west by the Salyan Highway. The site is located on a coastal plain that features undulations up to 2m in height in areas around the Yard. The coastal plain is backed by steep hills that form a ridgeline running approximately parallel to the coast. The coastal area in the vicinity of the yard also hosts shallow lagoons.

The BDJF Yard includes two areas: the area to the north that was previously used for construction of the ACG Phases 1, 2 and 3 jackets and the area to the south where the corresponding topsides were constructed (except for the Phase 1 Compression and Water Injection Platform (C&WP) and Phase 3 Production, Compression, Water Injection and Utilities (PCWU) topsides).

Several derelict structures including buildings, storage tanks and wellheads are present in the surrounding area.

The **Bibi Heybet Yard** is located approximately 8km south of Baku. The Caspian Sea bounds the yard to the east and south. Land to the west of the yard is mostly undeveloped but some buildings, approximately 1km away, do exist. To the north is the Bibi Heybet oil field. The yard is approximately 0.84km^2 and is essentially level with the regional topography, sloping gently (<1 degree) towards the Caspian Sea. The Phase 1 C&WP and Phase 3 PCWU topsides were fabricated at this yard.

The **South Dock Yard** is located approximately 8km to the south of Baku, adjacent to the Bibi Heybet Oilfield and in close proximity to the Bibi Heybet Yard. The facilities within the South Dock Yard include jetties and berths, cranes, offices, warehouse, mechanical and electrical repair shops, lay down areas, an enclosed painting facility and a steel fabrication and construction area. South Dock Yard has been used for various construction and upgrade projects, including barge and vessel upgrades, associated with ACG operations.

Areas surrounding the South Dock Yard include:

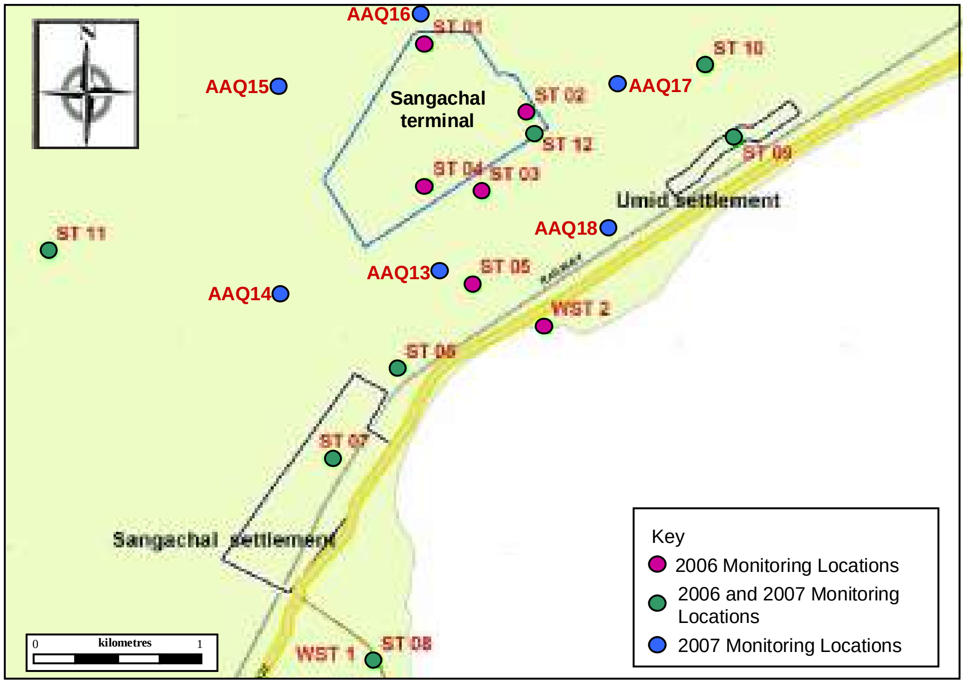
- **North:** A narrow strip of land joining the southern site to the main South Dock Yard and the Bibi Heybet Oilfield further beyond;
- **Northeast:** A small area of land where vessels are serviced;
- **South:** A concrete jetty and the Caspian Sea; and
- **Southwest:** South Bay Road and a steep escarpment with a residential development and mosque overlooking the South Dock Yard.

The **Zykh yard** is located on a narrow coastal fringe at the foot of a steep escarpment, approximately 15km to the east of Baku. Land in the immediate site vicinity is occupied by light and heavy industrial uses and the nearest residential properties are approximately 1km from the site perimeter. The yard has previously been used for the construction of the Shah Deniz project offshore facilities.

6.4.2 Air Quality

Ambient air quality monitoring has been undertaken around Sangachal Terminal since 1997, prior to the EOP activities commencing at the Terminal. Currently ACG Phases 1-3 and SD1 as well as EOP are operating at the Terminal. The methodology, monitoring locations and species monitored have varied across the monitoring surveys. The most recent and relevant completed were undertaken in 2006 and 2007. Figure 6.6 presents the monitoring locations in and around the Sangachal Terminal for the 2006 and 2007 surveys.

Figure 6.6 Ambient Air Quality Monitoring Locations 2006 and 2007



Ambient air quality measurements were assessed against IFC[7] and World Health Organisation Guidelines[8] (WHO) and in the case of benzene, the European Union (EU) Guidelines.[9,10,11]

The 2006 average values and standard deviations for NO_X[12] and SO_2 based on long-term measurements are shown in Table 6.3. Annual average guideline criteria for NO_X and SO_2 were not exceeded at any station. The criteria were exceeded during individual measurement cycles at three stations (though this does not infer a breech of the limits as a one off measurement is not sufficient to give an annual average). Of these, two stations were within the Terminal boundary (ST12) or within the contractor area (ST03) and the cause for exceeding the guidelines are likely to have been a localised source such as exhaust emissions from a vehicle or from equipment. ST06, where one exceedence was recorded, is an unpopulated area between the Terminal and Sangachal Town, adjacent to a sewage treatment plant. Guidelines were not exceeded at stations located within the Sangachal Town or Umid Settlement. Short-term monitoring for NO_X using chemiluminescence, SO_2 using ultraviolet fluorescence and particulates using partisol analysers did not detect substantial quantities of pollutants and the short term guideline values were not exceeded at any of the monitoring sites.

[7] IFC Environmental, Health and Safety Guidelines. General EHS Guidelines: Environmental, Air Emissions and Ambient Air Quality (2007)
[8] World Health Organisation Guidelines (1999)
[9] European Union Guidelines (2005)
[10] No guidelines were available for total volatile organic carbon.
[11] Historically in Azerbaijan ambient concentrations of NO_2, SO_2, CO and PM_{10} have also been assessed against 24 hour and 1 hour standards. These standards were not derived using the same health based criteria as the IFC, WHO and EU guideline values and the standards derived are not widely recognised.
[12] NO_x was assessed on a worst case basis assuming all nitrous oxides are NO_2.

Table 6.3 Average NO_X and SO_2 Air Quality Concentrations (µg/m³) (2006)

Monitoring Location	NO_X		SO_2	
	Concentration	Standard deviation (+/-)	Concentration	Standard deviation (+/-)
ST01	8.4	6.3	10.2	15.6
ST02	14.9	9.2	6.5	5.7
ST03	28.6	18.1**	24.1	38.9*
ST04	18.0	4.8	6.1	5.7
ST05	13.1	11.0	2.6	1.0
ST06	15.2	7.9	19.6	36.0*
ST07	13.6	5.7	3.2	2.8
ST08	13.2	5.1	3.3	1.5
ST09	11.8	5.5	9.1	9.6
ST010	13.0	4.8	1.8	0.3
ST011	4.0	1.1	2.2	1.2
ST012	16.4	4.0	16.5	31.6*
Applicable Limit	40 µg/m³***	-	50***	-

* Exceeded guideline during one sampling cycle.
** Exceeded guideline during two sampling cycles.
*** EU/WHO NO_2 annual average standard.
**** WHO/IFC annual average standard.

The average values for benzene and total volatile organic carbon (VOC), based on long-term measurements, ranged between 1.18 to 2.24µg/m³ and 49.8 to 85.4µg/m³, respectively (see Table 6.4 below). The highest measurements were recorded at ST10. Guideline values (5µg/m³) were not exceeded for benzene at any station or during any measurement cycle during 2006.

Table 6.4 Average Benzene and VOC Concentrations (µg/m³) (2006)

Monitoring Location	Benzene		VOC	
	Concentration	Standard deviation (+/-)	Concentration	Standard deviation (+/-)
ST01	1.2	0.4	52.5	33.0
ST02	1.8	1.2	69.0	47.8
ST03	1.7	0.3	75.0	29.9
ST04	1.2	0.1	76.8	69.3
ST05	1.5	1.2	49.8	28.2
ST06	1.6	0.7	59.8	23.8
ST07	1.9	1.4	70.2	26.5
ST08	1.2	0.6	81.2	62.7
ST09	2.0	0.8	62.6	34.9
ST010	2.2	1.6	85.4	59.3
ST011	1.2	0.7	85.5	54.11
ST012	1.3	0.8	53.0	34.1
Applicable Limit	5 µg/m³	-	-	-

Particulates (PM_{10}) were measured at the seven short-term stations and assessed against the IFC maximum 24-hour average standard of 50µg/m³ (see Table 6.5 below). Short-term measurements were exceeded at three locations, however these locations are all more than 500m from the Terminal boundary and the exceedances are unlikely to be due to Terminal activities.

Table 6.5 Average PM_{10} Concentrations (μg/m^3) (2006)

Monitoring Location	PM_{10}	
	Concentration	Standard deviation (+/-)
ST05	52.5	19.0**
ST06	41.5	31.8
ST07	44.0	22.6
ST08	102.0	1.4*
ST09	28.5	3.5
ST010	52.0	18.4**
ST012	32.5	23.3
Applicable Limit	50 μg/m^3	-

* Exceeded guideline during two measurement cycles
** exceeded guideline

Results are presented in full within the BP AzSPU Integrated Environmental Monitoring Programme: Annual Summary Report for 2006.

During 2007, the ambient air quality monitoring programme was redesigned to better reflect the operating plant as it is now, with some monitoring locations discontinued and several new monitoring locations initiated (Figure 6.6). Two rounds of monitoring were carried out using diffusion tubes, corresponding to a period when the Terminal oil-handling operations were shut-down and a second period when the Terminal was in full operational mode (Table 6.6).

Table 6.6 Average NO_X and SO_2 Air Quality Concentrations (μg/m^3) (2007)

Monitoring Location	Terminal shut-down period		Terminal operational	
	NO_x	SO_2	NO_x	SO_2
ST06	__*	__*	18.0	5.7
ST07	160.0	2.0	12.0	1.6
ST08	12.0	18.0	13.0	4.3
ST09	9.6	22.0	12.0	1.3
ST10	6.4	2.0	9.3	1.5
ST11	5.3	3.7	3.9	23.0
ST12	13.0	4.4	5.1	1.6
AAQ13	25.0	5.9	10.0	1.6
AAQ14	2.7	2.0	16.0	1.6
AAQ15	4.4	2.3	__*	__*
AAQ16	6.2	13.0	0.05	1.6
AAQ17	__*	__*	__*	__*
AAQ18	5.8	5.2	4.2	200.0
Applicable Limit	40 μg/m^3***	50***	40 μg/m^3***	50***

* Diffusion tubes were lost or stolen during the two monitoring cycles
** Exceeded guideline during one sampling cycle
*** EU/WHO NO_2 annual average standard
**** WHO/IFC annual average standard

The data shows one guideline exceedence for NO_X at ST07 (inside Sangachal Town). This occurred during the period when Terminal operations were shut down and would therefore be likely to have originated from a local source rather than from the Terminal.

A high SO_2 value also occurred at one location, AAQ18, an unpopulated area east of the Terminal – between the Terminal and the Caspian Sea. The value was recorded when the Terminal was operational. However, nearby monitoring locations (ST09, AAQ13 and ST12) did not indicate similarly elevated levels suggesting the source would have been localised in nature.

Short-term monitoring (24-hour) was carried out on different days at each of the locations during the same periods. No exceedences of the short-term guideline values were observed.

6.4.3 Noise

Noise surveys were undertaken in 2007 and 2008 in the vicinity of the terminal and at surrounding residential communities. Table 6.7 presents the daytime noise levels recorded.

Table 6.7 Noise Survey Results for Residential Communities in the Vicinity of Sangachal Terminal (2007 and 2008)

Location	2007[1]	2008[2]
	(l_{aeq})	(l_{aeq})
Azim Kend	44.3	38.7
Umid	50.9	49.4
Sangachal	50.9	51.2

[1]Averaged data from surveys conducted from January - April.
[2]Averaged data from surveys conducted from July - December.

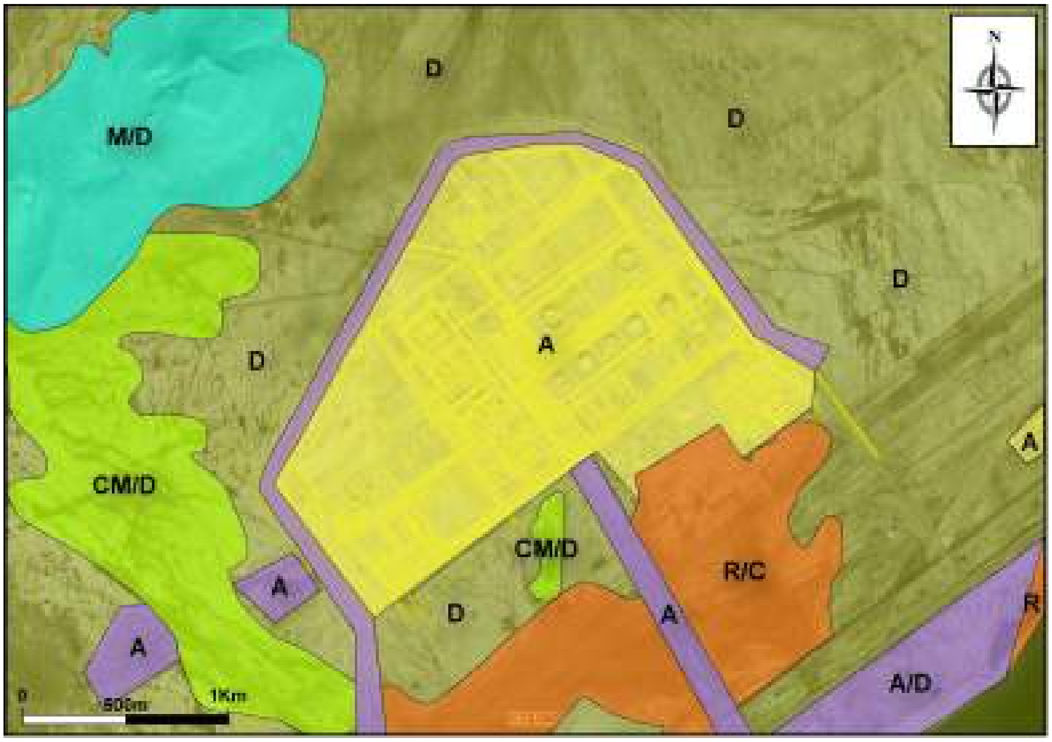
While the terminal is the largest and most visible potential source of noise the area, other noise sources of relevance for the surrounding communities include wind generated noise (wind speeds and greater than 5 knots more than 80% of the time), major roads and local domestic noise sources. Taking into consideration of these noise sources Table 6.5 demonstrates that IFC noise guidelines (55dB during daytime) are met at all residential community locations. Night time noise monitoring surveys are included within the future IEMP activities as insufficient night time survey results have been undertaken to date to provide typical night time noise levels at residential communities in the terminal vicinity.

6.4.4 Terrestrial Ecology

6.4.4.1 Habitats and Flora

Sangachal Terminal is located in a semi-arid region interspersed with areas of semi-arid vegetation (Refer to Figure 6.7). The area is dominated by a high percentage of bare soil, often in large patches, and a vegetation component dominated by low perennial shrubs such as *Salsola nodulosa* and *Salsola dendroides* interspersed with the perennial grass *Poa bulbosa*. The area particularly to the south/southeast of the Terminal also hosts chal-meadows – depressions that retain moisture and host a greater variety and structural diversity of plant species including *Tamarix ramosissima* and *Lycium ruthenicum*. Appendix 6A presents the habitats and predominant plant species identified in surveys undertaken in the vicinity of the Terminal between 2006 and 2008.

Figure 6.7 Approximate Distribution of Plant Community Types (Habitats) Around Sangachal Terminal.



Key: A = landscape changed due to anthropogenic activities; C = coastal vegetation; CM = Chal Meadow; D = Desert plain; DM = Desert mountain; R = Reed beds.

The central plains are heavily grazed by livestock (e.g. sheep) although the areas immediately surrounding the Terminal may have seen some recent reduction in grazing following the erection of a partial fence (not complete in the west). As such, moderate soil erosion occurs in vegetated areas and high rates of erosion can be seen in unvegetated areas. Since these unvegetated/low vegetation densities appear to be most common adjacent to the Terminal, they are also the least stable in terms of maintaining their ecosystem characteristics.

Sensitivity

The recovery rate of vegetation from significant disturbance or degradation is dependant on the type of vegetation and the soil conditions. For all terrestrial habitats it is expected that it will take between 9 and 12 years for the vegetation to recover.

Other than the initial land take for the Terminal, no significant additional adverse impacts (leading to degradation of habitat and / or loss of flora density / biodiversity) associated with Terminal operations have been observed in the vicinity of the Terminal.

6.4.4.2 Fauna

A recent survey of the area adjacent to the southern boundary of the Terminal, undertaken in 2008, revealed the presence of a variety of small vertebrate animals including six mammalian species, and four reptile species (See Appendix 6A). Of these only one species is listed in the Azerbaijan Red Book (i.e. is of national significance) and included in the IUCN Red List (i.e. international importance) namely *Testudo graeca*, the Spur-thighed tortoise. Of the remaining species *Mus musculus*, the common mouse, was detected at survey locations nearest Sangachal Settlement, and is considered an invasive species associated with human habitation. The other mammalian species (*Microtus socialis* (Social Vole)*, Lepus europaeus* (European Hare)*, Meriones libycus* (Libyan Jird)*, Vulpes vulpes* (Red Fox)*, and Erinaceus* *concolor* (Southern white-breasted Hedgehog) are native to the habitats occurring in the areas adjacent to Sangachal Terminal. Their continued presence in the area, together with the reptile species, suggests that, as yet, exotic species such as *Mus musculus* have not displaced native species in the areas around the terminal.

Sensitivity

Faunal species are most sensitive to disturbance during mating, pregnancy and juvenile stages (see ACG Phase 1 Appendix 11 for seasonal faunal sensitivities). Anthropogenic disturbances can lead to stress that can result in a possible decrease in reproductive success. Comparing 2008 results with earlier surveys in the vicinity of the Terminal (Table 6.1) there appears to have been little change in faunal diversity during the period of ACG activities. In particular, the continued presence of *Testudo graeca*, which is known to be sensitive to habitat fragmentation and degradation, suggests that areas around Sangachal Terminal have not been heavily impacted by terminal-generated environmental stressors.

6.4.5 Coastal Ecology

The coastal zone adjacent to the Terminal comprises several sub habitats including a rocky coastline with sparse vegetation cover (dominant species *Convolvulus persicus* and *Argusia siberica*), littoral reedbeds (*Juncusetum acutus* and *Phragmites australis*), shallow lagoons, and a salt marsh dominated by *Salicornia europea*. The semi-arid areas consist of two components *Artemisia fragans* and saltwort species (*Salsola denroides* and *Salsola nodulosa*). A number of species listed in the Azerbaijan Red Book occur in this area including *Ferula persica*, *Cladochaeta candidissima* (IUCN, Indeterminate), *Glycyrrisa glabra* and *Nitraria schoberii*.

15 faunal species have been recorded in the coastal zone. An area of phragmites (*Phragmites australis*) located southeast of the Terminal was the most diverse, including the following species, Wolf (*Canis lupus*), Fox (*Vulpes vulpes*), Marsh frog (*Rana ridibunda*) and European grass snake (*Natrix natri*). Caucasian agama (*Agama caucasia*) and Dahl's whipsnake (*Coluber najadum*) were also recorded.

6.4.6 Birds

6.4.6.1 Regional Environment

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 afforded local and international importance are also known to frequent the coastline.

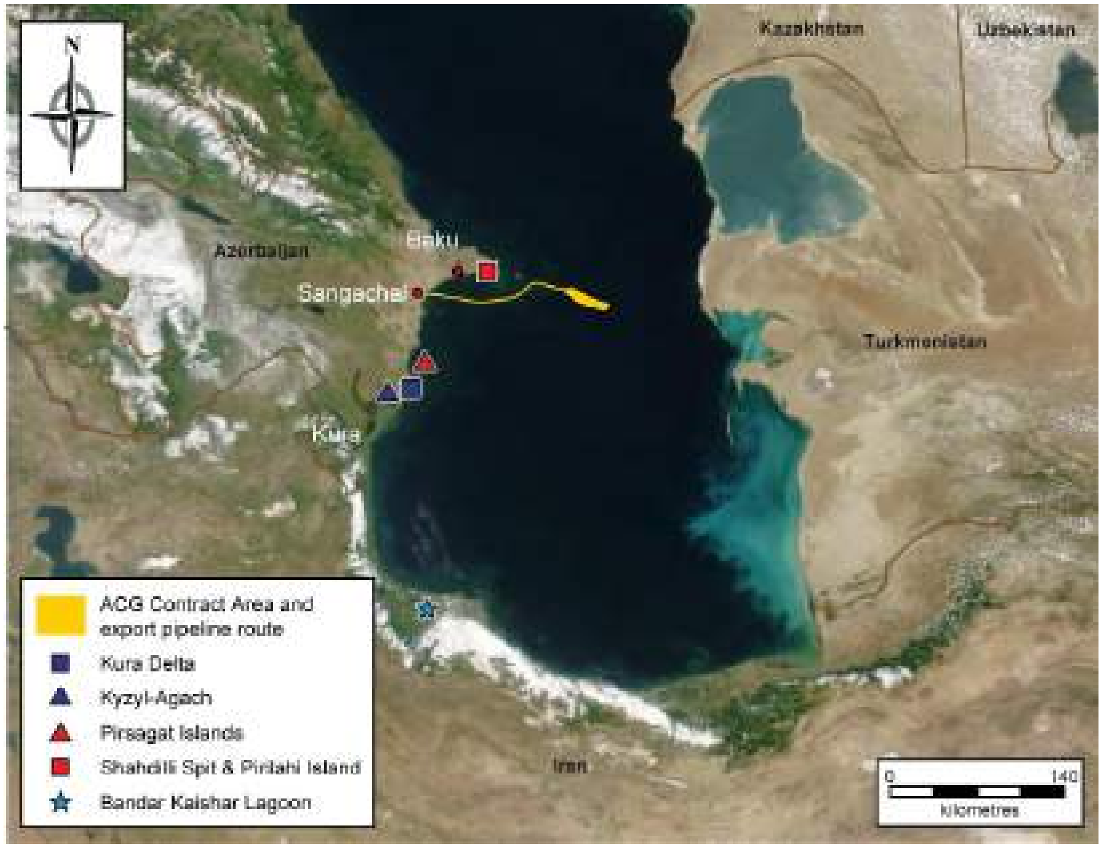
Important ornithological sites, located on the Caspian Sea's southwest coast include (Figure 6.8)[13]:

- **Kura Delta** - supports large populations of waders during the spring migration (approximately 92km south of Sangachal Terminal);
- **Kyzyl-Agach State Nature Reserve** - established in 1929 for the protection of wintering and migratory waterfowl, waders and steppe birds. It is estimated that there are 248 bird species within the reserve, a number of which are protected species (approximately 105km south of Baku);
- **Pirsaget Islands** – supports important bird colonies (approximately 37km south of Sangachal Terminal);
- **Shahdili spit and Pirilahi Island[14]** – the Shahdili spit is designated as a sanctuary, and together with Pirilahi Island has been identified as a candidate Ramsar site (approximately 77km and 98km respectively north east of Sangachal Terminal); and

[13] Phase 3 ESIA Section 6.3.2.8 (2004)
[14] Now declared the Absheron National Park

- **Bandar Kaisher Lagoon and mouth of Sefid Rud** – this area is an important staging and wintering area for a wide variety of migratory wildfowl (approximately 317km south of Sangachal Terminal).

Figure 6.8 Important Ornithological Sites Located on the Southwest Caspian Coast



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

The review highlighted that the breeding season of birds on the Shahdili and Pirilahi coastline commences 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 (for a complete list of species recorded refer to Appendix 6B). Four species recorded along both coastlines exceeded the 1% limit for the provision of Ramsar status and four rare and endangered bird species listed in the Red Book of Azerbaijan and the IUCN Red List of Threatened Species were also recorded (refer to Table 6.8).

Table 6.8 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	✓				✓
Pelecanus crispus		✓		✓	✓
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 6.9.

The autumn migration commences in the second half of August and continues until mid-December, with the most active period during November, while the spring migration starts in the second half of February and ends in April, with the most active period during March. Table 6.9 show the routes undertaken by the birds and the percentage of birds that use these routes.

Figure 6.9 Bird Migration Routes

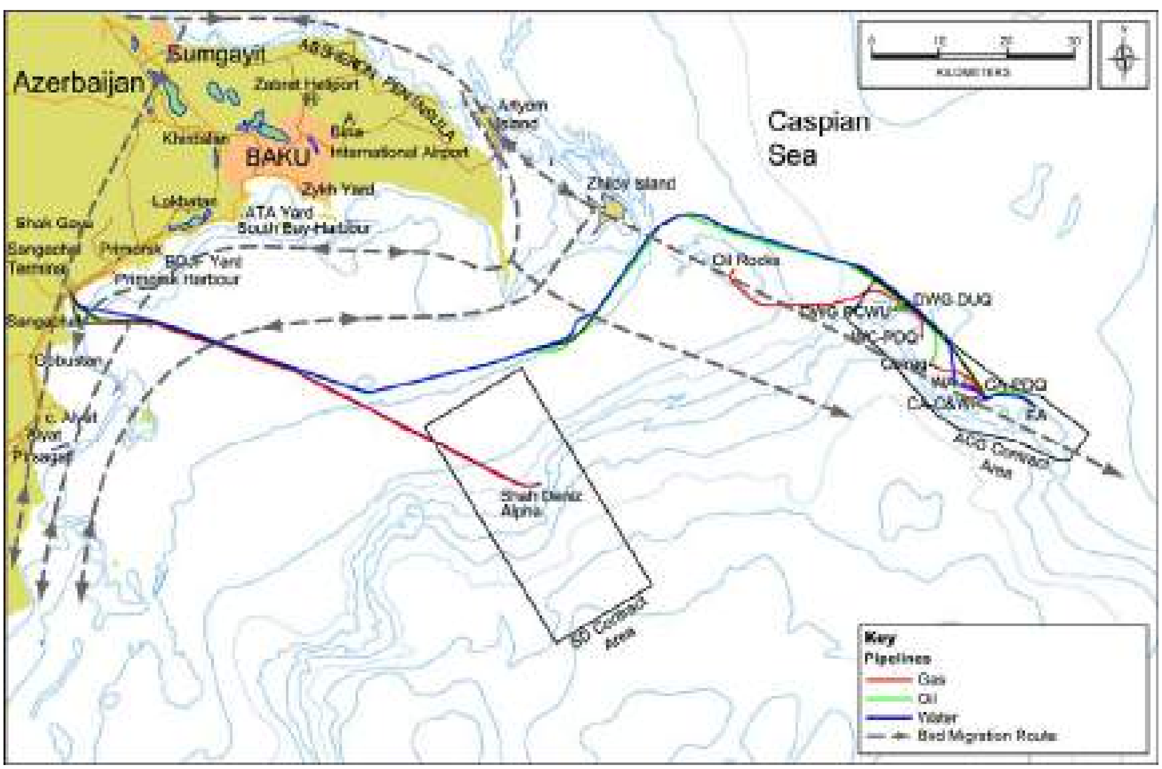


Table 6.9 Percentage of Birds Utilising Spring and Autumn Migration Routes

Routes	Migration Period	
	Autumn	Spring
South	51.2%	
Southeast	11.93%	
Southwest	36.64%	
North		39.76%
Northeast		25.50%
Northwest		26.32%

During the spring migration 19 and 29 bird species were recorded in the coastal waters of Pirilahi Island and the Shahdili coastline, respectively. In total 9 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 6.10).

Table 6.10 Migrating Birds of Importance Recorded in 2002 – 2006 Surveys

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

Birds have been observed flying through or near to the ACG Contract Area and in some cases have been observed resting on the existing platforms. However, staff have not observed birds using the platforms for roosting or nesting purposes.

The predominant direction of the current in the middle/south Caspian Sea is to the south. Therefore the areas most likely to be affected by a potential oil spill is the south Caspian coastline.

6.4.6.2 Sangachal Environment

The Azerbaijan coast lies on a major flyway[15] for waterfowl, raptors and other birds migrating between breeding grounds which extend to the Arctic and wintering areas in south Asia and Africa.

Several bird surveys have been undertaken between 2000 and 2006 (Table 6.1) in the Sangachal area. Concerns were raised, however, that the survey methodology did not allow the impacts of the Terminal operations on bird species and populations to be fully addressed. The monitoring system was therefore redesigned to address these shortcomings and implemented in 2008. The 2008 survey (in preparation) indicated that bird species diversity, richness and numbers were highest in the (unpopulated) areas to the south and southeast of the Terminal, particularly in the more mesic areas with chal-meadows and near reed beds.

[15] A flyway is the migration routes and areas used by water bird populations in moving between their breeding and wintering grounds.

The 2008 survey shows 111 species occurring in the immediate vicinity of the Sangachal Terminal, including both resident and migratory (including over-wintering, breeding and feeding) species (Appendix 6A). 80% of the species were identified as migratory birds.

During the 2008 survey, four Azerbaijan Red Book listed species where observed (Table 6.11). The Long-legged buzzard (*Buteo rufinus)* has been identified for inclusion in the Azerbaijan Red Data Book (ARB), while the Mute swan (*Cygnus olor*) is listed on the Azerbaijan Red Data Book and the Black bellied sandgrouse (*Pterocles orientalis*) is of regional and international importance. The Lesser kestrel (*Falco naumanni*) and Dalmatian pelican (*Pelecanus crispus*) where observed during the Phase 1 and 2 surveys and are listed on the IUCN Red Data List.

Table 6.11 Azeri Redbook/IUCN Red List bird species observed in the vicinity of the Terminal

Species	Common Name	Designation
*Buteo rufinus**	Long-legged buzzard	Proposed for inclusion in ARB
*Cygnus olor***	Mute swan	ARB
*Falco naumanni****	Lesser kestrel	2000 IUCN Red list. Proposed for inclusion in ARB
*Pelecanus crispus*****	Dalmatian Pelican	ARB, 2000 IUCN Red list
*Pterocles orientalis******	Black-bellied sandgrouse	ARB, 2000 IUCN Red list
*Neophron percenopterus***	Egyptian Vulture	IUCN Red List
*Pelecanus onocrotalus***	White Pelican	ARB
*Falco cherrug***	Saker Falcon	INCN Red List
*Coracius garrulous***	European Roller	IUCN Red List

* Observed during the Phase1, 2, and 2008 surveys
** Observed during the 2008 survey
*** Observed during the Phase 1 and 2 surveys
**** Observed during the Phase 2 survey
***** Observed during the Phase 1 and 2008 surveys.

The results of previous ornithological surveys in the Sangachal area are presented in the ACG Phase 3 ESIA, Section 6.3.2.8.

6.5 Offshore Environment

6.5.1 Introduction

The COP offshore activities (with the exception of installation and support vessel movements) will fall entirely within the ACG Contract Area. Figure 6.10 shows the Contract Area and the existing ACG export pipeline corridor in the context of the Caspian; the world's largest enclosed water body. Caspian is fed by numerous rivers; the largest of which being the Volga to the north, which accounts for 78% of the annual in flow[16].

Figure 6.10 The ACG Contract Area in the Context of the Caspian

[16] UNIDO (1998)

6.5.2 General Characteristics of ACG Contract Area

6.5.2.1 Sources of Information

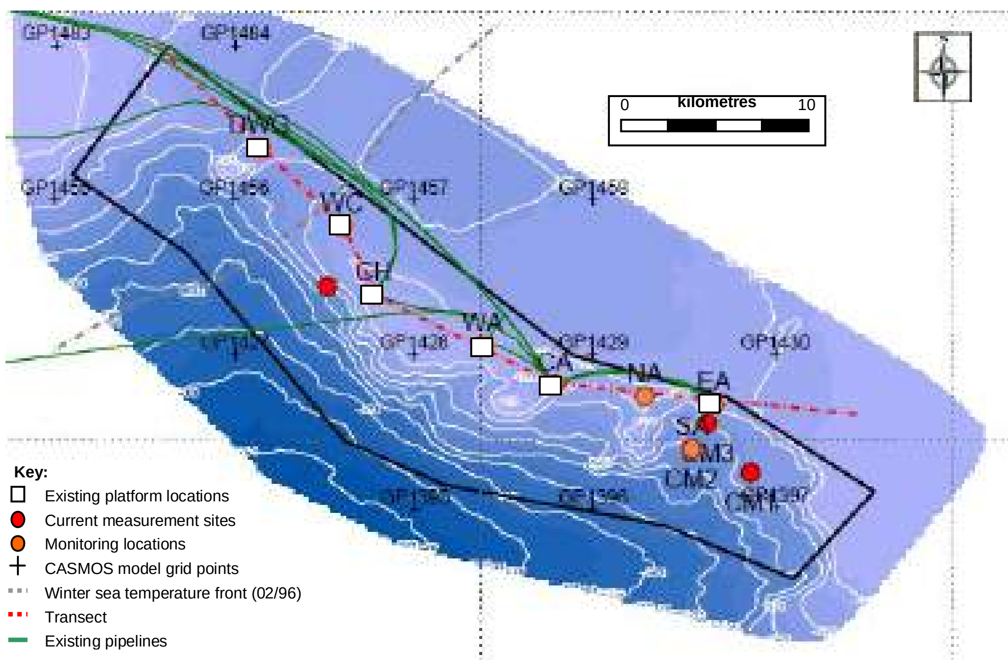
The AIOC has conducted environmental monitoring in the ACG Contract Area since the EOP baseline surveys in 1995 and 1996. During the period between 1996 and 2003, a number of operational surveys were carried out around the Chirag-1 platform and several baseline surveys were carried out at locations selected for the ACG Phase 1 (Central Azeri), Phase 2 (East and West Azeri) and Phase 3 (Deep Water Guneshli) developments.

In 2003, an overview of environmental monitoring outputs resulted in the design of the IEMP which was formally implemented in 2004 (see Section 6.2). Since the inception of the IEMP, regional surveys around the ACG Contract Area have been conducted in 2004, 2006 and 2008. Data from the 2008 surveys are not available at the time of writing, so the following description of the general characteristics of the ACG Contract Area is based on the results of the 2004 and 2006 regional surveys, with reference to previous surveys as reported in the ACG Phase 1, 2 and 3 ESIA where appropriate.

6.5.2.2 Bathymetry and Physical Oceanography

The WC-PDQ platform will be situated in the northern part of the Contract Area, approximately 5km to the north-east of the Chirag-1 platform. Water depth at the WC-PDQ location is approximately 160-175m. Seabed bathymetry throughout the area is irregular (Figure 6.11).

Figure 6.11 Seabed Bathymetry



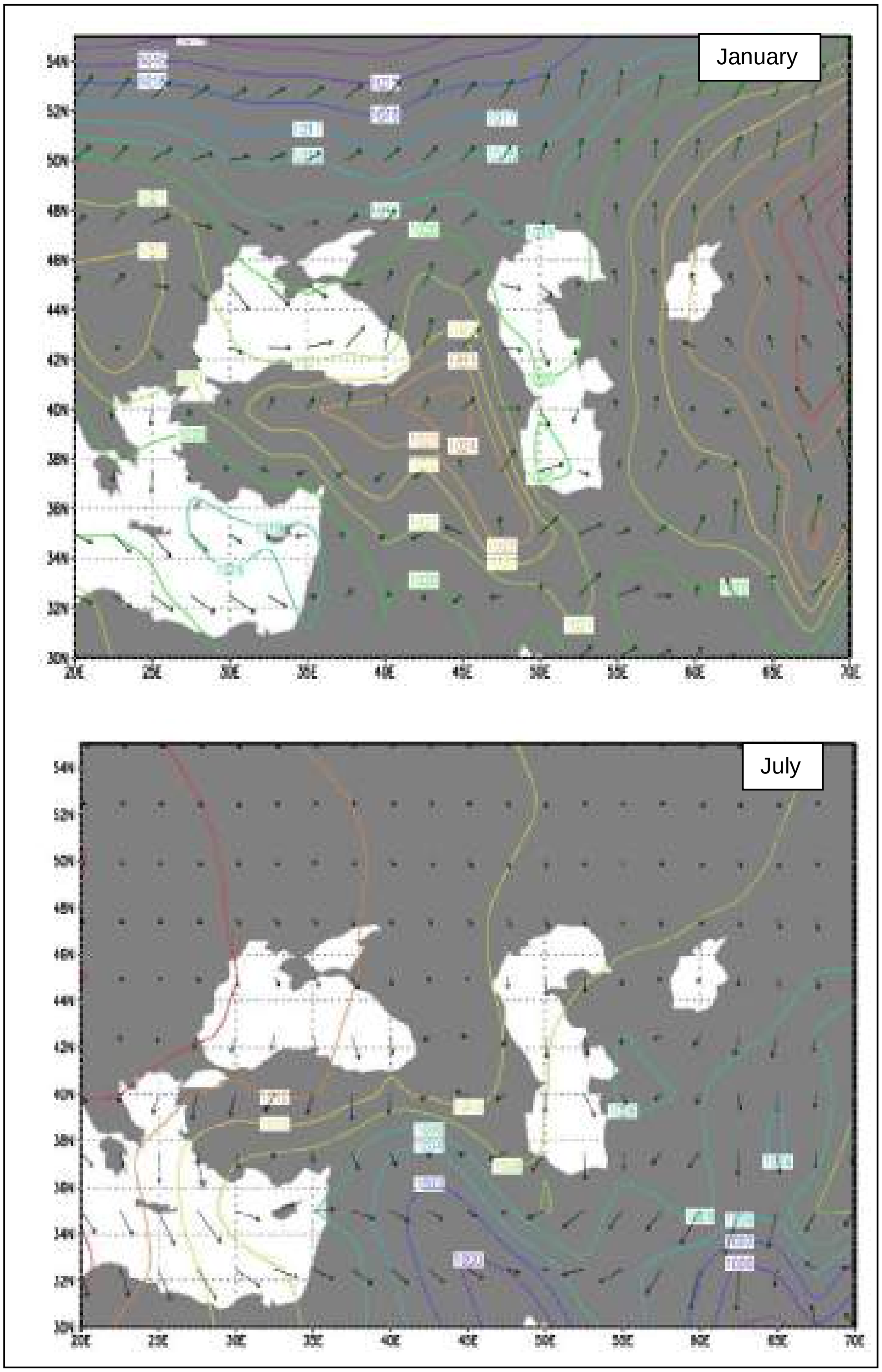
The Caspian Sea is the largest landlocked water body on Earth. From north to south it is just over 1,000km long spanning 36.5°N to just over 47°N. Its width varies from between 200km and about 450km (from 46.75°E to 54°E). It is made up of three basins: the Northern, Central and Southern Basins. The Northern Basin is the smallest (about 25% of the total surface area), but is very shallow and contains just 0.5% of the water volume. 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. Both large Basins have extensive continental shelves (water depths < 150m). The deepest recorded depth is in the Southern Caspian Basin and is just over 1000m.

The bathymetry of the ACG Contract Area is particularly complex. The ACG Contract Area lies on the southern flank of the Absheron sill: the sill that separates the Central and Southern Caspian Basins. Depths vary little longitudinally, but change rapidly transversely. The deepest waters – about 600m - are along the southern border of the Contract Area. The continental slope is very steep (up to 1:8) and the shallowest waters are found at the crest of the slope, where a few isolated regions are less than 100m. Further north the bathymetry plateaus at about 150m depth.

Winters: During winters the northern Caspian Sea is affected by airflow from Western Europe drawn in by the Siberian Anticyclone, while pressures over the southern part of the sea tend to be raised by local highs which form over the Armenian and Iranian highlands (see top image of Figure 6.12). A low pressure trough is formed between the two systems, lying across the Caspian from northwest to southeast. The trough forms in October and persists until March. The trough is closely associated with winter storm systems: either drawing in passing storms or developing storms locally. Winter air temperatures in the ACG Contract Area normally fall to about 5°C (about 8°C warmer than the northern Caspian), but may occasionally fall to below freezing.

A combination of the formation of very cold waters in the northern Caspian and regional cyclonic wind fields, leads to the development of a cold water current along the western shelf of the Central Caspian Basin. In most winters a component of the cold water current flows over the western Absheron sill (through the western part of the Contract Area) and along and down the continental slope. The currents can be strong. By February water temperatures will have fallen to about 11°C in the east, and as low as 7 °C in the west of the Contract Area. A water temperature front bisects the region – it is mobile but at the height of winter often lies in the vicinity of West Chirag.

Figure 6.12 Thirteen Year (1982-1994) Average Wind Fields for January and July[17]



The severity of Caspian winters is highly variable. This is most apparent in the extent of sea ice cover: in mild winters winter ice is limited to the Northern Basin, while in very severe winters it may form around the coast of the Central Basin and occasionally extends around

[17] Kalnay et al (1996) NCEP/NCAR Reanalysis Programme

the Absheron Peninsular. The variability may be associated, at least in part, with the major northern hemisphere weather index: the North Atlantic Oscillation Index[18].

Summers: The northern region of the Caspian is affected by a wedge of the Azores High, while the southern region is influenced by South Asian Low (see bottom image of Figure 6.12). A stratified water column develops in the Contract Area from late spring through summer. A thermocline occurs at water depths between 20 and 60m[13]. Across this thermocline the water temperature may drop sharply from above 20°C to 10-12°C. The depth of the thermocline increases during the summer and autumn months as surface water temperatures and wind-driven turbulence increase. During winter the thermocline breaks down, reforming again the following spring. During summer months the water of the Southern Basin becomes stratified and a strong thermocline forms between 30 and 60m. The average temperature of surface waters during August is about 27°C.

6.5.2.3 Currents

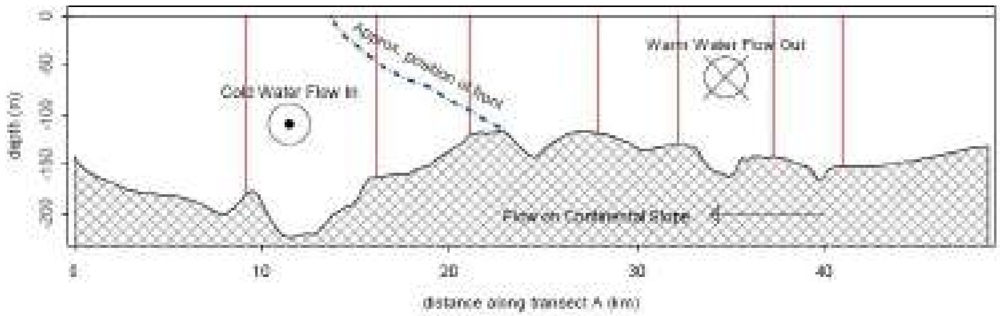
Currents in the region are complex and may be strong, especially during winter. Attempts to simulate the currents using computer models have been disappointing and present knowledge is based largely on local measurements. The main component of strong currents is a winter wind driven circulation modulated, and sometimes reversed, by the action of passing storms. Tidal currents in the Caspian are negligible.

Seasonal Flow: The largest current occurs during winter months. 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. Figure 6.13 is a sketch of the seasonal flow across the longitudinal axis of the ACG Contract Area. The front between the two water bodies is clear in sea surface temperature (SST) satellite images: surface waters temperatures may differ by more than 3ºC over one km.

The irregular depth of the Absheron sill complicates further the winter seasonal flow. The sill is deeper on the western side, near Deepwater Gunashli (maximum depth over 200m), than on the eastern side (depths 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.

[18] OceanMetriX (2002) Internal Report

Figure 6.13 Sketch of Winter Seasonal Flows Across the Absheron Sill Based Largely on Near Bottom Current Measurements Collected Between November 2007 and May 2008



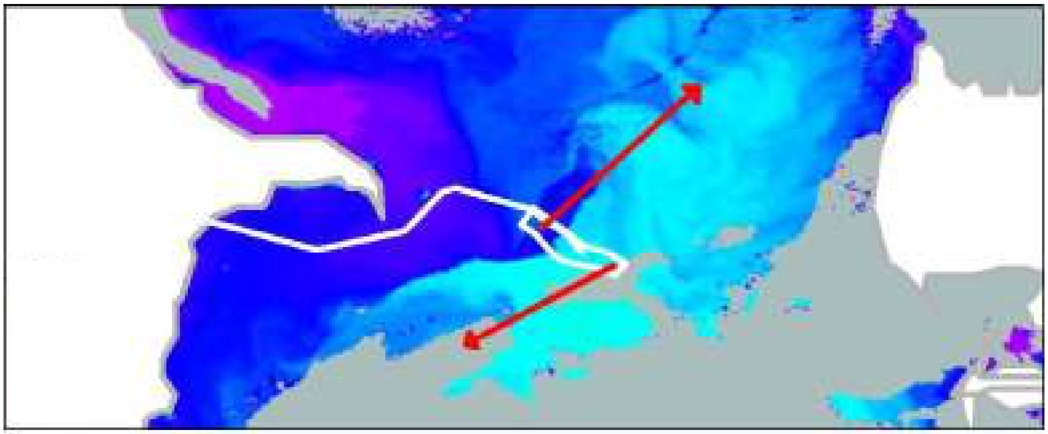
The variability of winter severity is reflected in the strength of the seasonal currents. For example, the measured mean flow in the Shah Deniz shelf edge region during the relatively benign winter of 2000 - 2001 was just 0.03 m/s, while during the relatively severe winter of 2005 - 2006 it was 0.13m/s. Long term measurements of water oxygen content at several transects across the Caspian also pick up the variability[19]. In mild winters oxygenated surface waters (composed at least in part by the cold North Caspian water), are only found in the Southern Caspian basin in depths less than 50m (eg 1968), while in very cold winters the waters penetrate to more than 600m depth in the Shah Deniz region (eg 1969).

Storm Driven Flows: The passage of storms with strong winds from the northwest may cause large current surges. As the storms build the southerly flow into the Southern Basin is enhanced. Later, however, as the storms decay, the currents in the western region of the ACG Contract Area reverse and flow strongly back into the Central Caspian. Figure 6.14 is a sea surface temperature satellite image from a period of backflow following a northwesterly storm in February 1996. The temperature front is clearly defined, as is a large eddy to the north of the ACG Contract Area. The red arrows shown on the plot are near bottom currents predicted from the CASMOS1 3D model at this time.

The reverse flow is centred at depth (probably around 100m) and maybe weak on the surface. These currents are the largest documented current phenomena in the ACG Contract Area, and 1-year values in the Deepwater Gunashli region are expected to exceed 0.7m/s 1m above the seabed, and more than 1m/s at mid depths. The mechanism linking the storms and the current surges is not understood. The CASMOS current models have been able to replicate the occurrence of some of the strong current flow events, but not their magnitude or vertical structure. It is thought that direct wind forcing (particularly winds from the northwest), atmospheric pressure changes and possibly eddying between the water bodies may play a roll in the development of the strong currents.

[19] Kosarev and Yablonskaya (1994)

Figure 6.14 Sea Surface Temperature 09:40 (GMT) 3rd February 1996 During a Strong Deep Water Current Event in the ACG Contract Area



Notes:
1. The arrows show CASMOS 1 near bottom current vectors at grid point 1456 (north of the front and grid point 1397 (south of front).
2. Grey areas denote regions of cloud cover.

Measurements of water currents made in the Contract Area from October to December 1996 indicated that currents were generally weak; less than 0.2m/s 90% of the time[20]. Maximum surface currents were 0.4m/s and mean surface currents 0.1 m/s. Maximum measured current velocity in the mid-water column was 0.65m/s, at a depth of 50m. Near the seabed, current speed and direction data collected along the ACG export pipeline corridor from October 1999 to May 2000, recorded a maximum current velocity of 1.26m/s.

6.5.2.4 Storm Surges and Waves

Storm surges are a common event in the Caspian causing temporary rises or falls in sea level. Significant sea level changes occur in the middle basin of the Caspian where the Contract Area is located. 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 northwest or from south and southeast[21]. Waves in the Caspian Sea, including in the Contract Area, are wind driven and subsequently the windiest months also exhibit the greatest wave action. The largest waves can be expected when the wind direction is northerly or southerly, as waves have longer time to build up at these wind directions.

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 higher 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 at between 6-24 hours[13].

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.

Severe weather in the Caspian is associated with strong winds blowing along the axis of the Sea: from the northwest/north or from the south/southeast. A variety of meteorological processes can generate strong winds over the Sea, the most important being extra-tropical cyclones and ridges of high pressure. Storm winds from the north are more frequent and

[20] Phase 1 ESIA, URS (2002)
[21] Kosarev and Yablonskaya (1994)

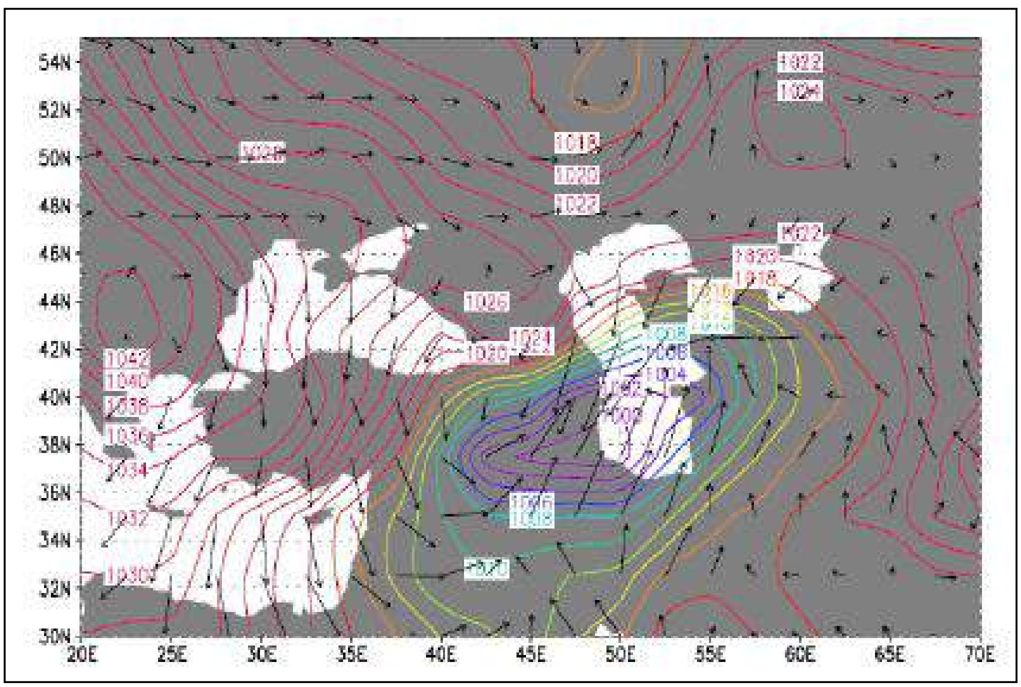
more severe than strong winds from the south. The following paragraphs describe the different types of weather systems associated with severe weather in the ACG Contract Area during the period October 1948 to January 2006.

Extra-Tropical Cyclones: The most severe weather (winds, waves and currents) are associated with extra-tropical cyclones. Data from the Chirag platform weather station (2003 to 2008) indicate an average of 6 large systems occur between October to May each year. They are most common in early winter (November), and late winter (February and March), suggesting that the Siberian High may block depressions at the height of the winter. When these storms do occur mid-winter, however, they tend to be very severe.

The Armenian highlands appear to block the passage of the cyclones directly from the west, and they normally approach the Caspian from either the southwest or northwest. Once over the Caspian they often intensify. The strongest winds often follow the passage of the storms, blowing from the north or northwest as the storms pass to the east of the Caspian.

Figure 6.15 shows wind and mean sea level pressure distributions during the most severe storm in the CASMOS 2 database. It was an extra-tropical cyclone which entered the Caspian from the southwest. Storm waves peaked in the vicinity of the Deepwater Gunashli platform site at about 8.7m significant wave height (denoted H_s[22]) from the north. Storms passing over the north of the Caspian may also develop severe weather, and the second most severe storm in the CASMOS 2 database was such an event. Waves peaked at 8.6m H_s in the Deepwater Gunashli region. During this event a spar buoy sited in 23m of water in the general vicinity of Shah Deniz is reported to have measured H_s of more than 7m.

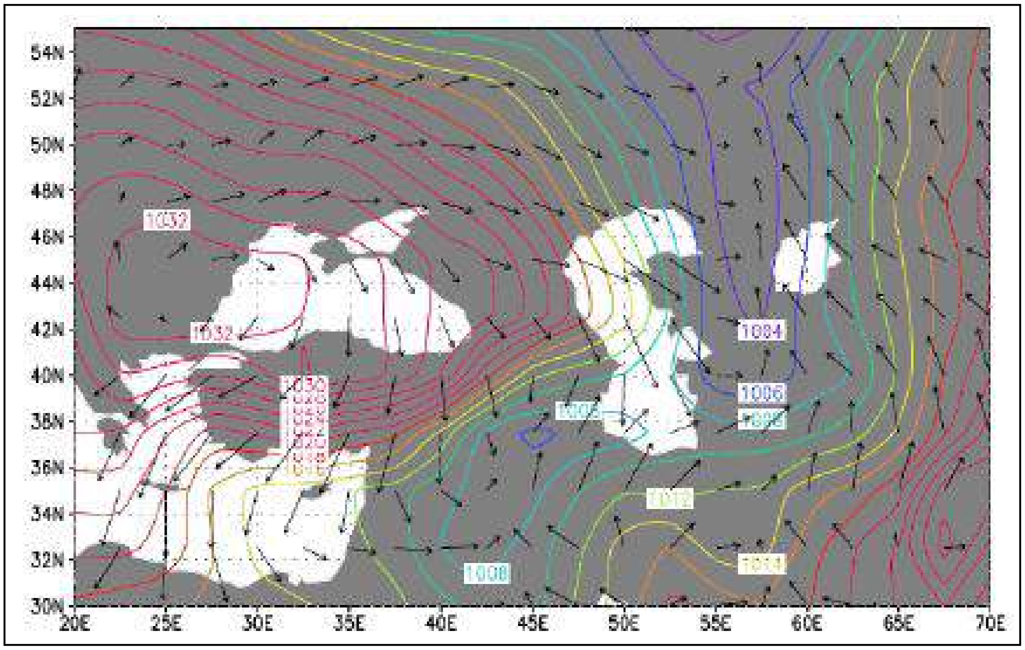
Figure 6.15 NCEP[23] Winds and Atmospheric Pressure During the Largest Storm in the CASMOS 2 Dataset



High Pressure Ridges from the Northwest or North: Ridges of high pressure commonly follow behind extratropical cyclones, but may also occur in isolation. During winter they bring cold northerly air masses and snow to the Caspian. Figure 6.16 shows an example of such an event. In terms of H_s it is the 8th most severe storm event in the Deepwater Gunashli region (7.5m from the north).

[22] Significant wave height (H_s) is approximately equal to the average of the highest one-third of waves
[23] National Center for the Environmental Prediction.

Figure 6.16 NCEP Wind and Pressure During a High Pressure Intrusion from the North West



High Pressure to the East: Possibly formed by an intensification of the Siberian Anticyclone and maybe associated with low pressure systems to the west of the Caspian. Such storms may bring strong southeasterly winds and seas to the ACG Contract Area. Their occurrence, however, is rare at something like once every 40 years. The largest in the CASMOS2 dataset generated waves of just 3.6m H_s in the Deepwater Gunashli region.

6.5.2.5 Physical and Chemical Composition of Seabed Sediments

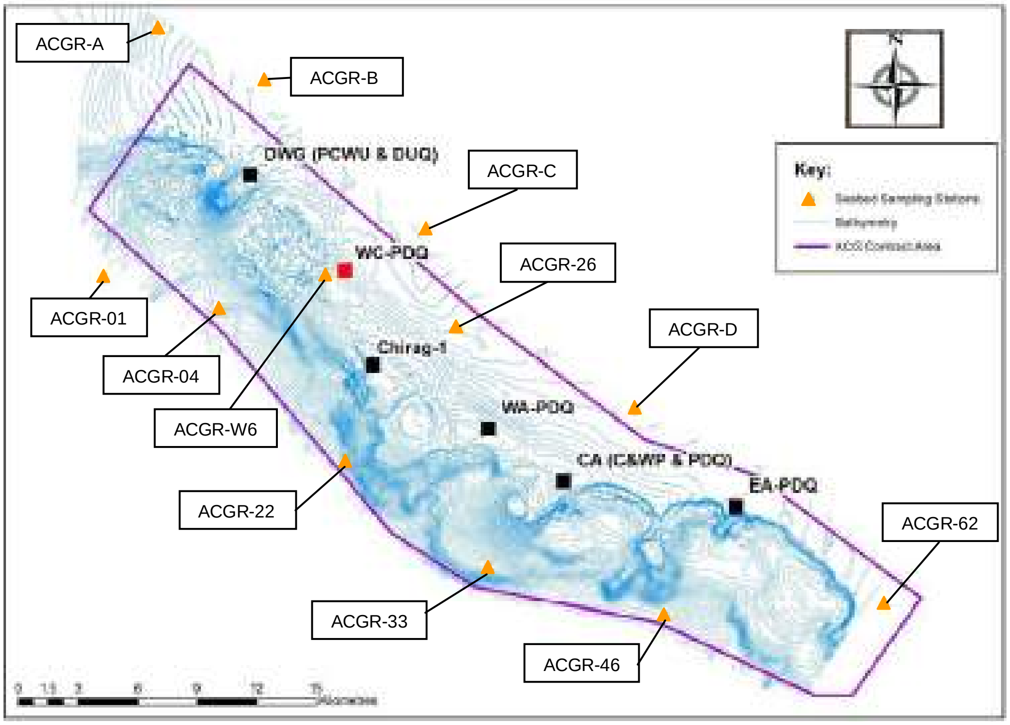
Sediment samples have been taken across the Contract Area during 38 surveys between 1995 and 2006. Since 1998, these samples have been collected and analysed using a consistent methodology, for:

- Macrobenthic invertebrates;
- Physical sediment structure and composition; and
- Heavy metals and hydrocarbons.

The most recent survey was undertaken in 2006 when sediment samples were taken from 12 regional stations as shown in Figure 6.17. Of these stations, 6 had previously been sampled during the 1995-96 EOP Baseline Surveys.

The results have demonstrated no evidence of systematic change in the physical characteristics of sediments at the 6 regional stations over the period since 1995. Whilst there is some variation at each station, in all cases the general characteristics (particle size range, organic content, etc) remain similar for each station over the period. The station classifications (i.e. silt, fine sand etc.) has remained unchanged. The most distinctive stations are ACGR-22 and ACGR-33, which are situated close to mud volcanoes. These stations have consistently homogeneous sediments with a high proportion of silt-clay and much higher organic content than other stations. Further details regarding physical sediment characteristics in the vicinity of the WC-PDQ platform location are provided in Section 6.5.3.2 below.

Figure 6.17 Location of ACG 2006 Regional Seabed Sampling Stations



Total hydrocarbon concentrations were low at all stations for the 2006 survey (with the exception of ACGR-22 and ACGR-33), with a range of 4-67 µg/g and a median of 12 µg/g. Average concentrations at stations ACGR-22 and ACGR-33 were 334 µg /g and 147 µg/g respectively, again reflecting the proximity of these stations to mud volcanoes. A very similar pattern was observed for PAHs. There was no evidence of any distinct temporal trend, and the 2006 hydrocarbon values were in most instances similar to, or lower than, the 2004 values. It is concluded that none of the regional stations show any evidence of anthropogenic hydrocarbon contamination.

There were no distinctive temporal trends in sediment concentrations for most heavy metals – concentrations of arsenic, copper, iron, and lead in 2006 were very similar to 2004, and showed no elevation above typical background levels (see Tables 6.12-6.14). Zinc concentrations were 10-20% lower in 2006 than in 2004, but this is not a sufficiently large difference to infer a real trend at present. Cadmium concentrations were consistently higher in 2006 than in 2004, but markedly so only at stations ACGR-W6 and ACGR-C. The highest values (0.42 and 0.43 µg/g) remain within the range of previously observed baseline values. In contrast, average barium concentrations were lower in 2006 than in 2004.

Station ACGR-B was distinctive, with very high arsenic concentrations and iron concentrations; more detailed study of the samples from this station identified the presence of a natural mineral, arsenopyrite.

Stations ACGR-W6 and ACGR-C were also distinctive in terms of sediment barium concentrations which were 6-10 times higher than the concentration at other stations (where concentrations were within the long-term background range). These two stations are located to the N and NNE of the Chirag-1 platform. Although they are not the closest stations in this direction (station ACGR-26 is closer, and lies closer to the direction of the presumed prevailing current), further investigation would be necessary to determine whether water based mud (WBM) and cuttings could be transported as far as these stations and may be the source of the elevated cadmium and barium concentrations.

Table 6.12 Summary of 2006 Survey Sediment Metals Concentrations Across 12 Monitoring Stations (µg/g)

	As	Ba HNO_3	Ba Fusion	Cd	Cr	Cu	Fe	Hg	Mn	Pb	Zn
Minimum	4	198	316	0.11	20	10	15700	0.014	303	8	22
Maximum	278	14200	16100	0.51	64	56	120000	0.090	1890	19	64
Median	9	824	999	0.20	45	27	30200	0.037	502	10	49
Mean	18	2138	2521	0.24	44	28	33233	0.040	600	11	48

Table 6.13 Summary of 2004 Survey Sediment Metals Concentrations Across 6 Monitoring Stations (µg/g)

	Concentration (g/g)								
	As	Ba	Cd	Cr	Cu	Fe	Hg	Pb	Zn
Minimum	4	190	0.06	24	9	11466	0.013	10	26
Maximum	23	19120	0.26	101	45	141295	0.147	22	79
Median	11	2539	0.14	78	25	29716	0.051	15	62
Mean	10	1560	0.14	86	23	27735	0.049	14	67

Table 6.14 Comparison of Sediment Chemistry Concentrations Across Monitoring Stations Surveyed (µg/g),1996-2006

Statistic	Year	As	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Pb	Zn	THC	UCM
Minimum	1996	2	213	0.05	23.2	14.9	12400	0.06	263	6.9	32.6	2.3	1
	2004	4	190	0.06	24	9	11466	0.013		10	26	3	0.4
	2006	4	198	0.11	20	10	15700	0.014	303	8	22	3.5	2.6
Maximum	1996	139	4970	0.88	82	55.7	133000	0.18	1060	173	116	660	520
	2004	23	19120	0.26	101	45	141295	0.147		22	79	1332	1191
	2006	278	14200	0.51	64	56	120000	0.09	1890	19	64	333.7	218.1
Median	1996	7.8	1055	0.115	52.6	29	31000	0.09	490	14.3	81.7	24	20.5
	2004	11	2539	0.14	78	25	29716	0.051		15	62	10.9	6.2
	2006	9	824	0.2	45	27	30200	0.037	502	10	49	18.35	15.8

6.5.2.6 Biological Characteristics of Seabed Sediments

A general description of the benthic environment of the Contract Area is provided within the ACG Phase 1, 2 and 3 ESIA. The results of the IEMP monitoring undertaken, as presented in the IEMP annual reports, confirmed that the benthos is typically dominated by a small number of amphipod and annelid species. Generally, the communities comprise 10-12 frequently occurring taxa, with a highly variable number of less frequently-occurring taxa. Based on the period of sampling and large number of samples taken, the IEMP programme has demonstrated that this variability is a natural characteristic of the area, due, in part, to the dynamic nature of the communities (i.e. a large number of species with rapid growth potential are known to be present) and in part to the scattered nature of the habitat, meaning a very variable distribution of small 'clumps' of organisms are present. The grab sampling undertaken to date has therefore resulted in either these organisms being present in reasonably large numbers in the sample taken or not being present at all.

The 2004-2005 IEMP annual report identified this sampling outcome and that, for the majority of species, occurrence in an individual survey is largely a matter of chance. As noted above, only 10-12 species regularly occur in all samples, and these species are common in all surveys. Consequently, there is invariably a high apparent rate of species 'turnover' between consecutive surveys, which limits the precision with which impact-related changes can be identified.

There were, however, some very large differences observed between the 2004 and 2006 regional surveys, the identification of which is not subject to these constraints. Between 2004 and 2006, there was a very large reduction in the number of taxa present at all stations. Table 6.15 shows that this was principally associated with much reduced diversity of amphipod and gastropod taxa (these two groups generally account for most of the diversity of South Caspian benthos). The identification of gastropod species is difficult and gastropods are generally present intermittently and in low abundance in most surveys, so it is usually difficult to attach much significance to the actual species present or absent. In the 2006 survey within all the samples taken, only three individuals of one species were recorded in a single sample. This indicates clearly that gastropods were virtually absent from the survey area in 2006 as compared to 2004.

Table 6.15 shows that the reduction in amphipod species number was even larger. This is potentially more significant since amphipods species were previously observed in greater diversity and accounted for a high proportion of the number of individual organisms present in any sample. From the sample results the reduction appears to be mainly associated with the genera *Niphargoides* and *Corophium*.

Table 6.15 Number of Taxa in Each Major Taxonomic Group, 1996-2006

Major Group	1996	2004	2006
Polychaetes	7	5	5
Oligochaetes	4	5	4
Cumacea	9	10	7
Amphipods	24	21	12
Gastropods	8	18	1
Total	52	59	29
Amphipods + Gastropods	32	39	13

The large reduction in species number was accompanied by reductions in total individual abundance and (to some extent) biomass. Changes in biomass between 2004 and 2006 for arthropods (crustacea and insect larvae) are difficult to interpret, since these data are biased by the presence in some samples of a few very large individual isopods. However, for annelids and molluscs, there was a consistent reduction in biomass at most stations. The changes in species number and individual abundance per station (giving a measure of biomass) are summarised in Table 6.16.

Table 6.16 Comparison of Species Number and Abundance, 1995-2006

Station	Year	Number	
		Taxa	Individuals
ACGR-01	2006	16	914
	2004	27	1646
ACGR-A	2006	16	544
	2004	22	1896
ACGR-04	2006	11	208
	2004	22	1558
ACGR-B	2006	19	524
	2004	21	3956
ACGR-W6	2006	25	996
	2004	24	4160
	2003	15	903
ACGR-22	2006	7	38
	2004	3	64
	1996	7	112
ACGR-C	2006	11	886
	2004	12	1618
ACGR-26	2006	8	750
	2004	12	1538
	1996	19	2356
	1995	13	1664
ACGR-33	2006	4	12
	2004	13	1594
	1996	6	50
	1995	5	30
ACGR-D	2006	10	1554
	2004	11	2328
ACGR-46	2006	5	34
	2004	19	428
	1996	13	628
	1995	13	558
ACGR-62	2006	18	546
	2004	27	4510
	1996	28	4008
	1995	23	2786

Surveys undertaken since 2004 have identified the presence of the alien polychaete *Nereis* which has been observed at all platform survey locations with the exception of DWG. In the 2004 regional survey, *Nereis* was present (one or two individuals) at two stations (ACGR-1 and ACGR-22). In 2006, one individual only was present in a sample collected at station ACGR-W6. *Nereis* therefore does not seem to have established a permanent presence at any of the regional monitoring stations.

As discussed in Section 6.5.2.5, the 2006 ACG regional survey indicated that there were no identifiable temporal trends in sediment structure or chemistry, and that the status of the sediment remained within established background conditions. There was, at most stations, no evidence of anthropogenic contamination and the concentrations of measured contaminants were well within the thresholds previously observed to support healthy biological communities.

Sediments at stations ACGR-W6 and ACGR-C exhibited higher concentrations of barium and cadmium than other stations. There was however, no evidence that these higher concentrations had any biological significance or impact.

The apparent loss of a large number of amphipod and gastropod species, resulting in communities at all stations being substantially impoverished compared to earlier surveys is not considered to be due to changes in any measured sediment properties. It is hypothetically possible that they could have been caused by contaminants such as pesticides transported into the Contract Area and arising from third party activities or historical pollution. It is equally possible however, that:

- These changes are simply part of a natural process of oscillation; or
- These changes reflect the impact of prior changes in the structure and productivity of the planktonic community (discussed below) and could possibly represent a point on a long-term trend of impoverishment.

The survey results demonstrate that the biological changes that have occurred throughout the Contract Area are not due to operational activities or the presence of any contaminants which might be associated with operational activities. Preliminary results of monitoring undertaken at the West Azeri platform in 2007 indicate that the diversity of amphipods and gastropods has returned to previous levels, suggesting that 2006 may have been an abnormal year.

6.5.2.7 Benthic Invertebrate Sensitivity

The seabed environment offshore is dominated by oligochaetes, polychaetes (predominantly ampharetid polychaetes) and amphipods. These organisms share several important characteristics:

- They are small - no more than 1-2 cm long;
- They have short generation times - between 4 and 12 weeks, which means that they can produce several generations per year; and
- They are either deposit or suspension feeders, which means that they are largely dependent on fine settled or suspended sedimentary material for food and that they are also exposed to any chemical contaminants associated with sediment particles.

Deposit and suspension feeders are well-adapted to maintaining their position in environments with high sediment deposition rates. Relatively short generation times mean that populations of these animals also have the potential to replace losses within months rather than years. Persistent impact is only likely in instances where there is sustained or persistent chemical contamination. Amphipods, for instance, are sensitive to hydrocarbons in sediment and populations may be reduced for as long as significant contamination is present.

In addition to the amphipods, oligochaetes and polychaetes, several other biological groups are important in the Contract Area. Bivalves become increasingly important closer to shore, although there are areas offshore where *Dreissena* and *Didacna* are present. Bivalves are either deposit feeders (*Abra*) or filter feeders (*Dreissena, Didacna, Cardium, Mytilaster*).

Bivalves reproduce and grow relatively slowly. Consequently, any damage to bivalve populations can take longer to repair. With the exception of *Abra*, bivalves are relatively vulnerable to water contamination because they filter large volumes of water.

Caspian gastropods are a diverse group, all of which are very small and are surface deposit feeders. Under optimal conditions, gastropods are generally capable of achieving high population densities quite rapidly, although there is no evidence of this in the Contract Area. Gastropods will be primarily vulnerable to surface sediment contamination and may also be relatively vulnerable to physical smothering. The evidence from the post-drilling survey at GCA5 (see Section 6.5.4 below) suggests that the discharge of WBM cuttings from a single well does not have any adverse effect on gastropods, even close to the well centre. It is therefore considered unlikely that smothering would, in practice, present a significant risk. The available evidence suggests that these small molluscs are capable of burrowing upwards through significant deposits of cuttings (specifically, WBM cuttings, which do not contain toxic chemical additives).

The insect larvae, *Chironomus* is similar in size and behaviour to the small annelids, but may be capable of suspension feeding as well as deposit feeding. Larvae can develop to adulthood in approximately 4 weeks, so this species has the capacity to recover rapidly from temporary disturbances.

Larger crustacea, such as cumacea and isopods, occur throughout the Contract Area, although only cumacea achieve significant abundance. Both types of crustacean are surface-dwellers and scavengers. Isopods are often encountered in higher abundance in the most 'impacted' areas close to well centres after drilling. As Section 6.5.4 presents however, low diversity was observed at both the baseline (predrilling) survey location as well as at the post-drill GCA5 location.

It is often suggested that the most vulnerable period for benthos is spring and summer, since this is usually the period of maximum reproduction and growth. This argument relies on an analogy with organisms such as birds and seals, where a major impact during pupping or nesting can severely damage a population. The majority of native benthic organisms have however, several generations per year and it is arguable that in fact they are most vulnerable to impact during winter, when reproduction and growth are at a minimum and the populations are therefore least resilient.

It has been suggested that the presence of *Pseudosolenia* results in poor feeding of the benthos. *Pseudosolenia* has been observed to dominate at all times of the year, and is common in BP routine surveys which are normally carried out during the summer months.

Pseudosolenia often takes up much of the available nutrients (Section 6.5.2.8), and also has very large cells which many native copepod species cannot efficiently feed on. However, it is improbable that *Pseudosolenia* leads to poor feeding of the benthos – the opposite is more likely, since any *Pseudosolenia* biomass not consumed by the zooplankton will settle onto the seabed when the cells die. With lower zooplankton abundances, and with zooplankton unable to feed effectively on *Pseudosolenia*, the consequence would be that a higher proportion of primary production would reach the benthic communities.

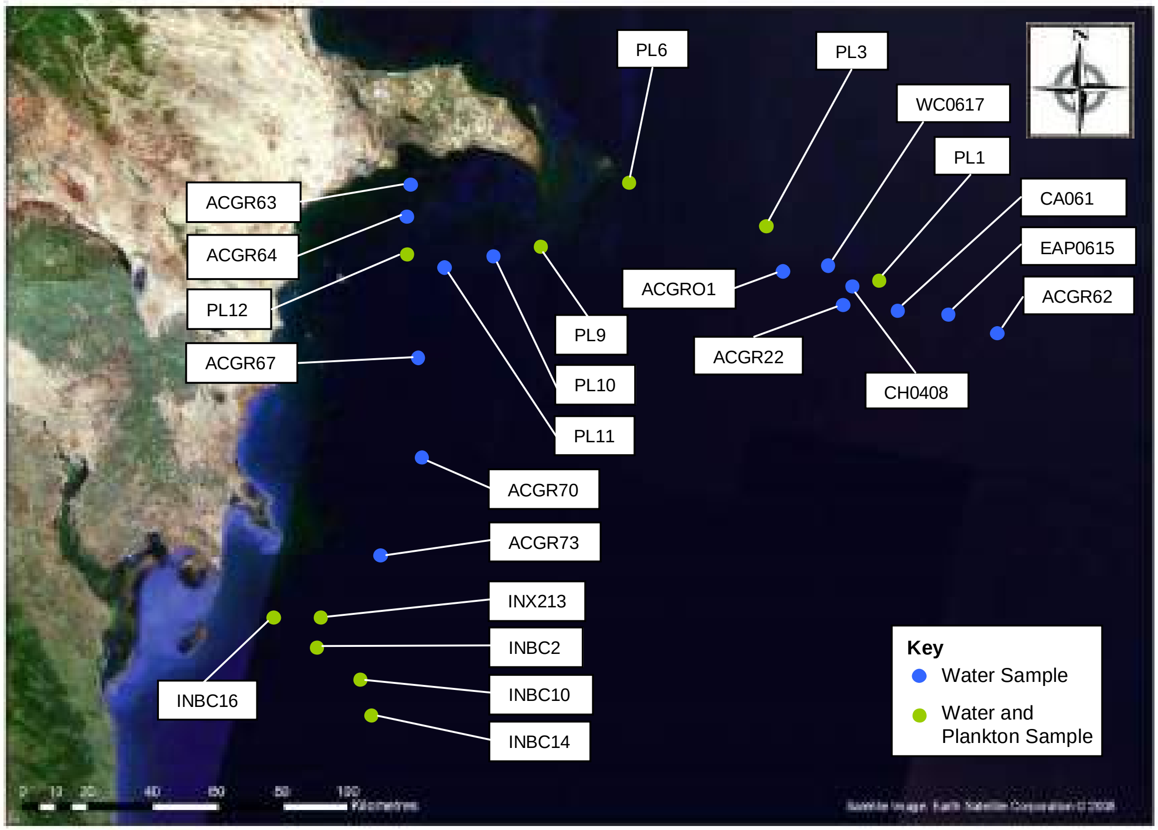
6.5.2.8 Water Column

Prior to the inception of the IEMP, water samples were taken in small numbers and at irregular intervals (usually at 2-3 stations during benthic surveys). Sample numbers and sampling frequency were too low to provide a reliable picture of water quality and the analytical methodologies did not yield reliable or interpretable results. The IEMP water sampling programme was designed to remedy these shortcomings and thus to provide interpretable information.

Between 5-11th July 2006, plankton and water samples were collected from the ACG and Inam[24] Contract Areas, at locations between these Contract Areas and along the existing ACG export pipeline corridor.

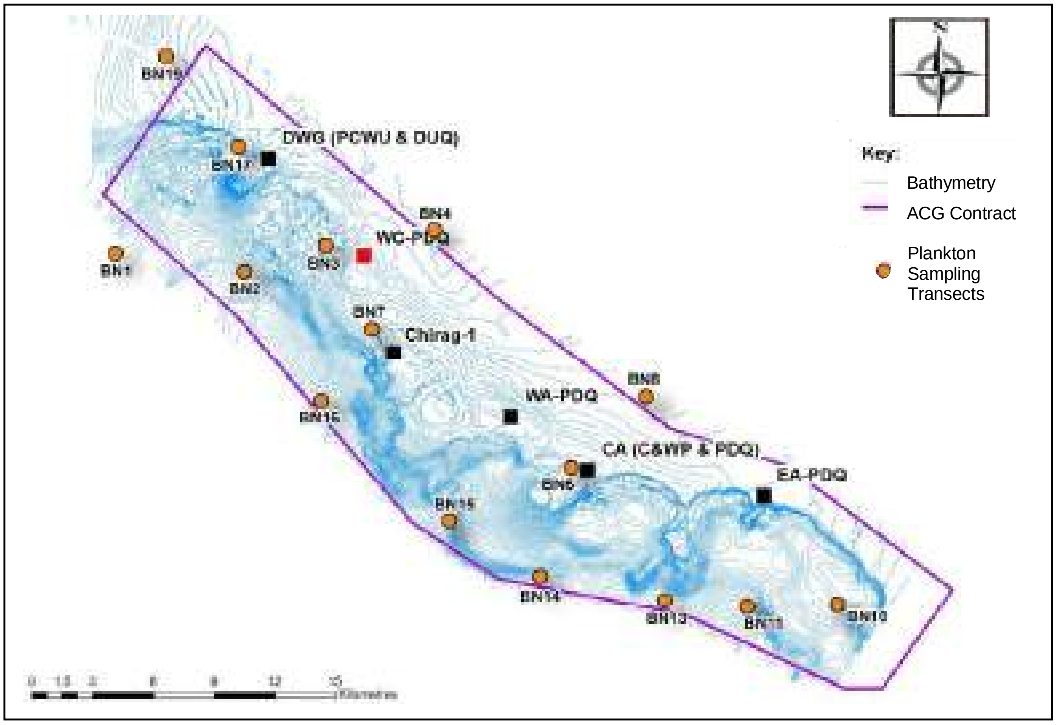
A total of 24 water samples (Figure 6.18) and 25 plankton samples (Figure 6.18 and Figure 6.19) were collected. Conductivity-Temperature-Depth (CTD) measurements were made at 10 deep-water stations (from surface to 100m) covering the Inam and ACG Contract Areas, the existing ACG export pipeline corridor and the potential Inam pipeline route. Salinity, temperature, dissolved oxygen, turbidity and pH measurements were also made on board the survey vessel as each water sample was retrieved to deck. Water and plankton samples were also collected for onshore analysis.

Figure 6.18 Water and Plankton Sampling Locations



[24] The Inam Contract Area, located approximately 175km to the south west of the ACG Contract Area, was included in order to provide updated baseline information as a basis for exploration drilling impact assessment and possible future developments

Figure 6.19 Location of ACG Contract Area Plankton Sampling Transects



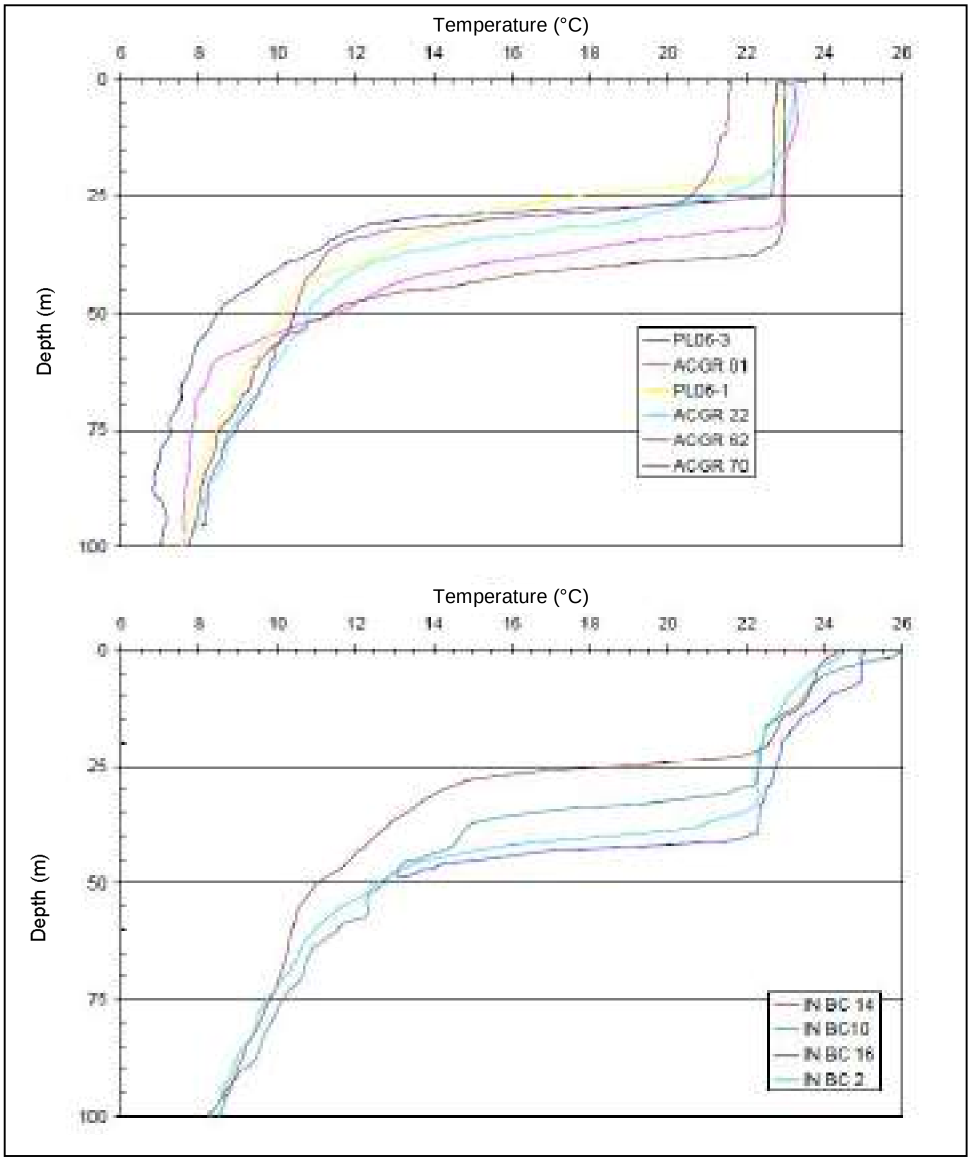
In situ Physical Water Measurements

Surface temperatures were similar in all samples, ranging between 23 and 25°C. Water temperature decreased with depth, with a distinct thermocline at depths of 25-35m (Figure 6.20).

Salinity varied little with depth or location. Turbidity levels in all samples were low; the highest values were observed in samples collected at the shallow-water ACG export pipeline stations PL 3, 6, 9, 10, 11, 12.

Dissolved oxygen concentrations were at or close to saturation in all surface samples, and declined to around 20% in samples from depths of >350m. Oxygen levels at a depth of 100m were in the range of 60-70%.

Figure 6.20 CTD Profiles from ACG, Pipeline and Inam Water Sampling Stations[25]



[25] CTD temperature values at depths of more than 50m were typically 3-4 ^{o}C lower than onboard sample values, reflecting the fact that samples recovered onto deck warmed rapidly while the measurements were being taken.

Chemical Measurements

Total suspended solids levels, biological oxygen demand (BOD) and chemical oxygen demand (COD) were low in all samples and did not vary systematically with location or depth. Nutrient concentrations (nitrate, total nitrogen, silicate and phosphate) increased substantially with depth at most locations. This reflects the sedimentation of phytoplankton through the water column, trapping the nutrients in water below the thermocline. This is a typical summer scenario, which progressively leads to nutrient depletion in surface waters as phytoplankton take up nutrients, die and settle to the seabed. During summer, in the presence of a strong thermocline, the only process which can act to retain nutrients in the surface layers is consumption by zooplankton, which then excrete ammonia and faecal material which can help to sustain phytoplankton populations. The high nutrient levels (particularly silicates), suggest that zooplankton populations were low and were only able to recycle a small proportion of the primary production. The full survey results are presented within the IEMP 2006 annual report.

Total hydrocarbon (THC) concentrations were lower than those recorded in regional water quality surveys in 2004 within the ACG Contract Area and in 2005 within the ACG and SD Contract Areas, with little variation between stations and depths. Concentrations were all close to the previously observed background concentration of 40-80µg/l and ranged from 18µg/l at INBC10 (surface) to 60µg/l at INBC2 (surface), with an overall average of 31.5 µg/l. Surface samples at stations CH08, ACGR CA10, PL9, PL10 and INBC2 were all slightly above the maximum permissible concentration (MPC) for fisheries water of 50µg/l.

Heavy metal concentrations were generally well below the relevant MPC or Environmental Quality Standard (EQS) levels and, with the exception of iron, showed little variation with location or depth. Iron concentrations were higher in the ACG export pipeline samples, to a large extent due to the shallower water where the influence of seabed sediment is greater.

Plankton

Phytoplankton

Table 6.17 summarises the number of phytoplankton species per major taxonomic group for the three areas in which plankton surveys were carried out in 2006. Species richness was higher in the ACG Contract Area than in the other locations surveyed, largely due to higher numbers of bacillarhiophytes. Bacillarhiophytes were the most diverse group in both the ACG Contract Area and the ACG export pipeline corridor. The same small group of taxa were however, numerically dominant in all locations. The invasive *Pseudosolenia* diatom was frequently the most abundant taxon and since this has an exceptionally large cell size it accounted for more than 80% of the phytoplankton biomass in all samples. This single taxon therefore accounts for a high proportion of the ‘standing crop’ of available food for zooplankton. Although it may have lower cell division rates (and therefore lower intrinsic population growth rates) than smaller species, *Pseudosolenia* may ‘lock up’ available nutrients and therefore limit the production of other species. *Pseudosolenia* cells may also be too large for many zooplankton species to feed on.

Table 6.17 Number of Phytoplankton Taxa per Major Taxonomic Group

Group	ACG Contract Area	ACG Export Pipeline Corridor	Inam Contract Area	Dominant Taxa
Cyanophyta	7	4	5	
Bacillarhiophyta	18	14	8	*Coscinodiscus* *Chaetoceros* *Pseudosolenia*
Dinophyta	11	9	12	*Prorocentrum*
Total	**36**	**27**	**25**	

Comparison between the ACG 2004 and 2006 surveys indicates that phytoplankton diversity is being maintained within the area with *Pseudosolenia* species remaining dominant to approximately the same extent across all surveys. Comparisons with earlier surveys (1999 and 2000) for the ACG export pipeline corridor and Inam Contract Area are not considered reliable, due to differences in methodology and uncertainty about the taxonomic precision of the earlier surveys. There is no indication at present however, of any adverse trends with respect to the phytoplankton.

Zooplankton

Analysis of the samples taken during the 2006 survey for zooplankton revealed that the holoplankton (permanent members of the plankton species, excluding temporary larval forms of fish and benthos) is severely impoverished. In the ACG Contract Area, along the ACG export pipeline corridor and in the Inam Contract Area, the zooplankton was completely dominated by two invasive species, *Acartia tonsa* (copepod) and *Mnemiopsis leydii* (predatory ctenophore). The latter has become established in the south Caspian since the late 1990s, and has been present in virtually all samples in IEMP surveys since 2004.

Native or acclimated copepod taxa, such as *Halicyclops, Eurytemora, Linmocalanus* and *Calanipeda* were regularly recorded in limited surveys until 2002. Since then, these taxa have been absent from samples collected in the more extensive IEMP surveys. This situation persisted in 2006, with the only exception being a single occurrence of *Eurytemora minor* in the Inam Contract Area.

Native cladocera have also undergone a substantial reduction in diversity and abundance. Species of only three genera (*Evadne, Pleopis, Polyphemus*) have been recorded in recent surveys, and these three genera were again the only cladoceran representatives in the 2006 surveys.

Although *Acartia* dominated the zooplankton in all locations numerically and in biomass, the abundance of this species was low – typically only a few individuals per litre. This suggests that overall productivity is low. However, it is also apparent that the dominance of *Acartia* means that at present it is the main available food source for planktivorous fish such as kilka, sprat and shad.

It is probable that the low zooplankton diversity and abundance can be attributed to the development of large and persistent populations of the planktivorous ctenophore *Mnemiopsis*. *Acartia,* which may be able to partially escape predation pressure because it has a different reproductive strategy from native zooplankton species.

As discussed above, water quality was generally good throughout the areas surveyed. Phytoplankton diversity appears, over the past few years, to be good and relatively consistent. Zooplankton diversity and abundance have been low across the period of the surveys undertaken, however many native species were not present in samples collected in the period 2004-2006.

Phytoplankton biomass was dominated by an invasive species, *Pseudosolenia calcar-avis*, and zooplankton biomass was also dominated by an invasive species, *Acartia tonsa*. Low zooplankton diversity is probably attributable to a third invasive species, *Mnemiopsis leydii*. These three species constitute the main route of production and energy flow in the pelagic system, and therefore also have a large influence on energy flow to fish populations and to the benthic organisms. All three species are likely to have been introduced over the past few decades in the ballast water of commercial shipping entering the Caspian.

Plankton Sensitivity

Both phytoplankton and zooplankton are considered sensitive to chemical contamination and it is for this reason that planktonic species are widely used in toxicity testing. If chemical contamination is present in the water column for any reason, the plankton are likely to respond more rapidly than other water column species. Plankton diversity and abundance is important, since these organisms represent a significant source of food and energy for higher organisms and in particular for ecologically and commercially important fish species such as kilka.

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

Sustained impact on plankton populations is likely to occur only under conditions where there is a sustained, wide-field discharge of chemicals at continuously toxic concentrations. Short-term, near-field discharges are unlikely to have a measurable impact.

The impact of the ctenophore *Mnemiopsis* is the subject of a number of studies sponsored by the Caspian Environment Programme and the littoral Caspian states but no conclusions are yet available about the nature and extent of the impact of this organism on the Caspian ecosystem. The observed decline in zooplankton diversity may, as noted above, be a result of predation by *Mnemiopsis*. If the decline proves to be a sustained phenomenon, then assessment of the impact of oil industry operations may be limited to estimating the effects on a single species.

The apparent decline in zooplankton abundance, if sustained, would be expected to eventually have measurable adverse consequences on both fisheries and on benthic communities, since zooplankton are a key link in the food chain linking these communities to the primary sources of energy.

Fish

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

- **Migratory Species**: This includes sturgeon and shad species whose spawning grounds are the rivers Kura, Terek, Samur and other rivers of the southwestern 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, sandsmelt and pipefish, are present within the nearshore and, less frequent, in offshore waters of the South Caspian throughout the year and 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 likey 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 mostly in the Contract Area during the winter. Mullet were introduced from the Black Sea in the 1930's. 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 September26. Mullet can be expected in the Contract Area.

Table 6.18 below shows the months when particular fish species are likely to be present in the Contract Area.

[26] Kosarev and Yablonskaya (1994)

Table 6.18 Seasonal Fish Presence in the Contract Area

Species	Activity	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Resident Fish	Feeding	■	■	■	■	■	■	■	■	■	■	■	■
	Breeding				■	■	■	■					
Carp	Feeding				■	■	■	■	■	■	■	■	
Sturgeon	Migrating			■	■					■	■	■	
Shad	Migrating								■	■	■	■	
Kilka	Feeding				■	■	■	■	■	■	■	■	■
	Breeding	■	■	■	■	■	■	■	■	■	■	■	
Mullet	Feeding	■	■	■	■	■	■	■	■	■	■	■	■
	Breeding						■	■	■	■			

A review undertaken in 2008 of the fish recorded in the Contract Area is summarised in Table 6.19.

Table 6.19 Fish Species recorded in the Contract Area, 2008

Name of Species	Importance
Acipenseridae family – sturgeons	All valuable commercial fish
Beluga – *Huso huso* (Linne)*	IUCN Endangered
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
Clupeidae family – Herrings	
Clupeonella genus (Kessler) – Kilka	All an important food source for other fish and seals.
Anchovy kilka – *Clupeonella engrauliformis* (Borodin) *	IUCN Low Vulnerability,
Big-eyed kilka – *Clupeonella grimmi* (Kessler) *	IUCN Low Vulnerability.
Caspian common kilka – *Clupeonella delicatula caspia* (Stetovidov)*	IUCN Low Vulnerability
Caspian salmon (*Salmo trutta caspius*)***	IUCN Endangered
Caspian lamprey (*Caspiomyzon wagneri*)***	IUCN Near Threatened
Alosa Cuvier genus – Shad	All an important food source for other fish and seals.
Caspian shad – *Alosa caspia caspia (Eichwald)* *	IUCN Least Concern
Big-eyed shad – *Alosa brashnikovi autumnalis (Berg)* *	IUCN Least Concern
Volga shad – *Alosa kessleri volgensis* (Berg)*	IUCN Least Concern
Black-backed shad – *Alosa kessleri kessleri* (Grimm) *	IUCN Least Concern
Cyprinidae family – Carps	
Kutum – *Rutilus frisii kutum* (Kamensky)*	IUCN Least Concern
Mugilidae family – Gray Mullets	All an important food source for other fish and seals
Golden mullet – *Lisa auratus* (Risso) *	IUCN Least Concern
Leaping mullet – *Lisa saliens* (Risso) *	IUCN Least Concern
Gobiidae family – Gobiids**	All an important food source for other fish and seals
Caspian goby – *Neogobius caspius* (Eichwald)	IUCN Least Concern
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
Caspian big-headed goby – *Neogobius kessleri gorlap* (Iljin)	IUCN Least Concern
Knipovich long-tailed goby – *Knipowitschia longicaudata* (Kessler)	IUCN Least Concern
Grimm big-headed goby – *Benthophilus grimmi* (Kessler)	IUCN Least Concern
Other species	
Sandsmelt (*Atherina mochon pontica*)***	Not Evaluated
Pipefish (*Syngnathus nigrolineatus*)***	IUCN Least Concern

* Have swim bladder
** Sometimes lacking swim bladder depending on species.
*** Species were observed in previous survey (Phase 3 ESIA Section 6.4.4.5).

In addition to the above species resident species such as pipefish and sandsmelt are thought to be present in the vicinity of the Contract Area (as outlined in the catch data from a sampling program carried out in the Gunashli field, 1999-2001).

During Sangachal fish population studies carried out as part of the ACG Phase 1 ESIA, large numbers of vobla (*Rutilus rutilus kurensis*) were recorded. This is a sub-species in the carp family unlisted by the ICUN and believed to feed in the area.

Other species of conservation concern that may be present in the Contract Area, but that have not been recorded in previous surveys, include the Caspian Lamprey (ICUN near threatened) and the Caspian salmon (ICUN Endangered). These may be present in the Contract Area as juveniles and outside their spawning periods. The spawning ground for such species are the rivers in southern Caspian.

Stock Declines

There has been substantial stock decline in both sturgeon fish (since the 1970s) and kilka. The loss in sturgeon fish is predominately due to over fishing that has and is currently being subsidised by fish hatcheries, although this is unlikely to greatly increase the natural population. Kilka has undergone decline as a result of over fishing, affecting reproduction scales and due to the invader comb-jelly *Mnemiopsis leidyi* which consumes kilka roe within its plankton diet.

Fisheries

Fishing activity within the Contract Area is not considered commercially viable due to its remoteness from the fish landing ports. The closest fisheries to the Contract Area are the kilka fisheries, concentrated on offshore banks along the western coast of the southern Caspian.

Sensitivity

The common threats to fish populations are over fishing, high levels of pollution and habitat loss. Impacts relating to the oil industry include direct (accidental spills, such as oil or chemicals) and indirect (consumption of contaminated prey) impacts. Fish species that spawn in the Contract Area are most vulnerable to oil and chemical spills. The most sensitive stages of the life cycle process are egg, larvae and fry. Species which could potentially spawn within the Contract Area are herring (Clupidae), kilka (*Culpeonella grimmi* and *C. angrauliformis*) and gray mullet (*Liza auratus and L. saliens*)

Fish species can also be affected by contaminated plankton. In order for plankton to be contaminated however, there would need to be a sustained, wide field discharge of chemicals at continuously toxic concentrations. Fish reproduce seasonally and therefore it is important that there is adequate food supply for maturing adults larvae and juveniles. A shortage in food supply could potentially deprive sensitive life stages of fish, which impacts on fish populations

Fish species are sensitive to increased turbidity and to noise impacts, which may discourage them from going into the Contract Area. Those species with swim bladders (noted in Table 6.19) are most susceptible. 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 8 hours.

Fish can detect sound at lower sound levels and may adopt an avoidance response. The four impact levels commonly used are:

- A level of 100 dBht (species) corresponds to nearly 100% avoidance by most individuals;
- A level of 90 dBht (species) and above which will cause a significant avoidance reaction by most individuals;
- A level of 75 dBht (species) and above which will cause a milder avoidance response occurs in a majority of individuals; and
- A level of 50 dBht (species) will give rise to a low likelihood of disturbance.

A level of 0 dBht (species) represents a sound that is at the hearing threshold for that species and is therefore at a level at which sound has the potential to be heard by that species. At this, and lower perceived sound levels no response occurs as the receptor cannot hear the sound.

Caspian Seal

In 2008 the Caspian Seal (*Phoca caspica*) was listed as 'Endangered' on the IUCN red list due to "*a decline exceeding 50% over the last three generations, reduction in the number of sites used, current hunting levels that almost certainly exceed sustainable harvest levels and the multiple ongoing negative impacts on the habitat of the Caspian Seal*"[27].

The Caspian Seal 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 to 111 thousand[28,29].

The majority of the Caspian Seals (85-90%) migrate from the north of the Caspian Sea, where they breed in the winter, to the south along the shelf zones where they spend the summer months feeding. Whelping takes place in the north of the Caspian Sea towards the end of January- beginning of February. The newborn pup is weaned for a month after birth, shortly after which the mating of the seals take place between mid-February and mid-March. Once the ice has begun to melt the seals migrate south, this migration has two routes, the majority along the east coast and the minority along the west. In the autumn (October) back migration commences. It should be noted that both breeding and migration timings can be shifted for up to a month subject to weather conditions.

Seals are known to reach the Azerbaijani sector of the Caspian Sea at the end of April / beginning of May, with a peak accumulation in the area observed at the end of May / beginning of June. Another peak in population occurs during the back migration north in early November.

No seals are known to currently breed in the Azerbaijani sector of the Caspian Sea. The majority of seals are only present while feeding during migratory cross overs. Dependent upon the severity of the winter period, the seals initially confine their feeding range to the coastal waters while replenishing their fat reserves, which have been depleted by up to 50% during the winter. They are particularly vulnerable during this time as there ability to swim would have decreased and they cannot stay long in the open water. Seals from the Turkmenistan rookeries and Turkmenistan territorial waters also swim to the Contract Area for feeding. Once their reserves have been replenished and buoyancy restored, the seals will start moving into the deeper water areas of the middle and southern Caspian (during May to June), where the kilka populations are concentrated, returning periodically to their haul-out sites.

[27] IUCN 2008 Red List.
[28] Krylov 1990
[29] Report of the Caspian International Seal Survey (CISS) team based on the results of the Caspian seals' census in 2006

A small proportion of the seal population is non-migratory and can be found on foraging expeditions all year round leaving their haul-outs and moving into the open water. Few of these seals will however, travel far offshore.

Sensitivity

The main causes of population decline of the Caspian Seal (*Phoca caspica*) in the past are associated with hunting, fishing activities, outbreaks of canine distemper and accumulation of heavy metal ion and organic pesticides.

Seals are also directly and indirectly sensitive to spills (such as oils or chemicals) and ongoing discharge causing contamination over time. They are most vulnerable during the breeding season and feeding periods (May to November). Seals are dependant on eyesight to hunt and are therefore, sensitive to any increases in turbidity.

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 8 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 is commonly used to determine avoidance.

Birds

A number of species of sea birds found in the ACG Contract Area have been identified in previous bird surveys (see Table 6.20). These four species have been highlighted as being the most numerically abundant in published data for the Absheron Peninsula[30] and the Shakhdilli-Pirallahi area[31]. None of these species are species of national and / or international concern. All four of the species are known to breed in the region and may be present throughout the year. Populations may vary with some migration occurring however. the Contract Area is not located within a recorded bird migration flyover route. Birds found in the area will be transient and not resident.[32].

Table 6.20 Seabird Species Found in the ACG Contract Area

Common Name	Scientific Name
Great cormorant	*Phalacrocorax carbo*
Herring gull	*Larus argentatus*
Common tern	*Sterna hirundo*
Sandwich tern	*Sterna sandvicensis*

Sensitivity

Bird species will be most vulnerable to potential oil spills. Birds that have been exposed to oil spills, even small amounts, usually die of hypothermia from loss of insulation, toxic poisoning from ingestion or the inability to feed as a result of the spills. To date no oil spills have occurred due to ACG activities.

[30] Gambarov et al. (1958); Gambarov (1968); Mustafaev et al. (1968).
[31] Sultanov and Kerimov (1998, 1999).
[32] Phase 3 ESIA, Section 6.4.5 (2004)

Sea birds spend short periods of time under water during hunting and feeding activities. During this activity, the birds may be susceptible to impacts from underwater sound. Being exposed to high levels of underwater sound over an extended period can result in tissue damage and/or hearing loss (temporary or permanent).

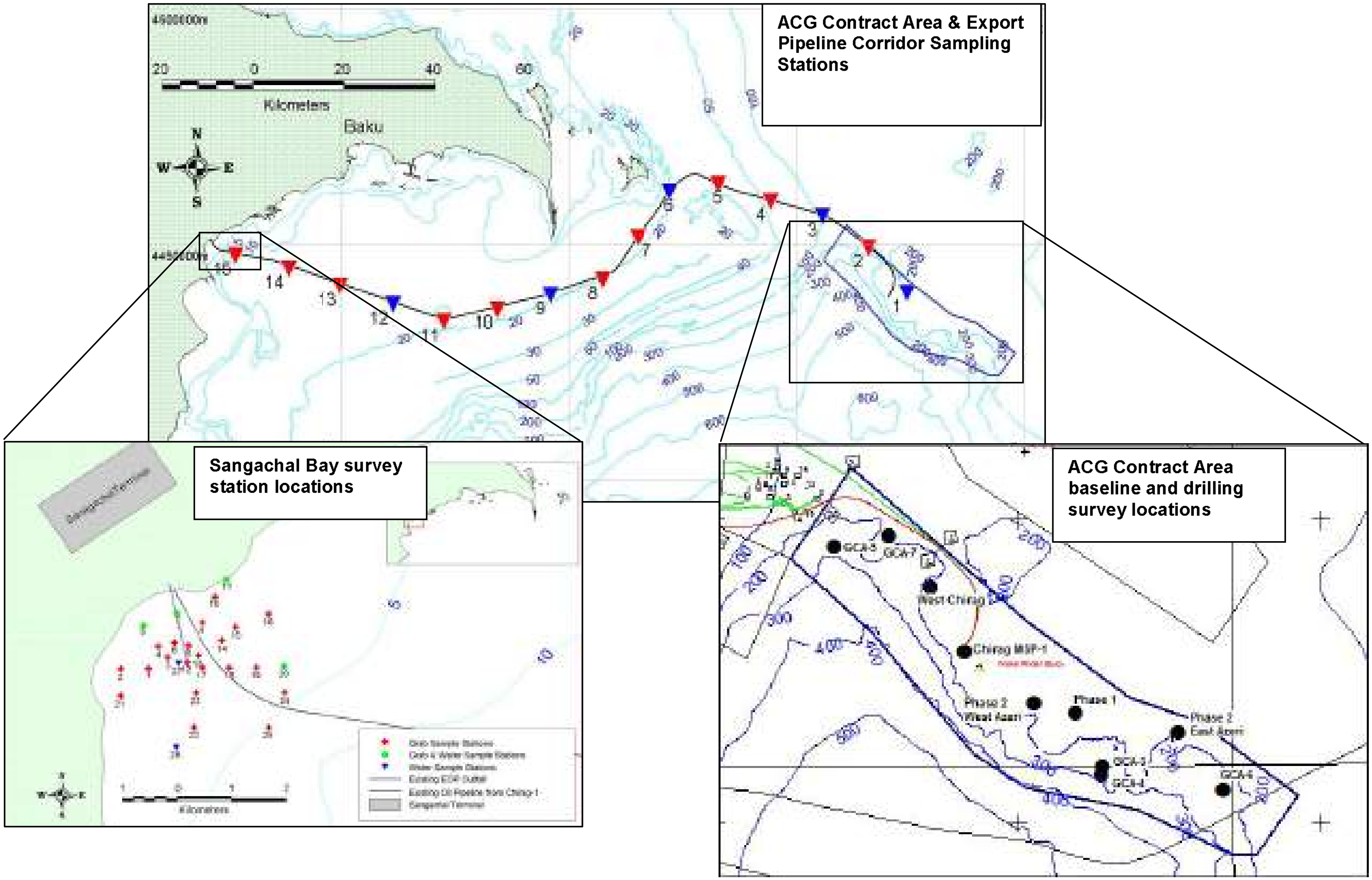
6.5.3 WC-PDQ Platform Location Characteristics

6.5.3.1 Sources of Information

The environmental characteristics of the WC-PDQ platform location have been determined principally on the results of a survey carried out in 2003 in an area which includes the proposed WC-PDQ platform position. To provide additional local context, reference is also be made to data from the Deep Water Guneshli (DWG) platform baseline survey carried out in 2001 (designated GCA7 at the time), and a survey carried out in 2000 following exploration well drilling at the nearby GCA5 location. The survey locations and location of the proposed WC-PDQ platform are indicated in Figure 6.21.

The sections below are limited to describing the physical, chemical and biological characteristics of the benthic environment in the vicinity of the proposed WC-PDQ platform location. Specific water column surveys were not conducted in the platform location vicinity but such surveys are of limited relevance; due to the natural variability in water and plankton characteristics, the results of a water column survey at a specific location cannot be considered representative of the location.

Figure 6.21 Platform, Pipeline Corridor and Sangachal Bay Survey Locations



6.5.3.2 Sediment Characteristics

Caspian sediments generally comprise components from distant sources, such as silt, clay and gravel of geological and fluvial origins, together with shell fragments and shell sand. Sediments can be characterised and distinguished using three basic parameters - mean particle diameter, silt / clay content (to indicate the geological component) and carbonate content (to indicate the biological component). Figure 6.22 depicts silt and clay content for sediments in the Contract Area (including the WC-PDQ location), along the ACG export pipeline corridor and in Sangachal Bay based on surveys conducted between 2000 and 2003. Figure 6.23 depicts the mean particle size diameter for the same locations.

The median survey value for sediment particle diameter ranged from less than 10 µm (Sangachal, GCA3, 4, 5 and 6) to almost 700 µm (Phase 1 location). Particle diameter at the ACG export pipeline stations was intermediate. Figure 6.23 shows the wide range of values at each location and the general trend of increasing sediment coarseness from nearshore to offshore.

Across the main part of the Contract Area (which includes the WC-PDQ platform location), median survey sediment particle diameter is in the range of 350 to 700 µm, and increases gradually from northwest (GCA 7) to southeast (Phase 1). Figure 6.23 also shows a difference in the distribution of values between locations with fine sediments (associated with a low median value) and locations with coarse sediments (associated with a high median value).

The pattern of distribution of carbonate content (Figure 6.24) is very similar to that for particle diameter and indicates that shell material contributes significantly to sediment coarseness. Silt-clay content is inversely related to both carbonate content and to particle diameter. Silt-clay content is typically high at Sangachal, along the ACG export pipeline corridor and at the post-drilling locations. Figure 6.22 shows that silt-clay content declines as particle diameter increases along the pipeline corridor from nearshore to offshore and also that it continues to decline gradually from northwest to southeast across the Contract Area, rising again at the most south easterly location (East Azeri).

Figure 6.22 Sediment Silt-Clay Content (%) - Median and Range

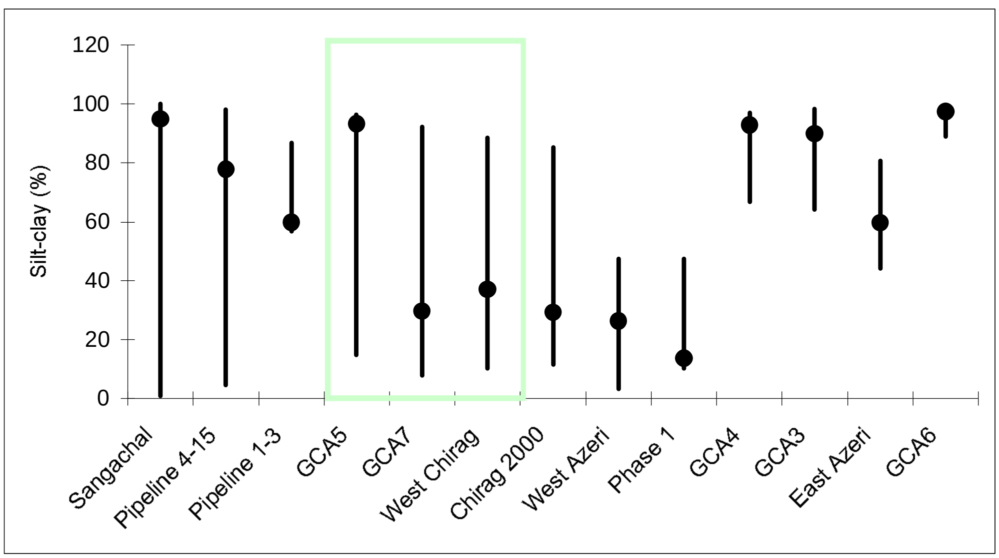


Figure 6.23 Sediment Particle Diameter - Median and Range µm

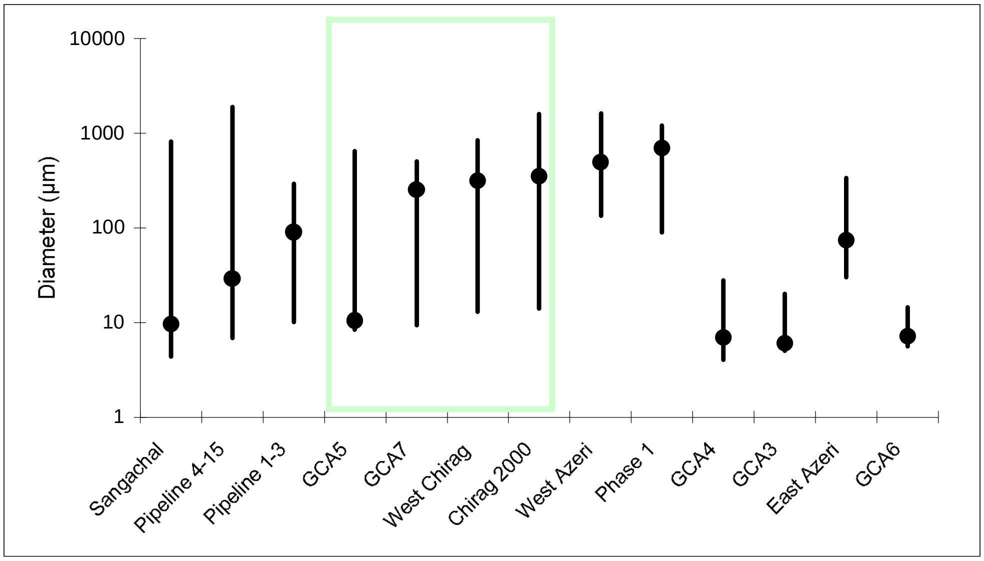
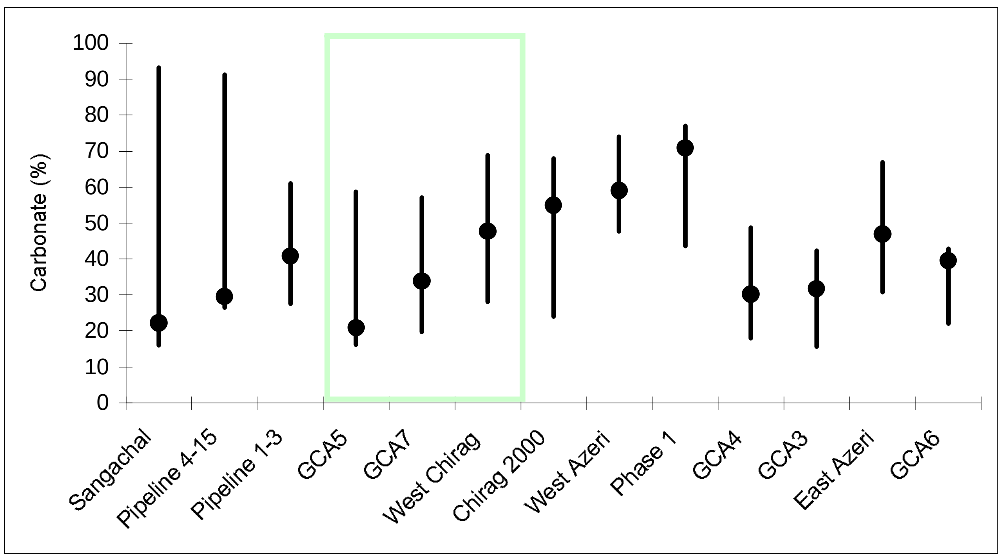


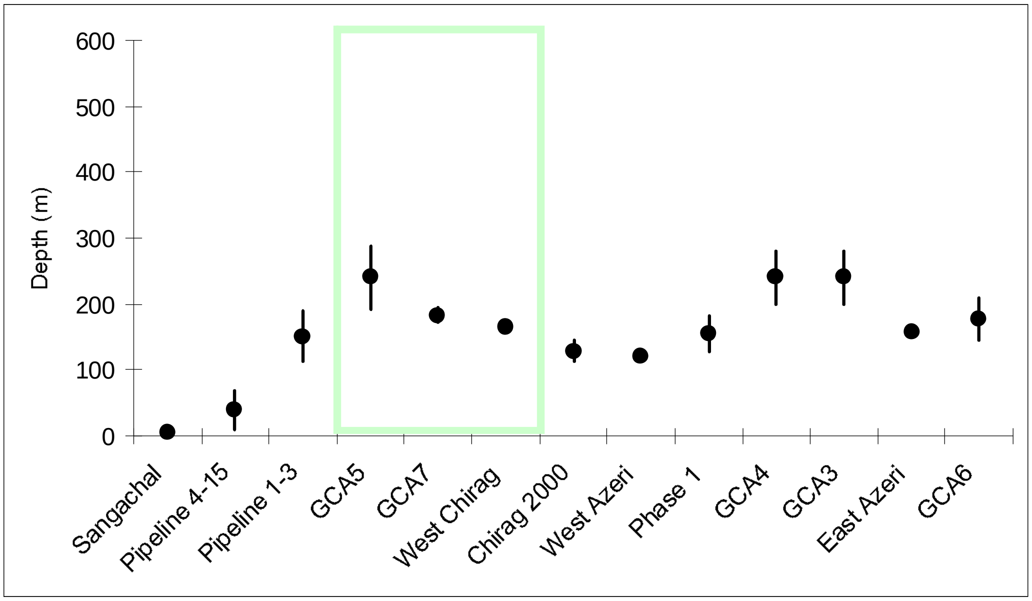
Figure 6.24 Carbonate (%) - Median and Range



The above figures show that the GCA7 and West Chirag 2003 locations are quite similar in terms of particle diameter, silt-clay content and carbonate content. For all three parameters, values for the West Chirag 2003 location are slightly higher. Since sediments within the Contract Area are however generally heterogeneous over small distances, the differences are not considered to be significant.

It is also worth noting that sediments at the GCA5 location, which is less than 5km from the GCA7 location, are much finer and consist almost entirely of fine silts and clays. The much finer sediments at this location are believed to be primarily related to the greater depth. Figure 6.25 summarises the depth range at survey locations across the Contract Area.

Figure 6.25 Median Depth, and Range, at Survey Locations Across ACG Contract Area



6.5.3.3 Sediment Chemistry

Hydrocarbons

Levels of hydrocarbon detected in sediments at the West Chirag, GCA5 and GCA7 locations are summarised in Table 6.21. This table indicates that total hydrocarbon concentrations at all three locations were within a similar, low, range. There was greater variation in % UCM. UCM represents the proportion of the total hydrocarbon present as an unresolved mixture and higher proportions generally indicate more weathered material. Conversely, lower proportions are often indicative of the presence of fresh (or relatively recently deposited) hydrocarbons. NPD represents the low molecular weight proportion of aromatic hydrocarbons (PAHs); the higher this proportion, the stronger the indication of the presence of fresh oil. Crude oil typically has a % NPD of around 80%, so the range of 46-60% in Table 6.21 suggests that there were no recent inputs of crude at any of the locations at the time of the surveys.

Table 6.21 Sediment Hydrocarbons (Median values for each location are given)

Location	Year	Type of survey	THC (µg/g)	%UCM	%NPD
GCA7	2001	Baseline	28	79	46
West Chirag	2003	Baseline	25	73	60
GCA5	2000	Post-drilling	20	41	54

Heavy Metals

Table 6.22 summarises the survey medians of sediment concentrations of six heavy metals (copper, iron and zinc, which are naturally present in all sediments and lead, mercury and barium, which are common industrial pollutants). Although these are not the only metals for which analytical data are available, they provide a comprehensive picture of the natural inorganic chemistry of the sediments and also indicate the extent to which drilling activities may have a localised effect on concentrations.

Table 6.22 Median Trace Metal Concentrations in Sediments (µg/g) at each Survey Location

Location	Type of survey	Ba	Fe	Hg	Pb	Zn	Cu
Mean continental crust concentrations		630	43200	0.04	15	65-106	25
GCA7	Baseline	3591	46007	0.02	51	75	19
West Chirag 2003	Baseline	4609	20608	0.103	15	54	24
GCA5	Post-drilling	998	27170	0.03	17	73	21

Table 6.22 shows that sediments in the West Chirag 2003 and GCA5 locations have similar concentrations of iron. These concentrations are typical of most of the Contract Area. Iron concentrations at the GCA7 location are more than twice as high and are more typical of nearshore sediments (and also of average surface rock concentrations). West Chirag and GCA5 sediments also had much lower lead concentrations (again, typical of most of the Contract Area) than sediments at the GCA7 location. These patterns for iron and lead suggest that the GCA7 sediments are of different origin, or are subject to different influences, than the sediments at the other two locations. This may reflect the fact that the GCA7 location sits on a distinct ridge close to the northern edge of the Contract Area.

Radioactivity in Sediments

Radioactivity in sediments were measured in the Chirag-1 post Saraline survey (2000), the GCA5 and GCA6 Post well survey and the Chirag-1 - Sangachal sub sea pipeline survey (2000).

Ranges observed for selected isotopes were:

- ^{241}Am (60 keV (kiloelectron volt): 1 – 4 Bq/kg (Becquerel per kilogram);
- ^{137}Cs (662 keV): 0.6 – 25 Bq/kg; and
- ^{210}Pb (Uranium series 46 kev): 23 – 111 Bq/kg.[33]

The results were all within the range that would be expected for surface marine sediments. In most cases, ^{210}Pb activities exceeded those of ^{226}Ra, again consistent with expectation. Any contamination with radium containing tailings or scale would be apparent as a significant excess of ^{226}Ra activity over that of ^{210}Pb or excess of ^{228}Ra over ^{212}Pb and this was not observed in any sample.

Considerable variability was apparent in the specific activities of ^{234}Th and ^{210}Pb, but this is consistent with the well established behaviour of these radionuclides in the marine environment and the observed specific activities were not abnormal. The data revealed no evidence of contamination with radium isotopes at any of these survey locations following drilling activities.

In a survey of sediment quality carried out under the Caspian Environmental Programme[34] all sediment samples in the Azerbaijan sector of the Caspian Sea contained <5 µg/g uranium, consistent with background levels.

6.5.3.4 Benthic Fauna

Data obtained from surveys of the 2001 GCA7 and the West Chirag 2003 location have been compiled and examined to establish the range of species likely to be present at the WC-PDQ location. Data from the GCA5 post-drilling survey location have also been included. Also, although no biological impact of drilling was detected at GCA5, the community composition as measured shortly after the cessation of drilling provides a realistic indication of the minimum diversity which might be expected at the WC-PDQ location.

[33] Source: AIOC ACG Monitoring Database.
[34] Mora and Sheikholeslami (2002)

Species diversity at all three survey locations was similar to other Contract Area locations, with the following species most common:

- *Hypania invalida;*
- *Isochaetides michaelseni;*
- *Psammoryctides deserticola;*
- *Caspiohydrobia curta;*
- *Gammarus pauxillus;*
- *Gammarus warpachowskyi;*
- *Saduria entomon caspia; and*
- *Chironomus albidus.*

The majority of other species are recorded at only a small number of stations and this is typical of the Contract Area as a whole.

56 taxa were recorded at GCA7 and 63 at the West Chirag 2003 location, while a total of 52 taxa were recorded at the GCA5 location. The slightly lower diversity at GCA5 may be attributable, in part, to the deeper water and finer sediment present at this location.

A comparison of the taxonomic composition (in terms of the major taxonomic groups) at the three survey locations is presented in Table 6.22. This shows that the diversity of polychaetes and oligochaetes was very similar between all three locations (although there was considerable variation in the actual species present). The most distinctive features of the table are:

- Similar amphipod diversity at GCA7 and West Chirag, but lower diversity at GCA5;
- Low gastropod diversity at GCA7, but high gastropod diversity at West Chirag and GCA5;
- Comparatively high cumacean diversity at GCA7, with much lower diversity at West Chirag and GCA5;
- Very low bivalve diversity at GCA7, with much higher diversity at both West Chirag and GCA5; and
- Higher bivalve diversity at West Chirag and GCA5.

These observations suggest that molluscs (bivalves and gastropods) are more diverse at GCA5 and West Chirag than at GCA7. Conversely, there are substantially fewer amphipod species at GCA5 than at the other two locations, which may reflect the greater depth and finer sediments at GCA5. Overall, however, there is no simple relationship between community composition and either depth or sediment structure. It is possible that any such relationships are not consistent between taxonomic groups.

The data summarised in Table 6.23 nevertheless provide a clear indication that the biological communities in the general area are characteristically diverse and that at all three locations this diversity is dominated by native invertebrate species. It is therefore reasonable to conclude that the community composition at the WC-PDQ platform location will be similar, given both the proximity of the locations to each other and the fact that the WC-PDQ platform location lies within the depth range covered by the three existing surveys.

A more detailed examination of the species lists for each of the three locations indicates that there are no unusually rare or threatened species present. Since these three locations 'bracket' the WC-PDQ platform location horizontally and by depth, it is concluded that it is highly unlikely that any rare, threatened or unusually sensitive species will be present at the WC-PDQ location.

Table 6.23 Number of Species Representing Each Major Taxonomic Group

	GCA7	West Chirag	GCA5
Amphipods	22	21	15
Gastropods	7	17	16
Polychaetes	6	5	5
Oligochaetes	7	6	5
Cumacea	8	4	3
Bivalves	1	5	4

6.5.3.5 Sensitivity in WC-PDQ Platform Location

The information presented in the previous section indicates that there is no clear or strong relationship between environmental characteristics and biological characteristics in the area occupied by the three survey locations. Within these survey data, there are also no indications of any relationships between biology and the concentrations of hydrocarbons and heavy metals.

Sediment chemistry suggests however, that the GCA7 location is significantly different from the GCA5 and West Chirag 2003 locations. The fact that there are corresponding differences in the diversity of gastropods, bivalves and cumacea might indicate that this has some biological significance, although no studies have been carried out to investigate this possibility further. The proposed platform location supports a benthic community which comprises typical and common offshore invertebrate species and which has no unusual or unique sensitivities compared to other parts of the Contract Area.

6.5.4 Observed Effect of West Azeri Platform Installation and Operations

This section discusses the observed impacts to the marine environment from the installation and operational activities of a platform.

As each new ACG platform is installed and becomes operational, it has been included in the routine, long-term AzSPU IEMP. The most recent information available is for the West Azeri (WA) platform, where the following benthic surveys have been carried out (see Figure 6.26 for survey locations):

- 2002: baseline survey for Phase 2 ESIA;
- 2005: post-installation survey (following template pre-drill activities and platform installation); and
- 2007: routine survey after two years of platform operation.

It has been estimated that approximately 1,350 tonnes of cuttings and 1,650m^3 of WBM were discharged in the interval between the 2005 and 2007 surveys.

Sediments at the West Azeri location are fairly coarse, with a median particle diameter of 533µm and corresponding low silt-clay content (see Table 6.24). Between 2005 and 2007, particle diameter were found to decrease overall but increase within an elliptical area extending about 200m east and west of the platform and about 500m north and south. Comparison of the three survey data sets indicates that there is a modest long-term decline in sediment particle size across the area as a whole. This does not appear to have any observable biological significance and the consistency of the trend across the area suggests that it is a natural process.

Figure 6.26 Layout of the West Azeri 2008 Survey Stations

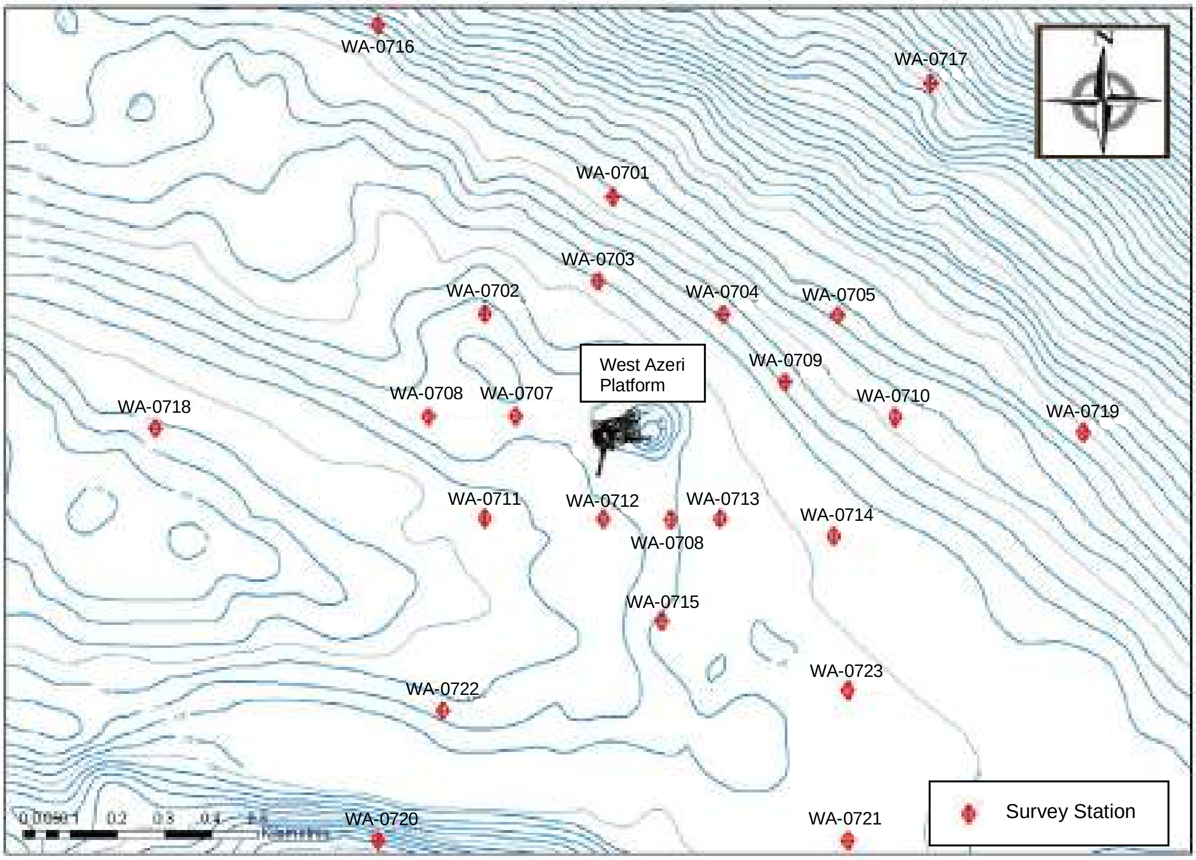


Table 6.24 Comparison of Sediment Properties, West Azeri, 2002-2007

	Mean Diameter (µm)			% Carbonate		
	2002	**2005**	**2007**	**2002**	**2005**	**2007**
Min	135	9	67	48	28	44
Max	1636	1307	1015	74	66	73
Med	495	448	349	59	61	62
Mean	565	534	478	62	53	61

A small quantity (less than 5 barrels) of linear alpha olefin (LAO) drilling mud was spilled during pre-drill activities in 2004 and this has remained detectable within the sediment samples between 2005 and 2007. Concentrations are low but a clear footprint is evident, extending from the south west to the north east in an elliptical area about 1,400m long and about 700m wide.

Weathered hydrocarbon concentrations are generally low, with the exception of Station 12 (300m south west of platform) and Station 3. Station 3 is anomalous: in both 2005 and 2007, concentrations of total hydrocarbons, PAH and heavy metals were substantially higher than at any other station, suggesting that there has been highly localised contamination by a complex waste material. With the exception of higher THC concentrations at station 12 (which did not indicate serious contamination), there was no overall trend in concentrations between 2002 and 2007, indicating that pre-drill, installation and production operations have not released measurable quantities of petroleum hydrocarbons to the surrounding environment.

There was also no overall trend in the concentrations of chromium, copper, iron, manganese and zinc over the 2002-2007 period. Mercury and arsenic concentrations increased from 2002-2005 but did not change significantly between 2005 and 2007. Lead concentrations decreased between 2005 and 2007 at most stations. Barium concentrations (obtained from fusion analysis) showed an increase from 2002 to 2005 and an overall decrease between 2005 and 2007. Within this overall trend there was however, an increase in concentration between 2005 and 2007 at stations closest to the WA platform. Concentrations of cadmium, barium and mercury were higher at stations close to the platform, while concentrations of chromium and iron were lower at stations closer to the platform. These changes may be partly associated with the deposition of cuttings generated and discharged whilst drilling with water-based muds.

A total of 85 benthic invertebrate taxa were identified, with between 1 and 50 taxa per station and an average of 36 taxa per station. The average number of taxa per station in 2002 was 19 and in 2005 was 30. Since installation of the platform, species richness per station has exhibited a progressive increase. Overall abundance was also higher in 2007 than in previous years.

The spatial distribution of abundance and species richness indicated that these were slightly lower at stations immediately around the platform; in this area of lower abundance and richness, polychaetes tended to be dominant, while at distances of more than 400m from the platform amphipods were dominant. Even within this area (which corresponds approximately to the barium footprint) species richness and abundance were however, generally high and comparable to both the baseline condition at this location and with the broader regional characteristics.

Since 2002, two distinct changes have been observed:

- The insect larva Chironomus has declined in abundance, and is no longer dominant (this species was relatively rare in 1995/96 and gradually became well-established across the Contract Area between 1996 and 2000); and
- The alien polychaete Nereis has become established and is present at an increasing number of stations (10 in 2005, 13 in 2007); abundance, however, remains low and the presence of this organism (whilst associated with the area of lowest abundance and richness) does not appear to have a serious impact at present.

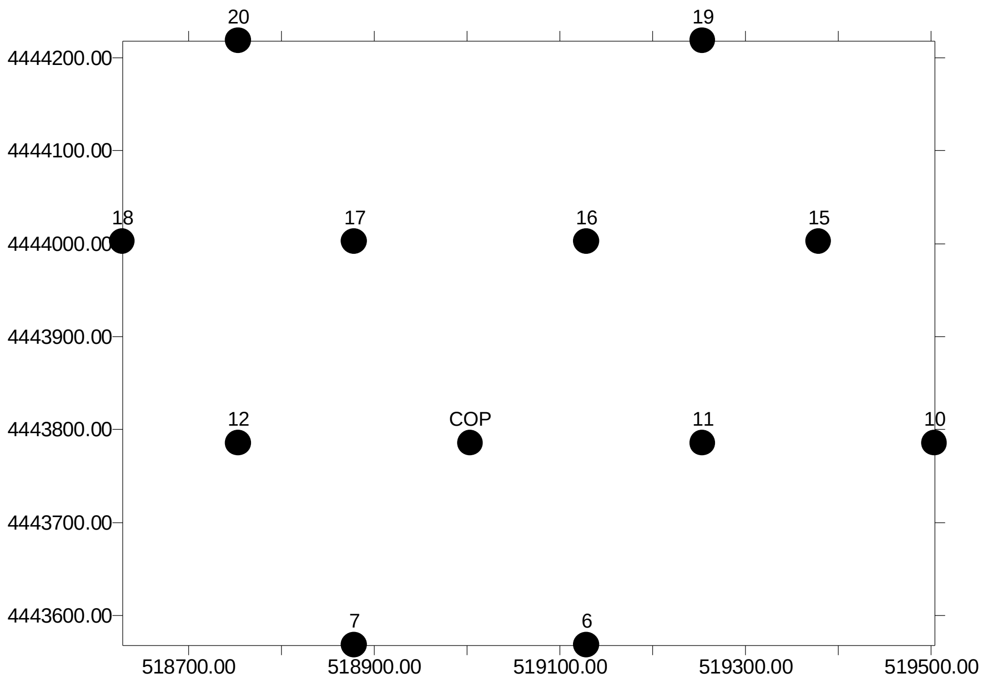
These changes have been observed both in the West Chirag platform vicinity and across the ACG Contract Area as discussed within Section 6.5.3.4 above.

Overall, the sediments in the West Azeri platform vicinity show no sign of ecologically significant contamination and the benthic community is diverse and abundant, suggesting that operational impacts have been minimal.

6.6 Benthic and Sediment Surveys Undertaken in 2009

A limited benthic and sediment survey was carried out in July 2009 to extend the 2003 West Chirag survey area to the NE. The survey comprised 12 stations, five of which were also sampled in 2003 (Stations COP, 6, 7, 12 and 18 in Figure 6.27). The aim of the survey was to assess and compare the status of the area in 2003 and 2009, and to determine whether there was any need to revise the conclusions based on the 2003 survey.

Figure 6.27 2009 COP Benthic Survey Stations



6.6.1 Biological Data

Table 6.25 presents a comparison of the number of taxa present in the 2003 and 2009 surveys for the major taxonomic groups. These major groups consist almost entirely of native or endemic species, and provide a reliable indication of diversity. The number of taxa present in 2009 was higher (79) than in 2003 (58), and the difference was largely due to the presence of a larger number of amphipod taxa in 2009 (40 versus 21). This magnitude of difference is consistent with the large natural fluctuations observed in ACG regional surveys conducted every two years between 2004 and 2008. Equally large natural fluctuations have been observed in the numbers of taxa observed for the gastropods, which are, together with amphipods, a major component of offshore Caspian biodiversity.

Comparisons of taxonomic richness over time at other ACG locations, and in the regional surveys, have shown that variation is largely associated with species which are present at a small number of stations and in low abundance; there is a high degree of consistency between surveys in terms of the persistent dominance of macrobenthic communities by a small number of ubiquitous amphipod, oligochaete, and polychaete species. This consistency is also present between the 2003 and 2009 COP location surveys.

Table 6.25 Comparison of Overall Taxonomic Richness for Major Taxonomic Groups Between 2003 and 2009 in the Vicinity of the COP Location

	2003	2009
Amphipods	21	40
Gastropods	17	22
Polychaetes	5	5
Oligochaetes	6	3
Cumacea	4	6
Bivalves	5	3
Total	**58**	**79**

Table 6.26 presents a more detailed comparison by station of the number of species and individual abundance for the 2009 surveys. The stations have been grouped to enable a comparison between the stations common to both surveys (2003-2009 stations) and the additional stations (2009 stations) sampled in 2009. The overall average values for both surveys are also indicated in the table.

Table 6.26 demonstrates that there is considerable variation within each survey, especially in terms of abundance. This is consistent with the practical aspects of sampling; the patchiness of distribution of most species means that abundance values are generally reliable only within a factor of plus or minus two at best (this is why data are usually log-transformed before any statistical analysis is carried out). Taking this constraint into account, the following conclusions can be drawn:

- Despite the overall difference in amphipod species richness between the two surveys, species richness is very similar between the 2003 survey, the overlap stations, and the 'new' 2009 survey stations. Only for gastropods is there an indication of consistently lower species richness at all 2009 stations, with all other major groups being very similar between years and between station groupings;
- Polychaete, cumacea, bivalve and gastropod abundance are higher in 2009 than in 2003, but are similar between both groups of 2009 stations; and
- Amphipod and oligochaete abundances are similar in both years and between both groups of 2009 stations.

In both years, the macrobenthos was dominated by the same small group of amphipod, oligochaete and polychaete taxa, this is a common feature of the ACG macrobenthos, and has been routinely observed in all surveys since 1998. As noted above, variation in the number of taxa present is always associated with taxa which are:

- Regularly observed over any period of several years;
- However are rarely present at many stations, or in significant abundance, in any single survey.

No new, or unusual, taxa were observed in the 2009 survey, and the overall conclusion is therefore that the environmental description based on the 2003 survey is a valid basis on which to assess the potential impact of the COP development.

Table 6.26 Station-by-Station and Overall Comparison of Species Richness and Abundance Between 2003 and 2009

Major taxonomic group		2003 average	2003-2009 stations					Additional 2009 stations								
			st-00	st-06	st-07	st-18	Average	st-12	st-15	st-16	st-17	st-10	st-11	st-19	st-20	Average
Polychaetes	Number of taxa	**6**	7	6	6	6	**6**	6	7	6	5	5	5	5	7	**6**
	Number of individuals	**373**	1060	850	847	547	**826**	510	4227	1663	283	767	987	2327	540	**1413**
Oligochaetes	Number of taxa	**5**	3	4	3	4	**4**	4	4	4	3	3	4	4	3	**4**
	Number of individuals	**337**	177	383	160	63	**196**	310	743	460	63	327	263	323	120	**326**
Cumacea	Number of taxa	**3**	5	4	5	1	**4**	2	4	5	4	2	3	6	4	**4**
	Number of individuals	**7**	197	80	67	3	**87**	50	130	33	30	80	17	163	53	**70**
Amphipods	Number of taxa	**22**	24	27	18	22	**23**	27	26	22	23	15	23	23	23	**23**
	Number of individuals	**469**	353	427	470	477	**432**	317	573	307	260	103	707	323	823	**427**
Bivalves	Number of taxa	**5**	4	5	4	3	**4**	4	5	2	4	2	4	3	1	**3**
	Number of individuals	**7**	127	237	197	140	**175**	220	187	163	140	33	83	67	53	**118**
Gastropods	Number of taxa	**18**	13	11	11	8	**11**	12	17	11	9	10	15	19	9	**13**
	Number of individuals	**30**	340	247	263	120	**242**	340	607	283	173	167	427	387	253	**330**

6.6.2 Sediment Composition and Chemistry

A comparison of sediment properties between the 2003 and 2009 surveys are presented in Tables 6.27 to 6.29. These tables indicate that:

- The range and average values are similar between 2003 and 2009;
- The average particle size is slightly larger and the average silt/clay content is slightly higher;
- All data is within the range of baseline conditions previously established for the ACG Contract Area;
- Evidence indicates that the extended area is generally similar in character to the original survey area;
- Values for Cu, Pb, Zn, and Ba are very similar between years;
- Values for Cr, Fe, and Cd are higher in 2009, possibly reflecting slightly higher silt/clay content;
- Values for Hg and THC are lower in 2009, however, THC is low in both surveys; and
- All values are within the range of baseline concentrations previously observed within ACG Contract Area.

Overall, the data for 2009 do not indicate any changes since 2003 which lie outside the established level of variation within and between previous surveys. The results are therefore considered to be consistent with, and representative of, the COP area.

Table 6.27 Comparison of Sediment Structure Between 2003 and 2009 Surveys

	Diameter (um)		% Carbonate		% Organic		% Silt/clay	
	2003	2009	2003	2009	2003	2009	2003	2009
Maximum	1145.3	1969.0	73.2	73.0	4.7	6.1	98.6	95.2
Minimum	7.5	8.7	20.2	21.2	1.4	1.5	7.3	3.7
Average	318.7	398.4	50.5	47.1	2.8	3.5	40.0	48.4

Table 6.28 Comparison of Sediment Heavy Metal Concentrations Between 2003 and 2009 Surveys

	Cu		Cr		Fe		Mn		Pb		Zn	
	2003	2009	2003	2009	2003	2009	2003	2009	2003	2009	2003	2009
Maximum	30.5	35.3	61.7	88.9	30120	44900	587	872	20.2	24.2	72.4	84.2
Minimum	17.6	9.8	12.5	16.7	9162	11300	319	312	10.4	12.7	35.9	20.9
Average	23.4	23.6	38.9	53.3	19910	27429	452	553	15.2	18.2	53.3	55.5

Table 6.29 Comparison of Sediment Heavy Metal and Hydrocarbon Concentrations Between 2003 and 2009 Surveys

	Ba		Cd		As		Hg		THC		UCM	
	2003	2009	2003	2009	2003	2009	2003	2009	2003	2009	2003	2009
Maximum	8488	9670	0.27	0.45	11.9	23.7	0.313	0.06	32.6	44.3	25.1	33.3
Minimum	2383	425	0.10	0.14	5	8.1	0.021	0.02	9.7	3.6	7.1	1.6
Average	4908	5362	0.18	0.31	8.8	15.7	0.11	0.04	22.3	12.5	16.8	8.6

6.6.3 Conclusion

The general characteristics of the COP 2009 survey area are similar to those of the 2003 West Chirag survey area. Some variation is apparent, but this does not indicate that there is any significant difference in either sediment composition or in macrobenthic community characteristics between the area originally surveyed and the adjacent area around the proposed COP location. The variation is consistent with the natural level of variation observed in regional and platform ACG surveys carried out since 2004. The 2009 survey does not indicate the presence of any unusual species or sediment characteristics, and specifically does not indicate the presence of any ecological components not detected in other ACG Contract Area surveys.

7 Socio-Economic Description

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7.1 Introduction

This Chapter reviews the existing socio-economic conditions relevant to the Chirag Oil Project (COP). National level data is drawn largely from the following sources:

- State Statistical Committee (SSC) of Azerbaijan reports, 2007, 2008 and 2009;
- The State Programme on Poverty Reduction and Economic Development, 2003-2005;
- Discussions with officials from the SSC, Ministries, local authorities, representatives of International Organisations (e.g. UNFPA, United Nations Population Fund) and independent experts representing civil society; and
- United Nations Human Development Reports.

With the exception of construction and onshore commissioning, COP activities will be predominantly offshore. No upgrade or expansion works are proposed at the Sangachal Terminal. The focus of this chapter is therefore, on providing a general overview of the socio-economic environment and establishing the local (i.e. Garadagh region) employment, community and economic conditions against which onshore construction / commissioning activities and subsequent ongoing COP production activities can be assessed. The socio-economic impact assessment is presented in Chapter 9 of this ESIA. The main interactions likely to arise from COP project activities, as identified through Scoping, are positive impacts on local economy and employment and therefore, this description of existing socio-economic conditions focuses on these.

7.2 Demographic Profile

7.2.1 Population

The population of Azerbaijan in December 2008 was 8,629,900 (Table 7.1)[1]. In 2008, 51.7% of the national population was officially resident in urban areas, a figure that had remained relatively constant over the previous 10 years. Officially, in 2007, 22% of the national population was resident in Baku city (which includes the Region of Garadagh). There are however, indications that the actual population of Baku may be significantly higher than the official figures suggest. The United Nations Development Programme (UNDP) has for example, suggested that the greater Baku metropolitan area may be home to approximately three million people or 35% of the country's entire population.[2]

Table 7.1 National Population, 1995 - 2008

	1995	2000	2002	2003	2004	2005	2006	2007	2008
Total	7,643.5	8,016.2	8,141.4	8,202.5	8,265.7	8,347.3	8,436.4	8,532.7	8,629.9
Urban (%)	52.4	51	50.7	50.6	51.5	51.5	51.6	51.5	51.7
Rural (%)	47.6	49	49.3	49.4	48.5	48.5	48.4	48.5	48.3
Male (%)	49.1	48.9	49	49.1	49.1	49.2	49.2	49.3	49
Female (%)	50.9	51.1	51	50.9	50.9	50.8	50.8	50.7	51

Table 7.2[3] presents national age profiles, including those for urban and rural areas. Overall, the demographic situation in Azerbaijan has been characterised by low population growth. During the period 1990 to 2000, the birth rate and natural growth rate decreased, infant and maternal mortality increased and the country experienced a negative migration balance, mainly due to the emigration of working-age men. Between 2004 and 2007 however, birth rates and the natural fertility rate of the population increased returning closer to their 1995 levels. The fertility rate for 2007 was 2.3 (2.1 for urban and 2.5 for rural

[1] Social Economical Development, State Statistical Committee, 2008, # 12, p. 114.
[2] United Nations Development Programme (UNDP) Azerbaijan, 2007: Converting Black Gold into Human Gold: Using oil Revenues to Achieve Sustainable Development.
[3] State Statistical Committee, 2008.

areas). The fertility rate for Garadagh District in 2008 was 2.05, lower than the national average[4]. Maternal mortality rates were lower and infant mortality rates significantly lower than in 1995. By 2007, average life expectancy at birth was 72.4 years (69.7 years among men and 75.1 years among women), significantly higher than 1995 levels.

Table 7.2 Age Profile, Urban and Rural, 2008

Age	Total		Urban		Rural	
	('000)	%	('000)	%	('000)	%
0-4:	639.7	7.9%	317.9	7.1%	362.8	8.7%
5-9:	680.7	6.4%	251.0	5.6%	303.3	7.3%
10-14:	764.9	8.9%	357.5	8.0%	407.4	9.8%
15-19:	926.5	10.7%	469.0	10.5%	457.5	11.0%
20-24:	870.9	10.1%	456.9	10.2%	414.0	9.9%
25-29:	724.0	8.4%	385.2	8.6%	338.8	8.1%
30-34:	619.5	7.2%	315.7	7.1%	303.8	7.3%
35-39:	640.7	7.4%	323.7	7.3%	317.0	7.6%
40-44:	670.7	7.8%	352.2	7.9%	318.2	7.6%
45-49:	667.7	7.8%	377.8	8.5%	289.9	7.0%
50-54:	456.5	5.3%	271.8	6.1%	184.7	4.4%
55-59:	304.1	3.5%	188.4	4.2%	115.7	2.8%
60-64:	147.0	1.7%	92.2	2.1%	54.8	1.3%
65-69:	209.4	2.4%	114.0	2.6%	95.4	2.3%
70 and over:	393.3	4.5%	191.5	4.3%	201.8	4.8%
Total:	8,629.9	100.0%	4,464.6	100.0%	4165.1	100.0%

In 2008, 70% of the country's population were in the age bracket 15 to 64. Twenty-three percent were in the 0 to 14 age bracket and 7% were 65 or older.

Official statistics number the Garadagh District population at 102,716 as of January 1st, 2008[5]. The age profile has remained relatively stable over recent years with the main growth sectors in the less than 4, 10 to 14 and 35 to 39 age brackets.

7.3 Education

The Azerbaijan education law guarantees the right to education for all its citizens irrespective of race, nationality or sex. In 2008, approximately 2.2 million people were students and education providers (330,000 teachers and other education providers) at various institutions throughout the country. In the age bracket of six to 16 years, school enrolment rates were 84.1% of the population. Around 86% of workers in the national economy had received an education to secondary level or above and there was almost universal literacy. Enrolment rates declined notably as the level of education increased (i.e. once compulsory education ended).

The period 1995 to 2006 witnessed a small increase in the number of pupils in general day schools and an increase (about 15%) in the number of teachers (Table 7.3)[6]. The most significant changes were in the growth in the number of secondary school pupils, which increased by 56%. Entries to specialised secondary institutions increased both in absolute terms (56% higher over the period) and as a proportion of the general population (from 10

[4] CIA World Fact Book, 2008.
[5] State Statistical Committee, 2008.
[6] State Statistical Committee, 2008 and 2009. Sustainable Development and Education, Baku, 2008.

to 20 per 10,000 people). The number of students entering higher education grew by 30% and the numbers graduating from higher education increased by 48% during the period. The data point to a high level of gender equity at all levels of the education system with 47% of students in higher education female in 2008.

Counter to this general improvement trend, in the period 2006 to 2008, there has been a decline in day school student numbers and the number of teachers. Numbers of students in specialised secondary educational and higher education institutions have remained more or less constant or increased slightly. Gender equity has also remained relatively constant.

Table 7.3 Key Education Indicators, 1995 to 2008

	1995	2000	2006	2008
Number of children in preschool institutions:	136,796	111,020	109,458	103,902
Number of pupils in general schools:	1,487,700	1,653,703	1,534,580	1,483,311
Percent (%) female:	50.81	48.44	47.59	47.50
Number of teachers in general schools:	152,959	161,492	175,423	159,420
Percent (%) female:	66.49	68.58	71.28	71.0
Number of pupils in vocational schools and vocational lyceums:	27,689	22,944	23,813	24,455
Percent (%) female:	25.00	36.70	28.66	28.7
Number of students admitted to secondary education:	9,707	14,823	15,157	-
Number of students in specialized secondary educational institutions:	33,553	42,612	56,872	-
Percent (%) female:	62.63	69.84	70.68	-
Number of students of specialized secondary educational institutions per 10,000 people:	44	54	68	70.7
Number of graduates of specialized secondary educational institutions per 10,000 people:	10	14	20	20
Number of students in higher educational institutions:	98,812	119,683	129,141	130,192
Percent (%) female:	43.85	41.66	47.44	47.50
Number of students in higher educational institutions per 10,000 people:	130	150	154	156
Number of graduates of higher educational institutions:	17,436	24,488	28,141	28,120
Number of graduates of higher education per 10,000 people:	23	31	34	33

7.4 Human Resource Development

Although dominating Azerbaijan's economic development, the oil and gas sector generates less than 2% of the country's jobs. The Government of Azerbaijan has therefore begun to implement a National Employment Strategy to "*convert black gold into human gold*"[7] to invest gains from the oil and gas sector in the skills and intellectual development of its people. This strategy is described in the UNDP Azerbaijan 2007 report, *Converting Black Gold into Human Gold: Using Oil Revenues to Achieve Sustainable Development*.

The report notes that almost 70% of unemployed people are in the 15[8] to 34 year age bracket and from the late 1990s through to 2007 more than 60% of unemployed had higher or secondary special education. In 2007, 49.7% of the registered unemployed were graduates of higher and vocational educational establishments. The report suggests that vocational education and training have experienced declining enrolments at secondary levels and there appears to be a gap between labour market needs and supply from educational institutions.

The UNDP argue that the focus of a human resource development strategy must be on the interface between those coming into the workplace, their qualifications, competencies and skills as a function of their educational experiences and labour market demand. It identifies three major issues:

- The need for re-assessment and reform throughout the entire education system from pre-school through higher education, while recognising strong traditions in education policy and practice;
- The need to diversify the national economy beyond the oil and gas sector, which will demand depth and diversity in workforce skills that do not exist at present; and
- The need to improve the standards of the vocational education and training facilities and institutions.

A review of the Vocational, Educational and Training (VET) system completed in February 2006 by the European Training Foundation identified a lack of reliable data on educational supply of and occupational demand for skilled workers, lack of coordination between educational level and skills requirements and shortages of middle level qualified workers. Labour Force Survey data suggest that higher educated people tend to concentrate in public sector occupations, which does not support diverse and sustained economic growth.

In summary:

- The public education system is creating a large number of secondary educated young people who find it very difficult to obtain jobs and more coordination, information and analysis is required to better understand and address the supply of educated labour and its current and anticipated demand;
- Skills development has been absorbed into a public vocational education system and a more integrated response with public / private cooperation and supply and demand analysis is required as is more flexible technical-vocational-educational training to raise skills to make the non-oil sector competitive internationally; and
- Human resource development alone is not sufficient for sustainable economic development and competitive export industries will be required to ensure employment of skilled workers and this in turn will require creation of economic conditions where potential investors are not deterred by lack of access to export markets, entrenched monopolies or governance issues.

[7] UNDP Azerbaijan, 2007, *op. cit.*
[8] According to Azerbaijan national law the working age starts at 15 years old. This age has been also recommended by the ILO (International Labour Organization UN Institution).

7.5 Income

The average monthly per capita income in 2006 was 74.4 AZN (Table 7.4)[9]. The SSC Households Budget Survey highlights however, disparities in incomes between rural and urban areas. Although per capita incomes in rural areas rose slightly faster than the national average between 2005 and 2006, they remained below the urban average (70.1 compared with 78.5 AZN / month). The average per capita income in Baku was 89.7 AZN / month in 2006 and 195.3 AZN / month in 2008.

Table 7.4 Income by Urban and Rural Areas, 2005 to 2006 (AZN / Month)

	2005	2006	% Change
Urban households:	68.0	78.5	15.4%
Rural households:	60.3	70.1	16.3%
All households:	64.4	74.4	15.5%

Table 7.5[10] shows the distribution of the population across the five wealth quintiles by urban and rural areas, indicating the uneven distribution of wealth. Over 70% of the rural population is in the lowest and second-lowest wealth quintiles. A similar proportion of the urban population is in the two highest quintiles. Countrywide, Baku has the largest proportions of population (83%) in the two highest wealth quintiles.

Wealth status has a strong positive relationship with education with 38% of men in the highest wealth quintile have at least some university education, compared with 3% of men in the lowest quintile. The corresponding proportions for women are 29% and 1%, respectively.

Table 7.5 Wealth Quintiles, Urban and Rural, 2006

	Lowest	Second	Middle	Fourth	Highest	Total
Urban	3.8	9.0	19.6	31.8	35.8	100
Rural	39.8	33.4	20.6	5.5	0.6	100

The structure of income sources is the single most important factor in explaining disparities between urban and rural incomes. In 2006, employment accounted for 31% of all income in Azerbaijan but 42.4% of income in urban households and only 17.4% in rural households. Self-employment accounted for 29.2% of income in urban households and 19.2% in rural areas. In contrast, agriculture accounted for 35.7% of rural incomes and average monthly nominal wages and salaries in the sector were only 35% of the average across the economy as a whole. Although the importance of rural employment increased substantially during the period 2000 to 2006, access to formal employment opportunities and the significantly lower salaries in agriculture, remain significant factors in the higher income levels in urban areas.

7.6 Community Programmes

7.6.1 Socio-Economic and Environmental Programmes

The ACG, Shah Deniz, BTC, SCP and associated projects play a significant role in social development within the region. In addition to the direct economic benefits provided through local employment and contracting, the projects have provided substantial support to community development projects supporting the goals of socio-economic development in host communities; strengthening civil society through the active participation of local Non

[9] State Statistical Committee, 2008.
[10] Demographic and Health Survey, 2006.

Governmental Organisations (NGO) and community-based organisations and improving ties between local government and local populations.

BP and its co-venturers support to socio-economic development includes a diverse range of initiatives to support regional economic development; local community-based projects; environmental and cultural heritage programmes. BP reports a gross social spend in Azerbaijan, by BP and its co-venturers, of approximately US$39M between 2002 and 2008 (Table 7.6)[11].

Table 7.6 BP / AIOC Social Spend, 2002 to 2008 (US$M)

	2002	2003	2004	2005	2006	2007	2008	Total
Gross Social Spend	600,000	2,710,000	8,640,000	6,290,000	6,750,000	7,390,000	6,430,000	38,810,000

7.6.2 Local Content Development

Similarly, BP and its co-venturers set ambitious targets to increase the value of contracts placed with local companies. In 2008 BP on behalf of its co-venturers, spent US$128M directly with local Azerbaijani small and medium size enterprises, a 15% increase from 2007 (Table 7.7)12. Key areas of local content development include enterprise development and training and access to finance.

Table 7.7 Local Content Spend, 2006 to 2008 (US$M)

	2006	2007	2008
Small & Medium-Sized Enterprises:	77	111	128
State-Owned Enterprises:	60	43	37
Joint Ventures:	520	450	408
Foreign Suppliers In-Country:	826	891	737
Total:	**1,483**	**1,494**	**1,310**

7.7 Economic Development

7.7.1 Overview

The European Bank for Reconstruction and Development has identified the following critical challenges to Azerbaijan's economy:[13]

- Improving the business environment through sustained anti-corruption measures, strengthening administrative capacity, enhancing the regulatory environment and the rule of law in order to create a level playing field conducive to further development of local private enterprises and attraction of foreign investment;
- Developing the non-oil and gas sectors of the economy to ensure poverty alleviation and sustainable development throughout the country including rural areas and cities outside the capital through long-term economic policies and incentive schemes;
- Further reforming and strengthening of the financial sector as an effective tool for channelling oil revenues into non-oil sectors and supporting diversification of the economy for sustainable future growth;
- Restructuring of the public infrastructure sector and continued investments to improve efficiency and service standards in transport, telecommunications, electricity,

[11] BP Azerbaijan Sustainability Reports, 2004-2007.
[12] BP Azerbaijan Sustainability Reports, 2006-2007.
[13] European Bank for Reconstruction and Development, 2007, Azerbaijan Strategy Overview

gas, water, sewerage, waste treatment, as well as cleaning the heavily polluted environment; and

- Maintaining the efficient long-term management of oil and gas revenues and ensuring macroeconomic stability through prudent monetary and fiscal expenditure policy to avoid excessive inflationary pressure and real exchange appreciation.

Between 1996 and 2000 trade, industry, transport and communications continued steadily to increase their contribution to GDP whereas agriculture declined by almost 30% over the same period. In 2002, the oil sector had accounted for 20% of GDP and over 50% of total industrial output whilst agriculture accounted for approximately 20% of production. In 2004, Azerbaijan was experiencing a sustained period of economic growth, with 2003 showing an 11.3% increase in GDP from the previous year. The key industries included oil and gas, steel, cement, chemicals and textiles.

Table 7.8[14] highlights rapid change in the macro-economy in the years since the ACG Phase 3 project including increase in GDP from US$8,680 in 2004 to US$29,399 in 2007; annual GDP growth rate of 25.60% in 2006 to 2007 and significant increases in industrial growth, salaries and personal income.

Table 7.8 Macroeconomic Data

	2004	2005	2006	2007	2008
GDP (US$M):	8,680.4	13,238.7	20,983.0	29,399.9	46,258.2
GDP Per Capita (US$):	1,060.3	1,600.4	2,508.5	3,473.9	5,403.9
GDP Growth Rate (Real):	9.80%	26.40%	34.50%	25.60%	10.8
Real Industrial Growth:	5.70%	33.50%	36.60%	24.00%	6%
Real Salary Growth:	29.70%	24.30%	14.30%	44.80%	24.2%
Personal Income (US$):	995.8	1,205	1,507	2,089	2,852
Inflation (12-month):	10.40%	5.40%	11.40%	16.70%	20.8%

Cumulative net Foreign Direct Investment (FDI) from 1994 through 2000 was estimated at US$4.1B of which most went into the oil and gas sector. Inflows of FDI over subsequent years, in major investments such as the ACG, BTC, Shah Deniz and SCP projects, contributed to the 2003 FDI figure of circa US$3.0B. Foreign investment had improved logistics facilities for the oil industry, introduced mobile telephony, rehabilitated the construction materials industry and increased demand for modern commercial property and business services in Baku. In 2006, Azerbaijan's economy received aggregated investments of US$6.7B (representing an annual growth rate of 14.8%) and US$7.97B in 2007 (17.8% annual growth). Foreign investment had however, made little impact on the non-oil sector, including agriculture that was central to the Azerbaijani economy. Continued state ownership of utilities also limited the level of direct foreign investment in this sector.

In the period since 2004, the country's GDP growth rate accelerated to become the world's highest, experiencing growth of 34.5% in 2006, 25.6% in 2007 and projected 18.2% in 2008. High levels of investment inflow caused the inflation rate to increase by 16.7% in 2007 and 20.8% in 2008 but the National Bank is now looking to peg the Manat to a basket of currencies rather than to the US dollar alone in order to strengthen the currency and to stimulate imports while maintaining downward pressure on domestic prices. Furthermore, the growth of real personal incomes is helping to counterbalance the negative consequences of increasing inflation.

[14] State Statistical Committee, 2008.
Social Economic Development (2008) State Statistical Committee, 2008, #12, p. 12.

Many sectors of the economy continue to be characterised by a high degree of market concentration and weak competition with dominant companies using their position to prevent potential competitors from entering the market[15].

7.8 Employment

The most recent population census was undertaken in April 2009. Preliminary results indicate that Azerbaijan has a population of 8,922,300; Baku has a population of 2,046,100 and the Garadagh District 108,200.

Azerbaijan has relatively high employment and labour force participation rates and a correspondingly low unemployment rate. Data on local employment figures vary. According to the State Statistical Committee 4,317,428 people are economically active in Azerbaijan. Unemployment is currently at 6.1%, with 261,411 people unemployed. Out of this number 42,183 are officially registered as unemployed (55.6% men 44.4% woman). However, according to the Ministry of Labour and Social Protection of Population unemployment is at 6.7%. According to an independent assessment (Newspaper 'Echo', November 20, 2009) there are at least 300,000 unemployed in Azerbaijan.

Table 7.9 shows the official employment and unemployment figures for Baku and the Garadagh District.

Table 7.9 Employment and Unemployment in Baku and Garadagh District

Years	Number of employees	Number of unemployed
Baku		
2000	522,500	4,930
2001	487,300	6,172
2002	433,300	7,057
2003	516,900	8,196
2004	554,700	9,296
2005	550,900	9,828
2006	573,600	9,634
2007	593,700	10,513
2008	616,400	11,169
Garadagh District		
2008	19,900	552

Non-oil sector employment is concentrated in low productivity jobs predominantly in agriculture (38.6% of total employment) with the majority of them engaged in subsistence farming (Table 7.10)[16]. The informal sector dominates and jobs are often seasonal and / or temporary in nature. Jobs requiring technical skills and computer proficiency often remain unfilled. Young people entering the labour market often have only general education or skills for which there is little demand while many adult job seekers have skills for jobs that are no longer available.

[15] Asian Development Bank, 2004.
[16] State Statistical Committee, 2009.

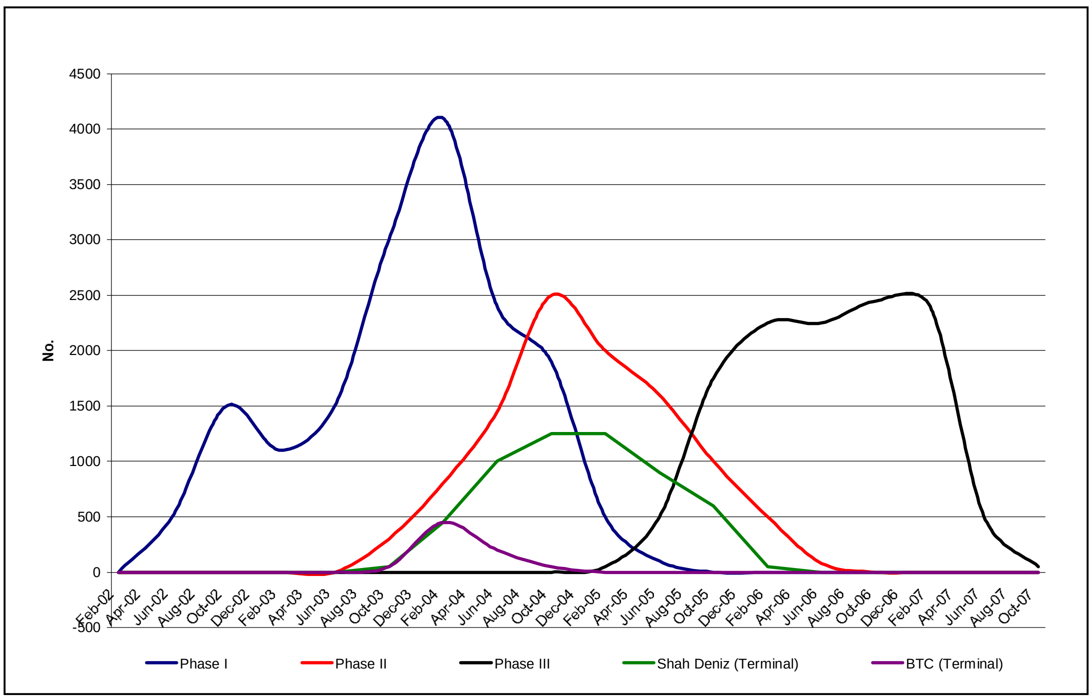
Table 7.10 Employment by Sector, 2008

Sector	'000 People	Percent (%)
Agriculture, Hunting and Forestry:	1,553.	38.3%
Fishing / Fish Breeding:	4.3	0.1%
Mining:	45.0	1.1%
Manufacturing:	198.6	4.9%
Energy and Water:	45.5	1.1%
Construction:	226.1	5.6%
Wholesale and Retail:	654.2	16.1%
Hotels and Restaurants	23.3	0.6%
Transport, Storage and Communications:	208.5	5.2%
Financial Services:	19.0	0.5%
Real Estate:	139.4	3.4%
Public Administration:	274.2	6.8%
Education:	345.7	8.5%
Health and Social Services:	183.1	4.5%
Other:	135.4	3.3%
Total	**4,056.0**	**100.0%**

7.8.1 BP Projects Employment

BP projects (construction and operations) have had a significant impact on employment[17]. Total construction employment from combined projects peaked at approximately 5,500 workers in mid-2004 and for the ACG Phase 3 project, in 2006 at around 2,500 staff (onshore and offshore construction)[18]. Following completion of construction activities however, the decrease in employment opportunities has been particularly pronounced in the local communities that had benefited from the policy of employing local personnel wherever possible. Figure 7.1 illustrates the construction workforce for ACG Phase 1, 2 and 3, Shah Deniz (terminal only) and BTC (terminal only) projects.

Figure 7.1 BP Projects Construction Workforce, 2002 to 2007



[17] BP Azerbaijan Sustainability Reports 2006 - 2007
[18] As reported by the ACG Phase 1-3 construction contractors

To maximise the positive impact from employment, the ACG Phase 1, 2 and 3, Sangachal Terminal and BTC construction projects adopted the following measures:

- **Targets:** BP contractually committed to specific national content targets through each of the projects. By September 2003 85% of the construction workforce was Azerbaijani[19];
- **Preference in Recruitment:** BP recruitment policy gave priority to local residents and by September 2003, 53% of the construction was from the Garadagh Region and in MacDermott's construction workforce, residents from Primorsk / Sahil alone accounted for over 40% of all hourly-employed staff throughout the period;
- **Information Centres:** Local community information centres were established in Sangachal, Umid and Sahil to enable local people to register for employment and the Centres developed a database of approximately 18,000 potential employees by September 2003; and
- **Training:** Extensive training programmes were implemented both prior to and during employment of the construction workforce, focusing on HSE, language and computer skills, driving and certified courses including painting, electronics, slinging and lifting, scaffolding and pipe coating and welding. McDermott's yard alone provided over 270,000 hours of HSE training; over 244,000 hours of craft training; and nearly 28,000 hours training in management, administration and computing skills. In the craft area, the yard provided 582 welders with an average of 300 hours training; 275 fitters an average of 80 hours craft training; and 258 riggers an average of 85 hours. Over 1,200 externally recognised qualifications were awarded to the yard's workforce during the period.

It is understood that a majority of the workforce employed and trained in the ACG Phase 1, 2 and 3, Sangachal Terminal and BTC construction projects, are now employed elsewhere in Azerbaijan and abroad. Anecdotal evidence suggests that many have used their skills and experience to gain employment in State-run construction yards, in the Baku construction industry and in the oil and gas sector in Kazakhstan and elsewhere. While this represents a significant benefit in terms of increasing technical skills and experience within the Azerbaijan workforce, it also means that the COP construction may require recruitment and training of a substantially new workforce.

7.8.2 Local Trading Centres

Sadarak Trading Centre, located in the Garadag region, has a management and support staff in of total 111 full-time employees. The trading centre comprises 5,300 individual trading outlets/small stores, providing employment for approximately 11,000 people[19].

A second trading centre (Bina) is located closely to the Sadarak Trading Centre, but administratively it belongs to the Nizami region. Administration of the Bina Trading Centre, however, may be soon transferred to the Garadag region. Construction of the Bina Centre, is still in progress and at the time of writing, 1,350 stores have been completed for commercial occupation and 32 people are employed within the centre's administration. It is predicted that the outlets completed to date will provide employment opportunities for approximately 3,000 people with potentially more employment created once the centre is fully constructed and operational. It can be reasonably assumed that, given the Bina Trading Centre is very close to settlements in the Garadag region, many of the employees will originate from the Garadag settlements. However, no official registration to confirm this data exists and vendors are not required to register their location of domicile residence[20].

[19] Data provided by trading centre management. Employment estimate based on approximately 2 employees per store.

7.9 Construction Yards

Two potential fabrication yards may be used for COP construction activities. Their locations are shown in Chapter 6, Figure 6.1.

The Baku Deepwater Jacket Factory (BDJF) Yard (formally the Shelfprojectsroi (SPS) Yard) was used for onshore construction, assembly and pre-commissioning during the ACG Phases 1, 2 and 3 projects. The yard lies approximately 20km south of Baku on the western coastline of the Caspian Sea. There is no informal / incidental use or occupancy of the land within the yard's boundary.
The Bibi Heybet (former Amec-Tekfen-Azfen (ATA)) Yard was used for platform topside onshore construction and pre-commissioning during the ACG Phases 1, 2 and 3 projects. The yard is located within the Bibi Heybet Oilfield approximately 8km to the south of Baku and is bound to the east and south by the Caspian Sea.

A Socio-Economic Baseline Study for the Bibi Heybet Yard was prepared in 2003. The survey identified 122 people living within 1.5km of the yard. A site reconnaissance visit undertaken in 2008 suggests that there are no longer any residential premises within close proximity to the yard.

8. Consultation and Disclosure

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8.1. Introduction

Stakeholder consultation is a required and crucial element of the ESIA process. Soliciting, collating and documenting the opinions of potentially affected people and interested parties ensures that project design and the ESIA reflects the collective views of the stakeholder base.

The Early Oil Project (EOP) and ACG Phases 1, 2 and 3 ESIA have all been undertaken prior to the COP and have all included extensive stakeholder consultation. Consultation for the COP has built on the consultation framework and methods established during these earlier ACG projects. Lessons learnt from previous projects' consultation have also guided the COP consultation programme.

8.2. COP Consultations and Disclosure Process

8.2.1 Overview

COP ESIA stakeholder consultation has:

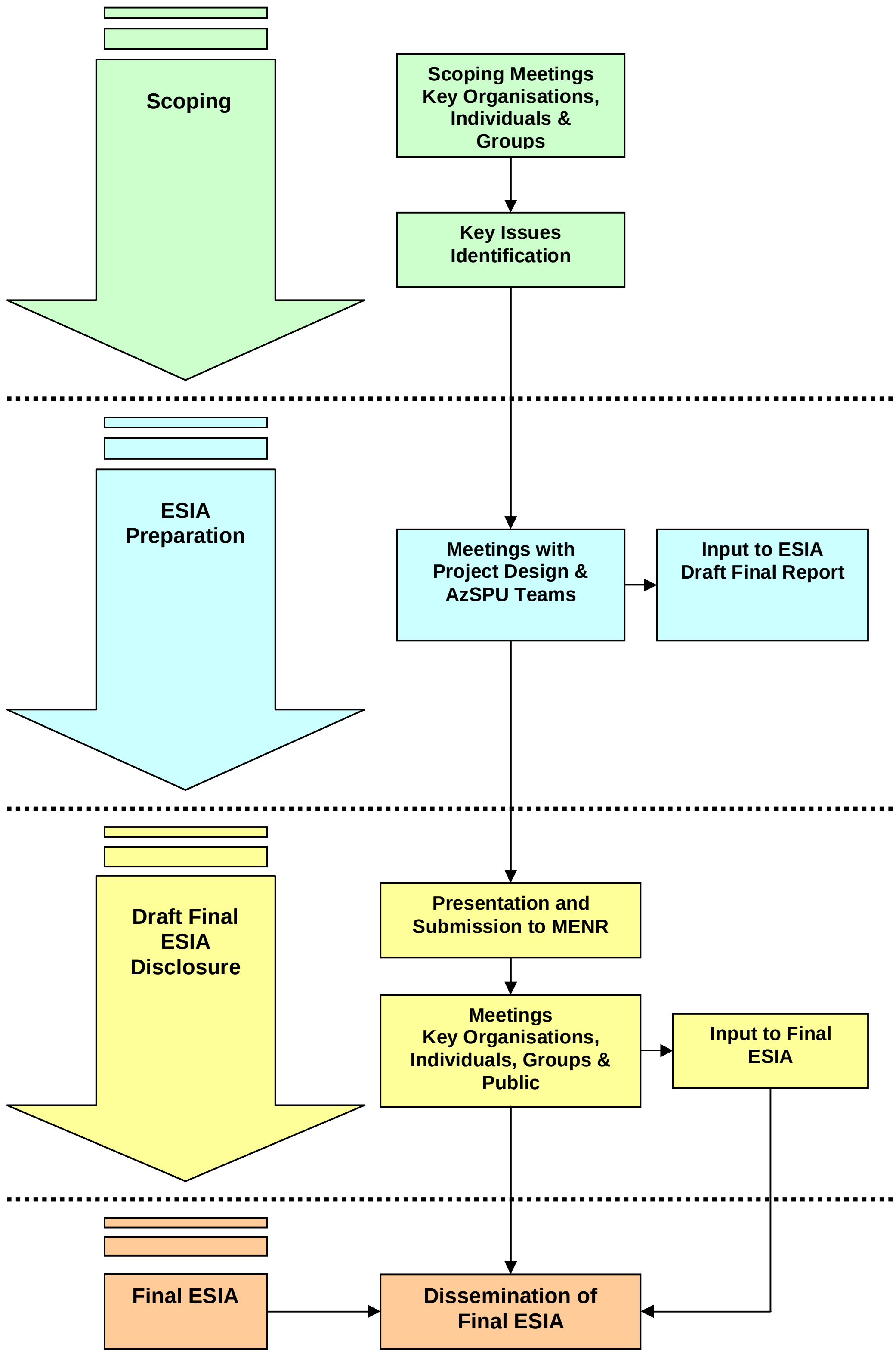
- Made use of the consultation framework and methods established for the earlier ACG and other BP projects in Azerbaijan;
- Been developed with reference to accepted guidance on expectations of ESIA consultation and disclosure;
- Considered the extent of consultation and disclosure already undertaken in recent years acknowledging the potential for stakeholder fatigue; and
- Incorporated recommendations made from a "lessons learned" review of earlier consultation programmes.

Figure 8.1 below illustrates the COP consultation and disclosure process. The COP Public Consultation and Disclosure Plan (PCDP) was initially drafted during the Scoping phase of the ESIA and has been continuously revised and updated at appropriate stages throughout the ESIA process. The PCDP also includes a summary of consultation and disclosure undertaken during earlier ACG phases for context.

8.2.2 Scoping, Consultation and Disclosure

ESIA Scoping phase consultation and disclosure included two workshops and one meeting with the MENR as well as internal consultation with existing offshore and onshore AzSPU operations teams. Consultation with the COP Design Team has also been completed during the preparation of the COP ESIA and during the Select stage of the BP Capital Value Process (CVP).

Figure 8.1 COP ESIA Consultation and Disclosure Process



8.2.2.1 MENR Consultation

A meeting with the MENR was held in August 2008. The meeting outlined AIOC's major project plans for the near future and included an overview of the COP and Shah Deniz Phase 2 (SDII) projects[1], including schedule and key focus areas for the projects' ESIA.

With regard to COP, the MENR requested the following:

- Produced water forecasts and the method for determining these[2]; and
- Potential transboundary impacts given that Azerbaijan has ratified the 1991 Convention on Environmental Impact Assessment in a Transboundary Context (i.e. the Espoo Convention)[3].

Appendix 8A presents the minutes from this Scoping meeting.

8.2.2.2 Public Consultation

Two Scoping phase consultation workshops were undertaken in Baku as follows:

- **22 September 2008:** COP ESIA Consultation Workshop for Scientists, Academics and NGO; and
- **23 September 2008:** COP ESIA Consultation Workshops for the general public.

Academic and scientific institutions invited to the September 22 workshop included:

- MENR;
- SOCAR;
- Baku State University;
- Caspian Environmental Programme;
- Gipromorneftegas Institute;
- State Oil Academy;
- Cabinet of Minister of the Azerbaijan Republic;
- Azerbaijan National Department of Hydrometeorology; and
- Azerbaijan National Academy of Sciences:
  - Fishery Institute of the Azerbaijan Republic;
  - Institute of Zoology;
  - Institute of Geography; and
  - Institute of Agrochemistry.

NGO in attendance at the September 22 workshop included:

- Ecograph;
- Sulh;
- Our House Common;
- Ecoscope;
- Sadr; and
- Azerbaijan Green Movement.

Attendees at this meeting were also invited to short presentations on Drilling, Offshore Production, Offshore Subsea Pipelines and the Sangachal Terminal.

The second consultation took the form of an open Public Meeting, which was advertised in advance in the local press.

[1] Preliminary discussions were held with regard to the SD II project as the scope and schedule for the project has yet to be defined.
[2] Refer to Chapter 11 Section 11.5.4
[3] Refer to Chapter 13

All meetings began with a general presentation of the COP followed by a presentation of the ESIA process. Each workshop concluded with a Questions and Answers session.

Scoping meeting presentations, minutes and attendance sheets are presented in Appendix 8B.

8.2.2.3 Offshore and Onshore AzSPU Operations and COP Design Team Consultations

The scope of the COP ESIA has been informed by reviews of previous ACG ESIA undertaken in consultation with AzSPU offshore, terminal and logistic representatives. These consultations highlighted that certain project related activities that may result in impacts, have been overlooked in previous ACG ESIA, which in turn has highlighted the need to consider and, where possible, assess additional technical design options in the COP ESIA[4].

8.2.2.4 ACG Research and Monitoring Group

A meeting with the ACG Research and Monitoring Group (RMG)[5] on COP Scoping was held on 26 August 2008. At the meeting, the COP and ESIA work scope was presented and discussed. Issues raised by the RMG included:

- Status of produced water disposal;
- Consideration of met ocean data in ESIA development studies; and
- Sewage treatment package performance.

8.2.2.5 Issues Raised During Scoping Consultation and Disclosure

Key issues raised during COP ESIA Scoping consultation are listed in Table 8.1 below. Those marked with an asterisk (*) were raised previously during the ACG Phases 1, 2 and/or 3 public consultation processes.

Table 8.1 Key Issues Raised During the COP ESIA Scoping Consultation Process

Concern	Section(s) Addressed
Disposal of produced water as generated at the offshore platform and at the Terminal. (*)	5.8.4 5.9.3 11.5.4
Disposal of drilling muds, drill cuttings and completion fluids as generated at the offshore platform. (*)	5.7.5 11.5.2
Disposal of domestic waste and sewage as generated at the offshore platform (noting problems on existing platforms).	5.8.6.14 5.8.6.15
Disposal of hydrotest water from offshore pipelines. (*)	5.5 10.6.2
Standards that are applied for environmental monitoring of the Caspian. (*)	2.10 Chapter 6
Monitoring of radioactivity associated with produced water used in the cement plant and with cuttings. (*)	Note 1
Analysis of the geological layers/seismic activity levels at the offshore platform location.	4.2.2
Local community concerns about poor air quality - sooting of laundry and respiratory complaints.	9.3 10.3 11.3

1. An assessment of the potential for Naturally Occurring Radioactive material (NORM) to be generated from the ACG Field was conducted for the ACG Phase 3 ESIA. Based on the results of testing of a produced water sample from the Chirag A6 well, the assessment concluded that the potential for NORM to be generated was very low. In the event that it was found to occur in scale build-up in process equipment, management including treatment and disposal will be undertaken in accordance with BP procedures and protocols.

[4] Refer to Chapter 3 Table 3.1 for a summary of lessons learnt and how they have been addressed for the COP

[5] Subsequently renamed the ACG&SD Environmental Monitoring Technical Advisory Group (MTAG)

8.3. Draft Final ESIA Report Consultation

As per the UNDP Handbook for EIA Process in Azerbaijan, the Draft Final ESIA report was submitted to the MENR and simultaneously released to public and stakeholder groups for comment. During the three-month review period, AIOC/BP held a public meeting and other relevant stakeholder meetings (Refer to Appendix 8C for meeting minutes).

Copies of the Draft Final ESIA Report, released in English, Russian and Azeri, was made publicly available at the following locations:

- BP website;
- Aarhus Public Environmental Information Centre, Baku;
- Baku Information Education Centre;
- Public libraries in Sangachal and Sahil;
- BP Hyatt, Natavan and Villa Petrolea receptions, Baku;
- M.F.Akhundov State Library, Baku; and
- Scientific Library of the Academy of Sciences of Azerbaijan.

Comments received from the public, stakeholder groups and the MENR on the Draft Final ESIA report were collated, analysed and responses issued where relevant. The ESIA was subsequently revised and finalised for MENR approval.

8.4. Post-ESIA Project Consultations

There will be a need for ongoing consultation and disclosure during the construction and operational phases of the COP. This phase of consultation will build on the well-established consultation and disclosure process established for earlier ACG projects bearing in mind differences between the COP and these earlier phases (e.g. minimal change at the Sangachal Terminal resulting from the COP).

When the COP enters its operational phase, the consultation process will be re-evaluated to ensure that it is still appropriate and effective in terms of communicating information about the project and to the right audience.

8.5. Consultation Under the Espoo Convention

As a signatory to the Convention on Environmental Impact Assessment in a Transboundary context (i.e. the Espoo Convention), the Azerbaijan Government is obliged to provide early notification to countries that may be subject to transboundary impacts as a result of a development within Azerbaijan.

Potential transboundary impacts, including potential impacts in the event of a major oil spill (e.g. blow out), are evaluated in detail within Chapter 13 of this ESIA and will be discussed with the MENR as part of the ESIA disclosure process.

9. Predrill Environmental Impact Assessment, Mitigation and Monitoring

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9.1 Introduction

For all phases of the Chirag Oil Project (COP), Activities and Events have been determined based on the COP Base Case as detailed within Chapter 5: Project Description; and the potential for Interactions with the environment identified.

In accordance with the impact assessment methodology (see Chapter 3), ESIA Scoping has been undertaken to identify selected Activities that may be "scoped out" from the full environmental impact assessment process based on Event Magnitude and the likely receptor Interaction. In addition, existing controls and mitigation have been identified. These include:

- Existing operational procedures used to ensure that activities are consistent with environmental expectations; and
- Feedback from existing operational and ambient monitoring of environmental performance and/or impacts.

Those Activities that have not been scoped out have been assessed on the basis of Event Magnitude and Receptor Sensitivity, taking into account the existing controls and mitigation, and impact significance determined. Monitoring and reporting undertaken to confirm that these controls are implemented and effective, as well as additional mitigation and monitoring to further minimise impacts, are provided.

Assessments of socio-economic, cumulative and transboundary impacts and accidental events have also been undertaken and are provided in Chapters 12, 13 and 14 respectively.

The structure of the impact assessment within this ESIA is provided within Table 9.1 below.

Table 9.1 Structure of COP Impact Assessment

<table>
<tr><th>Chapter</th><th>COP Phase</th><th>Content</th></tr>
<tr><td>9</td><td>• Predrilling</td><td rowspan="3">• Scoping Assessment of COP Activities, Events and Interactions.
• Identification of existing controls, mitigation, monitoring and reporting.
• Environmental impact assessment of COP activities based on:
o Event Magnitude
o Receptor Sensitivity
• Identification of any additional mitigation measures.</td></tr>
<tr><td>10</td><td>• Onshore Construction and Commissioning of Offshore Facilities
• Infield Pipeline Installation, Tie-in and Commissioning
• Platform Installation, Hook Up and Commissioning</td></tr>
<tr><td>11</td><td>• Platform Drilling
• Offshore Operations and Production
• Terminal</td></tr>
<tr><td>12</td><td>All Phases</td><td>Assessment of socio-economic impacts.</td></tr>
<tr><td>13</td><td>All Phases</td><td>Assessment of cumulative and transboundary impacts (including impacts associated with greenhouse gas emissions) and impacts arising from accidental events (including oil spills and spill management).</td></tr>
<tr><td>14</td><td>All Phases</td><td>Description of the COP Environmental and Social Management System including waste management plans and procedures.</td></tr>
</table>

9.2 Scoping Assessment

The COP predrill phase Activities and associated Events that have been scoped out due to their limited potential to result in discernable environmental impacts are presented in Table 9.2 (see Appendix 9A for all COP predrill Activities, Events and Interactions). The scoping process has used judgement based on prior experience of similar Activities and Events, especially with respect to earlier ACG developments. In some instances, scoping level quantification/numerical analysis has been used to justify the decision. Reference is made to relevant quantification, analysis, survey and/or monitoring reports in these instances.

Table 9.2 "Scoped Out" COP Predrill Routine and Non-Routine Activities

ID	Activity / Event	Ch. 5 Project Description Reference	Justification for "Scoping Out"
Pre-R13	Crew change operations	5.3.3 Table 5.9 and 5.3.4	• Crew changes will be made on a regular basis throughout the predrill phase either using helicopters or crew change vessels. • The low volume of emissions released will be dispersed across the entire flight path/vessel route and the wider area. Increases in pollutant concentrations will be very small and indistinguishable from existing background concentrations. • Helicopter flights will originate from Zabrat heliport. A portion of the flight path will be over residential receptors but at height (>500m). Noise disturbance will be temporary, of short duration and low intensity. • **Conclusion:** Emissions and noise from crew change operations is expected to result in no discernable impact to human receptors.
Pre-R15	Waste Management	5.3.4.3	• Waste generated during predrilling will be consistent with the type and quantity that have been routinely generated during previous MODU drilling work. • Waste on the MODU will be segregated at source, stored and transported in fit for purpose containers. • The CWAA at the AIOC supply base within the BDJF yard will be used as the main reception and consolidation point for solid waste from predrilling activities. • Waste will be managed in line with the principles described in Chapter 14 and will benefit from the operational experience that has been gained by AIOC of managing similar waste from 10 years of MODU drilling operations. • Waste minimisation and management plans will be established for the MODU and all waste transfers controlled and documented. • BP will manage the collection, transportation, treatment, disposal and storage of waste generated by the MODU via specialised approved waste management contractors - the destinations of the waste types is provided in Chapter 5. • **Conclusion:** Waste will be managed as described within Chapter 14. No discernable impact to the terrestrial or marine environment expected.

The COP routine and non-routine Activities and their associated Events assessed in accordance with the full impact assessment process are presented in Table 9.3.

Table 9.3 "Assessed" COP Predrill Routine and Non-routine Activities

ID	COP Activity	Ch. 5 Project Description Reference	Event	Receptor
Pre-R1	Tow out and positioning of Mobile Offshore Drilling Unit (MODU)	5.3.2.2	Other discharges to sea	Marine Environment
			Underwater noise and vibration	
			Seabed disturbance	
			Emissions to atmosphere (non GHG)	Atmosphere
Pre-R2	Vessel support including supply to MODU and backload to shore	5.3.3 Table 5.9	Other discharges to sea	Marine Environment
			Underwater noise and vibration	
			Emissions to atmosphere (non GHG)	Atmosphere
Pre-R3	Drilling and plugging the Pilot Hole	5.3.2.3	Drilling discharges to sea	Marine Environment
Pre-R4	Drilling with water based muds (WBM) (conductor and surface hole sections drilling)	5.3.2.4	Underwater noise and vibration	Marine Environment
			Drilling discharges to sea	
Pre-NR5	Discharge of residual WBM	5.3.2.4	Drilling discharges to sea	Marine Environment
Pre-R6	Drilling with non WBM (lower hole section drilling)	5.3.2.4	Underwater noise and vibration	Marine Environment
Pre-R7	Cementing discharges to seabed	5.3.2.5	Cement discharges to sea	Marine Environment
Pre-NR8	Excess cement discharge to seabed	5.3.2.5	Cement discharges to sea	Marine Environment
Pre-NR9	Well test flaring	5.3.2.8	Emissions to atmosphere (non GHG)	Atmosphere
Pre-R10	MODU power generation	5.3.3 Table 5.9	Emissions to atmosphere (non GHG)	Atmosphere
Pre-R11	MODU seawater lift and cooling discharge	5.3.3 Table 5.9	Water intake/entrainment	Marine Environment
			Cooling water discharge to sea	
Pre-R12	MODU treated black water/grey water/drainage discharges	5.3.3 Table 5.9	Other discharges to sea	Marine Environment
Pre-R14	MODU removal	5.3.2.2	Other discharges to sea	Marine Environment
			Seabed disturbance	
			Emissions to atmosphere (non GHG)	Atmosphere

Notes: GHG Emissions are addressed in Chapter 13.
Suspension fluid discharges are not planned during the predrill programme but may be necessary for safety reasons (e.g. if hydrogen sulphide is encountered following lower hole drilling). Refer to Chapter 11 Section 11.5.4.

9.3 Existing Controls, Monitoring and Reporting

Existing control measures, monitoring and reporting requirements relevant to the COP predrill routine and non-routine Activities are provided in Table 9.4 and form part of the AzSPU HSSE Integrated Management System (Refer to Chapter 14 for further details).

Table 9.4 COP Predrill Existing Controls, Monitoring and Reporting

	Category	Existing Controls	Monitoring	External Reporting
ATMOSPHERE	Emissions to atmosphere (non GHG) from MODU generators and engines, well test flaring and vessel generators and engines	• Diesel generators and engines are subject to maintenance in accordance with written procedures based on the manufacturers' guidelines or applicable industry code or engineering standards to ensure efficient and reliable operation and MODU engine/generator exhaust emissions' testing is undertaken at least annually in accordance with the relevant PSA requirement[1]. • Diesel for support vessels and the MODU will comply with MARPOL Annex VI Regulations for the Prevention of Air Pollution from Ships[2] . Average sulphur content is typically 0.0326%. • Well test burners are designed to achieve high burning efficiencies and for fallout free and smokeless combustion of liquid hydrocarbons produced during well testing. • Burners are operated in accordance with written procedures based on the manufacturers' guidelines or applicable industry code or engineering standard. • Well testing is undertaken by exception only. • Well test proposals are reviewed and challenged through existing BP internal processes.	• Emissions testing of MODU engine/generator exhausts to confirm that the NO_X, SO_X and CO emissions are at the specified levels (i.e. the levels and tolerances determined by the equipment manufacturer which confirm efficient operation) and confirm maximum concentrations do not exceed relevant standards[3]. Monitoring is undertaken in accordance with the existing AzSPU methodologies and procedures aligned with US EPA and ISO stack emissions measurement and calibration requirements. • Diesel samples are taken regularly to confirm diesel quality following onshore treatment. • Visual observations and process monitoring is undertaken to monitor flare efficiency, ensure that fallout out to the sea surface is minimised and that immediate corrective actions taken if fallout occurs.	• Generator and engine exhaust emission test results are submitted to the MENR. • Emission volumes based on fuel usage and volumes of oil and gas flared during each well test are calculated in tonnes and submitted to the MENR and SOCAR

[1] IC engines/turbines larger than 500 HP should be monitored on an annual basis to assure that the NO_X and CO emissions are at the specified levels.
[2] Sulphur content of 3.5%, effective from 1 January 2012.
[3] Sulphur oxides maximum concentration of 400 mg/Nm^3 and nitrogen oxides maximum concentration of 1000 mg/Nm^3.

	Category	Existing Controls	Monitoring	External Reporting
MARINE ENVIRONMENT	Drilling Discharges	• Non WBM and associated cuttings will not be discharged but recovered and the non WBM reused. All non WBM cuttings will be containerised and shipped to shore for disposal. Non WBM for reconditioning will be containerised and shipped to shore for treatment and subsequently returned offshore for use. • Cuttings and WBM are discharged below sea level (routinely at depth of 11m) in accordance with PSA requirements[4]. • During drilling, WBM is separated from cuttings as far as practicable and re-used. • WBM chemicals are of low toxicity (UK HOCNS "Gold" and "E" categories or equivalent toxicity to those chemicals previously approved for use). • Batches of barite supplied for use in WBM formulations meet applicable heavy metals concentration standards[5]. • No planned discharge of WBM or associated drilling cuttings with chloride concentration greater than permissible PSA standard[6].	• Should any changes to the drilling mud system be required during the predrill programme the Management of Change Process will be followed (Chapter 5 Section 5.11). As a minimum, tests in accordance with Caspian Specific Ecotoxicity Procedures will be undertaken if the WBM composition is changed. • Each batch of barite supplied for use in WBM is tested by the supplier to confirm cadmium and mercury content. • When WBM and cuttings are discharged the chloride concentrations are analysed twice a day. • Monitoring of potential effects on seabed and benthic communities is carried out in accordance with the IEMP (refer to Chapter 14)	• Volumes, composition and characteristics[7] of WBM and cuttings discharged are reported to the MENR. • Discharged WBM and cuttings' chloride concentrations are reported to the MENR. • Volumes, composition and characteristics[7] of non WBM and cuttings used, recovered and shipped to shore are reported to the MENR. • Ecotoxicity WBM test results are submitted to the MENR. • IEMP monitoring results are submitted to the MENR/Environmental Monitoring and Technical Advisory Group (EMTAG).
	Cement Discharges	• Cementing chemicals are of low toxicity (UK HOCNS "Gold" and "E" categories or equivalent toxicity to those chemicals previously approved for use). • Cement is designed to set in a marine environment preventing widespread dispersion. • The volume of cement used to cement each casing is calculated prior to the start of the activity. Sufficient cement is used to ensure that the casing is cemented securely and necessary formations isolated so that this safety and production critical activity is completed effectively while minimising excess cement discharges to the sea.	• Periodic ROV surveys are undertaken during predrill activities including cementing. Excess cement at the seabed is observed and corrective action taken, if required, to ensure cement discharges are minimised. • Monitoring of potential effects on seabed and benthic communities is carried out in accordance with the IEMP (refer to Chapter 14).	• The inventory of cementing fluid additives and the quantity of cementing fluids used for each well is submitted to the MENR. • IEMP monitoring results are submitted to the MENR/EMTAG.

[4] There shall be no unauthorized discharges directly to the surface of the sea. All discharges authorized by these guidelines shall be controlled by discharging into a caisson, whose open end is submerged at all times, a minimum of sixty (60) centimeters below the surface of the sea.
[5] Mercury <1 mg/kg and cadmium <3 mg/kg dry weight (total).
[6] There shall be no discharge of drill cuttings or drilling fluids if the maximum chloride concentration of the drilling fluid system is greater than four (4) times the ambient concentration of the receiving water.
[7] Includes those properties currently reported within the ACG End of Wells reports (e.g. specific weight and rheological properties).

	Category	Existing Controls	Monitoring	External Reporting
MARINE ENVIRONMENT	Cooling Water Intake and Discharges	• The design and operation of the cooling water system has been reviewed and confirmed that the temperature at the edge of the cooling water mixing zone (assumed to be 100m from the discharge point) will be no greater than 3 degrees more than the ambient water temperature[8]. • The biocide dosing system is designed to control biocide to the stated dosage concentrations, i.e. $1cm^3$ added to the pump reservoirs 3 times a minute. • The seawater intake design includes a screen to prevent fish entrainment.	• Biocide dosing levels are checked twice per 24 hours.	
MARINE ENVIRONMENT	Other Discharges (Ballast Water)	• Ballast tanks and drainage systems are designed so that oil and chemicals do not come into contact with ballast water. • Ballast water intake incorporates screens to prevent fish entrainment.	• A ballast logging system is maintained onboard.	
MARINE ENVIRONMENT	Other Discharges (Treated Black Water)	• Black water treated in accordance with MARPOL 73/78 Annex IV MEPC.2 (vi) requirements[9].	• Samples are taken from the MODU sewage discharge outlet and analysed monthly for total suspended solids, faecal coliforms and BOD. • Daily visual checks undertaken when discharging to confirm no floating solids are observable.	• MODU sewage sampling results, recorded daily observations and estimated volumes of treated black water discharged daily (based on POB) are submitted to the MENR.
MARINE ENVIRONMENT	Other Discharges (Grey Water, Galley Waste and Drainage)	• Grey water, deck drainage and washwater onboard the MODU discharged as long as no floating matter or visible sheen is observable. • MODU maceration unit designed to treat food wastes to applicable MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standard prior to discharge[10].	• Daily visual checks undertaken when discharging to confirm no floating solids are observable and no visual sheen.	• Recorded daily observations, estimated volumes of domestic wastes (grey water and galley waste) and drainage discharged daily onboard the MODU are submitted to the MENR.
General		• The MODU and support vessels are included within the scope of periodic environmental reviews. Review findings are summarised in addition to any necessary actions identified.		

[8] The COP Management of Change Process (Section 5.11) will be followed should any change to the design or operation of the cooling water system be required.
[9] 5 day BOD of less than 50mg/l, suspended solids of less than 50mg/l (in lab) or 100mg/l (on board) and fecal coliform 250MPN (most probable number) per 100ml. Residual chlorine as low as practicable.
[10] Macerated to particle size less than 25mm.

9.4 Impacts to the Atmosphere

9.4.1 MODU Power Generation

9.4.1.1 Event Magnitude

MODU power demand and generation is discussed in Chapter 5: Project Description, Section 5.3.3. Table 5.10 presents the estimated volume of emissions due to the operation of the MODU power generators and includes emissions associated with operating the MODU engines during tow-out, positioning and subsequent demobilisation[11].

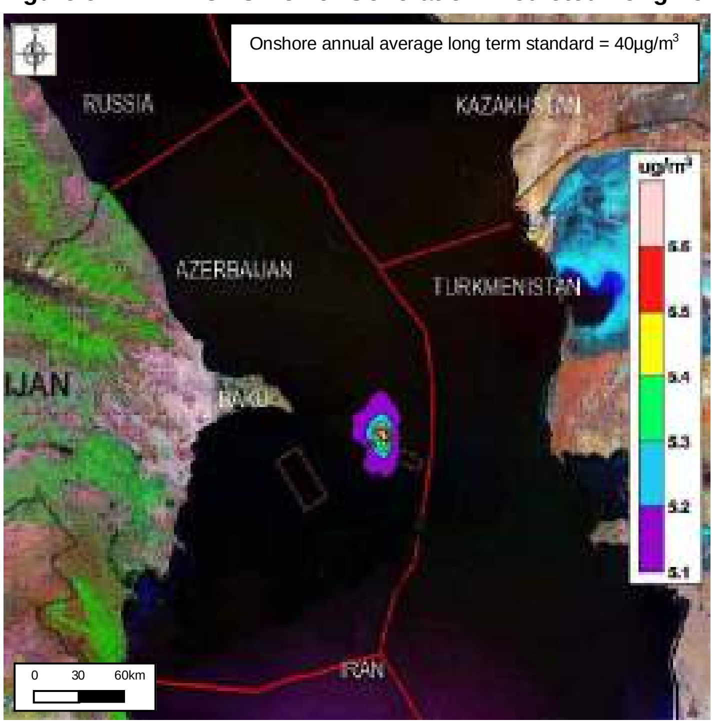
Modelling undertaken for MODU power generation is presented in Appendix 11B. The modelling focuses on NO_X (which comprises nitrous oxide (NO) and nitrogen dioxide (NO_2)) as the main atmospheric pollutant of concern, based on the larger predicted emission volumes as compared to other pollutants (SO_X, CO and non methane hydrocarbons) and the potential to impact upon human health and the environment.

Long term (annual average) NO_2 concentrations were modelled to assess the contribution of emissions from MODU power generation in the context of the relevant standard for NO_2[12]. This standard is relevant to locations where humans are normally resident (i.e. onshore settlements) and do not apply to commercial locations and workers, which are subject to standards under separate occupational health requirements.

The modelling conservatively assumed that, for the long term, all NO_X is converted to NO_2 and a background NO_2 concentration of 5.0µg/m^3 was assumed based on previous monitoring data obtained along the Sangachal coastline (refer to Chapter 6: Section 6.4.2).

The results demonstrated that, during routine predrilling activities, long term concentrations of NO_2 are predicted to increase by 0.5µg/m^3 up to 9km from the MODU, reducing to background concentrations at a maximum distance of 30km to the south and approximately 35km to the north (see Figure 9.1).

Figure 9.1 MODU Power Generation Predicted Long Term NO_2 Concentrations



[11] Appendix 5A presents the assumptions and supporting data used to estimate the emissions.

[12] Applicable annual average (long term) standard for NO_2 is 40µg/m^3.

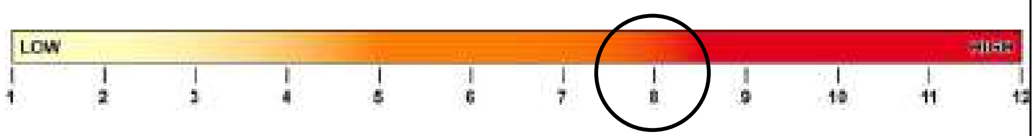
No exceedances of the onshore long term air quality standard at any distance from the MODU and no discernable change in NO_2 concentrations onshore were predicted[13].

Based on efficient operation, regular maintenance, planned use of good quality, low sulphur fuel and previous experience, routine operation of the MODU generators will not result in plumes of visible particulates from the generator exhausts.

Table 9.5 presents the justification for assigning a score of 8 to MODU power generation, which represents a Medium Event Magnitude.

Table 9.5 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Increases in concentrations of pollutant species will be indiscernible from background concentrations at onshore receptors.	1
Frequency	Emissions from MODU power generation will occur continuously during the predrill phase.	3
Duration	Emissions from MODU power generation will be continuous for 22 months.	3
Intensity	Long and short term concentrations of key pollutant, NO_2, are predicted to be significantly below relevant ambient air quality standards.	1
Total		**8**



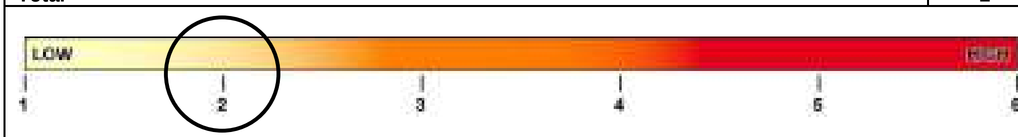
9.4.1.2 Receptor Sensitivity

Human Receptors

Table 9.6 presents the justification for assigning a score of 2 to human receptors, which represents Low Receptor Sensitivity.

Table 9.6 Human Receptor Sensitivity

Parameter	Explanation	Rating
Presence	There are no permanently present (i.e. resident) human receptors within 60km of the predrill location.	1
Resilience	Changes in air quality onshore will be indiscernible. Onshore receptors will be unaffected.	1
Total		**2**



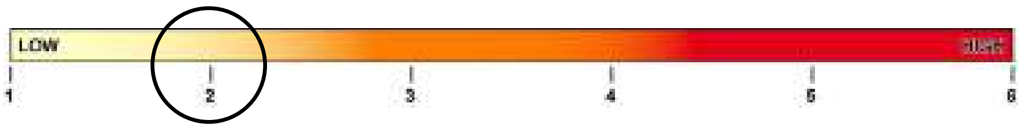
Biological/Ecological Receptors

Table 9.7 presents the justification for assigning a score of 2 to biological/ecological receptors, which represents Low Receptor Sensitivity.

[13] Historically in Azerbaijan ambient concentrations of NO_2, SO_2, CO and PM_{10} have also been assessed against specific 24 hour and 1 hour standards. These standards were not derived using the same health based criteria as the IFC, WHO and EU guideline values and the standards derived are not widely recognised. However, Appendix 11B (Update 1) includes an assessment of expected air quality concentrations against these standards for completeness. The modelling demonstrated that none of these standards would be exceeded during predrill activities.

Table 9.7 Biological/Ecological Receptor Sensitivity

Parameter	Explanation	Rating
Presence	Marine/bird species are mobile and will not be present at one location for long periods of time. The Contract Area is not located within a bird migration flyover route. Birds found in the area will be transient and not resident.	1
Resilience	Volume of emissions released (including visible particulates) will create a very small increase in pollutant concentrations in the atmosphere and in any washout from rainfall, which will not be discernable to biological / ecological receptors[14].	1
Total		**2**



9.4.1.3 Impact Significance

Table 9.8 summarises impacts on air quality associated with MODU power generation during the predrill phase.

Table 9.8 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
MODU Power Generation	Medium	(Humans) Low	**Minor Negative**
		(Biological/Ecological) Low	**Minor Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (refer to Table 9.4) and no additional mitigation is required.

9.4.2 MODU Well Test Flaring

9.4.2.1 Event Magnitude

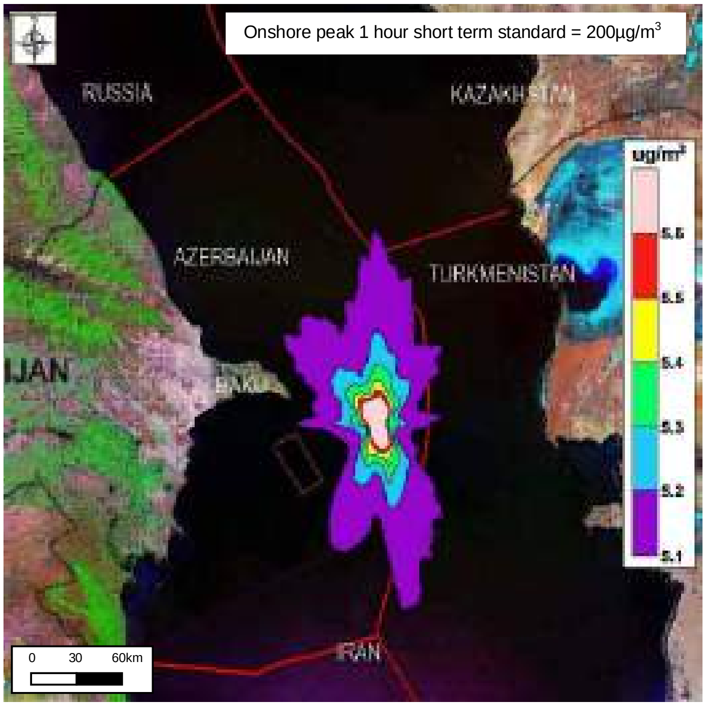
As stated within Chapter 5, Section 5.3.2.8, no routine well testing requiring flaring is planned during the predrill phase; well test flaring will be undertaken by exception only. As a worst case, up to 2 well tests may be undertaken with up to approximately 4,000 barrels of oil and approximately 360 tonnes of gas flared. Based on previous ACG experience, well test flaring would have a duration of approximately 2 days, depending on conditions encountered

Modelling undertaken for non routine MODU well test flaring is presented in Appendix 11B, focusing on key pollutant species, NO_2. Short term (1 hour peak) NO_2 concentrations were modelled to assess the contribution of emissions from well test flaring in the context of relevant standard for NO_2[15]. The modelling conservatively assumed that, for the short term, 50% of NO_X is NO_2 and 50% NO.

The results demonstrated that, during well test flaring, short term concentrations of NO_2 are predicted to increase by 0.6µg/m^3 20km from the MODU, reducing to background concentrations at a maximum distance of 175km to the north and south (see Figure 9.2).

[14] Note that ambient air quality standards are not relevant to biological/ecological receptors.
[15] Applicable 1 hour average (short term) standard for NO_2 is 200µg/m^3.

Figure 9.2 MODU Well Test Flaring Predicted Short Term NO_2 Concentrations

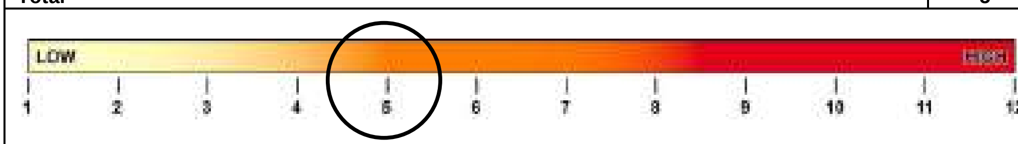


No exceedances of the onshore short term air quality standard at any distance from the MODU and no discernable change in NO_2 concentrations onshore were predicted[13].

Table 9.9 presents the justification for assigning a score of 5, which represents a Medium Event Magnitude.

Table 9.9 Event Magnitude

Parameter	Explanation	Rating
Extent / Scale	Increases in concentrations of pollutant species will be indiscernible from background concentrations at onshore receptors.	1
Frequency	Emissions will occur once.	1
Duration	Emissions will continue for up to 2 days.	2
Intensity	Short term concentrations of key pollutant, NO_2, are predicted to be significantly below relevant ambient air quality standards at the sensitive receptor locations.	1
Total		**5**



9.4.2.2 Receptor Sensitivity

In terms of Emissions to Atmosphere, Receptor Sensitivity is considered to be the same as per Section 9.4.1.2 above; therefore Receptor Sensitivity is Low (2), for both human and biological/ecological receptors.

9.4.2.3 Impact Significance

Table 9.10 summarises impacts on air quality associated with well test flaring during the predrill phase.

Table 9.10 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Well Test Flaring	Medium	(Humans) Low	**Minor Negative**
		(Biological/Ecological) Low	**Minor Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (refer to Table 9.4) and no additional mitigation is required.

9.4.3 Support Vessels

9.4.3.1 Event Magnitude

As stated within Chapter 5 Table 5.9, vessels will be required throughout the predrill phase to supply consumables (e.g. drilling mud, diesel) to the MODU and ship solid and liquid waste to shore for treatment and disposal. Up to 7 support vessels will be required per week[16].

Emissions of the key pollutant species relevant to human health, NOx, are expected to be considerably lower from vessels (approximately 234 tonnes) than those anticipated from worst case WC-PDQ platform emissions for the same period (approximately 1,498 tonnes).

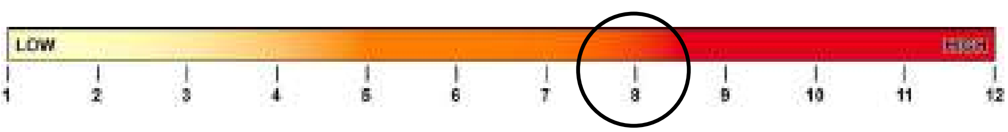
Emissions from vessel movements, which will occur across a relatively large geographic area, are expected to disperse rapidly and will result in increases in NO_2 concentrations that will be indiscernible from background levels at onshore receptors.

Based on efficient operation, regular maintenance, planned use of good quality, low sulphur fuel and previous experience, routine operation of the support vessels will not result in plumes of visible particulates from the vessel engine exhausts.

Table 9.11 presents the justification for assigning a score of 8, which represents a Medium Event Magnitude.

Table 9.11 Event Magnitude

Parameter	Explanation	Rating
Extent / Scale	Increases in concentrations of pollutant species will be indiscernible from background concentrations at onshore receptors.	1
Frequency	Emissions will occur continuously throughout the predrill programme.	3
Duration	Emissions will continue throughout the predrill programme.	3
Intensity	Long and short term concentrations of key pollutant, NO_2, are predicted to be significantly below relevant ambient air quality standards.	1
Total		**8**



9.4.3.2 Receptor Sensitivity

In terms of Emissions to Atmosphere, Receptor Sensitivity is considered to be the same regardless of the Event. As per Section 9.4.1.2 above, Receptor Sensitivity is Low (2) for both human and biological/ecological receptors.

[16] Note that does not include crew change vessels. Refer to Table 9.2 above.

9.4.3.3 Impact Significance

Table 9.12 summarises impacts on air quality associated with support vessels during the predrill phase.

Table 9.12 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Vessel Engines	Medium	(Humans) Low	**Minor Negative**
		(Biological/Ecological) Low	**Minor Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (refer to Table 9.4) and no additional mitigation is required.

9.5 Impacts to the Marine Environment

9.5.1 Underwater Noise & Vibration

9.5.1.1 Event Magnitude

Underwater noise will result from drilling of the predrill wells and vessel movements and has the potential to impact biological/ecological receptors (specifically seals and fish) in the marine environment. An analysis of the propagation of underwater noise has been undertaken in order to estimate distances at which various acoustic impacts on marine species may occur.

As described within the assessment, presented in Appendix 11C, thresholds for fatality and physical injury to marine animals have been developed for different species through experiment based on impulsive sound pressure levels. Based on the data available, the assessment used a conservative approach, assuming the same threshold limits for both seals and fish.

Audiological and behavioural thresholds are a function of the noise level and sound frequency and vary for different species. Given that data does not exist for many species including Caspian specific species, a generic audiogram approach[17] was adopted to develop representative audiological injury and behavioural thresholds for seals and fish (with and without swim bladders) based on proxy species.

The analysis showed that the source noise levels for vessel operations (190 dB re 1µPa at 1m) and drilling (170 dB re 1µPa at 1m) are below the levels at which lethal injury to fish and seals might occur (established as 240 dB re 1µPa), and at which direct physical injury might occur (established as 220 dB re 1µPa).

In terms of auditory injury, permanent deafness could arise in fish and seals if they remained within 8mof a vessel or the wellhead, for a period of 30 minutes or more. Temporary deafness could occur in fish and seals at distances up to 350m from the noise sources; again, only if the animals remained in the vicinity for a period of 30 minutes or more. In practice, it is deemed very unlikely that either of these conditions would be met.

In terms of behavioural reactions, the underwater assessment determined that noise generated by vessel operations would result in complete/strong avoidance by fish with swimbladders at distances up to 3m, and seals at ranges up to 5m and mild avoidance by both fish and seals up to 15m away (Figure 9.3). The range over which underwater noise remains audible to fish and seal depends on background noise levels. In the absence of site specific data two background noise levels were considered; a lower background noise level

[17] Harland E. J., "Measuring Underwater Noise: Perils And Pitfalls", *Proceedings of the Institute of Acoustics*, Vol 30, Pt 5, 2008.

(approximately 80 dB re 1 µPa), characteristic of a deep sea environment dominated by environmental (i.e. wind, rain and wave) noise, and higher background noise level (approximately 120 dB re 1 µPa), characteristic of a marine location where vessels frequently pass and operational offshore drilling platforms are present. Under the lower background noise level scenario, it was calculated that vessel noise would be inaudible to fish with swimbladders and seals beyond 44km from the noise source. Under the higher background noise scenario, it was calculated that vessel and drilling noise would be inaudible beyond 1km.

Figure 9.3 Predicted Distances Within Which Fish and Seals React to Underwater Drilling and Vessel Noise[18]

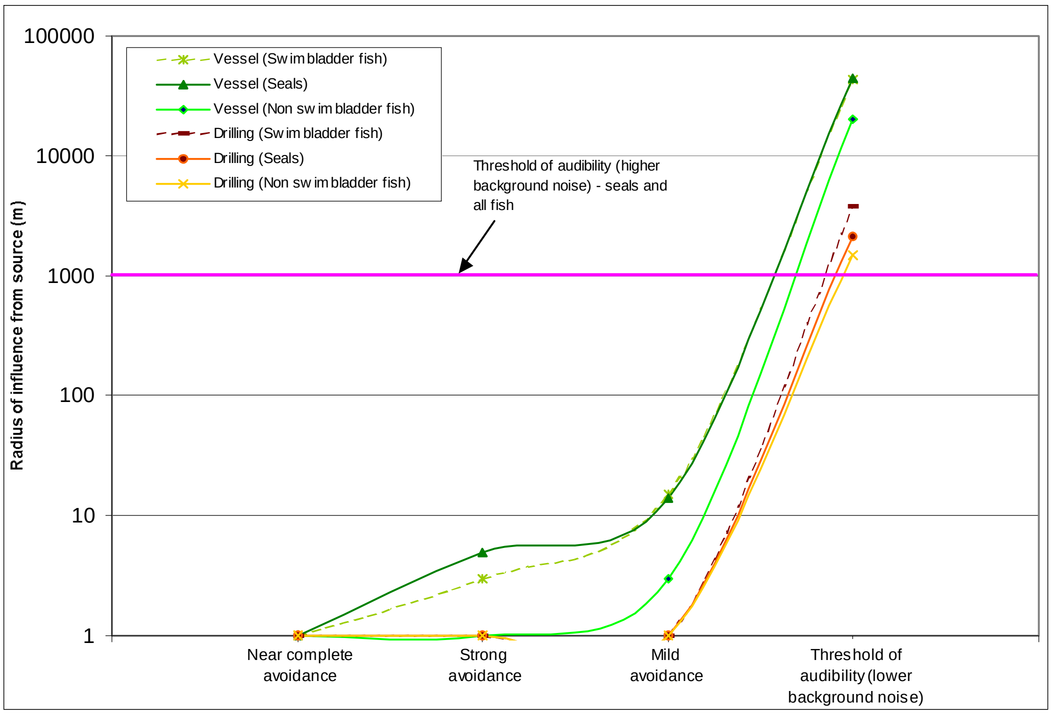
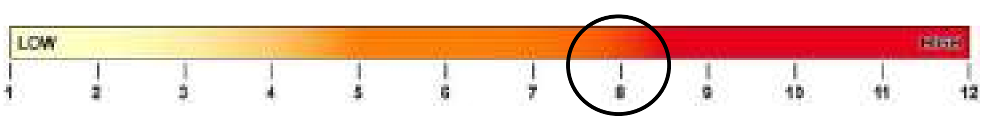


Table 9.13 presents the justification for assigning a score of 8, which represents a Medium Event Magnitude.

Table 9.13 Event Magnitude

Parameter	Explanation	Rating
Extent / Scale	Underwater sound emissions are unlikely to result in an avoidance response from fish/seals beyond 15m from the noise source.	1
Frequency	Underwater sound emissions occur continuously during the predrill phase.	3
Duration	Underwater sound emissions will last for more than one week (over the 22-month predrill phase).	3
Intensity	Taking into account concentration, accumulation and persistence of sound energy in the underwater environment, intensity is low.	1
Total		**8**



[18] Refer to Appendix 11C for source data.

9.5.1.2 Receptor Sensitivity

The only relevant biological receptors to underwater noise are seals and fish[19].

Seals and Fish

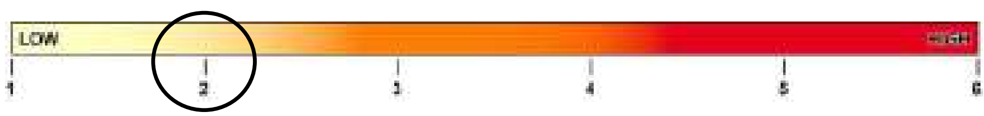
Predrill activities including vessel movements will take place at the WC-PDQ platform location and along support vessel routes from the Logistics Supply Base located at the BDJF yard to the platform location.

Recent data indicates that endangered species such as seals and sturgeon are not common in the ACG Contract Area (Appendix 6B) and the WC-PDQ platform location is not located in an important breeding or migration area for either species. However, Kilka and Mullet are present in the Contract Area.

Table 9.14 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.14 Receptor Sensitivity (Seals and Fish)

Parameter	Explanation	Rating
Resilience	Possibility that species may be temporarily affected by underwater drilling and vessel noise but effect would be short term and limited and ecological functionality will be maintained.	1
Presence	The fish most likely to be present for extended periods of time in the ACG Contract Area and at the WC-PDQ location are Kilka and Mullet throughout the year. However, neither the COP location nor the ACG Contract Area is exclusively used by these species and the Contract Area is not considered to be of primary importance.	1
Total		**2**



9.5.1.3 Impact Significance

Table 9.15 summarises impacts to seals and fish associated with drilling and vessel movements during the predrill phase.

Table 9.15 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Drilling and vessel movements	Medium	(Seals & Fish) Low	**Minor Negative**

The assessment above demonstrates that a Minor Negative impact to seals and fish from drilling and vessel movements is predicted. This is considered to be a conservative assessment, as the modelling demonstrates that underwater sound emissions are unlikely to result in an avoidance response from fish/seals beyond 15m from the noise source. . It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (refer to Table 9.4) and no additional mitigation is required.

[19] Plankton cannot sense the low frequency sound generated because the wavelength is longer than the organism and benthic invertebrates do not have sophisticated sound-sensing apparatus.

9.5.2 Drilling Discharges

9.5.2.1 Event Magnitude

Drilling discharges during predrilling will result from the following:

- **Pilot Hole -** Prior to commencing predrill template drilling, a pilot hole will be drilled with seawater depositing approximately 60m^3 of cuttings within an area where subsequent cuttings from template drilling will also be deposited (see Chapter 5: Project Description, Section 5.3.2.4).

- **36" Conductor Hole** - Following pilot hole drilling, the 36" conductor hole sections for up to a maximum of 20 predrill wells will be drilled with seawater with cuttings discharged directly from the holes to the seabed. The discharge from each conductor section will comprise about 230 tonnes of drilled subsurface material, 20 tonnes of bentonite (a clay) and seawater. As the discharge will occur at the seabed there will be limited dispersion of the drill cuttings.

- **28" Drilling Liner and 26" Surface Holes** - Cuttings from the 28" and 26" hole sections will be discharged from the MODU below surface level. The cuttings will be passed through separation equipment to recover as much drilling mud as possible, but it is estimated that for each well approximately 340 tonnes of mud will be discharged associated with approximately 155 tonnes of cuttings. At the end of each 28"/26" section, a further 160 tonnes of mud may be discharged (see Chapter 5: Project Description, Section 5.3.2.4).

A maximum of 20 predrill wells are planned and the deposition of cuttings and mud discharged during the overall predrill programme has been modelled to assess the area and depth of distribution (Appendix 11D). As the drilling mud contains particles of barite, which are of much higher density than other mud and cuttings material, the deposition of barite has been modelled separately. This has the added benefit of allowing the estimated pattern of barite deposition to be directly compared with the results of environmental monitoring following completion of the drilling programme.

Predrill wells will be drilled sequentially over a 22-month period, with an interval of approximately 1 day between successive wells. Drilling of the 36" and the 28"/26" hole sections will take approximately 30 hours per well per section. The water column Events (i.e. cuttings settlement plumes) will therefore be discrete and separated by periods of 4 to 5 weeks, whilst the seabed Events (i.e. cuttings deposition) will be cumulative.

Monitoring around existing platforms has shown evidence of cuttings (e.g. elevated barium concentrations in sediments) at distances of up to 500m. The discharge modelling reinforces this observation. Table 9.16 indicates that, under stagnant current conditions (0.01 m/s), barite and cuttings will be deposited within 40m of the position of the caisson from the 36", 28" and 26" sections. Under predominant current conditions (0.11 m/s), barite and fine cuttings from the 28"/26" sections will be deposited to a depth of >1mm up to 950m and up to 35m from the 36" sections.

Figure 9.4 indicates that the deposition depth of barite from all 20 of the 28" and 26" sections could, under conditions of constant current direction over the entire drilling programme, be approximately 3 - 4cm at a distance of 500m. Since the drilling programme will last 22 months, it is likely that the 'plume' visualised in Figure 9.4 will change direction with the current, resulting in thinner deposits spread radially in accordance with the currents prevailing during each 30-hour discharge period.

Table 9.16 Summary of Maximum Extent From the Point of Discharge and Area Covered by Sediment Greater than 1mm Thick for the 36" Section (Seabed Discharge) and the 28"/26" Sections (11 m Depth Discharge)

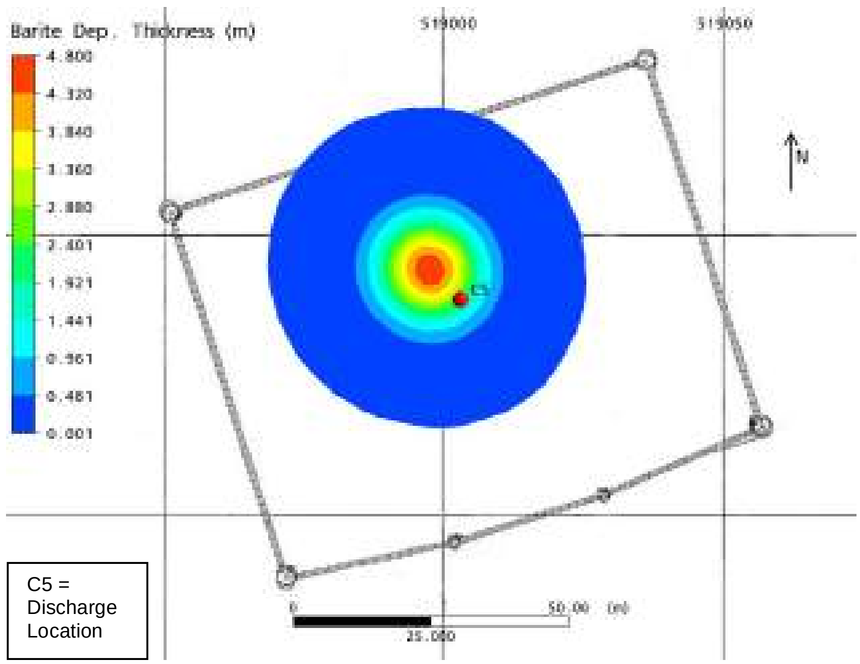
Maximum distance (m) covered by the deposition thickness >1mm (one well)						
Current Conditions	**Barite**		**Large Cuttings**		**Small Cuttings**	
	36"	**28"/26"**	**36"**	**28"/26"**	**36"**	**28"/26"**
Predominant	14	660	21	19	16	0*
Near Stagnant	15	26	21	19	17	22
Area (m^2) covered by the deposition thickness >1mm (one well)						
Current Conditions	**Barite**		**Large Cuttings**		**Small Cuttings**	
	36"	**28"/26"**	**36"**	**28"/26"**	**36"**	**28"/26"**
Predominant	618	19,676	1,421	855	838	0*
Near Stagnant	716	881	1,421	855	956	506
Maximum distance (m) covered by the deposition thickness >1mm (20 wells) **						
Current Conditions	**Barite**		**Large Cuttings**		**Small Cuttings**	
	36"	**28"/26"**	**36"**	**28"/26"**	**36"**	**28"/26"**
Predominant	27	950	34	32	30	835
Near Stagnant	28	38	34	32	31	33
Area (m^2) covered by the deposition thickness >1mm (20 wells) **						
Current Conditions	**Barite**		**Large Cuttings**		**Small Cuttings**	
	36"	**28"/26"**	**36"**	**28"/26"**	**36"**	**28"/26"**
Predominant	2,474	59,768	3,940	2,627	2,975	29,579
Near Stagnant	2,675	2,633	3,940	2,627	3,186	1,782

* For the single well case, there is not enough material accumulated at the seabed to surpass the 1mm thickness threshold, and hence the area covered is zero. A large area of >1mm thickness is observed for both Barite and Small cuttings in the 20 well case, while a small or practically inexistent area is observed for the single well case. This is due to the settling behaviour being affected by the current conditions, physical properties of each deposited material (e.g. size and specific gravity), and the fact that it is being deposited from 11m below the sea level. The latter allows for a considerable amount of horizontal advection and diffusion (spreading) of the particles.

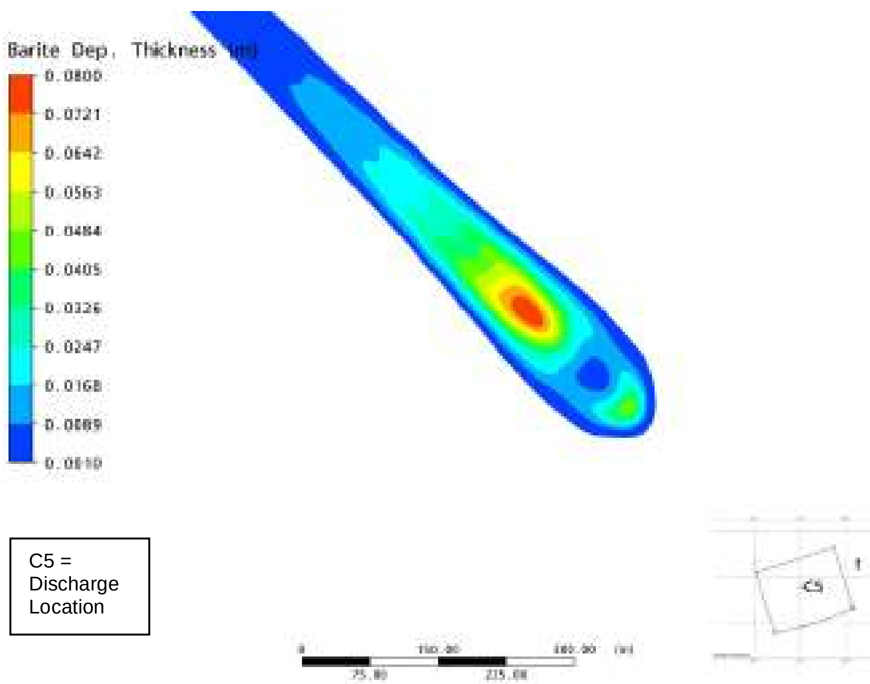
** 36" hole modelling assumed 48 wells and therefore results presented are an overestimate

Figure 9.4 Barite Deposition Thickness Contour Plots (Discharge from 28"/26" Sections at 11m Depth - 20 Wells)

a) Near Stagnant Current Conditions



b) Predominant Current Conditions



Drilling discharges are assigned an intensity score of 1 for the following reasons:

- A large proportion (approximately 50%) of the discharge consists of inert geological material (the cuttings);
- The drilling fluid components are inert or of very low toxicity;
- Only the solid, inert components of the drilling mud will settle to the seabed. Low toxicity soluble components, such as potassium chloride and minor additives, will dilute and disperse in the water column and will have neither acute or persistent effects;
- Evidence from monitoring in the vicinity of drilling operations where WBM cuttings have been discharged shows that there is no accumulation of drilling chemicals and only a very small effect on the benthos within the 'footprint' of the discharge (up to 500m from the drilling location); and
- The drilling fluids have been the subject of comprehensive testing and assessment and have been approved for use by the MENR for existing operations.

Toxicity tests were conducted on the proposed water-based mud formulations in 2007. The tests were carried out using Caspian zooplankton, phytoplankton and sediment-dwelling species, and assessed toxicity in the water column and sediment[20]. The results are summarised in Table 9.17, and indicate that all the WBM formulations were of very low toxicity.

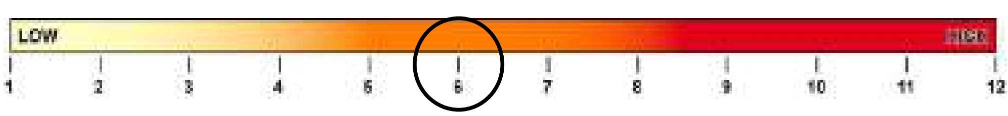
Table 9.17 Seawater Sweeps and Water Based Mud Toxicity Tests (2007)

Mud type	Water column		Sediment
	Zooplankton 48h LC_{50} (mg/l)	Phytoplankton 72h EC_{50} (mg/l)	Amphipod 96h LC_{50} (mg/kg)
Seawater sweeps (36” section)	>32000	>32000	>32000
KCl mud (28 and 26” sections)	>10000	>32000	>32000
Ultradril WBM (28 and 26” sections)	>32000	15591	>32000

Table 9.18 presents the justification for assigning a score of 6, which represents a Medium Event Magnitude.

Table 9.18 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Monitoring has shown evidence of cuttings at distances of up to 500m for other platforms.	1
Frequency	Discharges of WBM and associated cuttings will occur up to 40 times – once for each of the two well sections for each predrill well.	2
Duration	Duration of each discharge event is approximately 30 hours.	2
Intensity	Drilling discharges are considered to be of low intensity due to the composition and evidence from post wells surveys of no accumulation of drilling chemicals and previous toxicity tests.	1
Total		**6**



[20] The species tested were: Zooplankton: *Calanipeda aquae dulcis;* Phytoplankton: *Chaetoceros tenuissimus* and Sediment: *Pontogammarus maeoticus*

9.5.2.2 Receptor Sensitivity

Seals and Fish

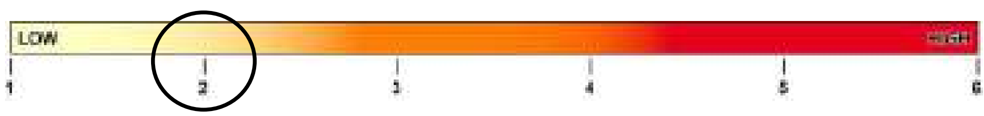
Drilling discharges will intermittently generate turbid plumes of limited duration and dimension. These plumes will not however, generate chemical contamination of the water column and will not occupy a significant proportion of the local water column. It is anticipated that both fish and seals will avoid the plumes.

Recent data indicates that endangered species such as seals and sturgeon are not common in the ACG Contract Area (Appendix 6B) and that the WC-PDQ platform location is not located in an important breeding or migration area for either species. However, Kilka and Mullet are present in the Contract Area.

Table 9.19 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.19 Receptor Sensitivity (Seals and Fish)

Parameter	Explanation	Rating
Resilience	Possibility that species may be temporarily affected by drilling discharges but effect would be short term and limited and ecological functionality will be maintained.	1
Presence	The most likely fish to be present for extended periods of time in the ACG Contract Area and the WC PDQ location are Kilka and Mullet throughout the year. However, neither the WC-PDQ location nor the ACG Contract Area is exclusively used by these species and the Contract Area is not considered to be of primary importance.	1
Total		**2**



Zooplankton

As for fish and seals, the principal potential interaction of drilling discharges with zooplankton is via the intermittent presence of short-duration turbidity plumes. Discharges from the MODU will normally take place at a depth of 11m, which is within the zooplankton productive zone present during spring, summer and early autumn. Cuttings will however, sink rapidly and will not impact a large volume of the productive zone. Unlike fish and seals, zooplankton cannot avoid turbidity plumes, but the dimension of the plume is sufficiently small that the “residence time” of individual organisms within the plume will be too short to cause significant harm.

In recent years, there has been a substantial impoverishment of zooplankton populations, to the extent that, within the Contract Area and across the wider region, the community appears to be permanently dominated by two alien species. Routine surveys across the Contract Area and the wider South Caspian region since 2004, have repeatedly confirmed the absence of native species of copepod. As discussed within Chapter 6: Environmental Description, with reference to detailed survey findings, changes in population and species presence are not considered to be associated with activities within the Contract Area such as drilling discharges, given that survey findings are equivalent across the wider region. None of the species currently present, or historically present, are rare or unique on a regional basis, and there are no observable regional variations across the Contract Area.

Zooplankton has high reproductive rates during spring, summer and autumn and localised populations tend to develop in patches in response to food availability. These patches then decline as local food resources are depleted. Consequently, zooplankton will be highly resilient to the effects of drilling discharges.

Table 9.20 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.20 Receptor Sensitivity (Zooplankton)

Parameter	Explanation	Rating
Resilience	Species or community unaffected or marginally affected.	1
Presence	Species not rare or unique on a regional basis. Species are assessed at the community level only.	1
Total		**2**

Phytoplankton

Phytoplankton populations across the Contract Area show seasonal variation in species dominance but are generally comprised of a small number of characteristic Caspian genera, mainly diatoms and chlorophytes. There is little spatial variation in overall species diversity within the Contract Area.

As with zooplankton, phytoplankton population development tends to be patchy. In areas where nutrient levels are temporarily high, growth will be rapid and dense patches can develop. The development of patches is limited both by local nutrient availability and by zooplankton grazing. Phytoplankton species are therefore well adapted to rapidly changing conditions.

Table 9.21 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.21 Receptor Sensitivity (Phytoplankton)

Parameter	Explanation	Rating
Resilience	Species or community unaffected or marginally affected.	1
Presence	Species not rare or unique on a regional basis. Little spatial variation in overall species diversity.	1
Total		**2**

Benthic Invertebrates

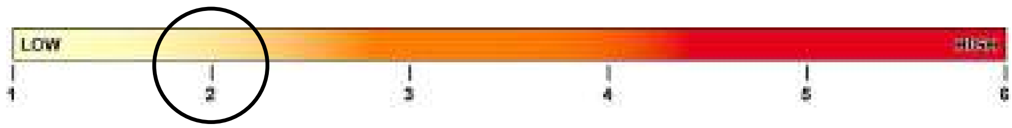
The benthic invertebrate communities in the vicinity of the WC-PDQ platform location are very similar to those across the rest of the Contract Area and the Azerbaijan sector of the South Caspian. There are no rare, unique or endangered species present.

The benthic community is dominated by native amphipod, gastropod, polychaete and oligochaete species, most of which have the potential to reproduce several times a year. With the exception of some bivalves, the dominant taxa are deposit feeders which routinely construct burrows to a depth of 10 cm or more (this is why field surveys take samples to a depth of 10-15 cm). Deposit feeders routinely construct burrows to a depth of 10 cm or more (this is why field surveys take samples to a depth of 10-15 cm). These species are physiologically equipped to construct new burrows through cuttings material deposited in layers of at least similar depth to that which they routinely penetrate during normal burrowing activity. Routine platform monitoring studies undertaken as part of the IEMP provide support for the conclusion that burrowing species can penetrate deposited cuttings, by demonstrating the presence of such organisms in samples taken at locations where barite concentrations indicate the presence of significant amounts of cuttings. In addition the cuttings will be of a similar particle size to their natural sediment, and unlike filter feeders, deposit feeders will not suffer from the clogging of feeding appendages.

Table 9.22 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.22 Receptor Sensitivity (Benthic Invertebrates)

Parameter	Explanation	Rating
Resilience	Species or community unaffected or marginally affected.	1
Presence	No rare, unique or endangered species present. Species are assessed at the community level only.	1
Total		**2**



9.5.2.3 Impact Significance

Table 9.23 summarises impacts to biological/ecological receptors associated with drilling discharges to sea during the predrill phase.

Table 9.23 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Drilling Discharges to Sea	Medium	(Seals & Fish) Low	**Minor Negative**
		(Zooplankton) Low	**Minor Negative**
		(Phytoplankton) Low	**Minor Negative**
		(Benthic Invertebrates) Low	**Minor Negative**

Based on the findings from the surveys as reported in detail within Chapter 6, very limited impact on benthic communities has been observed from existing drilling discharges from predrilling activities and operating platforms. It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (refer to Table 9.4) and no additional mitigation is required.

9.5.3 Cement Discharges

9.5.3.1 Event Magnitude

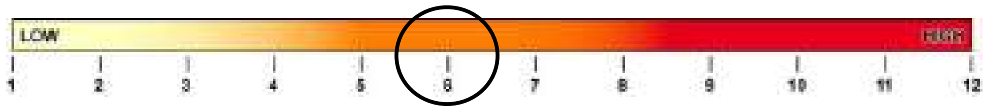
Cement discharge will occur routinely during the cementing of successive well casings. At most, this is estimated to amount to approximately 25 tonnes per well, of which approximately 12 tonnes would be cement, 8 tonnes would be barite, and the remainder would be low toxicity cementing chemicals. Approximately 0.7 tonnes of excess cement of the same composition may also discharged at the end of cementing each of the three well casings. Cementing is described in Chapter 5: Project Description, Section 5.3.2.5.

The event duration will be approximately one hour per casing, and therefore in total about 3 hours per well (although not continuous, since each section has to be drilled before being cemented). The cement is not expected to disperse (being designed to set in a marine environment) and will therefore set in-situ. It is not anticipated that there will be any chemical releases from the cement, which will be effectively chemically inert. The impact of cement discharge will therefore be limited to a small area immediately around the well.

Table 9.24 presents the justification for assigning a score of 6, which represents a Medium Event Magnitude.

Table 9.24 Event Magnitude

Parameter	Explanation	Rating
Extent / Scale	Cement will be deposited only within a few metres of the well.	1
Frequency	Cement discharges will occur 3 times for each of the predrill wells.	3
Duration	Each discharge event will last approximately 1 hour.	1
Intensity	The cement comprises inert materials (cement and barite) and low toxicity chemicals.	1
Total		**6**



9.5.3.2 Receptor Sensitivity

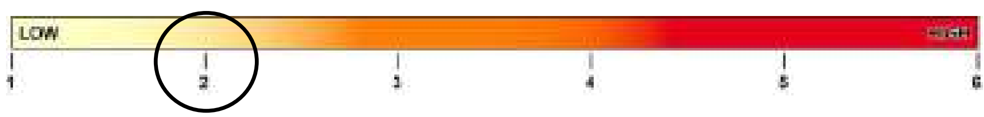
Cement discharges will be confined to a small area of seabed immediately around each well and no chemical releases are anticipated. Consequently, the only biological receptor is the benthic invertebrate community.

Benthic Invertebrates

Table 9.25 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.25 Receptor Sensitivity

Parameter	Explanation	Rating
Resilience	No rare, unique or endangered species at significant risk of exposure, receptor confined to benthic community close to well.	1
Presence	Toxicity and persistence of cement components is low, and cement will set rapidly. Effects will be limited to physical covering of small area of benthos.	1
Total		**2**



9.5.3.3 Impact Significance

Table 9.26 summarises impacts to benthic invertebrates associated with cement discharges during the predrill phase.

Table 9.26 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Cement discharges	Medium	Low	**Minor Negative**

The assessment has demonstrated that a Minor Negative impact to benthic invertebrates is predicted from cement discharges during the predrill phase. Cement chemicals are designed to be of low toxicity, chemically inert and to set in a marine environment. Therefore, only the seabed in the immediate vicinity of the wells will be affected. The Receptor Sensitivity of all marine organisms to cement discharges is considered to be low. It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (refer to Table 9.4) and no additional mitigation is required.

9.5.4 Cooling Water Intake and Discharge

9.5.4.1 Event Magnitude

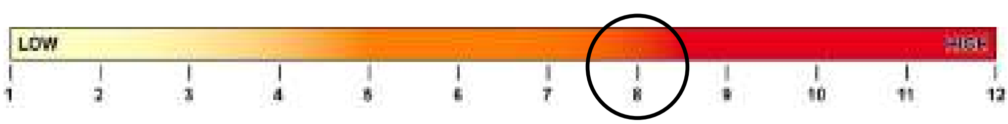
Cooling water will be lifted and discharged routinely during the 22-month predrill phase (refer to Chapter 5, Table 5.9). The intake/discharge rate may be up to 575m^3 per hour corresponding to an average rate of approximately 78l/s. The cooling water will be dosed with biocide onboard the MODU and discharged water will contain a maximum concentration of 270µg/l of Biocide DA, which consists of long-chain diamines. The biocide is readily degradable (78% in standard 28-day OECD test) and will not persist in the environment. Toxicity to marine organisms has been measured and LC_{50} values for fish species are in the range of 1-2mg/l[21]. Applying a conservative safety factor of 100 to the lower value, a no-effect concentration of approximately 10µg/l is estimated. The discharge would therefore require a dilution of 27-fold to reduce the biocide concentration to the conservative no-effect level. Since it is unlikely that any organism would remain permanently in the discharge plume, in practice it is expected that any potential effects would be mitigated at a lower level of dilution and therefore within a few metres of the point of discharge.

The seawater for cooling will be lifted from a depth of 9m and discharged via a caisson 1m above sea level. The intake is shallow and will therefore be at the same ambient temperature as the receiving water at all times of the year. The discharge temperature will be no more than 4-5^oC above ambient temperature and would therefore be compliant with the requirement that temperature at the edge of the cooling water mixing zone, 100m from the point of discharge, to be no greater than 3^oC more than the ambient water temperature. Since the dilution requirement to meet the temperature criterion is less than a factor of 2, it is expected that the requirement will be achieved within 4-5m of the point of discharge.

Table 9.27 presents the justification for assigning a score of 8, which represents a Medium Event Magnitude.

Table 9.27 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Affects an area less than 500m from source.	1
Frequency	Discharge will occur continuously through predrill.	3
Duration	Drilling activities will last for the duration of the predrill phase (22 months).	3
Intensity	Low intensity.	1
Total		**8**



9.5.4.2 Receptor Sensitivity

Cooling water intake velocity will be low and screens installed on the cooling water intake will prevent fish entering the cooling water system. Plankton will however, be entrained due to their small size. The volume flow rate is however, small compared to the water volume in the immediate surroundings of the MODU.

As noted above in Section 9.5.4.1, the area and volume of water within which any potentially harmful exposure might occur, is limited to within a few metres from the point of discharge, meaning the discharge plume would be very small in size. The temperature gradient at the edge of the plume is likely to be reasonably abrupt, provoking an avoidance reaction in fish and seals (although the probability of encounter with the plume for either group is very low based on their expected presence and the plume dimensions).

[21] Biocide DA MSDS.

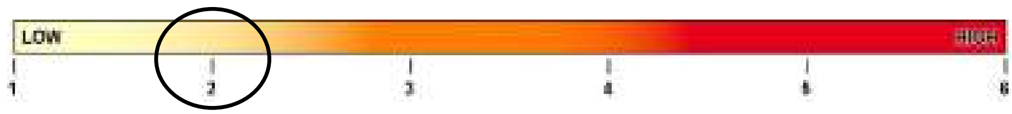
For all plankton, interaction with the plume depends on entrainment from the surrounding water and the process will ensure that individual plankton organisms do not remain in the plume for more than a few tens of seconds.

The cooling water discharge takes place at or immediately below the sea surface and therefore does not have the potential to interact with benthic invertebrates.

Table 9.28 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.28 Receptor Sensitivity (All Receptors)

Parameter	Explanation	Rating
Resilience	Exposure is negligible, so resilience is in effect high.	1
Presence	No significant presence of rare, unique or endangered species.	1
Total		**2**



9.5.4.3 Impact Significance

Table 9.29 summarises the impact of cooling water discharges to sea on seals and fish, zooplankton and phytoplankton based on the impact significance criteria presented in Chapter 3: Impact Assessment Methodology.

Table 9.29 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Cooling Water Discharges to Sea	Medium	(Seals & Fish) Low	**Minor Negative**
		(Zooplankton) Low	**Minor Negative**
		(Phytoplankton) Low	**Minor Negative**

The assessment has demonstrated that Minor Negative impacts to seals, fish, zooplankton and phytoplankton are predicted from cooling water intake and discharge during the predrill phase. Therefore, no additional mitigation beyond existing control measures (refer to Table 9.4) is deemed to be necessary.

9.5.5 Other Discharges

9.5.5.1 Event Magnitude

Other discharges to sea as detailed within Chapter 5, Table 5.9 comprise:

- **Ballast Water** – MODU ballasting activities will consist primarily of:

    - Ballasting the drilling rig for transit to the drilling location – minimum draft configuration for towing, so it may involve near shore discharge of some ballast water if the vessel has been anchored close to shore prior to mobilisation;
    - Taking on ballast water to increase the draft to the drilling configuration once on site;
    - Occasional uptake and discharge of ballast water during drilling operations; and
    - De-ballasting prior to demobilisation once drilling is completed.

  The ballast tanks are designed to ensure that ballast water does not come into contact with oil or chemicals and the intake is screened to prevent fish entrainment. Ballasting is undertaken in accordance with existing ballast water management plans, which include measures designed to avoid introduction of nearshore species offshore and vice versa. Uptake and discharge are therefore anticipated to have negligible environmental impact.

- **Treated Black Water** – Black water will be treated in accordance with MARPOL 73/78 Annex IV (as revised in 2004) and sludge shipped to shore. Based on 120 POB and an expected generation rate of $0.1m^3$/person/day, approximately $12m^3$ of treated effluent will be discharged per day during predrill. The flow rate is low, so the effluent will be rapidly diluted close to the point of discharge. The discharge of biologically treated black water offshore, including total suspended solids at the proposed treatment level, does not pose any risk of environmental impact.

- **Grey Water** - Grey water (approximately $26m^3$ per day) will be discharged directly to sea. Grey water (from showers, laundry etc) will contain primarily dilute cleaning agents (soaps and detergents) and the impact of discharge will be minimal.

- **Drainage -** Drainage including deck drainage and washwater) will be discharged via the open-drains system. Deck runoff including WBM spills collected via rig floor drains will be recycled to mud system or if not possible for technical reasons, diluted and discharged to sea (>60cm from sea surface) in accordance with applicable PSA requirements[22]. Oily water and bilge water will not be discharged, but contained on board the MODU and shipped to shore.

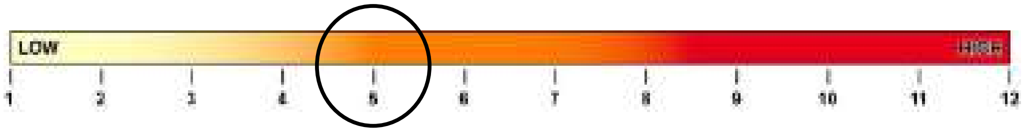
Event Magnitude is summarised in Table 9.30.

[22] There shall be no discharge of drill cuttings or drilling fluids if the maximum chloride concentration of the drilling fluid system is greater than 4 times the ambient concentration of the receiving water.

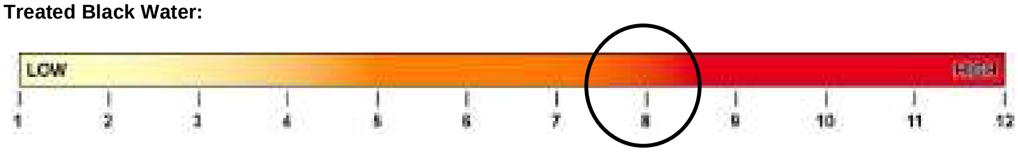
Table 9.30 Event Magnitude

Event Parameter / Discharge	Ballast Water	Treated Black Water	Grey Water	Drainage
Scale	1	1	1	1
Frequency	2	3	3	3
Duration	1	3	3	3
Intensity	1	1	1	1
Event Magnitude	**5**	**8**	**8**	**8**

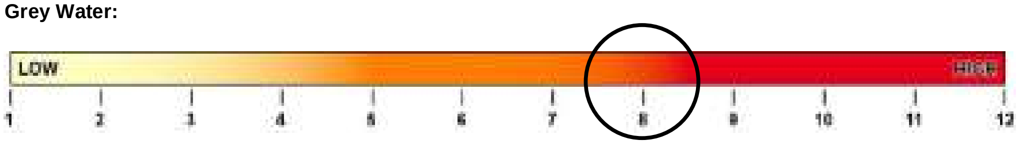
Ballast Water:



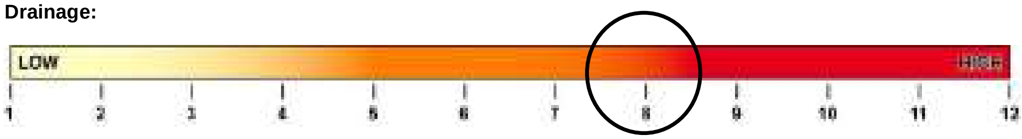
Treated Black Water:



Grey Water:



Drainage:



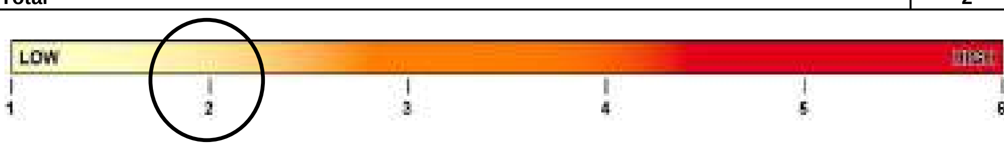
9.5.5.2 Receptor Sensitivity

All of the discharges are low in volume, do not contain toxic or persistent process chemicals and are considered to pose no threat to the environment or the identified biological/ecological receptors.

Table 9.31 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 9.31 Receptor Sensitivity (All Receptors)

Parameter	Explanation	Rating
Resilience	The extremely low level of exposure is equivalent to high resilience.	1
Presence	There is no significant presence of rare, unique or endangered species (i.e. the risk of exposure for any such species is close to zero).	1
Total		**2**



9.5.5.3 Impact Significance

Table 9.32 summarises the impact of other discharges to sea on seals and fish, zooplankton, phytoplankton and benthic invertebrates based on the impact significance criteria presented in Chapter 3: Impact Assessment Methodology.

Table 9.32 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Other Discharges to Sea **Ballast Water**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Treated Black Water**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Grey Water**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Drainage**	Medium	(All Receptors) Low	**Minor Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (refer to Table 9.4) and no additional mitigation is required.

9.5.6 Seabed Disturbance

9.5.6.1 Event Magnitude

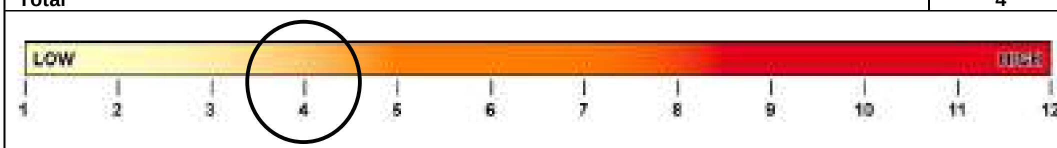
Positioning of the MODU will involve temporary disturbance of the seabed due to the anchoring of the drilling rig (Refer to Chapter 5, Section 5.3.2.2).

The area of seabed affected by the anchors and anchor chains is expected to be very small (approximately 12,800m^2) in the context of the Contract Area. In practice, it is likely that the majority of organisms within this area would be sufficiently mobile to re-establish themselves in close vicinity to the anchor locations. The presence of the anchors will therefore, render a small area of seabed unavailable to benthic organisms for the duration of the predrill programme. However, this would have no measurable effect on local benthic productivity.

Table 9.33 presents the justification for assigning a score of 4, which represents a Low Event Magnitude.

Table 9.33 Event Magnitude

Parameter	Explanation	Rating
Extent/ Scale	Disturbance will be limited to areas of anchor setting.	1
Frequency	Once.	1
Duration	Disturbance event will be of short duration.	1
Intensity	Physical disturbance only, within small areas and no potential for lasting damage.	1
Total		**4**



9.5.6.2 Receptor Sensitivity

Fish, seals and plankton are not considered to be sensitive to physical seabed disturbance of this type and magnitude. Benthic invertebrates are the primary receptor, but the nature of the disturbance is largely limited to temporary physical displacement.

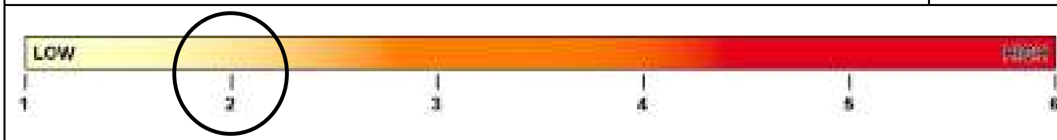
The primary impact associated with anchor setting and chain drag will be the disturbance and displacement of the sediment. The organisms living in the sediment are too small to be crushed by anchor and chain drag, although a small degree of mortality might occur at the point where the anchor initially impacts the seabed.

The displacement of sediment will not cause significant levels of mortality in benthic organisms. A small proportion of animals may be buried too deeply to recover to a position near the sediment surface, but the majority of organisms will be able to re-establish themselves once the anchors and chains have been removed.

Table 9.34 presents benthic invertebrates' Receptor Sensitivity.

Table 9.34 Receptor Sensitivity (Benthic Invertebrates)

Parameter	Explanation	Rating
Presence	No unique, rare or threatened benthos species present.	1
Resilience	Physical displacement of organisms will have limited short-term effects and is not predicted to cause significant long-term damage.	1
Total		**2**



9.5.6.3 Impact Significance

Table 9.35 summarises the impact of seabed disturbance associated with predrill activities to benthic invertebrates based on the impact significance criteria presented in Chapter 3: Impact Assessment Methodology.

Table 9.35 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Seabed disturbance from anchor handling	Low	Low	**Negligible**

It is considered that impacts are minimised as far as practicable and necessary and no mitigation is required.

9.6 Summary of COP Predrill Phase Residual Environmental Impacts

For all predrill phase environmental impacts assessed, it has been concluded that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 9.4) and no additional mitigation is required.

Table 9.36 summarises the residual environmental impacts for the predrill phase of the project.

Table 9.36 Summary of Predrill Residual Environmental Impacts

	Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from mobile drilling rig power generation	Medium	Low	**Minor Negative**
	Emissions from well test flaring	Medium	Low	**Minor Negative**
	Emissions from support vessel engines	Medium	Low	**Minor Negative**
Marine Environment	Underwater noise from drilling and vessel movements	Medium	Low	**Minor Negative**
	Drilling discharges	Medium	Low	**Minor Negative**
	Cement discharges	Medium	Low	**Minor Negative**
	Vessel and drilling rig cooling water discharge	Medium	Low	**Minor Negative**
	Vessel and drilling rig ballast water discharge	Medium	Low	**Minor Negative**
	Vessel and drilling rig treated black water discharge	Medium	Low	**Minor Negative**
	Vessel and drilling rig grey water discharge	Medium	Low	**Minor Negative**
	Vessel and drilling rig drainage discharges	Medium	Low	**Minor Negative**
	Seabed disturbance from anchor handling	Low	Low	**Negligible**

10. Construction, Installation, Hook-Up & Commissioning Impact Assessment, Mitigation and Monitoring

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10.1 Introduction

This Chapter of the Chirag Oil Project (COP) Environmental and Socio-Economic Impact Assessment (ESIA) presents the assessment of environmental impacts associated with the following COP phases:

- Onshore Construction and Commissioning of Offshore Facilities;
- Infield Pipeline Installation, Tie-in and Commissioning; and
- Platform Installation, Hook Up and Commissioning (HUC).

The impact assessment methodology followed and the structure of the COP impact assessment are described in full within Chapters 3 and 9 of this ESIA respectively.

10.2 Scoping Assessment

The COP Construction, Installation and HUC Activities and Events have been determined based on the COP Base Case, as detailed within Chapter 5: Project Description (see Appendix 10A).

Table 10.1 presents the Activities and associated Events that have been scoped out of the full assessment process due to their limited potential to result in discernable environmental impacts. Judgement is based on prior experience of similar Activities and Events, especially with respect to earlier ACG developments. In some instances, scoping level quantification/numerical analysis has been used to justify the decision. Reference is made to relevant quantification, analysis, survey and/or monitoring reports in these instances.

Table 10.1 "Scoped Out" COP Construction, Hook Up and Commissioning Routine and Non-routine Activities

ID *	Activity / Event	Ch. 5 Project Description Reference	Justification for "Scoping Out"
Con-NR1	Potential yard upgrades /expansion	5.4.2	• Yard extensions, if required, will involve minimal land-take of industrial land adjacent to existing established construction yards. • Yard upgrade works (e.g. systems refurbishment) will be undertaken within existing site buildings/waste/storage areas and works (including possible ground works) will be of limited scope. • Noise from upgrade works will not exceed relevant standards at the nearest residential receptors to yards.[1] • Vessel upgrade work will be completed at an existing port facility. • All yard extension and vessel upgrade work will be undertaken in accordance with site HSE plans that include: ○ Waste management plans; ○ Hazardous materials management and spill prevention procedures; ○ Discharge management plans[2]; and ○ Community disturbance management plans (if relevant) [3]. • An overview of the management system that will be used to manage construction environmental issues (including upgrade works) is provided in Chapter 14. • The potential land acquisition process, if required, is discussed in Chapter 12: Socio-Economic Impact Assessment. • **Conclusion:** Works will be of limited scope and short duration and will be undertaken in accordance with site HSE plans, resulting in negligible impacts to residential receptors and the terrestrial and marine environment.
Con-R2	STB01, PLBG and DBA upgrade works		
Con-R6	Construction yard utilities (drainage/ sewage)	5.4.10.2	• Sewage will either be treated by a sewage treatment plant at the construction yard(s) or collected onsite and transferred by road tanker or by sewer pipes to a municipal sewage treatment plant for treatment and disposal. If sewage is treated and discharged from a construction yard, the construction yard contractor will be responsible for agreeing and maintaining the discharge permit for sewage with the MENR.[4] • Contaminated drainage water will be collected and delivered to an appropriate licensed waste management contractor in accordance with the site waste management procedure[5]. • Uncontaminated rainwater will be discharged directly to the onshore/marine environment. • **Conclusion:** Discharge of treated sewage from the construction yards will be in accordance with MENR requirements.
Pip-R3	Installing concrete mats on the seabed in areas of soft sediment /free spans to support the subsea infield pipelines	5.5.2	• Concrete will be chemically inert and, based on previous ACG experience; mats will only affect very small areas of seabed in the context of the South Caspian. • **Conclusion:** Limited potential for disturbance to the seabed and no discernable impact to the marine environment.

[1] Refer to noise screening assessment (Appendix 10C) and Section 10.5.1 below.
[2] MENR approval is required for any discharge (except storm water) not detailed in this ESIA or not subject to a separate permitting process (e.g. discharge of treated sewage). The impact of the discharge on the environment and appropriate monitoring procedures will be submitted to the MENR for approval prior to the commencement of the activity.
[3] If yards other than BDJF are used.
[4] Including agreeing discharge standards and maintaining the discharge permit conditions stipulated by the MENR.
[5] Waste and spill management plans and procedures are discussed within Chapter 14.

ID *	Activity / Event	Ch. 5 Project Description Reference	Justification for "Scoping Out"
Ins-R3	Topside installation vessel operations - STB-01 and support vessels	5.6.3	• Scheduled to take less than one week in good weather conditions. • Vessel systems are designed to treat sewage, galley waste and deck drainage to applicable standards and discharge: ○ Black water: MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards[6] ○ Galley waste: Macerate to MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standard[7] ○ Deck drainage and wash water may be discharged as long as no visible sheen is observable. • No other planned discharges to the marine environment except for ballast water, vessel cooling water and approximately 35m^3 of uncontaminated sand. • **Conclusion:** Vessels are designed to discharge effluent/runoff in accordance with relevant standards determined for the protection of the marine environment. No discernable impact on the marine environment expected.
HUC-R2	Installation of buy back valve control system	5.6.4	• Plan to recover hydraulic fluids during buy back valve installation. • If not practicable for technical/safety reasons, discharge 0.1 litres of water/glycol based fluids of the same specification and environmental performance as used for previous ACG hydraulic control systems to the marine environment. • Small volume will disperse in minutes so little potential for acute toxicity in exposed organisms. • The fish most likely to be present for extended periods of time in the ACG Contract Area and at the WC PDQ location are Kilka and Mullet that may be present throughout the year. However, the ACG Contract Area, including the COP location, are not exclusively used by these species and the Contract Area is not considered to be of primary importance. • **Conclusion:** Limited potential for discernable impact on the marine environment.
HUC-R3	Offshore commissioning of the WC-PDQ deluge system	5.6.4	• Discharge of seawater via the WC-PDQ open drains caisson at 49.5m below sea level. • **Conclusion:** No chemical/temperature change in seawater and hence no expected impact from discharge.
HUC-R4	Offshore commissioning of the WC-PDQ foam system	5.6.4	• Discharge of approximately 20 litres of AFFF with 140m^3 of seawater via the WC-PDQ open drains caisson at 49.5m below sea level. • The current foam used by the AzSPU is of very low toxicity (LC_{50} 2.8 g/l for fish, 34.8 g/l for Daphnia) • Readily degradable (28-day degradation 92%) and no bioaccumulation potential. • Small volume will disperse in minutes so little potential for acute toxicity in exposed organisms. • 20 litres of AFFF would require only about 1,500m^3 of seawater to dilute to 96h no-effect level (a volume with an approximate radius of 7m). • The fish most likely to be present for extended periods of time in the ACG Contract Area and at the WC PDQ location are Kilka and Mullet that may be present throughout the year. However, the ACG Contract Area, including the COP location, are not exclusively used by these species and the Contract Area is not considered to be of primary importance. • **Conclusion:** Limited potential for discernable impact on the marine environment.
HUC—R5	DWG-PCWU brownfield works – diving support	5.6.5	• Vessel systems are designed to treat sewage, galley waste and deck drainage to applicable standards and discharge: ○ Black water: MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards[7] ○ Galley waste: Macerate to MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standard[8] ○ Deck drainage and wash water may be discharged as long as no visible sheen is observable.

[6] 5 day BOD of less than 50mg/l, suspended solids of less than 50mg/l (in lab) or 100mg/l (on board) and coliform 250MPN (most probable number) per 100ml. Residual chlorine as low as practicable.
[7] Macerated to particle size less than 25mm.
[8] The implications of DWG-PCWU shutdown required for brownfield works will be reviewed once the shutdown programme/procedure has been finalised. The results of this review will be communicated to the MENR.

ID *	Activity / Event	Ch. 5 Project Description Reference	Justification for "Scoping Out"
	vessels[8]		• No other planned discharges to the marine environment except for ballast water and vessel cooling water. • **Conclusion:** Vessel systems designed to discharge effluent/runoff in accordance with relevant standards determined for the protection of the marine environment. No discernable impact on the marine environment expected.
Con-R8 **Pip-R5** **Ins-R4** **HUC-R6**	Waste Generation	5.4.10.3 5.6.7.3	• Waste generated during these phases of the COP project will be consistent with the types of waste generated for the ACG Phase 1-3 projects, but of reduced quantity. • Waste will be segregated at source, stored and transported in fit for purpose containers. • CWAAs at the main construction yards (ATA and BDJF) developed to support the ACG Phase 1-3 projects will be used as the main reception and consolidation points for construction phase solid waste, depending on the construction yards used. • Waste will be managed in line with the principles described in Chapter 14 and will benefit from the operational experience gained from the ACG Phase 1-3 projects and continuing AIOC operations. • Waste minimisation and management plans will be established and all waste transfers controlled and documented. • BP will manage the collection, transportation, treatment, disposal and storage of waste generated during construction, installation and HUC via specialised approved waste management contractors - the destinations of the waste types is provided in Chapter 5. • **Conclusion:** Waste will be managed as described within Chapter 14. No discernable impact to the terrestrial or marine environment expected.

* Key: Con = Onshore Construction, Pip = Pipeline Installation, Tie in and Commissioning, HUC = Platform Hook Up and Commissioning, Ins = Platform Installation

The COP routine and non-routine Activities and their associated Events further assessed in accordance with the full impact assessment process are presented in Table 10.2.

Table 10.2 "Assessed" COP Construction, Installation, Hook Up and Commissioning Routine and Non-routine Activities & Interactions

ID *	COP Activity	Ch. 5 Project Description Reference	Event	Receptor
Con R3	Use of yard plant (generators and engines) during jacket, topside and drilling module fabrication and topside commissioning	5.4.4 – 5.4.7 & 5.4.9	Emissions to atmosphere (non GHG)	Atmosphere
			Onshore noise	Terrestrial Environment (Onshore Noise)
Con-R4	Use of yard cooling water system during onshore topside commissioning	5.4.8.1	Cooling water discharges to sea	Marine Environment
Con-R5	Commissioning of main platform generators and topside utilities	5.4.8	Emissions to atmosphere (non GHG)	Atmosphere
			Onshore noise	Terrestrial environment (Onshore Noise)
Pip-R1	Vessel operations – pipelay barge, anchor handling vessels and pipe supply barge	5.5.2	Emissions to atmosphere (non GHG)	Atmosphere
			Other discharges to sea	Marine Environment
			Underwater noise and vibration	
Pip-R2	Installing new oil pipeline wye and infield pipelines on seabed	5.5.2 & 5.5.4	Seabed disturbance - benthos	Marine Environment
Pip-R4	Infield pipeline cleaning, hydrotesting and dewatering	5.5.5, 5.5.5 & 5.5.6	Hydrotest discharges to sea	Marine Environment
			Other discharges to sea	
Ins-R1	Jacket installation vessel operations - STB-01, DBA and support vessels	5.6.2	Underwater noise and vibration	Marine Environment
			Other discharges to sea	
			Emissions to atmosphere (non GHG)	Atmosphere
Ins-R2	Foundation piling and grouting for jacket	5.6.2	Seabed disturbance - benthos	Marine Environment
			Underwater noise and vibration	
			Cement discharge to sea	
HUC–R1	WC-PDQ platform commissioning	5.6.4	Events associated with platform HUC are included within Chapter 11	-

* Key: Con = Onshore construction and commissioning, Pip = Pipeline Installation, Tie in and Commissioning, HUC = Platform Hook Up and Commissioning, Ins = Platform Installation
Note: GHG Emissions are addressed in Chapter 13

10.3 Existing Controls, Monitoring and Reporting

Construction and installation works will be tendered to contractors, who will be provided with detailed information on BP and AzSPU environmental and social expectations and standards. They will be required to establish and operate Environmental and Social Management Systems throughout the construction and installation phases (see Chapter 14) that encompass the control provided in Table 10.3.

Table 10.3 COP Construction, Installation and HUC Existing Controls, Monitoring and Reporting

	Category	Existing Controls	Monitoring	External Reporting
ATMOSPHERE	Emissions to atmosphere (non GHG) from construction yard emission sources, onshore platform generator commissioning and vessel generators and engines	• Construction yard generators and engines are subject to planned maintenance in accordance with written procedures based on the manufacturer's guidelines or applicable industry code or engineering standard to ensure efficient and reliable operation and exhaust emissions testing is undertaken at least annually in accordance with the relevant PSA requirement[9]. • During platform commissioning, diesel is routinely supplied for main generator commissioning from the diesel tank farm. • Community disturbance management and engagement plans will be implemented and maintained as a mechanism of communicating with the community and responding to community grievances at the selected yard(s) except BDJF (where there are no nearby residential receptors). • All platform generators are operated for a minimum duration to complete commissioning. • Where practicable, mains electricity or yard generators are used during commissioning. • Support vessels used during installation and HUC are routinely supplied with diesel from the tank farm which complies with MARPOL Annex VI Regulations for the Prevention of Air Pollution from Ships[10].	• Emissions testing of exhausts to confirm that the NO_X, SO_X and CO emissions are at the specified levels (i.e. the levels and tolerances determined by the equipment manufacturer which confirm efficient operation) and confirm maximum concentrations do not exceed relevant standards[11]. Monitoring is undertaken in accordance with the existing AzSPU methodologies and procedures aligned with US EPA and ISO stack emissions measurement and calibration requirements. • Diesel samples are taken regularly to confirm diesel quality following onshore treatment.	• Emission volumes based on fuel usage are calculated and submitted to the MENR and SOCAR at an agreed frequency.

[9] IC engines/turbines larger than 500 HP should be monitored on an annual basis to assure that the NO_X and CO emissions are at the specified levels.
[10] Sulphur content of 3.5%, effective from 1 January 2012.
[11] SOx maximum concentration of 400 mg/Nm^3 and NOx maximum concentration of 1,000 mg/Nm^3.

	Category	Existing Controls	Monitoring	External Reporting
TERRESTRIAL NOISE ENVIRONMENT	Construction yard plant and platform generator commissioning noise	• Steel works are planned to be undertaken in fabrication sheds, where practicable and feasible. • Grit blasting is planned to be undertaken in sheds or within enclosures where practical. • Plant/machinery is operated and maintained in accordance with written procedures based on the manufacturer's guidelines or applicable industry code or engineering standard. • All platform generators are operated for a minimum duration to complete commissioning. • Where practicable, mains electricity or yard generators are used during commissioning. • Community disturbance management and engagement plans will be implemented and maintained as a mechanism of communicating with the community and responding to community grievances at the selected yard(s) except BDJF (where there are no nearby residential receptors). • The main platform generators incorporate appropriate noise reduction measures[12], and are housed in a generator room/sound reduction enclosure to safeguard the health and safety of personnel on the platform.	• At yards other than BDJF (where there are no nearby residential receptors), a noise baseline survey and monitoring programme will be undertaken. Monitoring will be completed on a monthly basis during the day time and at night (if a night shift is worked at the site), at the boundary of the selected construction yards and potentially within the communities. • The noise monitoring programme described above will include at least one round of noise monitoring when platform generator commissioning is being undertaken.	• Results from noise monitoring surveys will be provided to nearby communities through the community engagement process that will be managed by the construction contractor.
MARINE ENVIRONMENT	Construction Yard Cooling Water Discharge	• The system will be designed to meet a temperature specification for the discharge at the edge of the mixing zone, or 100m if a mixing zone is not defined, no greater than 3 degrees more than the ambient water temperature. • Neutralising agent dosing will be controlled and checked to ensure neutralisation is effective and residual chlorine content is maintained at less than 1mg/l.	• Neutralising agent flow and dose pump records will be maintained. • Weekly sampling and analysis of the residual chlorine content of the discharge will be undertaken.	• Flow and dose pump records and weekly chlorine content sampling results will be managed by the construction contractor and submitted to the MENR
MARINE ENVIRONM	Pipeline Cleaning and Hydrotest Discharges	• Hydrotest water will be dosed with chemicals which are not environmentally persistent and which degrade readily both in the pipeline and the marine environment. • Biocide, oxygen scavenger and tracer dye products planned to be used include chemicals, which have been subject to risk assessments and approved by the MENR. ○		

[12] Measures include acoustic lagging of combustion air inlet ducting and exhaust ducts and fitting of a suitable splitter silencer to the gas turbine combustion air intake vent.

	Category	Existing Controls	Monitoring	External Reporting
	Discharges from cementing of the jacket pile sleeves	• Cementing chemicals are of low toxicity (UK HOCNS "Gold" and "E" categories or equivalent toxicity to those chemicals previously approved for use). • Cement is designed to set in a marine environment preventing widespread dispersion. • The volume of cement used to cement jacket piles into position is calculated prior to the start of the activity. Sufficient cement is used to ensure that the piles are cemented securely while minimising excess cement discharges to the sea.	• Periodic ROV surveys are undertaken during installation activities. Excess cement at the seabed is observed and corrective action taken if required to ensure that cement discharges are minimised. • Monitoring of potential effects on seabed and benthic communities is carried out in accordance with the IEMP (refer to Chapter 14).	• IEMP monitoring results are submitted to the MENR/ EMTAG.
	Noise from jacket piling	• The frequency of pile driving will be gradually increased to minimise underwater noise impacts to marine species.		
MARINE ENVIRONMENT	Other Discharges (Ballast Water)	• Vessel ballast tanks are designed to ensure that oil and chemicals do not come into contact with ballast water.	• Monitoring of potential effects on the water column is carried out in accordance with the IEMP (refer to Chapter 14).	• IEMP monitoring results are submitted to the MENR/ EMTAG.
	Other Discharges (Treated Black Water/Galley Waste)	• Vessel black water treated in accordance with MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards[13] . • Galley waste macerated to MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standard[14]	• Samples are taken from the sewage discharge outlet and analysed monthly for total suspended solids, faecal coliforms and BOD. • Residual chlorine content is measured daily. • Daily visual checks undertaken when discharging to confirm no floating solids are observable.	• Sewage sampling results, recorded daily observations and estimated volumes of treated black water discharged daily (based on POB), are submitted to the MENR.

[13] 5 day BOD of less than 50mg/l, suspended solids of less than 50mg/l (in lab) or 100mg/l (on board) and fecal coliform 250MPN (most probable number) per 100ml. Residual chlorine as low as practicable.
[14] Macerated to particle size less than 25mm.

Category	Existing Controls	Monitoring	External Reporting
Other Discharges (Deck drainage and washwater)	• Deck drainage and wash water may be discharged as long as no visible sheen is observable.	• Daily visual checks undertaken when discharging to confirm no visible sheen	
General	• Support vessels are subject to periodical performance review which include environmental performance. Corrective actions would be taken to address any performance gaps		

10.4 Impacts to the Atmosphere

10.4.1 Construction Yard Emission Sources

10.4.1.1 Event Magnitude

As stated within Chapter 5: Section 5.4, the WC-PDQ topside, jacket and drilling module will be constructed at a combination of established construction yards. At present, the options that are being considered for the construction and commissioning of the WC-PDQ topside and drilling support module include:

- BDJF yard;
- Zykh yard; and
- Bibi Heybet/South Dock yards[15].

It is intended that the WC-PDQ jacket will be constructed at the BDJF yard.

At each yard, the majority of power required for construction activities such as steel cutting, rolling and shaping will be provided from the Azerbaijan national grid. Onsite plant and equipment used including cranes, generators and vehicles, will consume diesel and gasoline resulting in emissions to atmosphere (refer to Appendix 5A).

A dispersion modelling assessment was undertaken to assess the potential magnitude of impacts from onshore construction phase emissions to any nearby receptors (see Appendix 10C). The assessment was based on an estimated diesel consumption by construction yard plant of 8.5 tonnes per day (sourced from records from previous ACG projects) and assumed plant was distributed evenly across the construction yard. The assessment considered NO_2 emissions, comparing the short term and long term average modelled concentrations at ground level to applicable air quality standards for the protection of human health[16]. Modelling of SO_2 and particulates was not deemed necessary as concentrations are expected to be very low based on efficient plant operation, regular maintenance and planned use of good quality, low sulphur diesel.

Wind conditions were determined from recent data available from the meteorological station at Baku and typical, high and low speed wind conditions were assessed. To assess a realistic worst case, emissions were modelled based on topside and drilling module construction being undertaken simultaneously at the same yard[17].

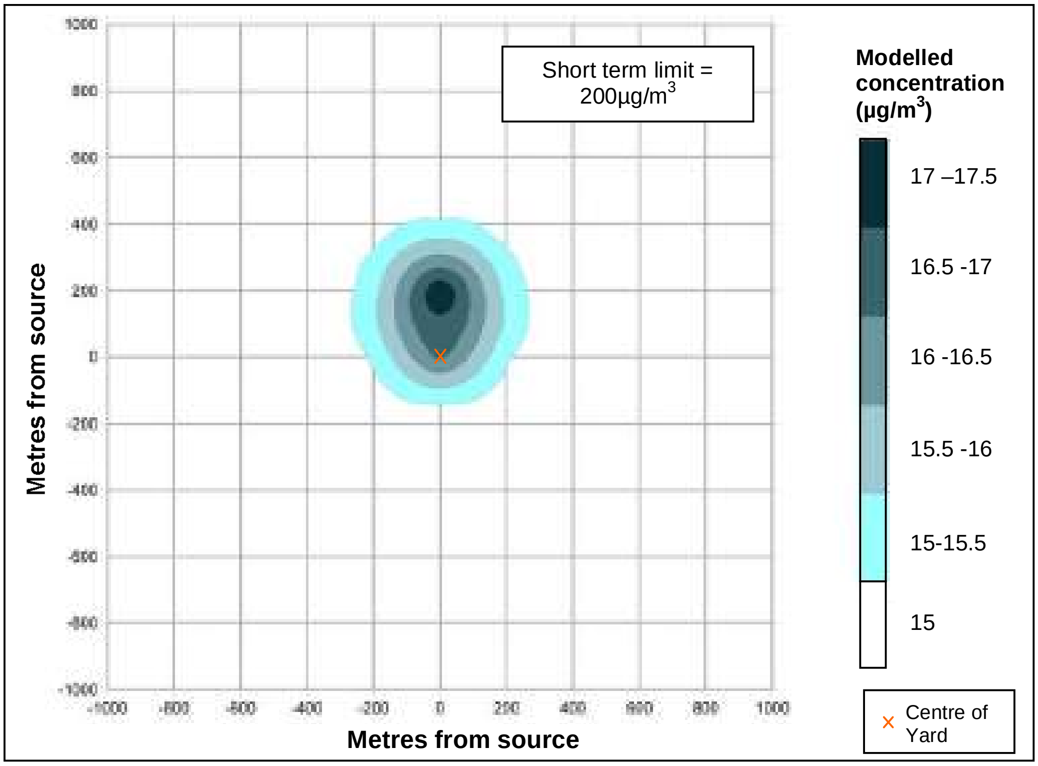
The background concentration of NO_2 (15µg/m^3) was determined from the air quality assessment undertaken in the vicinity of Sangachal (refer to Chapter 6: Section 6.4.2).

The modelling demonstrated that construction plant emissions are predicted to result in a maximum short term ground level NO_2 concentration of 17.5µg/m^3 125m from the centre of the yard, extending up to a distance of 230m away. This reduces to 16.5µg/m^3 at 275m and returns to background concentrations at distances over 420m under high wind speeds (15 m/s) (Figure 10.1).

There is predicted to be no increase in short term NO_2 concentrations beyond a distance of 200m from the centre of the yard for low wind speeds (1m/s); and 280m for medium wind speeds (5m/s).

[15] The Bibi Heybet yard will be operated by Amec-Tekfen-Azfen (ATA) and the South Dock yard will be operated by the Caspian Shipyard Company (CSC).
[16] Applicable 1 hour average (short term) and annual average (long term) standards for NO_2 are 200µg/m^3 and 40µg/m^3 respectively.
[17] This is an overestimate of emissions from the South Dock yard, as these activities will not occur simultaneously.

Figure 10.1 Maximum Short Term Ground Level Increase in NO_2 Concentration ($\mu g/m^3$) At Distance from Centre of Yard (High Wind Speed Conditions)



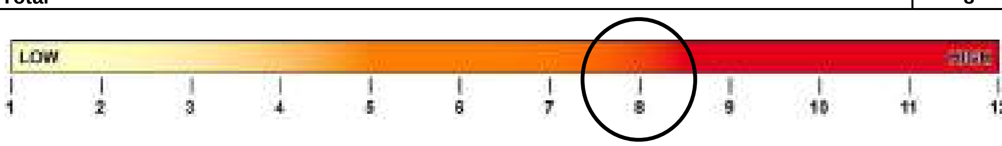
Construction yard plant emissions are predicted to contribute approximately 1.5µg/m^3 to long term average concentrations of NO_2 at 125m from the centre of the yard, returning to background levels at 420m.

Under all conditions assessed, the modelling predicted no exceedances of ambient air quality standards in the vicinity of the yards and no discernable increase in short term or long term concentrations of NO_2 more than 420m from the centre of the yard[18].

Table 10.4 presents the justification for assigning a score of 8, which represents a Medium Event Magnitude.

Table 10.4 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Emissions will not affect ambient air quality more than 500m from centre of the yard (based on worst case modelling).	1
Frequency	Emissions will occur continuously.	3
Duration	Emissions will continue throughout the construction period.	3
Intensity	Modelled long and short term concentrations of key pollutant, NO_2, are predicted to be significantly below relevant ambient air quality standards.	1
Total		**8**



[18] Historically in Azerbaijan ambient concentrations of NO_2, SO_2, CO and PM_{10} have also been assessed against specific 24 hour and 1 hour standards. These standards were not derived using the same health based criteria as the IFC, WHO and EU guideline values and the standards derived are not widely recognised. Appendix 10C, however, does show that the historic standards (provided in Appendix 11B Update 1) will not be exceeded during onshoreconstruction and commissioning operations.

10.4.1.2 Receptor Sensitivity

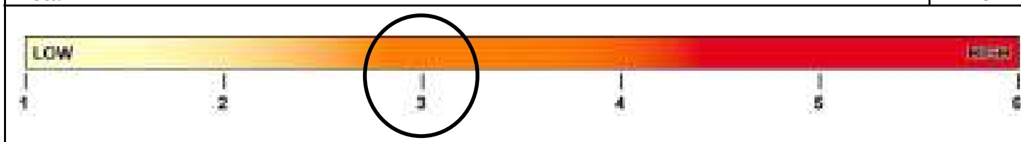
Human Receptors

All candidate construction yards are currently operational, are located within an industrial setting and have been used previously for ACG/SD construction works. The BDJF yard is the most remote. Residential properties are located within 500m of the South Dock yard boundary and 500m to 1km of the Zykh and Bibi Heybet yard boundaries.

Table 10.5 presents the justification for assigning a score of 3 to human receptors, which represents Medium Receptor Sensitivity.

Table 10.5 Human Receptor Sensitivity

Parameter	Explanation	Rating
Presence	All construction yards are located in established industrial areas. Residential properties are located within 500m to 1km of the boundaries of the Zykh, Bibi Heybet and South Dock yards[19].	2
Resilience	Modelling results have confirmed that emissions from construction yard sources will not exceed air quality standards and local receptors are not considered to be vulnerable.	1
Total		**3**

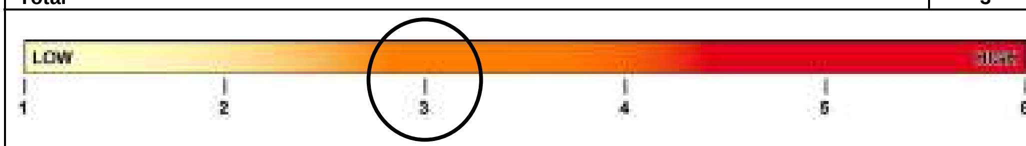


Biological/Ecological Receptors

Table 10.6 presents the justification for assigning a score of 3 to biological/ecological receptors, which represents Medium Receptor Sensitivity.

Table 10.6 Biological/Ecological Receptor Sensitivity

Parameter	Explanation	Rating
Presence	Bird species that may occasionally be present at the yard and adjacent areas are mobile and would not be present for long periods of time, with the exception of the lagoons, which are adjacent to the BDJF yard and support populations of overwintering and residential bird species. Terrestrial ecological receptors are very limited, given the industrial nature of the yards and their surroundings.	2
Resilience	Volume of emissions released (including particulates) due to yard generators and engines will create a very small increase in pollutant concentrations in the atmosphere and in any washout from rainfall, which will not be discernable to biological/ecological receptors[20].	1
Total		**3**



10.4.1.3 Impact Significance

Table 10.7 summarises impacts on air quality associated with yard plant emissions during the Construction, Installation and HUC phase.

[19] In accordance with the assessment methodology (Chapter 3), commercial locations and workers are considered to be of lower sensitivity than residential properties and in terms of air quality are subject to standards under separate occupational health requirements.

[20] Note that ambient air quality standards are not relevant to biological/ecological receptors.

Table 10.7 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Yard generators and engines	Medium	(Humans) Medium	**Moderate Negative**
		(Biological/Ecological) Medium	**Moderate Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 10.3) and therefore no additional mitigation is required.

10.4.2 Onshore Platform Generator Commissioning

10.4.2.1 Event Magnitude

As stated within Chapter 5: Section 5.4.8.3, all topside utilities will be commissioned at the topside construction yard over a 10 month period. Onshore commissioning of the 3 RB211 generators using diesel is planned to include:

- Each generator run separately and intermittently for a week, for up to 8 hours a day at a maximum load of approximately 26%; and
- 3 synchronisation tests of 8 hour duration, running 2 of the 3 generators together at a maximum load of approximately 26%.

During commissioning of the compression system and topside utilities, the platform generators are planned to run separately and intermittently for approximately 6 months. Commissioning of the topside will occur at either the BDJF yard or the Bibi Heybet yard.

Dispersion modelling, as described in Section 10.4.1, was undertaken to determine the likely magnitude of impacts from platform generator emissions to any nearby receptors (see Appendix 10C). Worst case impacts were considered based on the three 8 hour synchronisation tests and the results obtained were compared against the relevant short term standard for NO_2.

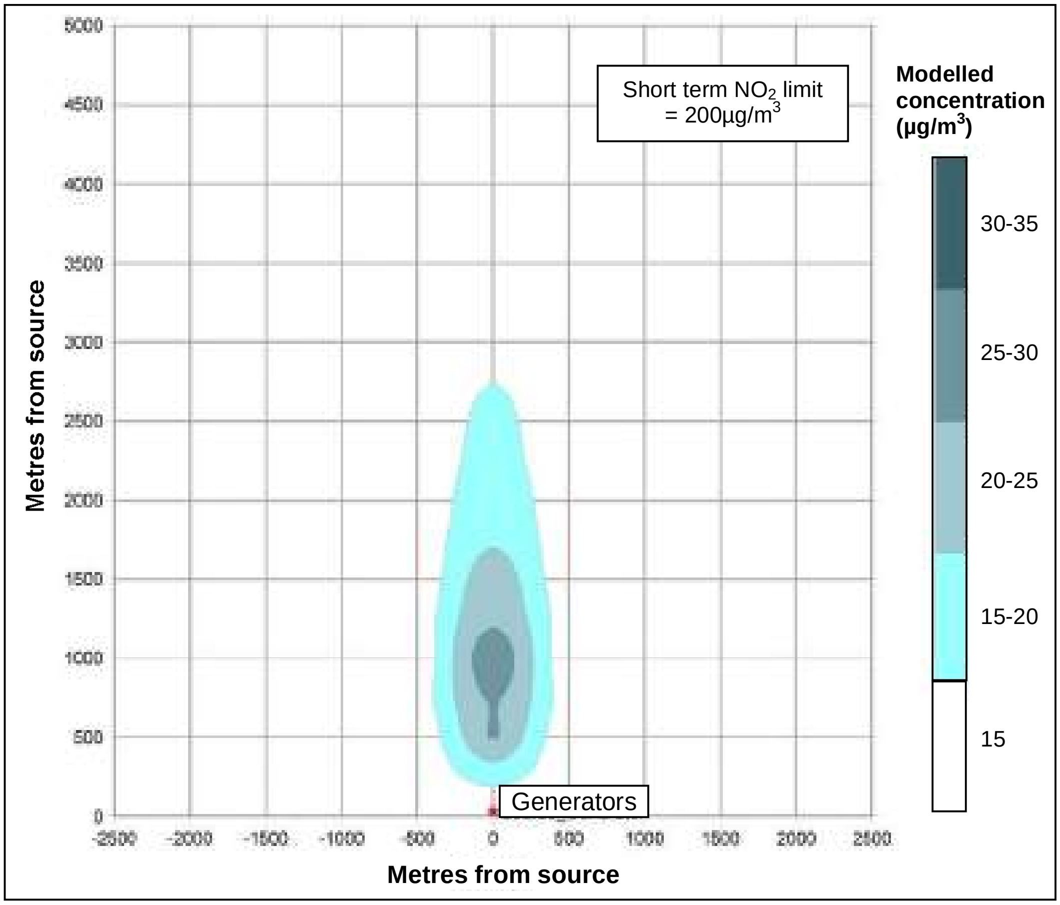
The short term concentrations obtained from the modelling under high, medium and low wind speed conditions are presented in Table 10.8.

Table 10.8 Maximum Short Term NO_2 Concentrations Under High, Low and Typical Wind Conditions (Platform Generator Emissions)

Wind Conditions	Maximum short term ground level NO_2 concentration ($\mu g/m^3$)	Distance from source (m)	Increase in short term concentration as % of short term standard
High (15 m/s)	30	500	7.5%
Medium (5 m/s)	25	1600	5%
Low (1 m/s)	16	3600	0.5%

Figure 10.2 presents the short term ground level NO_2 concentrations under high wind conditions.

Figure 10.2 Maximum Short Term Ground Level NO_2 Concentration (µg/m³) at Distance from Source (High Wind Speed Conditions)



The results demonstrate that under all meteorological conditions modelled, concentrations of NO_2 would not exceed the applicable short term standard for NO_2 of 200µg/m³. The maximum predicted short term increase in NO_2 concentrations represents less than 10% of the standard and is considered to be indiscernible from background levels[21] for all wind conditions[18].

Table 10.9 presents the justification for assigning a score of 6, which represents a Medium Event Magnitude.

Table 10.9 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Increases in concentrations of pollutant species will be indiscernible from background concentrations at all distances from the emission source.	1
Frequency	Emissions will occur continuously.	3
Duration	Emissions will occur for less than 24 hours.	1
Intensity	Modelled long and short term concentrations of key pollutant, NO_2, are predicted to be significantly below relevant ambient air quality standards.	1
Total		**6**

[21] In accordance with UK Environment Agency Air Quality Assessment Guidance.

10.4.2.2 Receptor Sensitivity

In terms of Emissions to Atmosphere, Receptor Sensitivity is considered to be the same regardless of the Event. As per Section 10.4.1.2, Receptor Sensitivity is Medium for both human and biological/ecological receptors.

10.4.2.3 Impact Significance

Table 10.10 summarises impacts on air quality associated with onshore commissioning of the platform generators during the construction, installation and HUC phase.

Table 10.10 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Onshore Platform Generator Commissioning	Medium	(Humans) Medium	**Moderate Negative**
	Medium	(Biological/Ecological) Medium	**Moderate Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 10.3) and no additional mitigation is required.

10.4.3 Jacket and Pipeline Installation Vessels

10.4.3.1 Event Magnitude

As stated within Chapter 5: Table 5.16, a pipelay barge, 3 anchor handling tugs and associated support vessels will be used for the infield pipeline installation works, scheduled to take place over a 3 month period. Support vessels will also be required over the 12 month testing and commissioning period. Topside installation will require the use of STB-01, DBA and support vessels (Chapter 5: Section 5.6.6).

NO_X, which comprises nitrous oxide (NO) and nitrogen dioxide (NO_2), is the main atmospheric pollutant of concern, based on the larger predicted emission volumes as compared to other pollutants (sulphur oxides or SOx, CO and non methane hydrocarbons) and the potential to impact human health and the environment.

NO_X emissions from vessels (approximately 2,065 tonnes) are expected to be of a similar scale to those anticipated from worst case scenario[22] WC-PDQ platform emissions (approximately 1,475 tonnes) over the same duration. Modelling of the worst case platform emissions (refer to Chapter 11: Section 11.4.1 and Appendix 11B) demonstrates that the emissions would result in no discernable change in NO_2 concentrations onshore. Therefore, emissions from vessel movements, which will occur across a relatively large geographic area, are expected to disperse rapidly and will result in increases in NO_2 concentrations that will be indiscernible from background levels at onshore receptors.

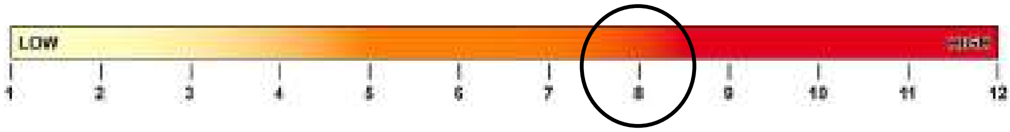
Based on efficient operation, regular maintenance, planned use of good quality, low sulphur fuel and previous experience, routine operation of the vessels will not result in plumes of visible particulates from vessel engine exhausts.

Table 10.11 presents the justification for assigning a score of 8 to vessel activities during installation and HUC, which represents a Medium Event Magnitude.

[22] Incorporating platform power generation and emergency flaring

Table 10.11 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Increases in concentrations of pollutant species will be indiscernible from background concentrations at onshore receptors	1
Frequency	Emissions will occur continuously.	3
Duration	Emissions will continue throughout the installation and HUC period.	3
Intensity	Modelled long and short term concentrations of key pollutant, NO_2, are predicted to be significantly below relevant ambient air quality standards.	1
Total		**8**



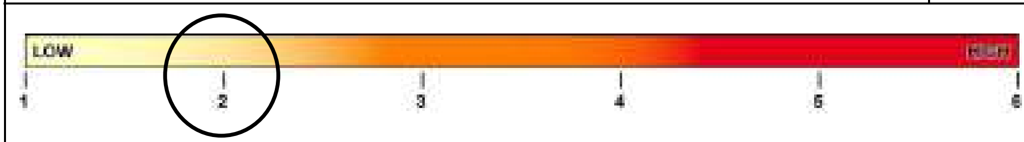
10.4.3.2 Receptor Sensitivity

Human Receptors

Table 10.12 presents the justification for assigning a score of 2 to human receptors, which represents Low Receptor Sensitivity.

Table 10.12 Human Receptor Sensitivity

Parameter	Explanation	Rating
Presence	There are no permanently present (i.e. resident) human receptors within 50km of the installation activities.	1
Resilience	Changes in air quality onshore associated with vessel emissions will be indiscernible. Onshore receptors will be unaffected.	1
Total		**2**

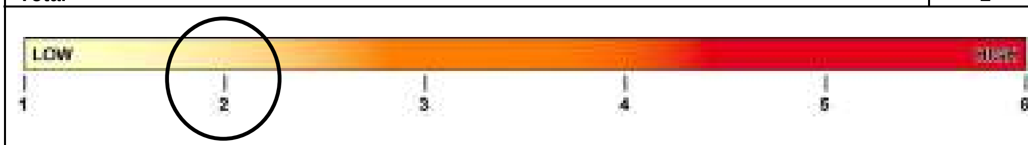


Biological/Ecological Receptors

Table 10.13 presents the justification for assigning a score of 2 to biological/ecological receptors, which represents Low Receptor Sensitivity.

Table 10.13 Biological/Ecological Receptor Sensitivity

Parameter	Explanation	Rating
Presence	Marine bird species are mobile and will not be present at one location for long periods of time. The Contract Area and infield pipeline routes are not located within a bird migration fly over route. Birds found in the area will be transient and not resident.	1
Resilience	Volume of emissions released (including visible particulates) will create a very small increase in pollutant concentrations in the atmosphere and in any washout from rainfall, which will not be discernable to biological/ecological receptors[23].	1
Total		**2**



[23] Note that ambient air quality standards are not relevant to biological/ecological receptors.

10.4.3.3 Impact Significance

Table 10.14 summarises impacts on air quality associated with support vessels during the installation and HUC phase.

Table 10.14 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Vessel Engines	Medium	(Humans) Low	**Minor Negative**
		(Biological/Ecological) Low	**Minor Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures and no additional mitigation is required (see Table 10.3).

10.5 Impacts to the Terrestrial Environment Associated with Onshore Noise

10.5.1 Construction Yard Plant

10.5.1.1 Event Magnitude

Noise at the selected construction yard(s) during the construction and commissioning phase will arise from the use of plant and machinery to undertake steel rolling, cutting and shaping, welding, grit blasting and the movement of materials around the site(s) by vehicles/cranes.

A noise modelling assessment was undertaken to determine the potential magnitude of impacts from onshore construction noise to any nearby receptors (see Appendix 10B).

Using reasonable worst case assumptions regarding plant and operating times across the construction period, predictions of potential noise impact from the construction activities at increasing distances from the source were undertaken and compared to the relevant environmental noise level guidelines[24].

The noise screening afforded by the buildings and perimeter fencing around each of the yards was assumed conservatively to provide 5dBA of attenuation. No account was taken for current operations at the construction yard(s).

The modelling demonstrated that 155m from the noise source, the daytime limit of 55dB will be met and at 475m, the nightime limit of 45dB Laeq will be met. These limits are applicable to residential dwellings, where people are normally present. The workplace limit of 70dB Laeq, applicable to commercial/industrial properties, was found to be met at a distance of 30m from the source (refer to Figure 10.3). The modelling predicted no exceedances of environmental noise standards at a distance of 475m or more from noise sources at the construction yard.

[24] 1hour L_{Aeq} for 1) Residential; institutional; educational i) Daytime (07:00 - 22:00) – 55dBA ii) Nighttime (22:00 - 07:00) – 45 dBA and 2) Industrial; commercial, Daytime and Nightime – 70 dBA

Figure 10.3 Predicted Noise Levels from Plant/Machinery at the Construction Yard

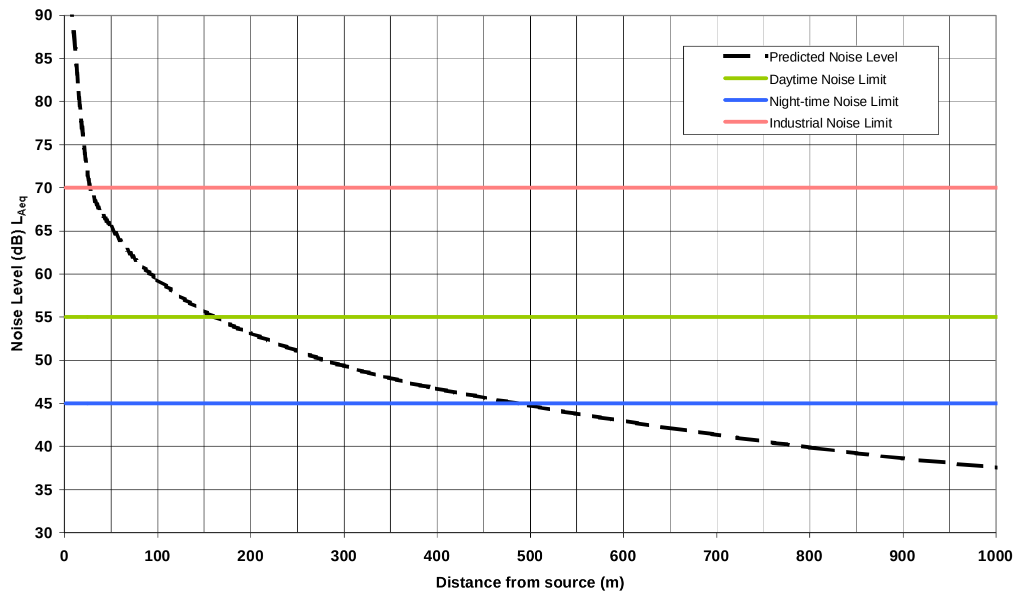
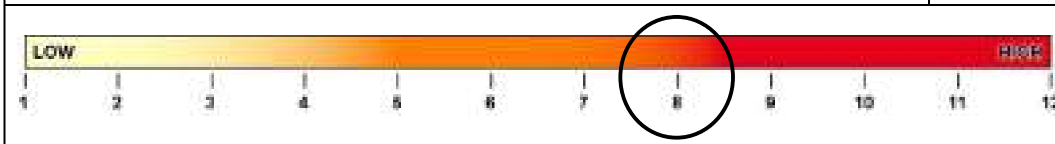


Table 10.15 presents the justification for assigning a score of 8 to construction yard plant operations, which represents a Medium Event Magnitude.

Table 10.15 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Noise will affect an area less than 500m from the source.	1
Frequency	Noise will occur continuously during the construction period.	3
Duration	Noise will be generated throughout the construction period.	3
Intensity	Noise standards will not be exceeded at the nearest residential receptors.	1
Total		**8**



10.5.1.2 Receptor Sensitivity

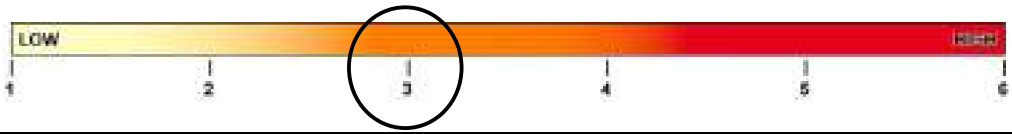
Human Receptors

All of the candidate construction yards are currently operational, located within an industrial setting and have been used previously for ACG/SD construction works. The BDJF yard is the most remote. Residential properties are located within 500m of the South Dock yard boundary and 500m to 1km of the Zykh and Bibi Heybet yard boundaries.

Table 10.16 presents the justification for assigning a score of 3 to human receptors, which represents Medium Receptor Sensitivity.

Table 10.16 Human Receptor Sensitivity

Parameter	Explanation	Rating
Presence	All construction yards are located in established industrial areas. Residential properties are located within 500m to 1km of the boundaries of the Zykh, Bibi Heybet and South Dock yards.	2
Resilience	Local receptors are not considered to be vulnerable to construction yard plant and machinery noise associated with the COP, given the existing operations at the yard and in the immediate yard vicinity.	1
Total		**3**

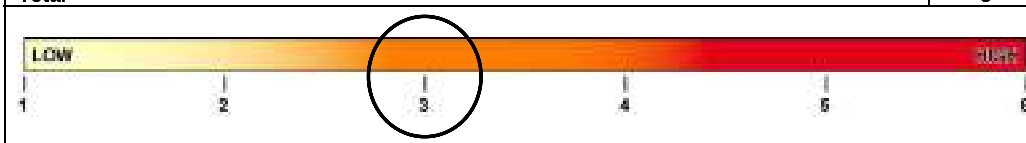


Biological/Ecological Receptors

Table 10.17 presents the justification for assigning a score of 3 to biological/ecological receptors, which represents Medium Receptor Sensitivity.

Table 10.17 Biological/Ecological Receptor Sensitivity

Parameter	Explanation	Rating
Presence	Birds species that may occasionally be present at the yard and adjacent areas are mobile and would not be present for long periods of time, with the exception of the lagoons, which are adjacent to the BDJF yard and support populations of overwintering and residential bird species. Terrestrial ecological receptors are very limited given the industrial nature of the yards and their surroundings.	2
Resilience	Given the existing industrial activities in and around the yards, species are expected to be unaffected or marginally affected by construction noise associated with the COP.	1
Total		**3**



10.5.1.3 Impact Significance

Table 10.18 summarises impacts to human receptors from noise due to construction yard plant operations.

Table 10.18 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Construction yard plant	Medium	(Humans) Medium	**Moderate Negative**
		(Birds) Medium	**Moderate Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 10.3) and no additional mitigation is necessary.

10.5.2 Onshore Platform Generator Commissioning

10.5.2.1 Event Magnitude

As described in Section 10.4.2.1, all topside utilities will be commissioned at the topside construction yard including the 3 RB211 generators, which will be run separately and intermittently for approximately 6 months. For an 8 hour period, it is planned to run 2 generators together at a maximum load of 26%. Topside commissioning will be undertaken at the BDJF or Bibi Heybet yards.

Noise modeling, as described in Section 10.5.1, was undertaken to determine the likely magnitude of noise impacts from the platform generators to any nearby receptors (see Appendix 10B). Worst case impacts were considered based on the operation of two generators concurrently for 8 hours and an allowance of 15dB Laeq was made for the screening afforded by the generator housing and acoustic controls associated with the platform generators.

The modelling demonstrated that at 175m or more from the noise source, the daytime limit of 55dB will be met; and at 550m from the noise source, the nightime limit of 45dB Laeq will be met. The industrial workplace limit of 70dB Laeq was found to be met at a distance of 35m from the source (refer to Figure 10.4). The modelling predicted no exceedances of environmental noise standards at a distance of 550m or more from noise sources at the construction yard.

Figure 10.4 Predicted Noise Level Associated with Onshore Platform Generator Commissioning

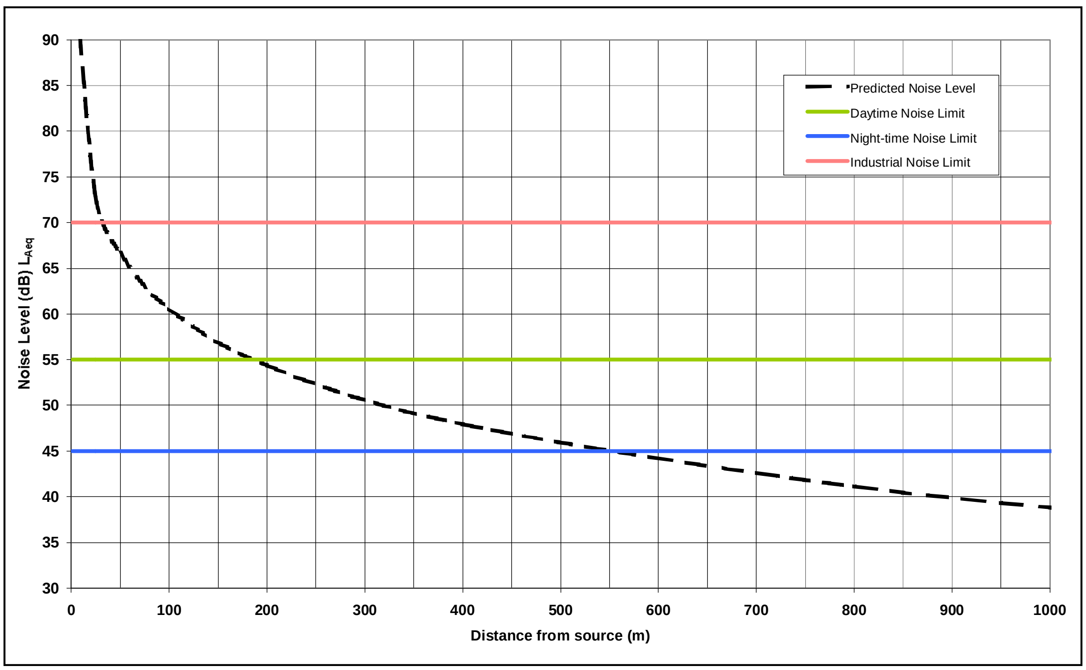
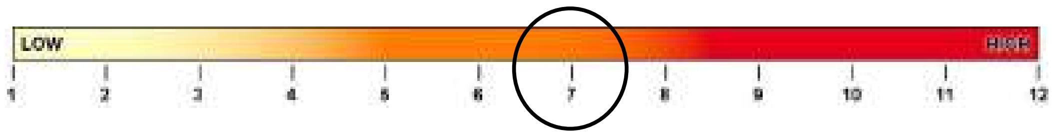


Table 10.19 presents the Event Magnitude for onshore platform commissioning. A Medium level Event Magnitude is assigned.

Table 10.19 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Noise will be noticeable and above relevant nightime limits greater than 500m from the construction yard, reducing to limit levels at less than 1km.	2
Frequency	Noise will occur continuously.	3
Duration	Noise will continue for up to 24 hours.	1
Intensity	Noise standards will not be exceeded at the nearest residential receptors to the selected topside yard.	1
Total		**7**



10.5.2.2 Receptor Sensitivity

In terms of noise, Receptor Sensitivity is considered to be the same regardless of the Event. As per Section 10.5.1.2, Receptor Sensitivity is Medium (3), for human receptors.

10.5.2.3 Impact Significance

Table 10.20 summarises impacts to human receptors and birds from noise due to onshore platform generator commissioning noise.

Table 10.20 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Onshore platform generator commissioning	Medium	(Humans) Medium	**Moderate Negative**
		(Birds) Medium	**Moderate Negative**

10.5.2.4 Additional Mitigation and Monitoring

The assessment above has demonstrated, with reference to numerical modelling, that noise from onshore platform generator commissioning will result in a Moderate Negative impact to bird and human receptors, taking into account the existing controls detailed within Table 10.3. The assessment is considered to be conservative as discussed in Section 10.5.1.1 and it is also unlikely that the platform generator tests will be undertaken during the nightime. Should it be necessary to undertake synchronisation tests of the generators at night, consultation will take place in the local community (within 700m of the sound source).

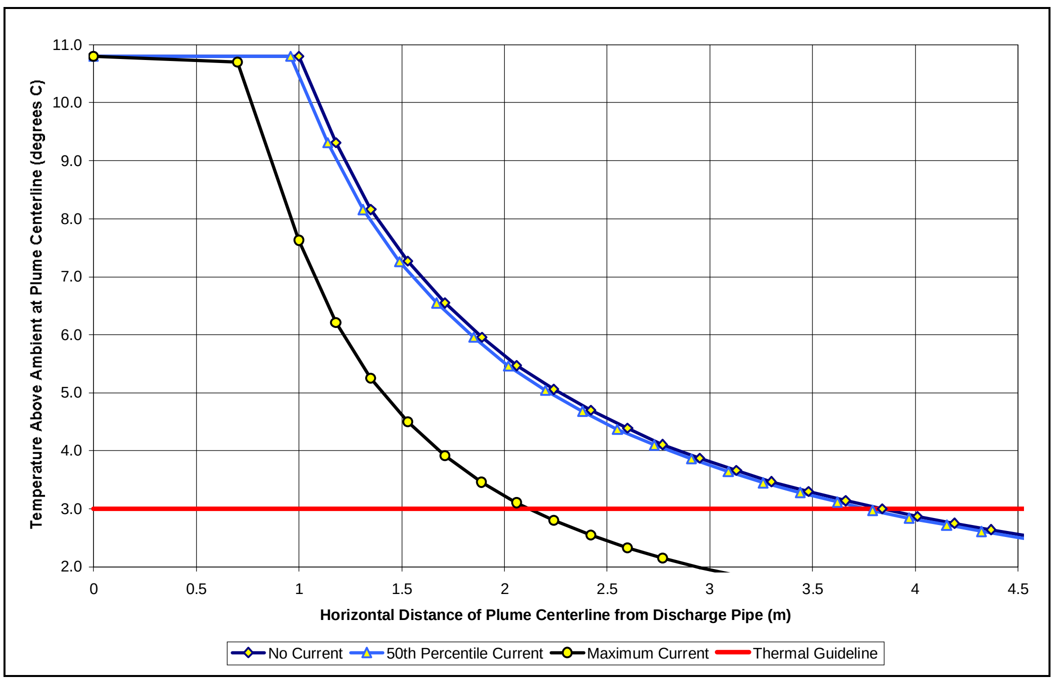
10.6 Impacts to the Marine Environment

10.6.1 Construction Yard Cooling Water Discharge

10.6.1.1 Event Magnitude

During onshore commissioning, seawater will be supplied to the topside via a temporary seawater lift system from the quayside, fitted with a 3mm diameter mesh to minimise entrainment. The seawater system will be designed to operate at a flow rate of approximately 575m^3/hr for a period of up to 6 months and will be of a similar design to that approved for previous ACG projects. Seawater will be abstracted from the construction yard quayside and discharged back to the sea after use. The temperature difference between the seawater intake and discharge will be constant and independent of season as the energy demand on the seawater cooling system when in use will be constant. The system will be designed to meet a temperature specification for the discharge at the edge of the mixing zone, or 100m if a mixing zone is not defined, no greater than 3°C more than the ambient water temperature. Dispersion modelling was carried out for a similar discharge during onshore commissioning of the Central Azeri (Phase 1) platform[25]. The modelling demonstrated that the temperature of the discharge plume would not be greater than 3°C in comparison with ambient temperatures within 4m of the point of discharge (Figure 10.5).

Figure 10.5 Predicted Cooling Water Plume Temperature Above Ambient at Distance from Discharge



The seawater system will be designed to incorporate continuous dosing of sodium hypochlorite at a concentration of 2mg/l. Prior to discharging the cooling water, a neutralising agent (sodium thiosulphate) will be added. Neutralisation agent dosing will be controlled and checked to ensure neutralisation is effective and residual chlorine content is maintained at less than 1mg/l.

Table 10.21 presents the Event Magnitude for construction yard cooling water discharge. A Medium level Event Magnitude is assigned.

[25] Thermal Dispersion Modelling in Support of the ACG Central Azeri Project, ASA, January 2003.

Table 10.21 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Cooling water discharges will be diluted to an acceptable level within 4m of the point of discharge.	1
Frequency	Discharge of cooling water will take place continuously.	3
Duration	The discharge will be continuous for 6 - 8 months during topside commissioning.	3
Intensity	Discharges will be consistent with project standards and with previously approved practices and will contain no harmful persistent materials.	1
Total		**8**

10.6.1.2 Receptor Sensitivity

The discharge will take place close to the quayside adjacent to a construction yard in an industrialised setting. In addition to the modelling for Central Azeri, a risk assessment was carried out for the same discharge process during the commissioning of the DWG-DUQ platform topside. This assessment concluded that neither temperature nor chemical dosage presented an environmental risk, even within the confines of the southern part of the BDJF yard harbour.

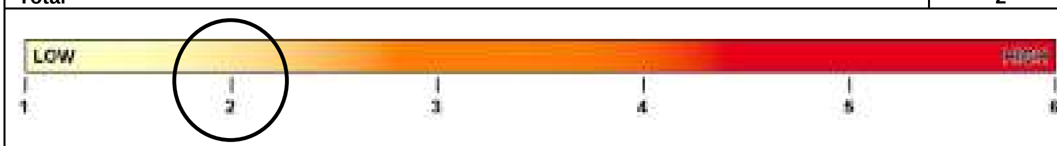
Due to the location of the construction yards within heavily industrialised areas, the presence of seals or threatened species of fish is extremely unlikely. The benthos of the coastal zone is largely dominated by pollution-tolerant invasive species, with few native species present. No plankton studies have been carried out in the vicinity of construction yards, but it is probable that species diversity is lower than in open waters; and that communities will tend to be dominated by organisms which are tolerant of, or can competitively exploit, water which will often be of poorer quality than open coastal water.

In summary, no sensitive, rare or threatened species are anticipated to be present in the vicinity of construction yards, and the species most likely to be present and dominant will be those most tolerant of the discharges and emissions historically associated with shipping and industrial activity.

Table 10.22 presents the biological/ecological Receptor Sensitivity.

Table 10.22 Receptor Sensitivity

Parameter	Explanation	Rating
Presence	Seals and fish are not expected to be present consistently or in significant numbers near the discharge source. No significant exposure of benthos or plankton.	1
Resilience	The species likely to dominate in the area of the construction yards are expected to be predominantly invasive species with a high tolerance to anthropogenic impacts.	1
Total		**2**



10.6.1.3 Impact Significance

Table 10.23 summarises impacts to biological/ecological receptors from construction yard onshore topside commissioning cooling water discharge.

Table 10.23 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Cooling water discharge from onshore commissioning of topside	Medium	(Biological/Ecological) Low	**Minor Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 10.3) and no additional mitigation is required.

10.6.2 Pipeline Cleaning and Hydrotest Discharge

10.6.2.1 Event Magnitude

The process of gauging, hydrotesting, leak testing and integrity testing the infield pipelines (gas and oil, water injection and produced water) will use seawater dosed with a biocide, oxygen scavenger and tracer dye. The products planned to be used include a THPS-based biocide product (tetrakys-hydroxymethyl phosphonium sulphate), ammonium bisulphite (oxygen scavenger) and fluorescein (tracer dye).

All 3 COP pipeline hydrotest chemicals (biocide, oxygen scavenger and tracer dye) have been subject to a comprehensive risk assessment for ACG Phases 1, 2 and 3 and for Shah Deniz Stage 1. The oxygen scavenger and tracer dye products are both of very low toxicity and have low bioaccumulation potential.

2 THPS-containing biocide products (B TROSKIL 88 and BIOTREAT 4535) are under consideration both of which meet the performance standards established by previous ACG studies and approved by the MENR.

THPS biocide products have been shown to degrade by more than 90% within six months in the pipeline and an extensive World Health Organisation review has provided evidence that the biocide hydrolyses rapidly in the environment. Experimental studies conducted for ACG Phase 2, Phase 3 and Produced Water Disposal Projects has indicated that toxicity also reduces by 90% during a 6 month holding period[26]. On the basis of the aforementioned studies, it was estimated conservatively that:

- For degraded biocide (i.e. biocide which had been in the pipeline for more than 6 months), a dilution ratio of 300:1 would be required to reach the point at which no biological effects would occur; and
- For ‘fresh’ biocide (e.g. discharged as overfill during initial flooding operations), a dilution ratio of 3,000:1 would be required to reach the point at which no biological effects would occur.

Table 5.18 in Chapter 5: Project Description[27] indicates that a number of separate discharges of hydrotest water will take place. These will range in volume up to 4,675m^3. These discharges will be of limited duration (from approximately 1 minute to approximately 8 hours) and will not overlap in time and space. The discharge of hydrotest water from infield pipelines was thoroughly assessed for ACG Phase 2 and a risk assessment submitted to, and approved by, the MENR. To provide further information specific to the COP on the volume of water potentially impacted, a representative range of discharges (covering depth, volume and

[26] Refer to DWG Hydrotest Final Report 2007

[27] As stated in Chapter 5: Section 5.5, the design and routing of the infield pipelines is ongoing throughout Define. The cleaning and hydrotest discharge volumes and associated chemical dosing, represent the likely worst case for the purposes of this assessment.

discharge velocity) have been mathematically modelled, including a conservative discharge of 7,000m^3, which represents a worst case scenario.

The modelling results for summer and winter conditions (Appendix 10D) indicate that the 3,000:1 dilution criterion will be reached within 200 - 900m for the 'fresh' discharges (i.e. up to 1,200m^3, Figure 10.6) and that the 300:1 dilution criterion will be reached within 100 - 400m for the larger (i.e. ~7,000m^3) 'degraded' discharges (Figure 10.7). These plumes, which move horizontally i.e. do not rise or fall, will occur below the productive zone and will be of sufficiently small dimension that it is very unlikely that any individual organism would remain in the plume for more than a few tens of minutes at most. Once the plume is diluted beyond the 300:1 criterion, chemical concentrations will be too low to have any adverse effect and the residual low concentrations of biocide will rapidly hydrolyse into harmless components.

Figure 10.6 Plume Dimensions for Discharge of 1,200 m^3 'Fresh' Hydrotest Water Under Stagnant and Predominant Current Conditions

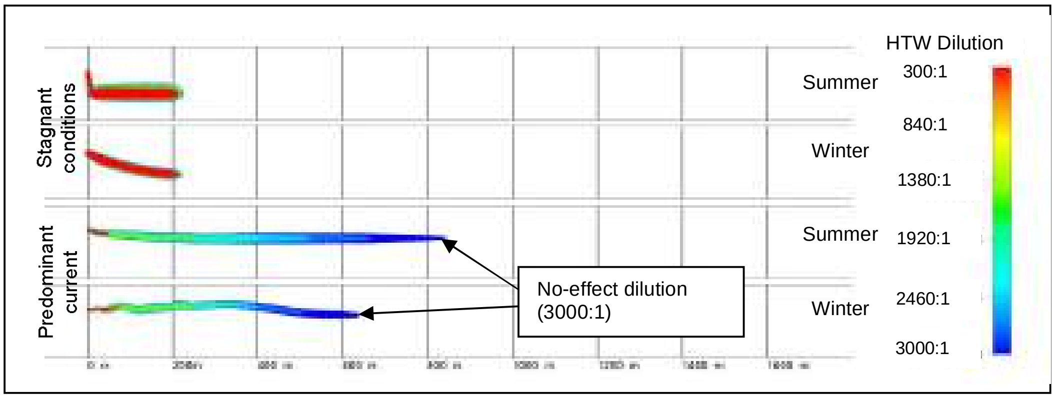
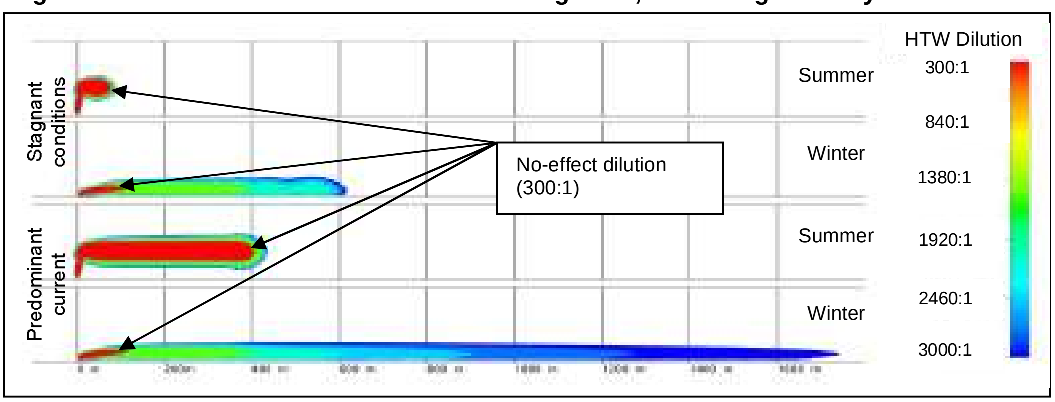


Figure 10.7 Plume Dimensions for Discharge of 7,000m^3 Degraded Hydrotest Water



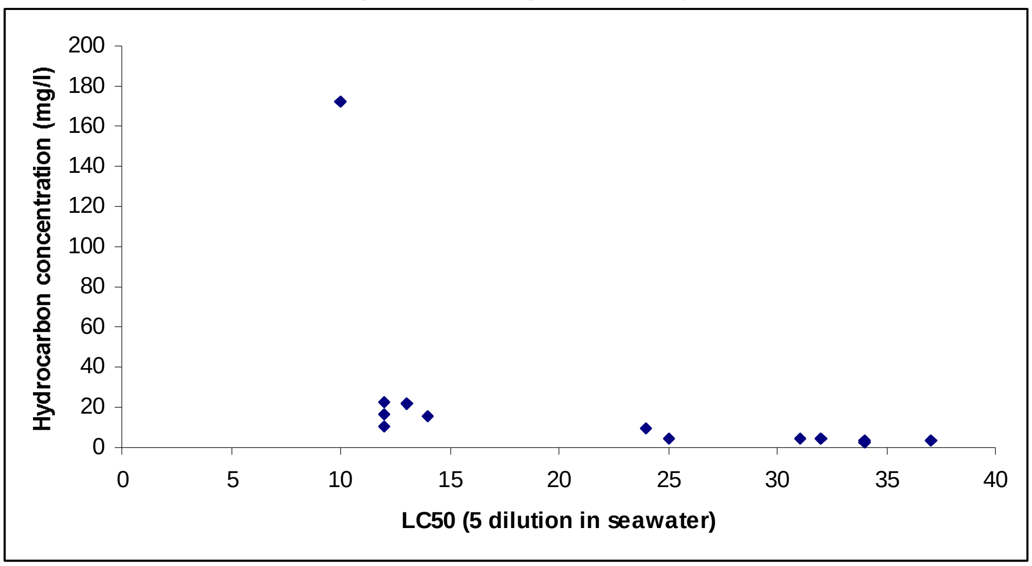
These chemicals, which are not environmentally persistent, have been approved for use in previous ACG and Shah Deniz projects. Data accumulated during these previous hydrotest operations has confirmed a high rate of reduction in biocide concentration and toxicity between the time a pipeline is filled with hydrotest water and the time it is emptied in preparation for commissioning.

As stated within Chapter 5 Section 5.5.4, to tie in the COP infield oil pipeline, it is planned to remove a section of the DWG oil export pipeline and install a new wye piece. The wye will be cleaned and hydrotested prior to tie in. In the event that it is not possible to recover the hydrotest water prior to tie in, it may be necessary to discharge to sea up to 1,110 m^3 of hydrotest water containing traces of hydrocarbon at concentrations of up to 100 ppm. The discharge would take place at a depth of 168m, and at a rate of approximately 0.44 m^3/s. The discharge duration would be approximately 1.4 hours.

The discharged water will contain ‘fresh’ chemicals of the same type and concentration used in the hydrotest operations described above, and the volume of discharge will be similar to the scenario presented in Figure 10.6. Estimation of the impact of a discharge containing hydrocarbons therefore needs to assess the magnitude of the additional contribution of the hydrocarbons.

It is assumed that the water will be well-mixed with, and equilibrated with, the residual hydrocarbon present in the pipeline following cleaning operations. Consequently, the form and composition of the hydrocarbon in the water is likely to be similar to that of produced water following separation from the production stream. Studies were carried out in March 2008 (refer to Chapter 11 Section 11.5.4.1) on produced water samples obtained from separation equipment at Sangachal Terminal. These studies included comprehensive chemical analysis and toxicity testing. In general, the toxicity of all samples was low, and hydrocarbon (total aliphatics) concentrations ranged from 4.34 mg/l to 171.9 mg/l. Figure 10.8 illustrates the relationship between toxicity (LC_{50} expressed as % dilution in Caspian seawater) and total hydrocarbon concentration. This shows that, while there is a weak trend towards higher toxicity (lower LC_{50}) at higher hydrocarbon concentrations, toxicity does not increase markedly at very high hydrocarbon concentrations, and that aliphatic hydrocarbons are therefore not a dominant source of toxicity in produced water. However, for the purposes of estimating the impact of wye section discharge, the LC_{50} for the highest concentration (171.9 mg/l) is used as an approximate indication; this LC_{50} is 10%, which means that the a 10-fold dilution in seawater is required to reach a concentration at which a 50% effect was observed on the test population. If a very conservative safety factor of 100 is applied to this value, it is estimated that a 1000-fold dilution would be sufficient to reach a no-effect concentration for the discharge. At this point, the hydrocarbon concentration would be approximately 100 µg/l (0.1 ppm).

Figure 10.8 Relationship Between Produced Water Toxicity (LC_{50} expressed as % Dilution in Caspian Seawater) and Total Hydrocarbon Concentration

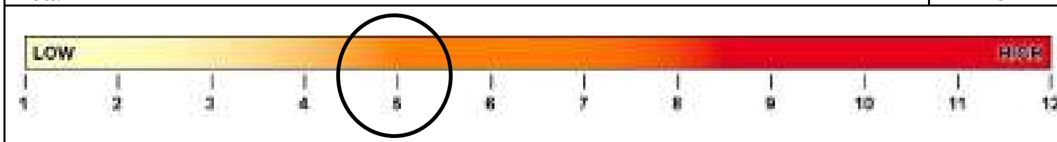


In the assessment for discharge of fresh hydrotest water, a dilution of 3000-fold was conservatively estimated to be sufficient to reach a no-effect concentration. This is three times greater than the dilution estimated to be required for water contaminated with hydrocarbon at a concentration in excess of 100 ppm. To assess whether the combined presence of hydrotest chemicals and hydrocarbon will result in an increase in the no-effect plume dimensions a comparison is made with the national MPC for total hydrocarbons (0.05ppm). A dilution of 2000 fold would be required to reduce the discharge hydrocarbon concentration of 100 ppm to this level. The MPC is a concentration which represents an upper limit intended to provide long-term protection to the environment, and concentrations lower than this would therefore not be expected to have any adverse effects. Since this concentration will be reached within the plume predicted for hydrotest chemicals alone, the presence of hydrocarbons at the margins of the hydrotest plume will not contribute any additional effects. It is therefore concluded that the impact of this discharge will be similar, in terms of plume dimension and duration, to that predicted for a 1,200m^3 discharge of hydrotest water.

Table 10.24 presents the justification for assigning a score of 5, which represents a Medium Event Magnitude for all hydrotest discharges.

Table 10.24 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Hydrotest discharges will be diluted to a 'no effect' level within 500m of the source.	1
Frequency	Discharges will take place up to 50 times.	2
Duration	Individual events will have a duration of between a few minutes and a few hours.	1
Intensity	Discharges will be consistent with project standards and with previously approved practices and will contain no harmful persistent materials.	1
Total		**5**



10.6.2.2 Receptor Sensitivity

Small volume (i.e. approximately 1-20m^3) discharges of short duration will take place near the sea surface. No receptors are considered to be sensitive to these small discharges. Dispersion modelling (see Appendix 10D) indicates that a no-effect concentration will be reached within 300m of the source for all surface and near-surface hydrotest discharges.

Larger volume discharges of treated seawater will occur near the seabed and at a level below the productive zone. Plankton (which is present in highest abundance at or near the productive zone around the thermocline) is not considered to be sensitive to these discharges.

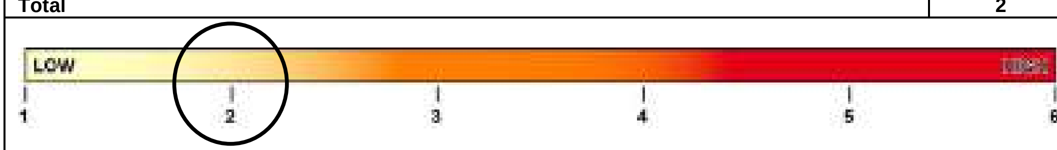
While it is possible that seals and bottom-feeding fish may occasionally be present near the location of seabed discharges, the frequency of discharge occurrence is low and the maximum zone of potential impact will be within a radius of no more than 800m. It is therefore considered that seals and fish do not have a particular sensitivity to near seabed discharges.

As the seabed discharges will be discharged in an upward direction, the dispersion plumes will have minimum contact with the seabed and so the potential for benthic invertebrates to be exposed to the hydrotest discharges is low.

Table 10.25 presents the justification for assigning a score of 2 to biological/ecological receptors, which represents Low Receptor Sensitivity.

Table 10.25 Receptor Sensitivity

Parameter	Explanation	Rating
Presence	Seals and fish are not expected to be present consistently or in significant numbers near the seabed discharge sources. No significant exposure of benthos or plankton.	1
Resilience	Although exposure is unlikely, seals and fish would not be adversely affected by short-term exposure to the discharges.	1
Total		**2**



10.6.2.3 Impact Significance

Table 10.26 summarises impacts to biological/ecological receptors associated with pipeline hydrotest discharges.

Table 10.26 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Hydrotest discharge	Medium	(Biological/Ecological) Low	**Minor Negative**

10.6.2.4 Additional Mitigation and Monitoring

The assessment above has demonstrated, with reference to numerical modelling, that pipeline hydrotest discharges will result in a Minor Negative impact to biological/ecological receptors. The selection of a biocide, which degrades readily both in the pipeline and in the environment, is considered to provide good mitigation for environmental impacts. This assessment is supported by a number of field and laboratory studies carried out on the same chemical during previous phases of the ACG development.

Prior to the commencement of pipeline hydrotest activities, a hydrotest management plan will be prepared and subsequently maintained. This plan will establish, and regularly update, a schedule of hydrotest events together with a detailed set of commissioning procedures. The MENR will be informed of the hydrotest schedule and will be notified of any changes to the schedule.

Experience gained during the commissioning of the ACG Phase 3 pipelines demonstrated that, in most instances, it is not technically practicable to undertake a programme of field sampling and analysis during hydrotest activities; this constraint applies particularly to events which involve the discharge of degraded hydrotest chemicals after the fluid has been in a pipeline for a period of several months. Accordingly, the following measures will be undertaken for the COP to provide the most effective and practicable monitoring and assurance:

- The amounts of chemicals used, together with the dosage rates and water flow rates during all pipeline filling, top-up and pressure testing activities will be rigorously recorded;
- The actual volumes of fresh or degraded hydrotest water released during each pipeline discharge event will be rigorously recorded; and
- Laboratory samples (seawater dosed with chemicals at the rate recorded during offshore pipeline fill activities) will be prepared and stored onshore under simulated pipeline conditions. These samples will be periodically subject to chemical analysis and toxicity testing in order to measure the rate of chemical degradation and associated toxicity reduction.

As described in Section 10.6.2.1 above it is planned to send hydrocarbon-contaminated hydrotest water and cleaning fluids from the new wye installation activities to Sangachal. In the event that discharge of hydrocarbon contaminated hydrotest water from the infield oil wye and pipeline cleaning hydrotest activities is necessary, additional laboratory studies will be carried out to establish the toxicity of this water in order to confirm the results of the assessment as presented within this ESIA. The information collected as a result of these hydrotest monitoring and assurance measures will be collated, interpreted, and issued in the form of a final close-out report to the MENR once all pipeline commissioning activities have been completed.

10.6.3 Cement Discharges

10.6.3.1 Event Magnitude

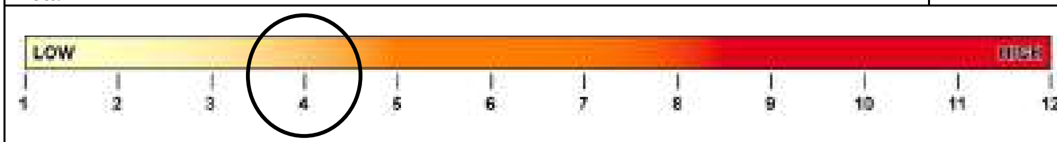
During grouting of the jacket sleeves to the main foundation piles, up to 50m^3 of cement will be discharged to the seabed. The volume of cement used to cement jacket piles into position is calculated prior to the start of the activity and the amount of cement discharged will be restricted to the minimum required to ensure that the platform piles are securely grouted into position.

The cement is not expected to disperse (being designed to set in a marine environment) and will therefore set in-situ. It is not anticipated that there will be any chemical releases from the cement, which will be effectively chemically inert. The impact of cement discharge will therefore be limited to a small area, immediately around the foundation piles.

Table 10.27 presents the justification for assigning a score of 4, which represents a Low Event Magnitude.

Table 10.27 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Scale will be limited to within a few metres of the source and the discharge will not disperse.	1
Frequency	Once only.	1
Duration	Event will be of short duration (less than 24 hours).	1
Intensity	Discharges will be consistent with project standards and with previously approved practices, and will contain no harmful persistent materials.	1
Total		**4**



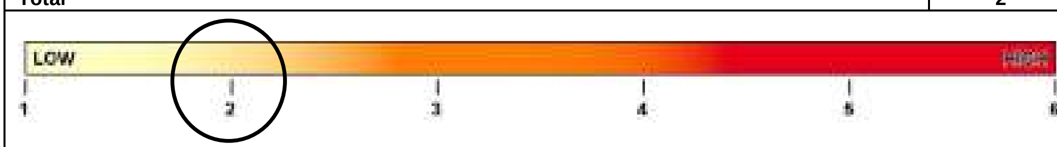
10.6.3.2 Receptor Sensitivity

Seals, fish and plankton are not considered to be at risk of exposure to the cement discharge. The discharge will occlude a small area of seabed with consequent impact on the benthos living within this area.

Table 10.28 presents the justification for assigning a score of 2 to benthic invertebrate receptors, which represents Low Receptor Sensitivity.

Table 10.28 Receptor Sensitivity

Parameter	Explanation	Rating
Presence	No unique, rare or threatened species of benthos present.	1
Resilience	The cement will cover a few square metres of seabed, within which a small amount of benthic biomass will be damaged. No effect beyond the immediate area and therefore no significant impact on local benthic community health.	1
Total		**2**



10.6.3.3 Impact Significance

Table 10.29 summarises impacts to biological/ecological receptors associated with piling cement discharges.

Table 10.29 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Piling cement discharges	Low	(Biological/Ecological) Low	**Negligible**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 10.3) and no additional mitigation is required.

10.6.4 Underwater Noise and Vibration

10.6.4.1 Event Magnitude

Underwater noise will result from driving the jacket foundation piles and vessel movements. It therefore has the potential to impact biological/ecological receptors (specifically seals and fish) in the marine environment

As discussed within Chapter 9: Section 9.5.1.1, an analysis of the propagation of underwater noise was undertaken in order to estimate distances at which various acoustic impacts on marine species may occur (refer to Appendix 11C). The analysis showed that the source noise levels for vessel operations (190 dB re 1μPa at 1m) are below the levels at which lethal injury to fish and seals might occur (established as 240 dB re 1μPa). Piling operations (210-220 dB re 1μPa at 1m) would only give rise to direct physical injury (established as 220 dB re 1uPa) in seals at up to 1 m from the noise source. It is considered very unlikely that physical injury would occur, given existing controls and the behavioural reactions discussed below.

In terms of auditory injury, the assessment demonstrated that the levels of noise from piling and vessels could cause permanent deafness in fish and seals if they remained within 8 m of a vessel, or 40 m of a piling location, for a period of 30 minutes or more. Temporary deafness could occur in fish and seals at distances up to 350m from the noise source; again, only if the animals remained in the vicinity for a period of 30 minutes or more. In practice, it is deemed unlikely that either of these conditions would be met.

In terms of behavioural reactions, the underwater assessment determined that noise generated by vessel operations would result in complete/strong avoidance by fish with swimbladders at distances up to 3m, and seals at ranges up to 5m and mild avoidance by both fish and seals up to 15m away (Figure 10.9). The range over which underwater noise remains audible to fish and seal depends on background noise levels. In the absence of site specific data two background noise levels were considered in the underwater noise assessment; a lower background noise level (approximately 80 dB re 1 μPa), characteristic of a deep sea environment dominated by environmental (i.e. wind, rain and wave) noise, and higher background noise level (approximately 120 dB re 1 μPa), characteristic of a marine location where vessels frequently pass and operational offshore drilling platforms are present.

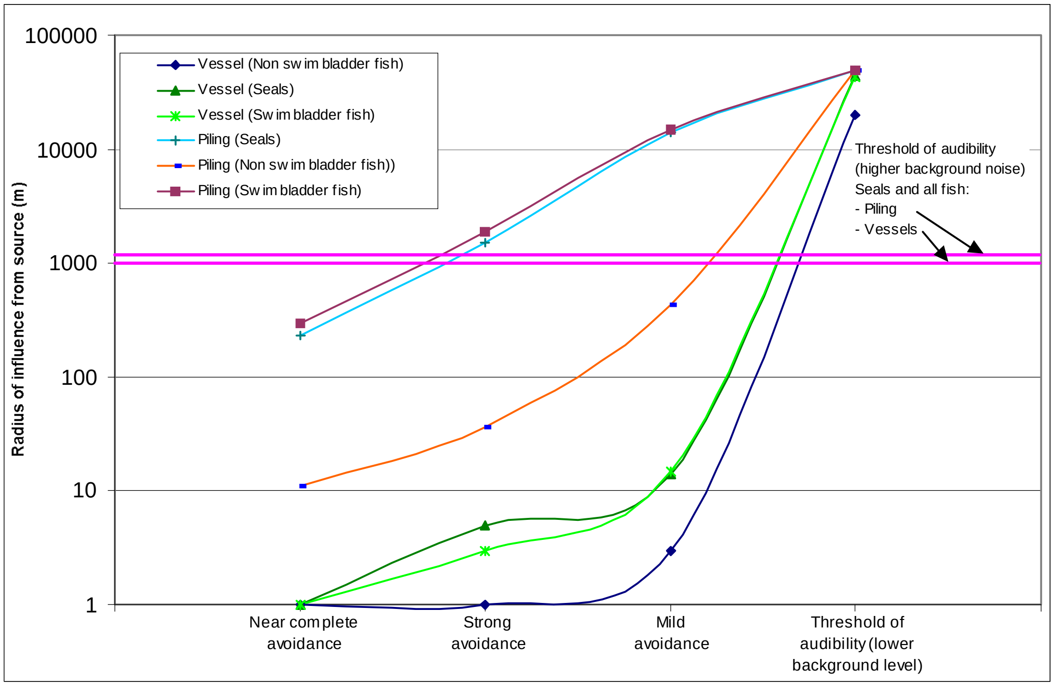
Under the lower background noise level scenario, it was calculated that:

- Piling noise would result in complete/strong avoidance by fish with swimbladders at distances up to 1.9km, and seals at ranges up to 1.5km, mild avoidance by both fish and seals up to 15km away and would be inaudible to fish with swimbladders and seals beyond 49km from the noise source; and
- Vessel noise would be inaudible to fish with swimbladders and seals beyond 44km from the noise source.

Under the higher background noise scenario, it was calculated that:

- Vessel noise would be inaudible to all fish and seals beyond 1km; and
- Piling noise would be inaudible to all fish and seals beyond 2km.

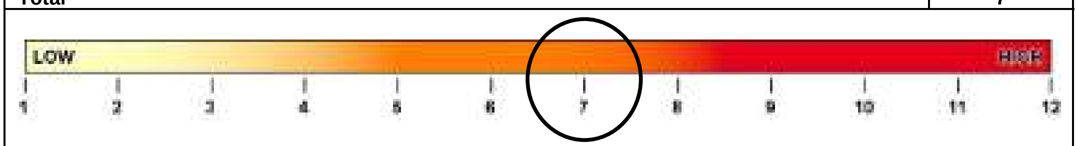
Figure 10.9 Predicted Distances Within Which Fish and Seals React to Underwater Piling and Vessel Noise[28]



Tables 10.30 and 10.31 present the justification for assigning a score of 7 and 8 to piling and vessel activities respectively, which represent Medium Event Magnitudes.

Table 10.30 Event Magnitude (Piling)

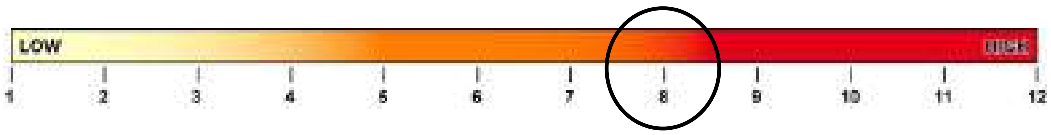
Parameter	Explanation	Rating
Extent/Scale	Underwater sound emissions may result in an avoidance response from fish/seals at more than 1km from the noise source.	3
Frequency	Underwater sound emissions from pile driving will occur up to 50 times.	2
Duration	Each pile driving event will last minutes in duration.	1
Intensity	Taking into account the concentration, accumulation and persistence of sound energy in the underwater environment, it is considered that this is low intensity event.	1
Total		**7**



[28] Refer to Appendix 11C for source data.

Table 10.31 Event Magnitude (Vessels)

Parameter	Explanation	Rating
Extent/Scale	Underwater sound emissions are unlikely to result in an avoidance response from fish/seals beyond 15m from the noise source.	1
Frequency	Underwater sound emissions occur continuously over installation and HUC phase.	3
Duration	Underwater sound emissions will occur over the installation and HUC phase.	3
Intensity	Taking into account concentration, accumulation and persistence of sound energy in the underwater environment, intensity is low.	1
Total		**8**



10.6.4.2 Receptor Sensitivity

The only relevant biological receptors to underwater noise are seals and fish[29].

Seals and Fish

Piling activities will take place at the WC-PDQ platform location and vessel movements will occur along support vessel routes from the Logistics Supply Base located at the BDJF yard to the platform location.

Recent data indicates that endangered species such as seals and sturgeon are not common in the ACG Contract Area (Appendix 6B) and that the WC-PDQ platform location is not located in an important breeding or migration area for either species. However, Kilka and Mullet are present in the Contract Area.

Table 10.32 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 10.32 Receptor Sensitivity

Parameter	Explanation	Rating
Resilience	Possibility that species may be temporarily affected by underwater piling and vessel noise but effect would be short term and limited. Ecological functionality will be maintained.	1
Presence	The fish most likely to be present for extended periods of time in the ACG Contract Area and at the WC PDQ location are Kilka and Mullet throughout the year. However, neither the COP location nor the ACG Contract Area is exclusively used by these species and the Contract Area is not considered to be of primary importance.	1
Total		**2**

10.6.4.3 Impact Significance

Table 10.33 summarises impacts to seal and fish associated with jacket foundation piling and vessel movements.

[29] Plankton cannot sense the low frequency sound generated because the wavelength is longer than the organism and benthic invertebrates do not have sophisticated sound-sensing apparatus.

Table 10.33 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Jacket foundation piling and vessel movements	Medium	(Seals & Fish) Low	**Minor Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 10.3) and no additional mitigation is required.

10.6.5 Seabed Disturbance

10.6.5.1 Event Magnitude

Installation of infield pipelines will involve two forms of disturbance:

- Temporary disturbance from the repeated relocation of the anchors used to control the position of the pipe-lay barge; and
- Permanent disturbance arising from the presence of the pipelines on the seabed.

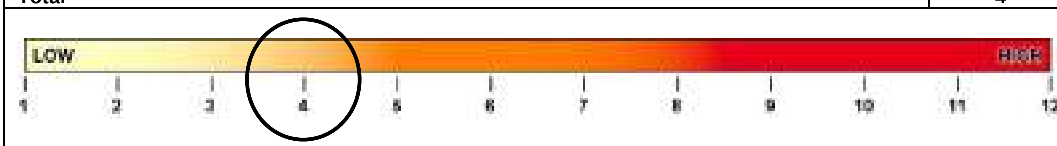
The pipelines are all of relatively small diameter (maximum 30 inches). The maximum possible disturbance would therefore be the longitudinal area of each pipeline. In total the COP infield pipelines are planned to occupy an area of 0.08km^2, 0.02% of the Contract Area (refer to Chapter 5: Section 5.5). In practice, it is likely that the majority of organisms within this area would be sufficiently mobile to re-establish themselves on either side of the pipeline since this would involve movement of only 30cm to 40cm at most. The presence of the pipelines will subsequently render a small area of seabed unavailable to benthic organisms. However, this is a very small fraction of the available area and would have no measurable effect on local benthic productivity.

The concrete coating of the pipeline is chemically inert by design (in order to protect the pipeline over several decades), and will have no effect on either the adjacent sediments or water column.

Table 10.34 presents the justification for assigning a score of 4, which represents a Low Event Magnitude.

Table 10.34 Event Magnitude

Parameter	Explanation	Rating
Extent/ Scale	Disturbance will be limited to areas of anchor setting and the area occupied by the COP infield pipelines.	1
Frequency	Once only per pipeline.	1
Duration	Disturbance events will be of short duration.	1
Intensity	Physical disturbance only, within small areas and no potential for lasting damage.	1
Total		**4**



10.6.5.2 Receptor Sensitivity

Fish, seals and plankton are not considered to be sensitive to physical seabed disturbance. Benthic invertebrates are the primary receptor but the nature of the disturbance is largely limited to temporary physical displacement.

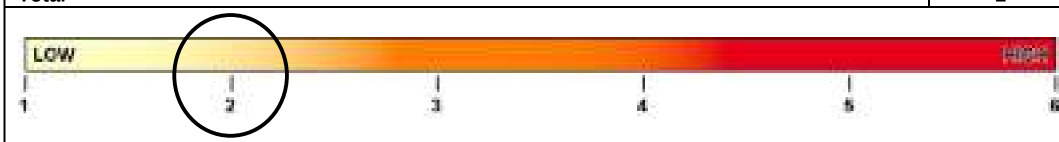
The primary impact associated with anchor setting and chain drag will be the disturbance and displacement of the sediment. The organisms living in the sediment are too small to be crushed by anchors and chain drag, although a small amount of mortality might occur at the point where the anchor initially impacts the seabed.

The displacement of sediment will not cause significant levels of mortality in benthic organisms. A small proportion of animals may be buried too deeply to recover to a position near the sediment surface, but the majority of organisms will be able to re-establish themselves once the anchor and chain have been moved to their next position.

Table 10.35 presents benthic invertebrates' Receptor Sensitivity.

Table 10.35 Receptor Sensitivity

Parameter	Explanation	Rating
Presence	No unique, rare or threatened benthos species present.	1
Resilience	Physical displacement of organisms will have limited short-term effects and is not predicted to cause significant long-term damage.	1
Total		**2**



10.6.5.3 Impact Significance

Table 10.36 presents the marine impacts associated with seabed disturbance during the construction, installation and HUC phase.

Table 10.36 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Seabed disturbance from anchor handling and pipelay	Low	(Benthic Invertebrates) Low	**Negligible**

It is considered that impacts are minimised as far as practicable and necessary (Table 10.3).

10.6.6 Other Discharges

10.6.6.1 Event Magnitude

Other discharges to sea will result from the operation of jacket and pipeline installation vessels (refer to Section 10.4.3. above) and pipeline installation. These will comprise:

- **Ballast Water** – Support vessels will occasionally take up and discharge ballast water during installation support activities.

  Vessel ballast tanks are designed to ensure that ballast water does not come into contact with oil or chemicals. Uptake and discharge are not considered to present a significant environmental hazard.

- **Treated Black Water** – Black water will be treated in accordance with MARPOL 73/78 Annex IV (as revised in 2004) requirements and sludge will be shipped to shore. During pipelay, based on 280 POB and an expected generation rate of $0.1m^3$/person/day, approximately $28m^3$ of treated effluent will be discharged per day. The flow rate is low, so the effluent will be rapidly diluted close to the point of discharge. Total suspended solids, BOD and coliforms at the proposed treatment level do not pose any risk of environmental impact.

- **Grey Water** - Grey water (approximately $62m^3$ per day) will be discharged directly to sea. Grey water (from showers, laundry etc) will contain only dilute cleaning agents (soaps, detergents) and the impact of discharge will be minimal.

- **Drainage -** Drainage (including deck drainage and washdown water) will be discharged directly to sea, provided no visible sheen is observable. No contaminated water will be discharged and so no environmental impact is anticipated.

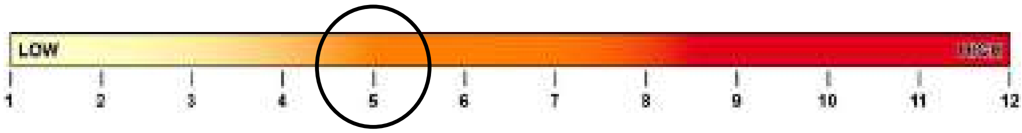
- **Oil Line Wye Spool Water** – approximately $65m^3$ of seawater containing hydrotest chemicals will be released as the section of existing pipeline is removed to accommodate the new wye piece (refer to Chapter 5: Table 5.19). This water may contain some residual hydrocarbons at concentrations estimated not to exceed 100 mg/l. The volume of the discharge is sufficiently small that hydrocarbon concentrations would be reduced to very low levels within a few metres of the source.

Event Magnitude is summarised in Table 10.37.

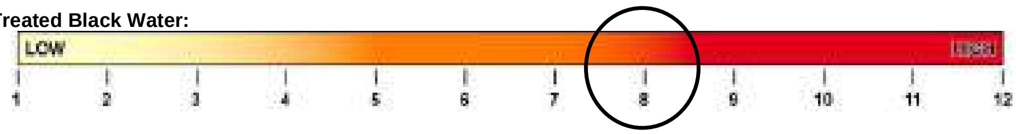
Table 10.37 Event Magnitude

Event Parameter / Discharge	Ballast Water	Black Water	Grey Water	Drainage	Oil Line Wye Spool Water
Scale	1	1	1	1	1
Frequency	2	3	3	3	1
Duration	1	3	3	3	1
Intensity	1	1	1	1	1
Event Magnitude	**5**	**8**	**8**	**8**	**4**

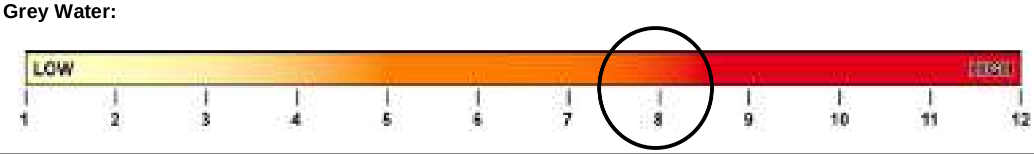
Ballast Water:



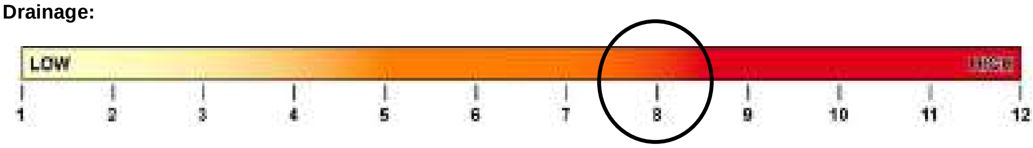
Treated Black Water:



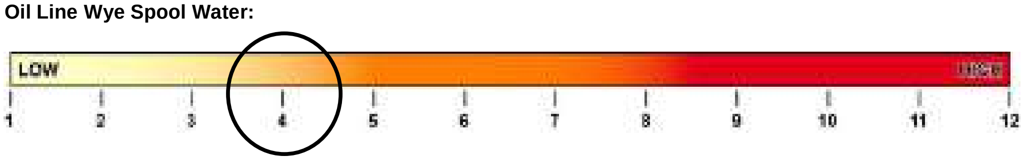
Grey Water:



Drainage:



Oil Line Wye Spool Water:



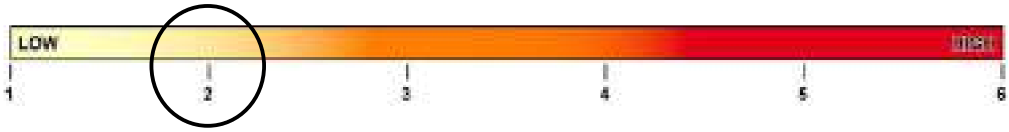
10.6.6.2 Receptor Sensitivity

All of the discharges are low in volume (with the exception of sewage chlorination of treated black water) and do not contain toxic or persistent process chemicals. Receptors are not considered to be sensitive to these small discharges.

Table 10.38 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 10.38 Receptor Sensitivity (All Receptors)

Parameter	Explanation	Rating
Resilience	The extremely low level of exposure is equivalent to high resilience.	1
Presence	There is no significant presence of rare, unique or endangered species (i.e. the risk of exposure for any such species is close to zero).	1
Total		**2**



10.6.6.3 Impact Significance

Table 10.39 summarises the impact of other discharges to sea on seals, fish, zooplankton, phytoplankton and benthic invertebrates based on the impact significance criteria presented in Chapter 3: Impact Assessment Methodology.

Table 10.39 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Other Discharges to Sea **Ballast Water**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Treated Black Water**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Grey Water**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Drainage**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Oil Line Wye Spool Water**	Low	(All Receptors) Low	**Negligible**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 10.3) and no additional mitigation is required.

10.7 Summary of COP Construction, Installation and HUC Residual Environmental Impacts

For all construction, installation and HUC phase environmental impacts assessed it has been concluded that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 10.3) and no additional mitigation is required. Should it be necessary to undertake synchronisation tests of the platform generators at night, additional mitigation will comprise consultation will take place in the local community (within 700m of the sound source) to ensure that impacts are no more than moderate negative.

Table 10.40 summaries the residual environmental impacts for the construction, installation and HUC phase of the project.

Table 10.40 Summary of Construction, Installation and HUC Residual Environmental Impacts

	Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from yard generators and engines	Medium	Medium	**Moderate Negative**
	Emissions from onshore platform generator commissioning	Medium	Medium	**Moderate Negative**
	Emissions from support vessel engines	Medium	Low	**Minor Negative**
Terrestrial Noise Environment	Noise from construction yard plant	Medium	Medium	**Moderate Negative**
	Noise from onshore platform generator commissioning	Medium	Medium	**Moderate Negative**
Marine Environment	Underwater noise from jacket foundation piling and vessel movements	Medium	Low	**Minor Negative**
	Cooling water discharge from onshore commissioning of topside	Medium	Low	**Minor Negative**
	Pipeline hydrotest discharge	Medium	Low	**Minor Negative**
	Discharge of oil line wye spool water	Low	Low	**Negligible**
	Jacket foundation pile cement discharge	Low	Low	**Negligible**
	Support vessel ballast water discharge	Medium	Low	**Minor Negative**
	Support vessel treated black water discharge	Medium	Low	**Minor Negative**
	Support vessel grey water discharge	Medium	Low	**Minor Negative**
	Support vessel drainage discharge	Medium	Low	**Minor Negative**
	Seabed disturbance from anchor handling and pipelay	Low	Low	**Negligible**

Chapter 11 Operations Impact Assessment, Mitigation and Monitoring

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11.1 Introduction

This Chapter of the Chirag Oil Project (COP) Environmental and Socio-Economic Impact Assessment (ESIA) presents the assessment of environmental and socio-economic impacts associated with the following elements of the COP operations phase:

- Platform Drilling;
- Offshore Operations and Production; and
- Terminal Operations.

The impact assessment methodology followed and the structure of the COP impact assessment are described in full within Chapters 3 and 9 of this ESIA respectively.

11.2 Scoping Assessment

The COP Operations Activities and Events have been determined based on the COP Base Case as detailed within Chapter 5: Project Description (see Appendix 11A).

Table 11.1 presents the Activities and associated Events that have been scoped out of the full assessment process, due to their limited potential to result in discernable environmental impacts. Judgement is based on prior experience of similar Activities and Events, especially with respect to earlier ACG developments. In some instances, scoping level quantification/numerical analysis has been used to justify the decision. Reference is made to relevant quantification, analysis, survey and/or monitoring reports in these instances.

Table 11.1 "Scoped Out" COP Operations Routine and Non-routine Activities

ID *	Activity / Event	Ch. 5 Project Description Reference	Justification for "Scoping Out"
Ops-NR10	Fire system tests	5.8.6.9	• Firewater pump testing will typically occur on a weekly basis for a short duration (approximately 1 hour) with seawater taken from the seawater cooling system dosed with chlorine/copper. • Chlorine/copper in discharged water is in trace amounts and pose no risk to the environment (refer to Section 11.5.6 below). • There will be no planned discharge of fire fighting foam except during emergency system tests (typically once every four months). • Discharge of approximately 20 litres of AFFF with 140m^3 of seawater via the WC-PDQ open drains caisson at 49.5m below sea level. • The current foam used by the AzSPU is of very low toxicity (LC_{50} 2.8 g/l for fish, 34.8 g/l for Daphnia), readily degradable (28-day degradation 92%) and has no bioaccumulation potential. • The small volume of foam will disperse in minutes so little potential for acute toxicity in exposed organisms. • 20 litres of AFFF would require only about 1,500m^3 of seawater to dilute to 96h no-effect level (a volume with an approximate radius of 7m). • The fish most likely to be present for extended periods of time in the ACG Contract Area and at the WC PDQ location are Kilka and Mullet that may be present throughout the year. However, the ACG Contract Area, including the COP location, is not exclusively used by these species and the Contract Area is not considered to be of primary importance. • **Conclusion**: Limited potential for discernable impact on the marine environment.
Ops-NR13	Pipeline operations and maintenance – pigging of oil and gas lines	5.9.4	• Pigging of COP oil and gas infield pipelines will generate additional pigging waste that will be recovered at the Sangachal Terminal. • The pigging waste will be of similar composition and disposed of in accordance with the existing Terminal Waste Management Plan, using an approved and licensed waste management contractor. • No planned discharge of pigging waste to the marine environment. • **Conclusion:** Waste quantities generated will not require additional resources to handle it and the waste will be managed in accordance with established practices.
Ops-R16	Crew change operations	5.8.8	• Crew changes will be made on a regular basis either using helicopters or crew change vessels. • The low volume of emissions released will disperse across the entire flight path/vessel route and the wider area. Increases in pollutant concentrations will be very small and indistinguishable from existing background concentrations. • Helicopter flights will originate from Zabrat heliport. A portion of the flight path will be over residential receptors but at height (>500m). Noise disturbance will be temporary, of short duration and low intensity. • **Conclusion:** Emissions and noise from crew change operations expected to result in no discernable impact to human receptors.
Ops-R17	Physical presence of WC-PDQ platform	5.8	• The COP WC-PDQ platform will be located between the existing DWG and Chirag-1 offshore facilities and approximately 60km from the nearest onshore settlement on the Absheron Peninsula. • The platform will not be visible from onshore and therefore there will be no visual intrusion to onshore receptors. • The footprint of the platform (including the drilling template) is negligible in the context of the South Caspian. • The fish most likely to be present for extended periods of time in the ACG Contract Area and at the WCPDQ location are Kilka and Mullet that may be present throughout the year. However, neither the COP location or the ACG Contract Area are exclusively used by these species and the Contract Area is not considered to be of primary importance. • The Contract Area is not located within a bird migration flyover route. • **Conclusion:** The platform (including at night when lit/flaring) will not be visible from onshore and no discernable impact on ecological/biological receptors is expected.

ID *	Activity / Event	Ch. 5 Project Description Reference	Justification for "Scoping Out"
Ops-18 Ter-03	Waste generation		• Waste generated during the operational phase will be consistent with the types and quantity of waste generated by the existing ACG operational platforms. • Waste types generated at the terminal are not expected change as a result of the COP. • Waste will be segregated at source, stored and transported in fit for purpose containers. • The CWAA at the AIOC supply base within the BDJF yard will be used as the main reception and consolidation point for solid waste from offshore. • Waste will be managed in line with the principles described in Chapter 14 and will benefit from the operational experience that has been gained from continuing AIOC operations • Waste minimisation and management plans will be established and all waste transfers controlled and documented • BP will manage the collection, transportation, treatment, disposal and storage of waste generated during the operational phase via specialised approved waste management contractors- the destinations of the waste types is provided in Chapter 5. • **Conclusion:** Waste will be managed as described within Chapter 14. No discernable impact to the terrestrial or marine environment expected.
Ter-04	Onshore discharges		• Only routine discharges from the terminal are treated sewage and storm water drainage. As COP will require no additional facilities the contribution of COP will be indiscernible from existing operation. • **Conclusion**: There will be no discernable impact to the terrestrial environment associated with COP related discharges at the terminal.

*Key: Ops = Offshore Operations, Ter = Terminal

The COP routine and non-routine Activities and their associated Events assessed in accordance with the full impact assessment process are presented in Table 11.2.

Table 11.2 "Assessed" COP Routine and Non-routine Operations Activities

ID*	Activity	Ch. 5 Project Description Reference	Event	Receptor
Ops-R1	Predrill well tie-in and re-entry	5.7.3	Underwater noise and vibration	Marine Environment
Ops-R2	Driving conductor section and drilling surface hole section with WBM	5.7.4	Drilling discharges to sea	Marine Environment
			Underwater noise and vibration	
Ops-NR3	Discharge of WBM residual mud	5.7.4	Drilling discharges to sea	Marine Environment
Ops-R4	Cement losses during casing cementing	5.7.7.1 and 5.3.2.5	Cement discharges to sea	Marine Environment
Ops-NR5	Excess cement discharge to sea	5.7.7.1 and 5.3.2.5	Cement discharges to sea	Marine Environment
Ops-R6	Power generation, cranes, emergency generator testing, purge and pilot flaring	5.8.6.3 and 5.8.6.5	Emissions to atmosphere (non GHG)	Atmosphere
Ops-NR7	Non-routine platform flaring	5.8.6.6	Emissions to atmosphere (non GHG)	Atmosphere
Ops-NR8	Non-routine produced water discharge	5.8.4	Produced water discharges to sea	Marine Environment
Ops-R9	Seawater lift and cooling water discharge	5.8.6.6	Water intake/entrainment	Marine Environment
			Cooling water discharge to sea	
Ops-R11	Platform drainage	5.8.6.11	Other discharges to sea	Marine Environment
Ops-R12	Sewage and galley waste discharges	5.8.6.14 and 5.8.6.15	Other discharges to sea	Marine Environment
Ops-R14	Maintenance of produced water and injection water pipelines (pigging)	5.8.7	Pigging discharge to sea	Marine Environment
Ops-R15	Support vessel operations	5.8.8	Emissions to atmosphere (non GHG)	Atmosphere
			Underwater noise and vibration	Marine Environment
			Other discharges to sea	
Ter-R1	Use of existing terminal processing and storage facilities	5.9.4	Emissions to atmosphere (non GHG)	Atmosphere
Ter-NR2	Non-routine flaring associated with COP at the terminal	5.9.4	Emissions to atmosphere (non GHG)	Atmosphere

*Key: Ops = Offshore Operations, Ter = Onshore Operations
Note: GHG Emissions are addressed in Chapter 13

11.3 Existing Controls, Monitoring and Reporting

Existing control measures, monitoring and reporting requirements relevant to the COP operations routine and non-routine Activities are provided in Table 11.3 and form part of the AzSPU Integrated HSSE Management System (refer to Chapter 14 for further details).

Table 11.3 COP Operations Existing Controls, Monitoring and Reporting

	Category	Existing Controls	Monitoring	External Reporting
ATMOSPHERE	Emissions to atmosphere (non GHG) from routine platform operations (from use of the main power generators, platform cranes, testing of the emergency generators, fire water pumps fugitive emissions and pilot/purge flaring), non-routine flaring and vessel generators and engines	• Platform generators, cranes and pumps are subject to planned maintenance in accordance with written procedures based on the manufacturer's guidelines, or applicable industry code or engineering standard to ensure efficient and reliable operation; and exhaust emissions' testing is undertaken at least annually in accordance with the relevant PSA requirement[1]. • Diesel transported to and stored onboard the platform and supplied to support vessels is routinely provided from the onshore tank farm and complies with MARPOL Annex VI Regulations for the Prevention of Air Pollution from Ships[2]. Average sulphur content is typically 0.0326%. • The high pressure (HP) flare is designed for at least 98% destruction efficiency and smokeless design. • There will be no continuous flaring or venting during routine operations (with the exception of purge/pilot flaring and flaring of off gas from the diesel and mud tanks and the glycol regeneration package for safety reasons). • Planned or unplanned flaring or venting of hydrocarbons shall be minimised where practical without compromising the safety of personnel or the integrity of plant. • Unplanned equipment outages and/or plant upsets shall be corrected in a timely manner in order to eliminate flaring as soon as practical. • Fugitive VOC losses shall be minimised through limiting flange connections and instrument intrusions, and the installation of low loss valves where practicable on the platform. • If available and suitable for use, fuel gas will be used for power generation during platform commissioning and start up to minimise emissions.	• Emissions testing of platform exhausts to confirm that the NO_X, SO_X and CO emissions are at the specified levels (i.e. the levels and tolerances determined by the equipment manufacturer which confirm efficient operation) and confirm maximum concentrations do not exceed relevant standards[3]. Monitoring is undertaken in accordance with the existing AzSPU methodologies and procedures aligned with US EPA and ISO stack emissions measurement and calibration requirements. • Diesel samples are taken regularly to confirm diesel quality following treatment.	• Exhaust emission test results are submitted to the MENR. • Emission volumes based on fuel usage and calculated flare volumes and submitted to the MENR, SOCAR and the State Statistical Committee at an agreed frequency.

[1] IC engines/turbines larger than 500 HP should be monitored on an annual basis to assure that the NO_X and CO emissions are at the specified levels.
[2] Sulphur content of 3.5%, effective from 1 January 2012.
[3] SOx maximum concentration of 400 mg/Nm^3 and NOx maximum concentration of 1,000 mg/Nm^3.

	Category	Existing Controls	Monitoring	External Reporting
ATMOSPHERE	Emissions to atmosphere (non GHG) from onshore operations	• The high pressure flare is designed for at least 98% destruction efficiency and smokeless design. • There will be no continuous flaring or venting during routine operations (with the exception of purge/pilot flaring for safety reasons). • Planned or unplanned flaring or venting of hydrocarbons shall be minimised where practical without compromising the safety of personnel or the integrity of plant. • Unplanned equipment outages and/or plant upsets shall be corrected in a timely manner in order to eliminate flaring as soon as practical. • A number of gas turbine generators and fired heaters incorporate Dry Low-NO_X Emission (DLE) burners to minimise NO_X emissions. • Combustion plant at the terminal will be subject to regular maintenance in accordance with written procedures based on manufacturer's guidelines, or applicable industry code or engineering standard to ensure efficient and reliable operation; and emissions testing of combustion plant exhausts are undertaken at least annually in accordance with the relevant PSA requirement. • Storage tanks are of the external floating roof type incorporating appropriate controls including low loss fittings and seals to minimise emissions during transfer. • A procedure is in place to record and respond to community complaints including air quality and noise.	• Monitoring conducted in compliance with the PSA requirements as a minimum. Current practice, anticipated to continue during COP operations, is aligned with relevant USEPA and ISO methodologies and includes: ○ Annual monitoring of significant stack emissions for NO_x, SO_x and CO. ○ Quarterly ambient air quality monitoring for NO_x, SO_x and VOC. ○ Monitoring of non-routine flaring events (flow velocity and duration). • Ambient air monitoring is undertaken at and around the Sangachal Terminal as part of the IEMP.	• Stack emission test results are submitted to the MENR. • Emission volumes based on fuel usage and calculated flare volumes are submitted to the MENR, SOCAR and the State Statistical Committee at an agreed frequency. • IEMP monitoring results are submitted to the MENR/EMTAG.
MARINE ENVIRONMENT	Noise from conductor section hammering	• The frequency of conductor section hammering will be gradually increased to minimise underwater noise impacts to marine species.		

	Category	Existing Controls	Monitoring	External Reporting
MARINE ENVIRONMENT	Drilling Discharges	• Non WBM and associated cuttings will not be discharged but recovered and the non WBM reused. Non WBM cuttings will be routinely reinjected. When the CRI well is not available, non WBM cuttings will be containerised and either transported to another operational platform for reinjection or shipped to shore for treatment. • Cuttings and WBM are discharged below sea level in accordance with PSA requirements[4]. • During drilling, WBM is separated from cuttings as far as practicable and re-used. • WBM chemicals are of low toxicity (UK HOCNS "Gold" and "E" categories or equivalent toxicity to those chemicals previously approved for use) • Batches of barite supplied for use in WBM formulations meet applicable heavy metals concentration standards[5]. • No planned discharge of WBM or associated drilling cuttings with chloride concentration greater than permissible PSA standard[6] .	• Should any changes to the drilling mud system be required during the drilling programme, the Management of Change Process will be followed (Chapter 5: Section 5.11). As a minimum, tests in accordance with Caspian Specific Ecotoxicity Procedures will be undertaken if the WBM composition is changed. • Each batch of barite supplied for use in WBM is tested by the supplier to confirm cadmium and mercury content. • When WBM and cuttings are discharged, the chloride concentrations are analysed twice a day. • Monitoring of potential effects on seabed and benthic communities is carried out in accordance with the IEMP (refer to Chapter 14).	• Volumes, composition and characteristics[7] of WBM and cuttings discharged are reported to the MENR. • Discharged WBM and cuttings' chloride concentrations are reported to the MENR. • Volumes, composition and characteristics of non WBM and cuttings used, recovered and shipped to shore are reported to the MENR. • Ecotoxicity WBM test results are submitted to the MENR. • IEMP monitoring results are submitted to the MENR/EMTAG.

[4] There shall be no unauthorized discharges directly to the surface of the sea. All discharges authorized by these guidelines shall be controlled by discharging into a caisson, whose open end is submerged at all times, a minimum of sixty (60) centimetres below the surface of the sea.
[5] Mercury <1 mg/kg and cadmium <3 mg/kg dry weight (total).
[6] There shall be no discharge of drill cuttings or drilling fluids if the maximum chloride concentration of the drilling fluid system is greater than four (4) times the ambient concentration of the receiving water.
[7] Includes those properties currently reported within the ACG End of Wells reports (e.g. specific weight and rheological properties).

	Category	Existing Controls	Monitoring	External Reporting
MARINE ENVIRONMENT	Cement Discharges	• Cementing chemicals are of low toxicity (UK HOCNS "Gold" and "E" categories or equivalent toxicity to those chemicals previously approved for use). • Cement is designed to set in a marine environment preventing widespread dispersion. • The volume of cement used to cement each casing is calculated prior to the start of the activity. Sufficient cement is used to ensure that the casing is cemented securely and necessary formations isolated so that this safety and production critical activity is completed effectively while minimising excess cement discharges to the sea.	• Surveillance of cement discharge build up is routinely performed as part of platform/template subsea inspections routines. Excess cement at the seabed is observed and corrective action taken if required, to ensure cement discharges are minimised without comprising safety[8]. • Monitoring of potential effects on seabed and benthic communities is carried out in accordance with the IEMP (refer to Chapter 14).	• The inventory of cementing fluid additives and the quantity of cementing fluids used for each well is submitted to the MENR. • IEMP monitoring results are submitted to the MENR/EMTAG.

[8] During casing cementing operations the discharge of cement to the seabed is the best indicator that sufficient cement has been circulated to secure the casing to the rock interface. Ensuring sufficient volumes of cement are circulated is critical to the integrity of the casing/well, maintaining well control and isolation of subsurface strata. These measures decrease the risk of incidents occurring such as the recent CA gas leak.

	Category	Existing Controls	Monitoring	External Reporting
MARINE ENVIRONMENT	Produced Water Discharge	• Produced water equipment is designed such that produced water comprises an oil content (as defined by EPA method 1664A[9]) of no more than: ○ Daily maximum 42 mg/l ○ Monthly Average 29 mg/l • Produced water equipment including sand cyclones, oil hydrocyclones, transfer pumps and degassing and skimming equipment are proven technology and consistent with recognised industry practice. • Planned preventive maintenance of produced water equipment will be undertaken to ensure effective and reliable operation. • Two COP produced water transfer pumps (one spared) are provided to minimise discharge during pump maintenance/outage. • All produced water equipment is designed to operate across the full range of expected operating conditions. • COP Base case design includes: ○ Antifoam and demulsifier chemicals, selected to remain in the oil phase in the platform separators. ○ Biocide and oxygen scavenger dosing systems designed such that dosing can be discontinued during produced water discharge. • Chemicals present in produced water discharge (scale inhibitor and reverse demulsifier) of comparable environmental performance to those previously approved for use in the ACG projects. Should any changes to the production chemicals be required during the drilling programme, the Management of Change Process will be followed (Chapter 5: Section 5.11).	• Flowmeter installed to monitor produced water flow rate. • Daily sampling of produced water discharge, offshore lab analysis and gravimetric extraction method at onshore lab to verify accuracy of daily lab analysis undertaken. • Online produced water analyser package to monitor oil content following hydrocyclone treatment. Analyser package maintained and calibrated in accordance with written procedures based on the manufacturer's guidelines, or applicable industry code or engineering standard.	• Volume and hydrocarbon composition of produced water discharged reported to the MENR/SOCAR.
	Pigging Discharges	• Chemical discharges within COP produced water used during pigging will be controlled as above, with biocide and oxygen scavenger dosing systems designed such that dosing of both can be discontinued during pigging. • Pigging operations will take place no more frequently than is necessary (on the basis of accumulated data on pigging solids) to maintain pipeline integrity and flow rates.	• Where feasible, samples will be collected periodically during discharge events to allow monitoring of the discharge's composition.	• Volume estimates of discharges associated with pigging will be recorded and reported within 6 monthly operations reporting to the MENR/SOCAR.

[9] Note that EPA method 1664A replaces withdrawn EPA 413.1 (79) which is quoted within the PSA

	Category	Existing Controls	Monitoring	External Reporting
MARINE ENVIRONMENT	Cooling Water Intake and Discharges	• The design and operation of the cooling water system has been reviewed and confirmed that the temperature at the edge of the cooling water mixing zone (assumed to be 100m from the discharge point) will be no greater than 3 degrees more than the ambient water temperature[10]. • The copper/chlorine biocide control system is designed to control concentrations to the stated dosage (chlorine 50 ppbv, 5 ppbbv copper), incorporating automatic controls to prevent over dosing. • The seawater intake design includes: ○ An intake screen to prevent entrainment of fish and larger organisms; ○ Low water intake velocity; and • Water intake at depth, which is below the productive zone where plankton are most prolific (i.e. at a minimum depth of 105m).	• Biocide dosing levels are checked automatically.	• Volume of cooling water will be reported at agreed frequency to the MENR/SOCAR
	Other Discharges (Vessel Ballast Water)	• Vessel ballast tanks and drainage systems are designed so that oil and chemicals do not come into contact with ballast water. • Ballast water intake incorporates screens to prevent fish entrainment.		
	Other Discharges (Vessel/ Platform Treated Black Water)	• Vessel black water treated in accordance with MARPOL 73/78 Annex IV MEPC.2 (vi) requirements[11]. • Platform sewage treatment package designed in accordance with PSA requirements such that black water effluent is treated to applicable USCG Type II standards[12].	• Samples are taken from the sewage discharge outlet and analysed monthly for total suspended solids, fecal coliforms and BOD. • Daily visual checks undertaken when discharging to confirm no floating solids are observable.	• Sewage sampling results, recorded daily observations and estimated volumes of treated black water discharged daily (based on POB) are submitted to the MENR.
	Other Discharges (Vessel/ Platform Grey Water, Galley Waste and Drainage)	• Platform grey water, deck drainage and wash water discharged in accordance with relevant standards[13]. • Environmental factors are considered prior to selection of platform chemicals including cleaning fluids such as detergents. • Platform maceration unit designed to treat food wastes to applicable MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standard prior to discharge[14].	• Daily visual checks undertaken when discharging to confirm no floating solids are observable and no visual sheen.	• Recorded daily observations, estimated volumes of domestic wastes (grey water and galley waste) and drainage discharged daily are submitted to the MENR.
General		• The platform and support vessels are included within the scope of environmental reviews. Review findings are summarised in addition to any necessary actions identified.		

[10] The COP Management of Change Process (Section 5.11) will be followed should any change to the design or operation of the cooling water system be required.
[11] 5 day BOD of less than 50mg/l, suspended solids of less than 50mg/l (in lab) or 100mg/l (on board) and fecal coliform 250MPN (most probable number) per 100ml. Residual chlorine as low as practicable.
[12] Sanitary waste may be discharged from a U.S. Coast Guard certified or equivalent Marine Sanitation Device (MSD) to meet USCG Type II standards of total suspended solids of 150mg/l and fecal coliforms of 200MPN (most probable number) per 100ml
[13] Grey water, deck drainage and wash water may be discharged as long as no floating matter or visible sheen is observable.
[14] Macerated to particle size less than 25mm.

11.4 Impacts to the Atmosphere

11.4.1 Offshore Operations

11.4.1.1 Event Magnitude

Routine emissions during offshore operations will arise from use of the main power generators, platform cranes, testing of the emergency generators, fire water pumps and pilot/purge flaring. Non-routine emissions will arise from flaring due to emergencies and/or equipment malfunctions, repairs or maintenance or lack of availability for associated gas export[15,16] (refer to Chapter 5: Sections 5.8.6.4 - 5.8.6.6). In addition, during platform commissioning and start up, while it is planned to use fuel gas received from the "buy back system" from the 28" marine export gas pipeline, it may be necessary to use temporary diesel generators (refer to Chapter 5: Section 5.6.4 and Appendix 5A).

Modelling undertaken for the offshore operations is presented in Appendix 11B. The modelling focuses on NO_X (which comprises nitrous oxide (NO) and nitrogen dioxide (NO_2)) as the main atmospheric pollutant of concern, based on the larger predicted emission volumes as compared to other pollutants (SOx, CO and non methane hydrocarbons) and the potential to impact upon human health and the environment.

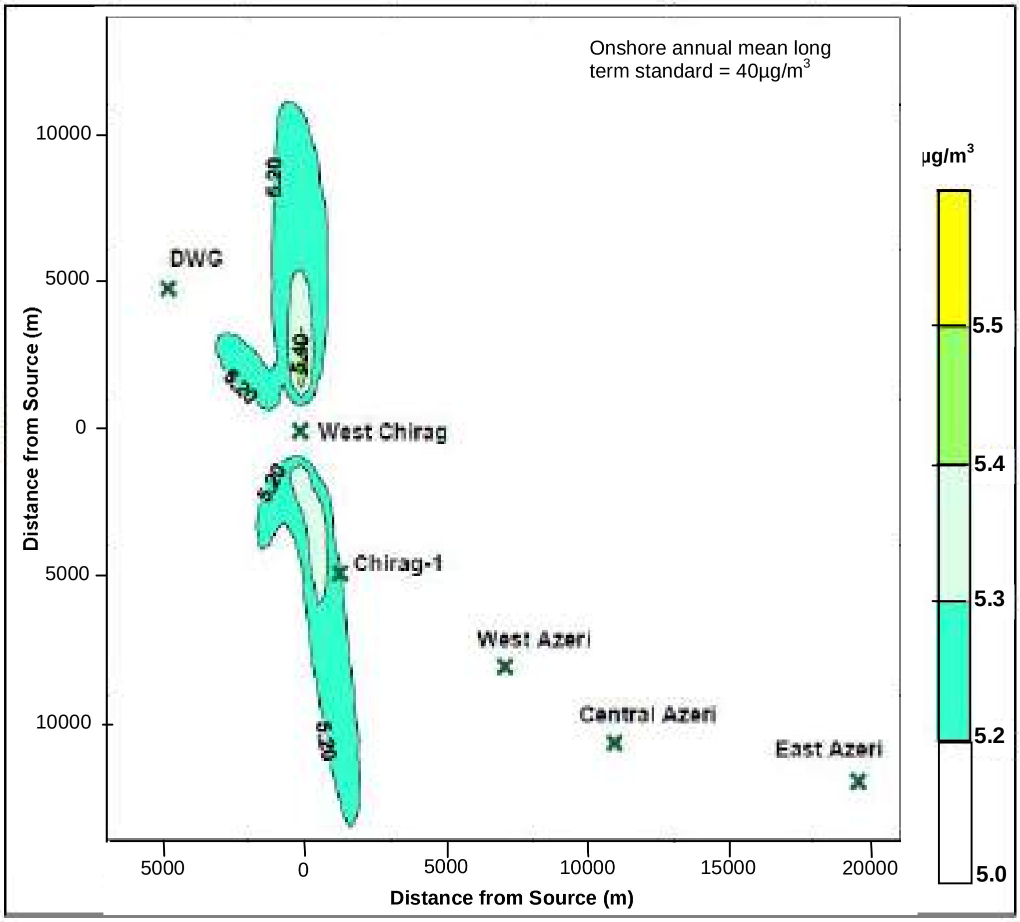
Short term (1 hour maximum) and long term (annual average) NO_2 concentrations were modelled to assess the contribution of emissions from COP offshore operations in the context of relevant standards for NO_2[17]. These standards are relevant to locations where humans are normally resident (i.e. onshore settlements) and do not apply to commercial locations and workers, which are subject to standards under separate occupational health requirements.

The modelling conservatively assumed that, for the long term, all NO_X is NO_2 and for the short term, 50% of NO_X is NO_2, the remainder being NO. A background NO_2 concentration of 5.0µg/m^3 was assumed based on previous monitoring data obtained along the Sangachal coastline (refer to Chapter 6: Section 6.4.2). Both routine and non-routine operation (i.e. including flaring associated with restricted gas export and emergency shutdown flaring) of the platform was modelled[18].

The results demonstrated that, during routine operations, the long term concentration of NO_2 is predicted to increase by 0.3µg/m^3 2km from the platform, reducing to background concentrations at a maximum distance of 14km to the south and approximately 12km to the north (see Figure 11.1).

[15] As defined within Article XV of the ACG PSA.
[16] Accidental events and emergencies are discussed in Chapter 13.
[17] Applicable 1 hour average (short term) and annual average (long term) standards for NO_2 are 200µg/m^3 and 40µg/m^3 respectively.
[18] Appendix 11B provides full details of modelling input and assumptions, for model limitations and sources of uncertainty.

Figure 11.1 WC-PDQ Platform Predicted Long Term NO_2 Concentrations Under Routine Conditions



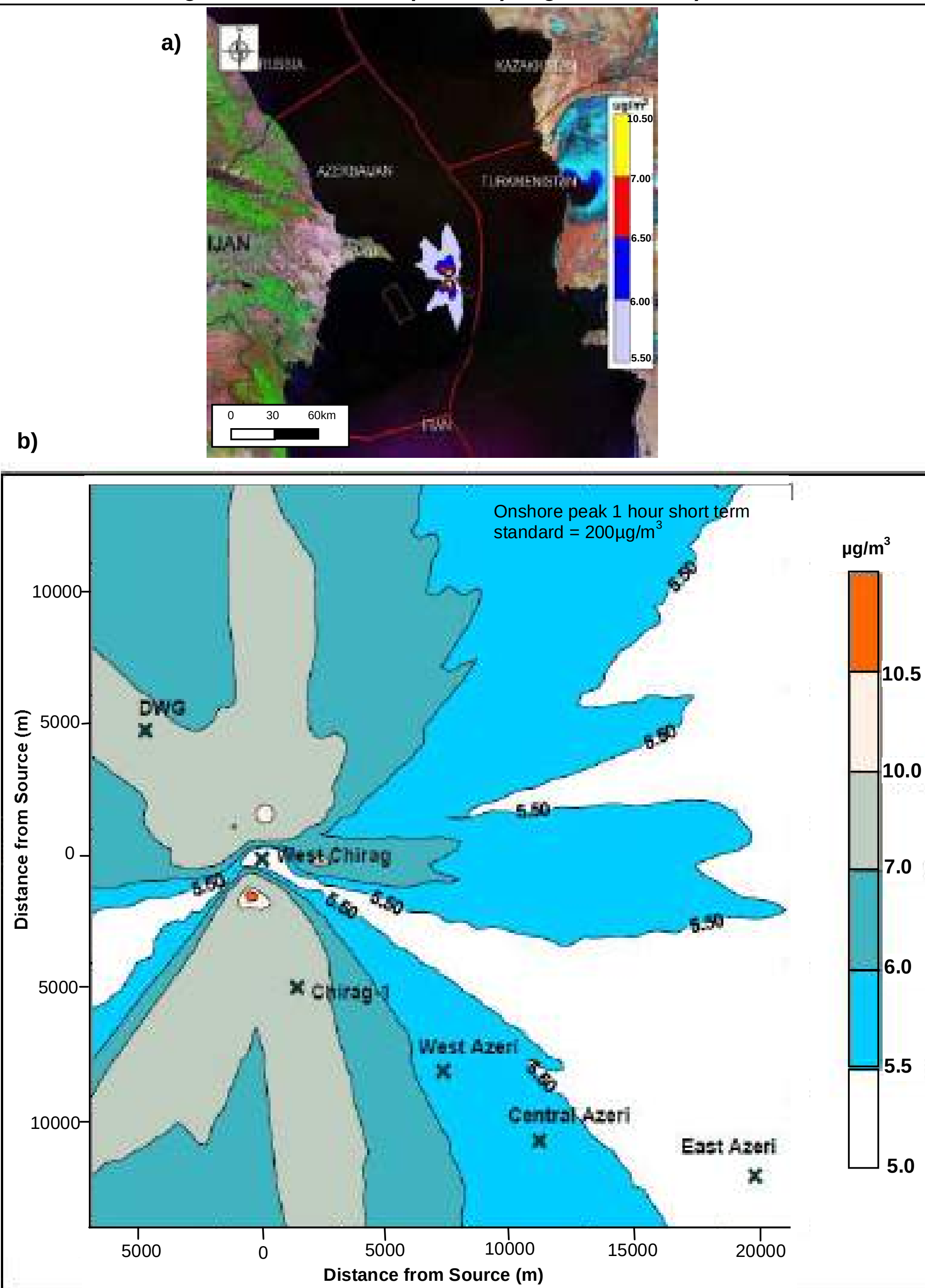
No exceedances of the onshore long term air quality standard at any distance from the WC-PDQ platform and no discernable change in NO_2 concentrations onshore were predicted[19].

Non-routine flaring undertaken at the platform due to restricted gas export will typically be a short term event and would be expected to last, at worst, a number of hours in duration[20]. The modelling for this scenario demonstrates that the maximum short term concentration of NO_2 is predicted to be 10.5µg/m^3 at a distance of 1.2km south of the WC-PDQ platform, reducing to 7µg/m^3 at a distance of 1.95km. Figure 11.2 shows the results obtained on a a) regional and b) local scale.

[19] Historically in Azerbaijan ambient concentrations of NO_2, SO_2, CO and PM_{10} have also been assessed against specific 24 hour and 1 hour standards. These standards were not derived using the same health based criteria as the IFC, WHO and EU guideline values and the standards derived are not widely recognised. However, Appendix 11B (Update 1) includes an assessment of expected air quality concentrations against these standards for completeness. The modelling demonstrated that none of these standards would be exceeded during routine platform operations or during non routine flaring.

[20] It should be noted that non routine flaring during platform start up may extend for longer periods, however the flowrate of hydrocarbon flared and the associated emission release rates will be less than the restricted gas export scenario modelled.

Figure 11.2 WC-PDQ Platform Predicted Short Term NO_2 Concentrations From Flaring - Restricted Gas Export at a) Regional Scale b) Local Scale[21]

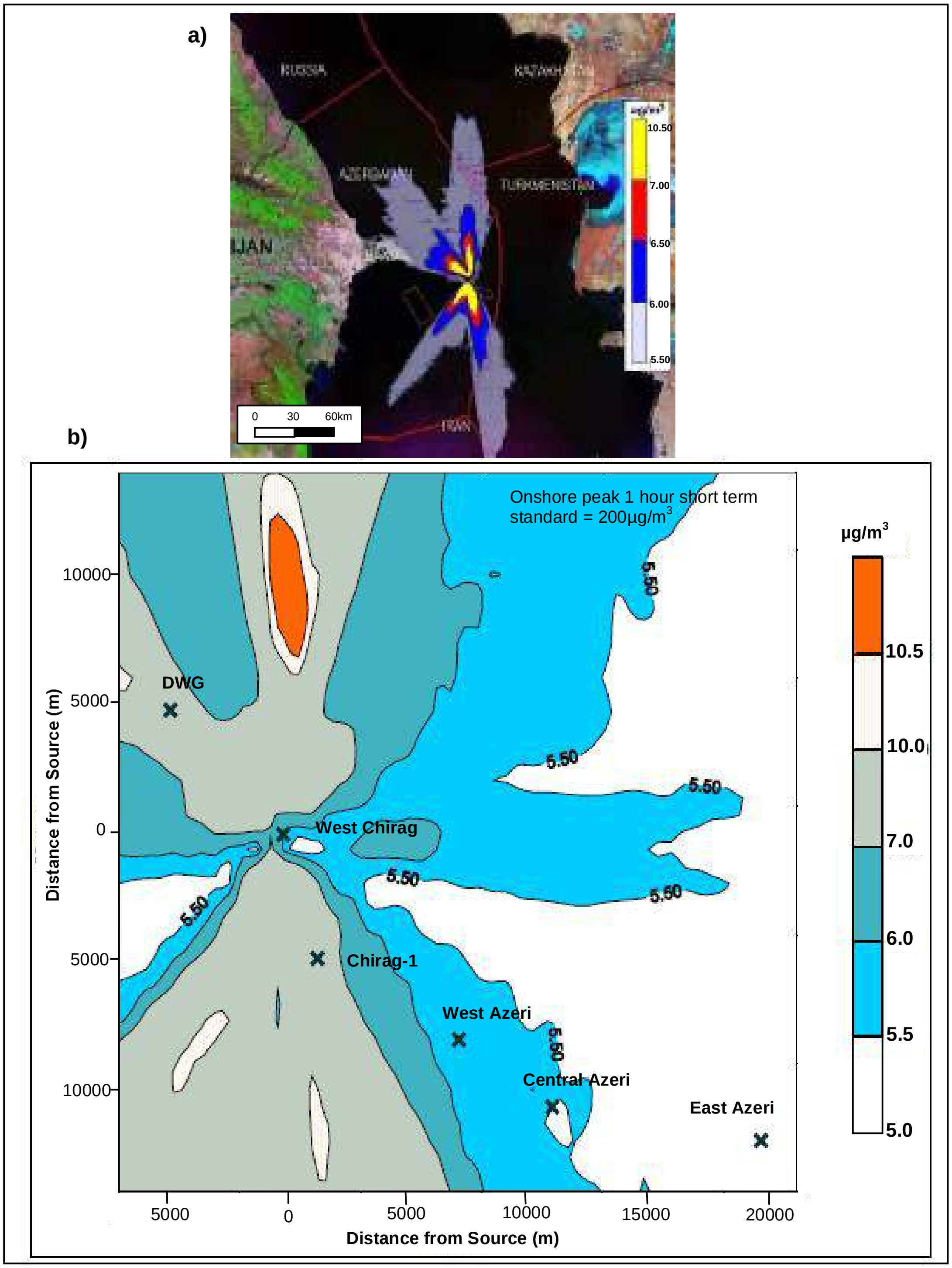


As a worst case, an emergency depressurisation may be necessary, whereby the platform is isolated from production and export pipelines and the process inventory on the platform is directed to flare. The complete depressurisation of a platform is rapid and typically most of the inventory is flared within one hour.

[21] A larger grid size was used when modelling at the regional scale, leading to slight variations in the concentration plots

Under emergency flaring conditions, the modelling demonstrates that the maximum short term concentration of NO_2 is predicted to be 10.5µg/m^3 at a distance of 6.9km from the WC-PDQ platform, reducing to 7µg/m^3 at a distance of 14km (Figure 11.3).

Figure 11.3 WC-PDQ Platform Predicted Short Term NO_2 Concentrations From Flaring Due to Emergency Shutdown Flaring at a) Regional Scale b) Local Scale[22]



[22] A larger grid size was used when modelling at the regional scale, leading to slight variations in the concentration plots

For both the restricted gas export and emergency scenarios modelled, no exceedances of the onshore short term air quality standard at any distance from the WC-PDQ platform and no discernable change in NO_2 concentrations onshore were predicted. Short term concentrations onshore will increase by less than 1μg/m^3, which represents less than 1% of the short term standard. Once non-routine flaring ceases and routine operations commence, emissions from these flaring events will disperse rapidly in the atmosphere and NO_2 concentrations will return to those forecast for routine operations (Figure 11.1)[19].

Based on efficient operation and regular maintenance, operation of the platform generators and flaring will not result in plumes of visible particulates.

Tables 11.4 and 11.5 present the justification for assigning a score of 8 to emissions from routine and non-routine offshore operations, which represents Medium Event Magnitude.

Table 11.4 Event Magnitude (Routine Operations)

Parameter	Explanation	Rating
Extent / Scale	Increases in concentrations of pollutant species will be indiscernible from background concentrations at onshore receptors.	1
Frequency	Emissions will continuously throughout offshore operations.	3
Duration	Emissions will occur throughout the offshore operations phase.	3
Intensity	Modelled long and short term concentrations of key pollutant, NO_2, are predicted to be significantly below relevant ambient air quality standards.	1
Total		**8**

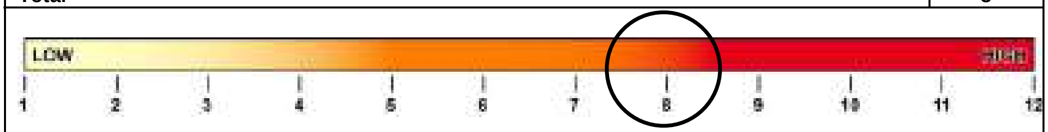
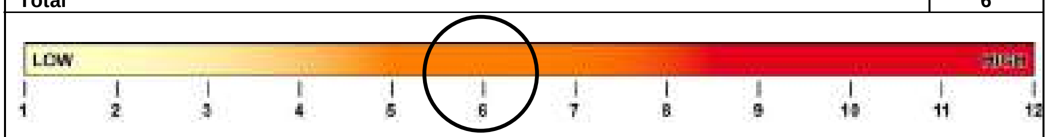


Table 11.5 Event Magnitude (Non-Routine Operations: Flaring)

Parameter	Explanation	Rating
Extent/Scale	Increases in concentrations of pollutant species will be indiscernible from background concentrations at onshore receptors.	1
Frequency	Non-routine flaring will typically occur periodically for short periods throughout offshore operations.	3
Duration	Non-routine flaring will typically occur for periods of hours.	1
Intensity	Modelled long and short term concentrations of key pollutant, NO_2, are predicted to be significantly below relevant ambient air quality standards.	1
Total		**6**



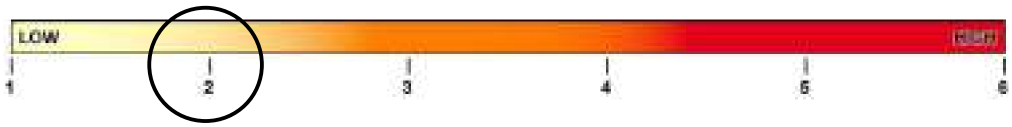
11.4.1.2 Receptor Sensitivity

Human Receptors

Table 11.6 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 11.6 Human Receptor Sensitivity

Parameter	Explanation	Rating
Presence	There are no permanently present (i.e. resident) human receptors within 60km of the platform location.	1
Resilience	Changes in air quality onshore associated with emissions from COP offshore operations will be indiscernible. Onshore receptors will be unaffected.	1
Total		**2**

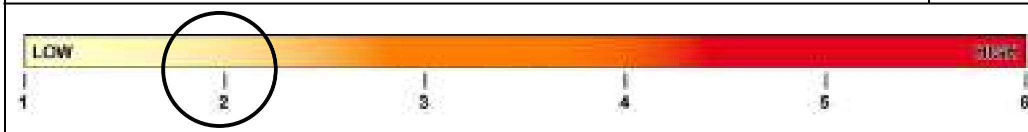


Biological/Ecological Receptors

Table 11.7 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 11.7 Biological/Ecological Receptor Sensitivity

Parameter	Explanation	Rating
Presence	Marine/bird species are mobile and will not be present at one location for long periods of time. The Contract Area is not located within a bird migration flyover route. Birds found in the area will be transient and not resident.	1
Resilience	Volume of emissions released (including visible particulates) due to power generation will create a very small increase in pollutant concentrations in the atmosphere and in any washout from rainfall, which will not be discernable to biological/ecological receptors[23].	1
Total		**2**



11.4.1.3 Impact Significance

Table 11.8 summarises impacts on air quality associated with offshore operations.

Table 11.8 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Offshore power generation and non-routine flaring	Medium	(Humans) Low	**Minor Negative**
		(Biological/Ecological) Low	**Minor Negative**

It is considered that impacts are minimised are far as practicable and necessary through the implementation of the existing control measures (refer to Table 11.3) and no additional mitigation is required.

11.4.2 Support Vessels

11.4.2.1 Event Magnitude

As stated within Chapter 5: Section 5.8.8, support vessels will be required throughout the operations phase to supply consumables (e.g. drilling mud, diesel) to the platform and ship solid and liquid waste to shore for treatment and disposal. A worst case of one return vessel trip per week has been assumed for the operational phase.

[23] Note that ambient air quality standards are not relevant to biological/ecological receptors.

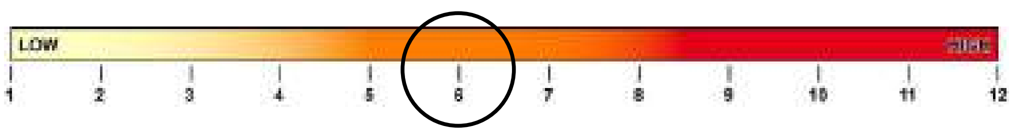
Emissions of the key pollutant relevant to human health, NOx, are expected to be considerably lower from vessels (approximately 456 tonnes) than those anticipated from worst case WC-PDQ platform emissions (approximately 9,535 tonnes)[24]. Emissions from vessel movements will disperse rapidly across a relatively large geographic area, and it is expected that, as for modelled platform emissions, increases in NO_2 concentrations will be insignificant and indiscernible from background levels at onshore receptors.

Based on efficient operation, regular maintenance, planned use of good quality, and low sulphur fuel, routine operation of the vessels will not result in large plumes of visible particulates from the vessel engine exhausts[25].

Table 11.9 presents the justification for assigning a score of 6, which represents a Medium Event Magnitude.

Table 11.9 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Increases in concentrations of pollutant species will be indiscernible from background concentrations at all distances from the emission source.	1
Frequency	Emissions will occur more than 50 times.	3
Duration	Emissions will occur for up to 24 hours.	1
Intensity	Long and short term concentrations of key pollutant, NO_2, are predicted to be significantly below relevant ambient air quality standards.	1
Total		**6**



11.4.2.2 Receptor Sensitivity

In terms of Emissions to Atmosphere, Receptor Sensitivity is considered to be the same regardless of the Event. As per Section 11.4.1.2, Receptor Sensitivity is Low (2) for both human and biological/ecological receptors.

11.4.2.3 Impact Significance

Table 11.10 summarises impacts on air quality associated with support vessels during the operations phase.

Table 11.10 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Support Vessel Engines	Medium	(Humans) Low	**Minor Negative**
		(Biological/Ecological) Low	**Minor Negative**

It is considered that impacts are minimised are far as practicable and necessary through the implementation of the existing control measures (refer to Table 11.3) and no additional mitigation is required.

[24] Incorporating platform power generation and emergency flaring.

[25] Note that SO_2 emissions from vessels are expected to be approximately 0.1% of platform SO_2 emissions (Refer to Appendix 5A)

11.4.3 Onshore Operations

11.4.3.1 Event Magnitude

Emissions at the Sangachal Terminal from COP onshore activities will be associated with an increased load on existing heaters and turbines, increased oil storage (resulting in VOC emissions) and an increase in non-routine flaring.

As demonstrated within Figure 5.21 of Chapter 5, the predicted emissions from the COP are not expected to exceed the forecast peak emissions associated with ACG Phases 1 - 3 (due to predicted reductions in emissions from these ACG Phases during the COP's lifetime[26]).

Air dispersion modelling was carried out for the ACG Phase 3 ESIA (Appendix 11, ACG Phase 3 ESIA), including EOP, ACG Phase 1, 2 and 3 and Shah Deniz Gas Export Stage 1. Emissions were modelled at the stages they were likely to be highest (i.e. during start up and at peak production):

- EOP, ACG Phase 1, 2, Shah Deniz in normal operation plus ACC Phase 3 start up (2008); and
- EOP, ACG Phase 1, 2, 3 and Shah Deniz in normal operation (2010), at peak production.

In addition, the following emergency shutdown (ESD) scenarios were modelled:

- EOP, ACG Phase 1, 2, 3 and Shah Deniz operation with the addition of ESD of ACG FFD via elevated flare at a rate of 100 MMscfd for 1 hour; and
- ACG Phase 1, 2, 3 EOP and Shah Deniz operation with the addition of ESD of Shah Deniz via ground flare at a rate of 990 MMscfd.

At Sangachal Town (approximately 2.5km south west of the Terminal), the modelling demonstrates that, under worst case conditions, assuming emergency shutdown of all ACG platforms, the short term concentration of NO_2 is predicted to increase by 63.7µg/m^3 above the background short term concentration of 8µg/m^3. The annual mean NO_2 concentration is predicted to increase by 0.8µg/m^3. Figure 11.4 shows the predicted short term NO_2 concentrations moving south west.

[26] Similarly, light and noise levels generated by Terminal operations are not expected to increase above existing levels as a result of the Terminal receiving COP derived oil and gas.

Figure 11.4 Predicted Maximum 1 Hour Peak NO_2 Concentrations Moving South West from the Terminal (Emergency Shutdown Flaring of All ACG Facilities)

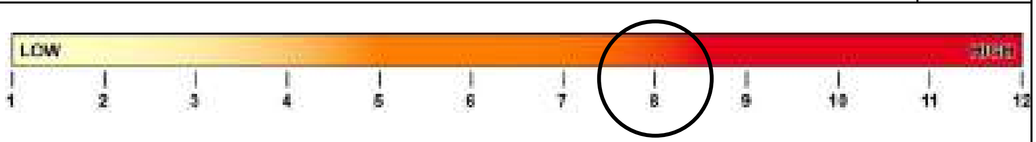
The modelling of onshore air emissions indicates that under all reasonable normal and worst case plant conditions (i.e. normal operation and emergency/upset worst case flaring conditions), ambient air quality concentrations of all pollutants will comply with the relevant ambient air quality standards at the nearest residential receptors[27].

Given that over its lifetime the COP is expected to contribute approximately 20% to the emissions associated with the Terminal, increases in NO_2 concentrations associated with COP alone are likely to be indiscernible.

Tables 11.11 and 11.12 present the justification for assigning a score of 8 to emissions from routine and non-routine COP onshore operations, which represent Medium Event Magnitudes.

Table 11.11 Event Magnitude (Routine Operations)

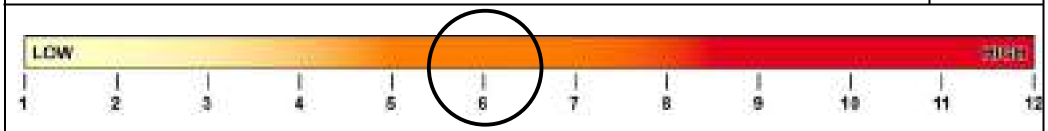
Parameter	Explanation	Rating
Extent/Scale	Increases in concentrations of pollutant species associated with the COP will be insignificant/indiscernible at residential receptors in the vicinity of the Terminal.	1
Frequency	Routine emissions will occur continuously.	3
Duration	Emissions will continue for the COP project lifetime.	3
Intensity	Ambient air quality standards will not be exceeded at the residential receptors in the vicinity of the Terminal.	1
Total		**8**



[27] The modelling demonstrates that the historic Azeri 1 hour NO_X standard of 85 µg/m^3 will also be met.

Table 11.12 Event Magnitude (Non-Routine Operations: Flaring)

Parameter	Explanation	Rating
Extent/Scale	Increases in concentrations of pollutant species associated with the COP will be insignificant/indiscernible at residential receptors in the vicinity of the Terminal.	1
Frequency	Non-routine flaring associated with COP will occur periodically for short periods throughout offshore operations.	3
Duration	COP non-routine flaring will typically occur for periods of hours.	1
Intensity	Ambient air quality standards will not be exceeded at the residential receptors in the vicinity of the Terminal.	1
Total		**6**



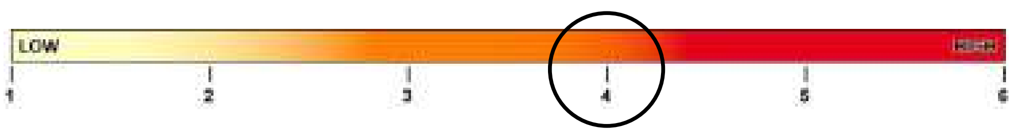
11.4.3.2 Receptor Sensitivity

Human Receptors

Table 11.13 presents the justification for assigning a score of 4, which represents Medium Receptor Sensitivity.

Table 11.13 Human Receptor Sensitivity

Parameter	Explanation	Rating
Presence	Permanently present (i.e. resident) human receptors exist within 1km of the Terminal.	3
Resilience	Existing ambient NO_2 concentrations within residential areas in the Terminal vicinity are less than 50% of the applicable air quality standard, indicating good air quality.	1
Total		**4**

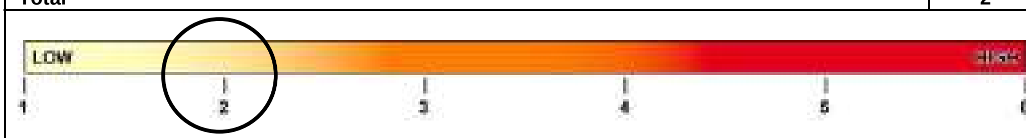


Biological/Ecological Receptors

Table 11.14 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 11.14 Biological/Ecological Receptor Sensitivity

Parameter	Explanation	Rating
Presence	Bird/terrestrial species are mobile and will not be present at one location for long periods of time. Terrestrial ecological receptors are limited in the vicinity of the Terminal[28].	1
Resilience	Volume of emissions released (including particulates) due to onshore operations will create a very small increase in pollutant concentrations in the atmosphere and in any washout from rainfall, which will not be discernable to biological/ecological receptors[29].	1
Total		**2**



[28] Refer to Chapter 6.
[29] Note that ambient air quality standards are not relevant to biological/ecological receptors.

11.4.3.3 Impact Significance

Table 11.15 summarises impacts on air quality from onshore combustion plant emissions and flaring.

Table 11.15 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Onshore combustion plant emissions and flaring	Medium	(Humans) Medium	**Moderate Negative**
		(Biological/Ecological) Low	**Minor Negative**

It is considered that impacts are minimised are far as practicable and necessary through the implementation of the existing control measures (see Table 11.3) and no additional mitigation is required.

11.5 Impacts to the Marine Environment

11.5.1 Underwater Noise and Vibration

11.5.1.1 Event Magnitude

Underwater noise will result from a number of operational activities including vessel movements, hydraulic hammering of the conductor drill sections and drilling of the surface and lower holes. It therefore has the potential to impact upon biological/ecological receptors (specifically seals and fish) in the marine environment.

As discussed within Chapter 9: Section 9.5.1.1, an analysis of the propagation of underwater noise was undertaken in order to estimate distances at which various acoustic impacts on marine species may occur (refer to Appendix 11C).

The analysis showed that the source noise levels for vessel operations (190 dB re 1μPa at 1m) and drilling operations (established as 170 dB re 1μPa) are below the levels at which lethal injury to fish and seals might occur (established as 240 dB re 1μPa). Hammering activities (210-220 dB re 1μPa at 1m) would only give rise to direct physical injury (established as 220 dB re 1μPa) in seals at up to 1 m from the noise source. It is considered very unlikely that physical injury would occur, given existing controls and the behavioural reactions discussed below.

In terms of auditory injury, the assessment demonstrated that the levels of noise from hammering, drilling and vessels could cause permanent deafness in fish and seals if they remained within 8 m of a vessel or drilling location, or 40 m of a hammering location, for a period of 30 minutes or more. Temporary deafness could occur in fish and seals at distances up to 350m from the noise source; again, only if the animals remained in the vicinity for a period of 30 minutes or more. In practice, it is deemed unlikely that either of these conditions would be met.

In terms of behavioural reactions, the underwater assessment determined that noise generated by vessel and drilling activities would result in complete/strong avoidance by fish with swimbladders at distances up to 3m, and seals at ranges up to 5m and mild avoidance by both fish and seals up to 15m away (Figure 11.5). The range over which underwater noise remains audible to fish and seal depends on background noise levels. In the absence of site specific data two background noise levels were considered in the underwater noise assessment; a lower background noise level (approximately 80 dB re 1 μPa), characteristic of a deep sea environment dominated by environmental (i.e. wind, rain and wave) noise, and higher background noise level (approximately 120 dB re 1 μPa), characteristic of a marine location where vessels frequently pass and operational offshore drilling platforms are present.

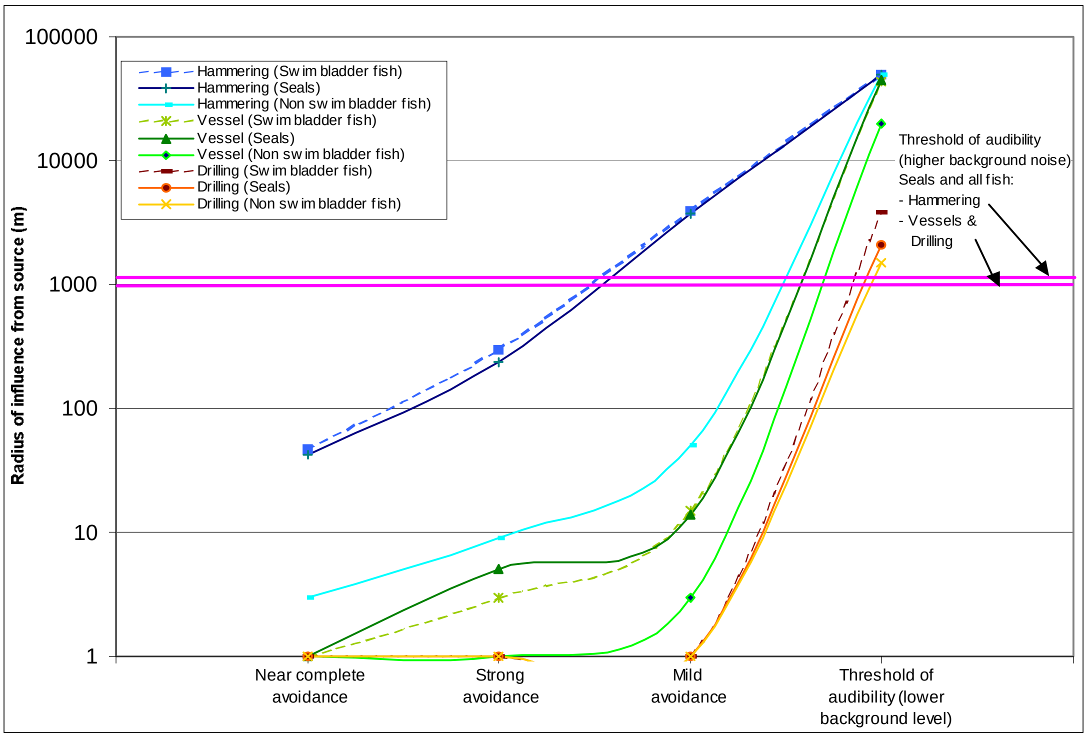
Under the lower background noise level scenario, it was calculated that:

- Hammering noise would result in complete/strong avoidance by fish with swimbladders at distances up to 295m, and seals at ranges up to 235m, mild avoidance by both fish and seals up to 3.9km away and would be inaudible to fish with swimbladders and seals beyond 49km from the noise source; and
- Vessel and drilling noise would be inaudible to fish with swimbladders and seals beyond 44km from the noise source.

Under the higher background noise scenario, it was calculated that:

- Vessel and drilling noise would be inaudible to all fish and seals beyond 1km; and
- Hammering noise would be inaudible to all fish and seals beyond 2km.

Figure 11.5 Predicted Distances Within Which Seals and Fish React to Underwater Hammering, Drilling and Vessel Noise[30]



Tables 11.16, 11.17 and 11.18 present the justification for assigning a score of 8 to drilling, vessel and hammering activities, which represent Medium Event Magnitudes.

[30] Refer to Appendix 11C for source data.

Table 11.16 Event Magnitude (Hammering)

Parameter	Explanation	Rating
Extent/Scale	Underwater sound emissions will affect an area of greater than 1 km from the source.	3
Frequency	Underwater sound emissions from hammering each platform well conductor section.	2
Duration	Each event will last approximately three days.	2
Intensity	Taking into account the concentration, accumulation and persistence of sound energy in the underwater environment, it is considered that this is a low intensity event.	1
Total		**8**

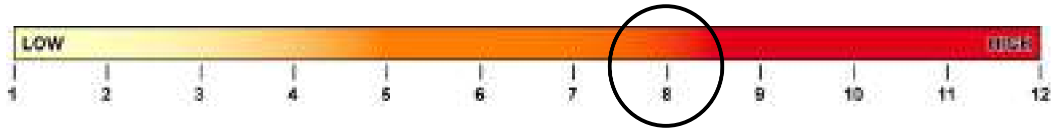


Table 11.17 Event Magnitude (Drilling)

Parameter	Explanation	Rating
Extent/Scale	Underwater sound emissions are unlikely to result in an avoidance response from fish/seals beyond 15m from the noise source	1
Frequency	Underwater sound emissions from drilling will occur more than 50 times.	3
Duration	Underwater sound emissions will last for more than one week.	3
Intensity	Taking into account the concentration, accumulation and persistence of sound energy in the underwater environment, it is considered that this is a low intensity event.	1
Total		**8**

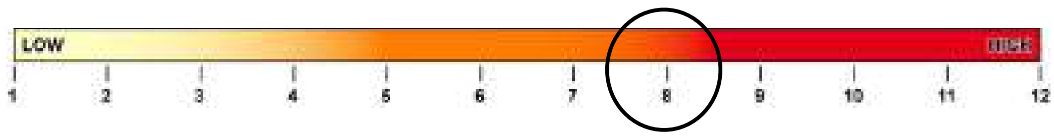
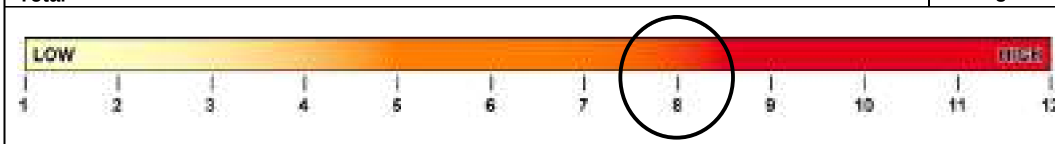


Table 11.18 Event Magnitude (Vessels)

Parameter	Explanation	Rating
Extent/Scale	Underwater sound emissions are unlikely to result in an avoidance response from fish/seals beyond 15m from the noise source	1
Frequency	Underwater sound emissions occur almost continuously over during the operations phase from regular support vessel activity.	3
Duration	Underwater sound emissions will occur over almost continuously during the operations phase from regular supply vessel activity	3
Intensity	Taking into account concentration, accumulation and persistence of sound energy in the underwater environment, the intensity is low.	1
Total		**8**



11.5.1.2 Receptor Sensitivity

The only relevant biological receptors to underwater noise are seals and fish.[31]

Seals and Fish

Operational underwater noise will emanate from the wellhead locations and along the support vessel route from the Logistics Supply Base located at the BDJF Yard to the platform location.

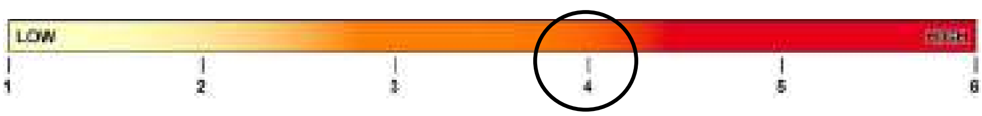
[31] Plankton cannot sense the low frequency sound generated because the wavelength is longer than the organism and benthic invertebrates do not have sophisticated sound sensing apparatus.

Recent data indicates that seals and sturgeon are not common in the ACG Contract Area (refer to Appendix 6B for recent survey reviews) and that the WC-PDQ platform location is not an important or significant habitat for either. The likelihood of exposure to hammering, drilling or vessel noise for these species is therefore low.

Table 11.19 presents the justification for assigning a score of 4, which represents Medium Receptor Sensitivity.

Table 11.19 Receptor Sensitivity

Parameter	Explanation	Rating
Resilience	Possibility that species may be temporarily affected by underwater hammering, drilling and vessel noise but the effect would be short term and limited. Ecological functionality will be maintained.	2
Presence	The fish most likely to be present for extended periods of time in the ACG Contract Area and at the WC-PDQ location are Kilka and Mullet throughout the year. However, neither the COP location or the ACG Contract Area are not exclusively used by these species and the Contract Area is not considered to be of primary importance.	2
Total		**4**



11.5.1.3 Impact Significance

Table 11.20 summarises impacts to seals and fish from underwater noise associated with hammering, drilling and vessel activities.

Table 11.20 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Operational noise	Medium	(Seals & Fish) Medium	**Moderate Negative**

It is considered that impacts are minimised are far as practicable and necessary (refer to Table 11.3) and no additional mitigation is required.

11.5.2 Drilling Discharges

11.5.2.1 Event Magnitude

For operational well drilling from the platform, it is intended to use the same procedures and drilling mud formulations as the predrill operations (except for the conductor hole). These are described in Chapter 5: Section 5.7.4 and summarised as follows:

- The **36” Conductor Hole** of each of the planned platform wells will not be drilled. Instead, the conductor will self penetrate as far as subsurface conditions permit and then be driven into place using hydraulic hammering (refer to Chapter 5: Section 5.7.4); and
- The **28/”26” Surface Hole** section of each of the planned platform wells will be drilled with WBM, as per the predrill wells. Cuttings from the 28”/26” sections will be discharged via the platform cuttings caisson. The cuttings will be passed through separation equipment to recover as much drilling mud as possible. However, it is estimated that for each well, approximately 340 tonnes of mud will be discharged associated with approximately 155 tonnes of cuttings. At the end of surface hole drilling, a further 500 tonnes of mud in total may be discharged (see Chapter 5: Section 5.7.4).

Discharges from operational drilling will take place from the platform cuttings caisson at a depth of 136m. Therefore, the cuttings (and associated mud) will settle more rapidly and will disperse less widely than the discharges from the MODU. Each well will take approximately 40 days to drill and 40 days to complete (estimated annual average of 3.6 wells) and discharge events will therefore be separated by intervals of more than 10 weeks.

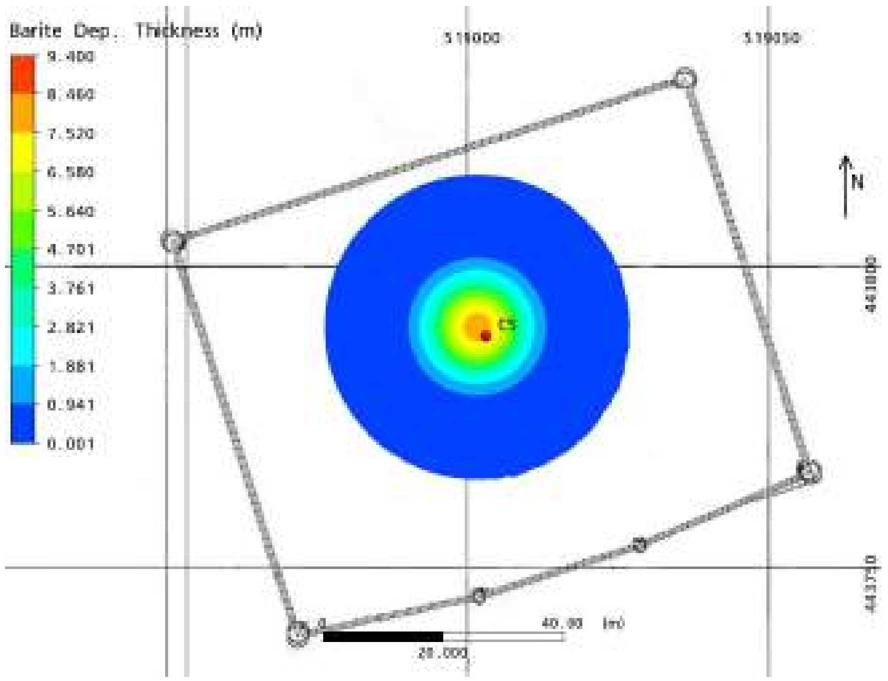
The dispersion of cuttings from operational drilling has been modelled (Appendix 11D). This confirms that the spread of cuttings will be much less than is the case for the near-surface discharges from predrill activities. Table 11.21 summarises the distance at which a depth of >1mm deposit will occur under stagnant and predominant current conditions. Figure 11.6 illustrates the pattern of deposition for barite for a 28 well programme under the same current conditions (the barite deposition pattern is similar to that for fine cuttings; coarse cuttings settle within a much smaller area). Operational drilling discharges are predicted to settle within 100m of the platform. The 28 well modelling scenario represents a worst case as the COP Base Case comprises 26 platform wells.

Table 11.21 Predicted Distribution of Discharged Drill Cuttings from MODU Drilling (136m Depth Discharge)

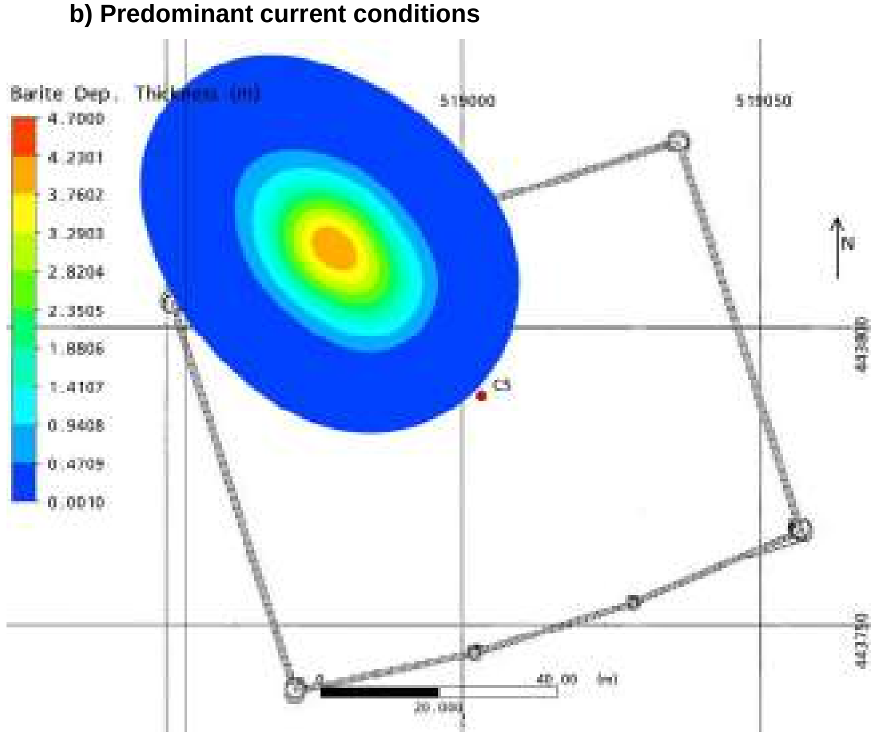
Maximum distance (m) covered by the deposition thickness >1mm (one well)			
Current Conditions	**Barite**	**Large Cuttings**	**Small Cuttings**
Predominant	63	17	58
Near Stagnant	22	17	13
Area (m^2) covered by the deposition thickness >1mm (one well)			
Current Conditions	**Barite**	**Large Cuttings**	**Small Cuttings**
Predominant	1,634	820	605
Near Stagnant	1,321	820	374
Maximum distance (m) covered by the deposition thickness >1mm (28 wells)			
Current Conditions	**Barite**	**Large Cuttings**	**Small Cuttings**
Predominant	73	27	69
Near Stagnant	28	27	24
Area (m^2) covered by the deposition thickness >1mm (28 wells)			
Current Conditions	**Barite**	**Large Cuttings**	**Small Cuttings**
Predominant	3,041	2,120	1,950
Near Stagnant	2,042	2,120	1,448

Figure 11.6 Barite Deposition Thickness Contour Plots (Discharge from Caisson at 136m depth - 28 wells)

a) Near stagnant current conditions



b) Predominant current conditions



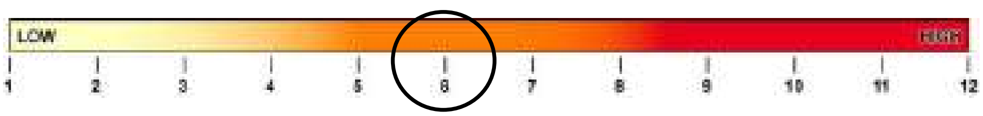
Drilling discharges are assigned an intensity score of 1 for the following reasons:

- A large proportion (approximately 50%) of the discharge consists of inert geological material (the cuttings);
- The drilling fluid components are inert or of very low toxicity;
- Only the solid, inert components of the drilling mud will settle to the seabed; low toxicity soluble components, such as potassium chloride and minor additives, will dilute and disperse in the water column and will have neither acute or persistent effects;
- Evidence from the IEMP in the vicinity of drilling operations where WBM cuttings have been discharged shows that there is no accumulation of drilling chemicals and only a very small effect on the benthos within the 'footprint' of the discharge; and
- The drilling fluids have been the subject of comprehensive testing and assessment and have been approved for use by the MENR for existing operations (refer to Chapter 9 Section 9.5.2 for results of toxicity tests).

Table 11.22 presents the justification for assigning a score of 6, which represents a Medium Event Magnitude.

Table 11.22 Event Magnitude

Parameter	Explanation	Rating
Extent/ Scale	Modelling has shown evidence of cuttings at distances of up to 500m for other platforms.	1
Frequency	Discharge of WBM and cuttings will occur during drilling of each of the 26 platform drilled wells.	2
Duration	Duration of each discharge event is approximately 30 hours.	2
Intensity	Drilling discharges are considered to be of low intensity due to the composition and evidence from post well surveys of no accumulation of drilling chemicals.	1
Total		**6**



11.5.2.2 Receptor Sensitivity

Seals and Fish

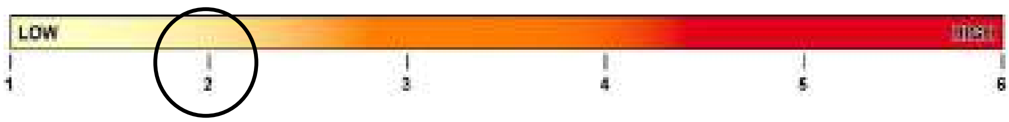
Drilling discharges will intermittently generate turbid plumes of limited duration and dimension. These plumes will not however, generate chemical contamination of the water column and will not occupy a significant proportion of the local water column. It is anticipated that both fish and seals will avoid the plumes.

Recent data indicates that endangered species such as seals and sturgeon are not common in the ACG Contract Area (Appendix 6B) and that the WC-PDQ platform location is not located in an important breeding or migration area for either species. However, Kilka and Mullet are present in the Contract Area.

Table 11.23 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 11.23 Receptor Sensitivity

Parameter	Explanation	Rating
Resilience	Possibility that species may be temporarily affected by drilling discharges but the effect would be short term and limited. Ecological functionality will be maintained.	1
Presence	The fish most likely to be present for extended periods of time throughout the year in the ACG Contract Area and at the WC-PDQ location are Kilka and Mullet. However, the COP location or the ACG Contract Area are not exclusively used by these species and the Contract Area is not considered to be of primary importance.	1
Total		**2**



Plankton

Due to the depth at which the discharge will take place, the cuttings will settle through a relatively small fraction of the lower water column (about 40m) and will not interfere with the productive zone where the majority of plankton and planktivorous fish (e.g. Kilka) occur.

Table 11.24 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 11.24 Receptor Sensitivity

Parameter	Explanation	Rating
Resilience	Highly resilient.	1
Presence	Species not rare or unique on a regional basis.	1
Total		**2**

Benthic Invertebrates

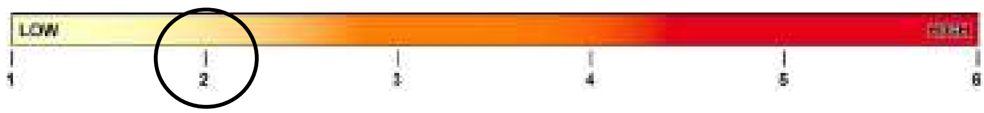
The benthic invertebrate communities in the vicinity of the COP are very similar to those across the rest of the Contract Area and the Azerbaijan sector of the South Caspian. There are no rare, unique or endangered species present.

The benthic community is composed of predominantly small organisms and is dominated by native amphipod, gastropod, polychaete and oligochaete species, most of which have the potential to produce several generations per year. With the exception of some bivalves, the dominant taxa are deposit feeders, which burrow in the sediment. These species are unlikely to be affected by less than 10cm of cuttings deposition and will not suffer from the clogging of feeding appendages which can affect filter-feeders. Observations from IEMP monitoring around existing platforms confirms that benthic community diversity and abundance remains high in areas of cuttings deposition (within the range of 250 - 500m of the platform).

Table 11.25 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 11.25 Receptor Sensitivity

Parameter	Explanation	Rating
Resilience	No rare, unique or endangered species at significant risk of exposure.	1
Presence	Drilling mud and cuttings of low toxicity, and monitoring of existing platforms demonstrates that the benthic community is resilient to the deposition of cuttings.	1
Total		**2**



11.5.2.3 Impact Significance

Table 11.26 summarises impacts to biological/ecological receptors from drilling discharges.

Table 11.26 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Cuttings and WBM discharge	Medium	(Seals & Fish) Low	**Minor Negative**
		(Plankton) Low	**Minor Negative**
		(Benthic Invertebrates) Low	**Minor Negative**

Based on the findings from the surveys reported in detail within Chapter 6, very limited impact has been observed from existing drilling discharges from operating platforms. It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 11.3) and no additional mitigation is required.

11.5.3 Cement Discharges

11.5.3.1 Event Magnitude

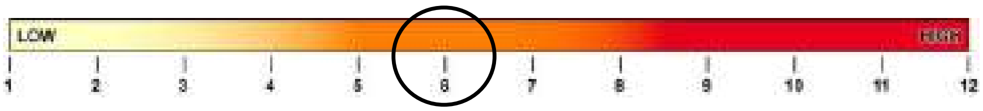
Cement discharge will occur during the cementing of successive well casings. At most, this is estimated to amount to approximately 13 tonnes per well, of which approximately 5 tonnes would be cement, 6.5 tonnes would be barite, and the remainder would be low toxicity cementing chemicals. Approximately 0.7 tonnes of excess cement of the same composition may also be discharged at the end of cementing each of the 2 lower well casings where it cannot be recovered. As the conductor section will be hammered into place, unlike the predrill wells, it will not be cemented. Cementing associated with platform drilling is described in Chapter 5: Project Description, Section 5.7.7.1.

The discharge event duration would be approximately 1hour per casing and therefore in total about 2 hours per well (although not consecutive, since each section has to be drilled before being cemented). The cement is not expected to disperse (being designed to set in a marine environment) and will therefore set in-situ. It is not anticipated that there will be any chemical releases from the cement, which will be effectively chemically inert. The impact of cement discharge will therefore be limited to a small area of accumulation immediately around the well.

Table 11.27 presents the justification for assigning a score of 6, which represents a Medium Event Magnitude.

Table 11.27 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Cement will be deposited only within a few metres of the well.	1
Frequency	2 discharge events per well for each of the 26 platform drilled wells.	3
Duration	Each discharge event will last approximately 1 hour.	1
Intensity	The cement comprises inert materials (cement and barite) and low toxicity chemicals.	1
Total		**6**



11.5.3.2 Receptor Sensitivity

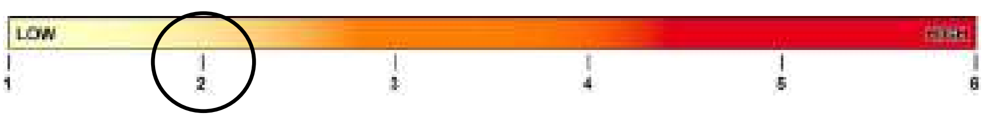
Cement discharges will be confined to a small area of seabed immediately around each well and no chemical releases are anticipated. Consequently, the only potential biological receptor is the benthic invertebrate community.

Benthic Invertebrates

Table 11.28 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 11.28 Receptor Sensitivity

Parameter	Explanation	Rating
Resilience	No rare, unique or endangered species at significant risk of exposure. Receptor confined to benthic community close to well.	1
Presence	Toxicity and persistence of cement components is low and cement will set rapidly. Effects will be limited to physical covering of a small area of benthos.	1
Total		**2**



11.5.3.3 Impact Significance

Table 11.29 summarises impacts to benthic invertebrates from cement discharges.

Table 11.29 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Cement discharge	Medium	Low	**Minor Negative**

Cement chemicals are of low toxicity, chemically inert and designed to set in a marine environment. Therefore, only the seabed in the immediate vicinity of the wells will be affected. The Receptor Sensitivity of all marine organisms to cement discharges is considered to be low. It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 11.3) and no additional mitigation is required.

11.5.4 Produced Water Discharge

11.5.4.1 Event Magnitude

The produced water system is described in Chapter 5: Section 5.8.4. The discharge of produced water would occur only during periods when all or part of the produced water handling and export system to the DWG platform is unavailable (the system is designed for overall 98% availability).

It is not, at this time, possible to estimate with confidence the frequency and duration of discharge events. However, for the purposes of this impact assessment, discharge durations of 12, 24 and 72 hours are considered. From the produced water profile (Chapter 5: Figure 5.2), and on the basis of 98% reinjection availability, it can be estimated that discharge rates will range from a minimum of approximately $33m^3$/hr in 2015 to a maximum of $833m^3$/hr in 2024. However, from the profile it is also clear that during most of this period the discharge rate will be in the range of approximately 400 - 500m3/hr.

At the present time, significant amounts of produced water have not been generated from existing (Phase 1, 2 and 3) platforms and therefore no data is available on the 'routine' composition of water from ACG operations. Two studies were undertaken where samples were collected from separation or treatment equipment at Sangachal Terminal in 2008 (at that time, all water was separated onshore and this was the most reliable location from which to obtain samples).

Analysis of samples from Terminal coalescers indicated that:

- Produced water salinity was typically in the range of 30 - 40‰;
- Dispersed oil concentrations were generally low (close to the monthly discharge standard of 29mg/l); and
- ACG produced water has a characteristically high content of organic and volatile fatty acids (typically around 10g/l in total).

Produced water separated on the WC-PDQ platform will be treated by hydrocyclones to reduce the dispersed oil concentration[32] to a maximum daily oil concentration of 42 mg/l and monthly maximum of 29 mg/l.

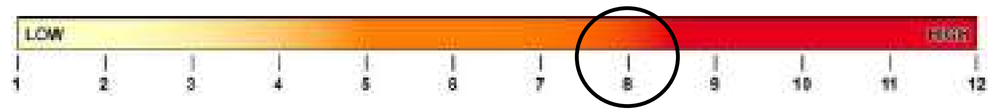
The dispersion of discharged produced water was modelled to assess the size of the dispersion plume and mixing zone (refer to Appendix 11E). Modelling covered the 3 discharge durations defined above, for a typical discharge rate of $450m^3$/hr under stagnant and predominant current conditions. This indicated that the discharge would typically be diluted by a factor of 100 within 40m of the discharge caisson. The modelling indicated that under all conditions the plume would reach a steady state within 5 hours and it would persist for no more than 3 hours after the discharge ceased.

Table 11.30 presents the justification for assigning a score of 8, which represents a Medium Event Magnitude.

[32] As defined by EPA method 1664A

Table 11.30 Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Dispersion modelling indicates that a produced water discharge of $450m^3$/hr would be diluted to no effect concentrations within 500m of the source.	1
Frequency	Not certain; likely to be more than 50 times over the operational phase.	3
Duration	Not certain; assumed to be between 12 and 72 hours as a worst case.	2
Intensity	Available data indicates that ACG produced water is low in toxicity and in persistent compounds, but assigned a score of 2 to take account of possible changes in composition over time.	2
Total		**8**



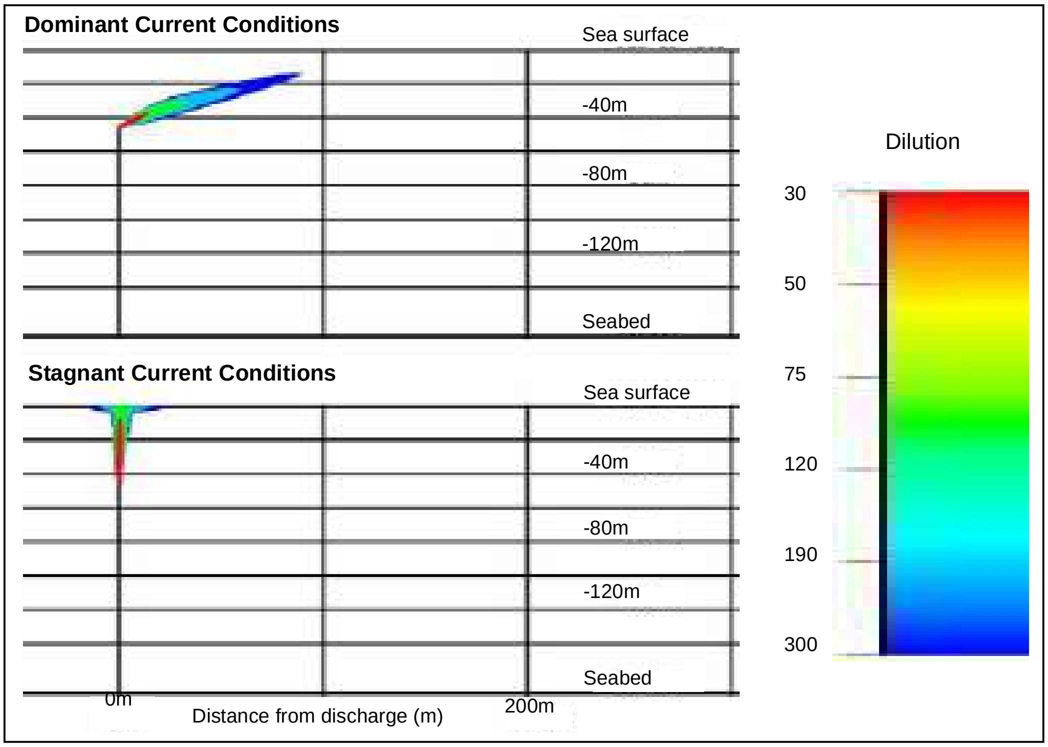
11.5.4.2 Receptor Sensitivity

The Sangachal Terminal samples were tested for aquatic toxicity using Caspian species and test results indicate that, while toxicity was variable, it was also generally low. Effluent toxicity results are normally expressed in terms of the degree of dilution (the percentage of effluent in the test medium) required to reach the test end-point (in this case, 50% mortality of the test organisms in 48hr, or 48hr LC_{50}). The LC_{50} values for ACG produced water samples from Sangachal ranged from approximately 8% to approximately 32%. These results mean that the 50% toxicity endpoint would occur when the produced water was diluted by between 3 and 12 times.

The discharge plume will be present only in the water column and will not reach the seabed. Consequently, seals, fish and plankton are potentially exposed to the discharge. As noted above, presently available information suggests that ACG produced water is of low toxicity. The most notable components are the organic and volatile fatty acids, which although present in high concentrations are of low toxicity and are readily degradable. While the Sangachal Terminal samples would have contained traces of production chemicals, the low overall toxicity demonstrated that these largely remained in the oil phase and were not present at biologically significant concentrations in the separated water.

The assumed discharge durations are short, and if a 'safety factor' of 10 is applied to the LC_{50} dilution requirements, it is estimated that a dilution of 120-fold would be sufficient to mitigate effects on organisms in the receiving water. As with other discharges, it is important to bear in mind that in practice, it is extremely unlikely that any individual organism would remain in the discharge plume for more than a few minutes: large organisms are able to actively avoid discharge plumes, while smaller organisms can only enter the plume in water entrained by the mixing process, being rapidly carried into areas of higher dilution by the mixing process. The dispersion modelling referred to above indicated that a dilution of 100-fold would be reached within 40m of the point of discharge, and that within 3 hours of the cessation of the discharge all produced water present would be diluted by more than 100-fold (i.e. plume persistence at this level would be a maximum of 3 hours after end of discharge). Figure 11.7 presents typical dispersion plumes (to a dilution of 300-fold) under stagnant and dominant current conditions

Figure 11.7 Produced Water Dispersion Plumes Under Stagnant and Dominant Current Conditions



Existing data indicates that oil concentrations in the produced water are likely to be low, and will be further reduced on the WC-PDQ platform by treatment by the hydrocyclones and will have been diluted at the edge of the mixing zone to concentrations, which would not present a risk of bioaccumulation or food chain transfer.

As discussed above the Sangachal Terminal samples were tested for a number of chemicals in addition to oil. Table 11.31 presents the results obtained for various metallic and organic chemical parameters along with representative data for seawater from recent ACG Contract Area environmental surveys.

Table 11.31 Results of Terminal Produced Water and Seawater Analysis

Parameter	Unit	Seawater	Average of 4 samples, 2008		Average of 3 samples, 2008		
			SL9	SL14	Coalescer 2	Coalescer 4	Coalescer 6
Ba	µg/l	25.4	592	1418	1268.3	1166	2598.3
Ni	µg/l	0.91	92.2	56.4	49.8	42.1	<25.0*
Co	µg/l	0.02	78.3	46.9	33.65	30.3	0.6
B	mg/l	3.08	50.3	47.6	101.2	91.6	114.4
Mg	mg/l	650	30.5	29.4	11.56	9.9	13.29
Zn	µg/l	1.04	48.3	28.4	<200*	<200*	<200*
Cu	µg/l	0.69	13.3	16.5	<12.5*	<12.5*	<12.5*
Pb	µg/l	0.3	5.4	5.1	<10.0*	<10.0*	<10.0*
Cr	µg/l	4.35	86.8	53	84.45	104.8	38.9
Fe	µg/l	<10	70.1	26.6	979.7	1032.3	545.6
Cd	µg/l	0.01	0.18	0.59	<0.50*	<0.50*	<0.50*
Total Phenols	mg/l	<0.5	1.73	0.74	0.35	0.35	0.57
Total organic acids	mg/l	nd	6307	5125	4220	2160	74
Total PAH	µg/l	0.075	28.4	66.2	0.52	0.84	0.62
Total Aliphatics (C9- 38)	mg/l	<0.02	1.55	2.78	24	12	1.9

Average total phenol concentrations varied between 0.35 and 1.73 mg/l in a total of 7 samples collected from ACG coalescers at Sangachal Terminal. A World Health Organisation report[33] reported that phenol had little bioaccumulation potential, and typically degraded by 50% in 9 days in seawater; it is therefore of limited persistence and will not accumulate through the food chain. Aquatic toxicity was reported to be moderate, with LC_{50}s for fish and crustacea ranging from 8.8 to 330 mg/l. If a safety factor of 100 is applied (representing a conservative approach for short-duration discharges), the short-term no-effect concentration would lie between 0.088 and 0.33 mg/l. If the lower of these values is compared with the highest average value in Table 11.31, a dilution of approximately 20-fold would be required. If an even more conservative safety factor of 1000-fold was applied, the corresponding dilution would be 200-fold, which is slightly greater than the dilution estimated to be required on the basis of whole-effluent toxicity tests (which therefore suggests that a safety factor of 100 is more appropriate).

The WHO report also considers observed environmental concentrations. Although ACG environmental surveys have recently not detected phenols in seawater above the detection limit of 0.5 µg/l, levels of phenol dissolved in rain water from Portland, USA, were found to range from 0.08 to 1.2 µg/l and averaged above 0.28 µg/l. Concentrations reported for surface water in the Netherlands were 2.5-6.5 µg/l for two major rivers, 0.3-7 µg/l for lakes, and 1.5 µg/l for coastal waters. Industrial rivers in the USA were reported to contain 0-5 µg/l, but 3-24 µg/l was reported for Lake Huron. Phenol was also detected in 2/100 raw water supplies in 1977 in the US EPA National Organics Monitoring Survey.

Quantified cadmium concentrations in ACG produced water samples ranged from 0.18 to 0.59 µg/l, which is approximately 18 to 59 times the concentration recently measured in Caspian seawater. The data represent total cadmium in both produced water and seawater, and the fraction present as the free (toxic) ion is not known. However, at most a dilution of 59-fold would be required to dilute produced water to background ambient levels, and this degree of dilution is well within the overall no-effect dilution requirement (120-fold) estimated on the basis of whole-effluent toxicity measurements using Caspian species.

During periodic well start-up when the platform is operational, it may be necessary to dose the crude oil stream with methanol at a rate of up to 100 litres per hour for up to eight hours to protect flowlines and valves (refer to Chapter 5 Section 5.8.6.16). During this period it is possible that produced water may be discharged as described within Section 11.5.4.1 above. Until the produced water portion in the COP LP separators reaches 5%, produced water will be transported onshore with the oil. Based on a lowest expected produced water rate of 4,000 bpd at the platform the worst-case discharge concentration of methanol (for a single well, and assuming no mixing and dilution with water from other wells which are not being dosed with methanol) would be approximately 3,800 mg/l. Methanol is completely water soluble, so it is assumed that it would all partition into the water phase when injected into the reservoir fluids at the wellhead.

Methanol is classified by the OSPAR Commission as a substance that is considered to pose little or no risk to the marine environment (PLONOR). International studies report LC_{50}s ranging from 900-529-5 mg/l for zooplankton and 1400-29700 mg/l for fish, with median values of 18756 and 17720 mg/l respectively. Tests carried out with Caspian zooplankton reported LC_{50}s of >3200 mg/l.

The appropriate no-effect safety factor for a short term discharge (ie, 8 hours duration) is 10. Applying this safety factor to available toxicity data, median no-effect concentrations of 1772-1876 mg/l are estimated for the results of international studies, and >320 mg/l for Caspian studies. Taking a conservative approach, if a no-effect concentration of 320 mg/l is assumed, the discharge (containing up to 3800 mg/l) would require a dilution of 12-fold to ensure that no toxic effects occurred.

A concentration of 3800 mg/l methanol within a produced water discharge containing approximately 10,000 mg/l of organic and volatile fatty acids would increase the soluble

[33] IPCS, Environmental Health Criteria no 161, Geneva 1994

hydrocarbon loading by approximately 40%. Given that these organic and fatty acids are individually of low toxicity, and that overall produced water toxicity is also moderate, it is therefore assumed, as a worst case, that the presence of methanol would increase produced water toxicity in proportion to its mass contribution. Based on the required 120-fold dilution required to achieve a a no-effect concentration for WC-PDQ produced water as discussed above, it is therefore estimated that the no-effect concentration for a discharge containing methanol at 3800 mg/l would require a dilution of 160-fold. This increased dilution requirement would temporarily increase the distance at which a no-effect concentration was reached from approximately 40m to about 60m (refer to Figure 11.7).

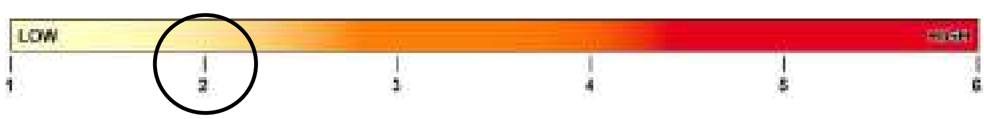
Methanol is highly degradable, with UNEP/WHO reporting 75% degradation in 5 days and 99% degradation in 15-20 days. It is a readily-metabolisable substrate for many types of bacteria. Methanol will not persist in the environment and will not biaccumulate.

Neither seals nor fish are considered to be at risk of anything more than transient exposure to a discharge plume and are therefore not considered to be at risk of toxic effects as a result of direct exposure. The primary potential receptors are therefore planktonic species.

Table 11.32 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 11.32 Receptor Sensitivity

Parameter	Explanation	Rating
Resilience	No rare, unique or endangered species at significant risk of exposure. Plankton most likely to be exposed for brief periods.	1
Presence	Toxicity and persistence of produced water are expected to be low, and any limited effects on individual planktonic organisms will not adversely affect local populations.	1
Total		**2**



11.5.4.3 Impact Significance

Table 11.33 summarises impacts to ecological/biological receptors from produced water discharge.

Table 11.33 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Produced water discharge	Medium	Low	**Minor Negative**

Results of tests on produced water confirm that the discharge standards will provide adequate protection to the marine environment and the COP design includes equipment, which is capable of achieving these standards. Although it is unlikely to occur, the short-term presence of methanol in a produced water discharge would have minimal additional impact. The size of the no-effect mixing zone would be temporarily increased from about 40m from the discharge point to about 60m. Methanol is not persistent or bioaccumulative and will degrade rapidly. The event magnitude of produced water discharge has been estimated on the assumption of complete unavailability of the COP system for exporting produced water to DWG PCWU for 2% of the time. Careful management and planning of operations and maintenance has the potential to reduce periods of unavailability and COP operations will identify any practicable measures to minimise the need for discharge. The sensitivity of marine species is considered to be low and the resulting Minor Negative impact is deemed to be acceptable. No additional mitigation beyond existing controls is required (see Table 11.3).

11.5.5 Water Intake/Entrainment and Cooling Water Discharge

11.5.5.1 Event Magnitude

Cooling water will be lifted and discharged routinely on the WC-PDQ platform during the COP operational phase (refer to Chapter 5: Section 5.8.6.7). The cooling water system will use approximately 3,360m^3 of seawater per hour, supplied by 2 pumps lifting water via two separate caissons.

The intake of water via the caissons has been modelled (refer to Appendix 11F) to assess the risk of entrainment of fish and other organisms. The intake modelling study showed that water velocity would not exceed 13cm/s within a few centimetres of the intake and that the velocity gradient would extend less than 3m, even under near-stagnant current conditions. Consequently, it is concluded that:

- There is a sufficient velocity gradient for fish to detect the intake; and
- The water velocity close to the intake is sufficiently low that even small fish would have no difficulty in avoiding the intake.

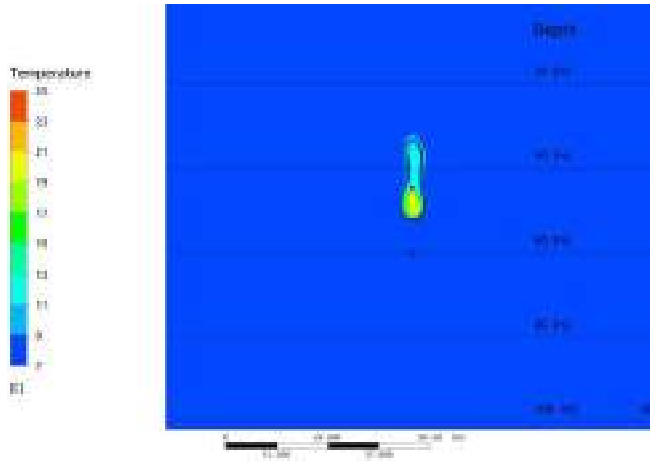
A screen is provided as primary protection to obstruct the passage of fish and larger organisms. However the water intake is at a depth of 105m, considerably below the productive zone. At this depth, fish and plankton populations are likely to be minimal and production will be negligible.

The potential impact of the discharge of cooling water has also been modeled (refer to Appendix 11D). The cooling water dispersion plumes for summer and winter under stagnant and typical current conditions are illustrated in Figure 11.8. The black line shown for each plume indicates the point at which the water temperature is estimated to be 3°C above ambient temperature, and in each case this occurs within 30m of the point of discharge.

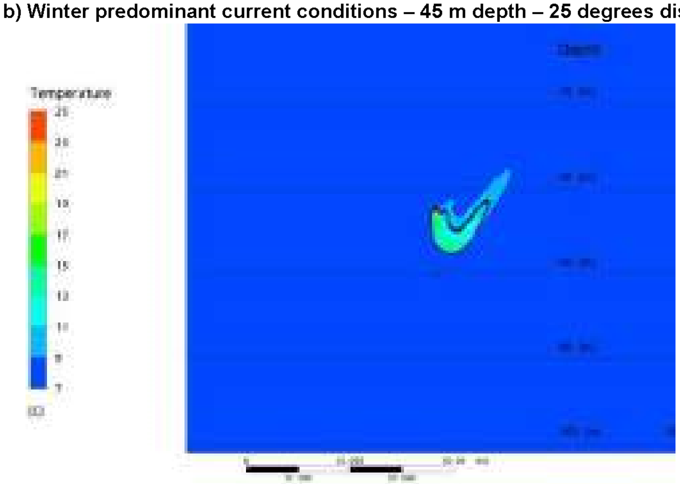
The cooling water system will include a copper/chlorine biocide control system, but the concentration of both elements in the discharge will be below the international EQS and national MPC levels.

Figure 11.8 Temperature Contour Plots for Summer and Winter (Stagnant and Predominant Current Conditions)

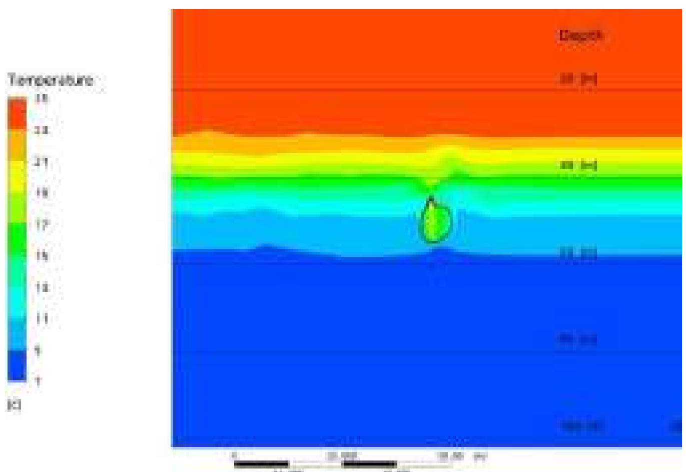
a) Winter near-stagnant current conditions – 45 m depth – 25 degrees discharge



b) Winter predominant current conditions – 45 m depth – 25 degrees discharge



c) Summer near-stagnant current conditions – 45 m depth – 25 degrees discharge



d) Summer predominant current conditions – 45 m depth – 25 degrees discharge

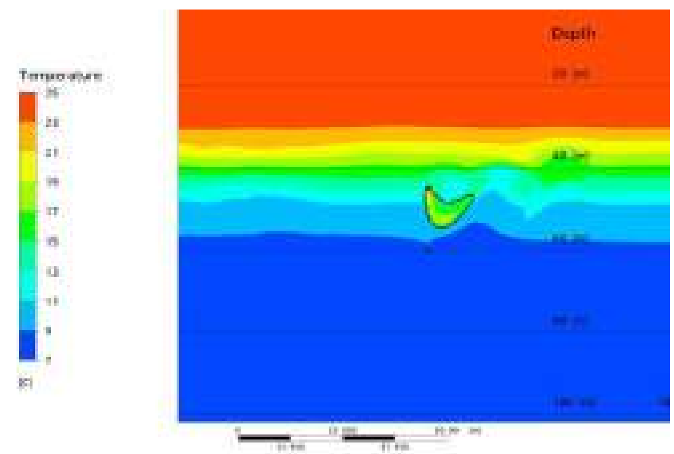
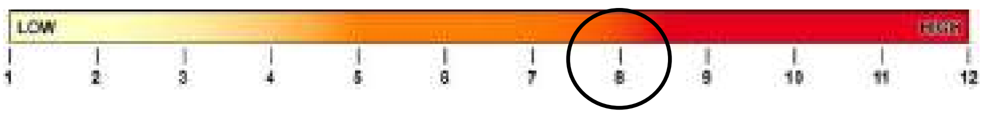


Table 11.34 presents the justification for assigning a score of 8, which represents a Medium Event Magnitude.

Table 11.34 Event Magnitude

Parameter	Explanation	Rating
Extent / Scale	The area within which intake and cooling water discharge effects might occur is limited to less than 30m for discharge, and to the velocity gradient would extend to less than 3m in any direction for intake.	1
Frequency	Intake and discharge occur continuously throughout the COP 13 year operational period.	3
Duration	The cooling water system will operate throughout the 13 year operational phase.	3
Intensity	Discharges will be consistent with relevant standards and with previously approved practices. It will contain no harmful persistent materials.	1
Total		**8**



11.5.5.2 Receptor Sensitivity

Benthic invertebrates will not be exposed to either cooling water intake or discharge. The dimensions of the intake current field and the discharge plume are small and the residence time of any water column organism within the discharge plume will be too short to cause harm. Seals are not considered to be at risk from the intake, and fish present at the intake depth are considered capable of detecting the low intake velocity gradient and avoiding it.

Zooplankton and phytoplankton would not be able to avoid entrainment, but the intake is at a depth of 105m and therefore well below the depth at which the main populations of both groups occur.

Table 11.35 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 11.35 Receptor Sensitivity

Parameter	Explanation	Rating
Resilience	Seals, fish and plankton are not expected to be present consistently or in significant numbers within the water volume affected by either intake or discharge. No significant exposure of benthos.	1
Presence	Although exposure is unlikely, seals and fish would not be adversely affected by short term exposure to the discharges. Plankton are unlikely to be exposed to discharge.	1
Total		**2**

11.5.5.3 Impact Significance

Table 11.36 summarises impacts to biological/ecological receptors from water intake and cooling water discharge.

Table 11.36 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Water intake and cooling water discharge	Medium	Low	**Minor Negative**

11.5.5.4 Additional Mitigation and Monitoring

The design of the intake and discharge process, and in particular the depth at which these occur, will minimise the exposure of marine organisms, which are considered to have low sensitivity. The resulting Minor Negative impact is considered to be acceptable and does not require additional mitigation beyond existing controls (see Table 11.3). However, in order to enable cooling water discharge temperature to be monitored, the temperature probe at the discharge point will be connected to a system for recording temperature at regular intervals. The primary purpose will be to confirm that the discharge temperature is sufficiently low that the edge of the cooling water mixing zone will not exceed ambient by more than 3ºC.. It is extremely unlikely that this would occur, as modelling presented in Appendix 11.D demonstrates, the discharge temperature would need to be 75ºC or more for this to occur, which is beyond the operating parameters of the cooling water system.

11.5.6 Pigging Discharge

11.5.6.1 Event Magnitude

Pigging is described in Chapter 5: Section 5.8.7 and Table 5.30 summarises the produced water and injection water pipeline pigging volumes and locations of discharge. Tables 5.38 and 5.29 describe the chemicals present in the produced water and injection water.

Following the start of production, the produced water pipeline will be pigged from DWG to WC-PDQ typically weekly for up to six months using inhibited seawater from the DWG seawater injection treatment system. Once the percentage of water in oil at the WC-PDQ platform reaches approximately 5% and there is sufficient water from WC-PDQ to drive a pig, the line will be pigged weekly in the opposite direction (i.e. from WC-PDQ to DWG in the normal direction of flow). Pigging may be less frequent and will depend on pipeline condition. In both cases, the pigging operation will generate a discharge of approximately 920m^3 of inhibited seawater initially, and then produced water, over a period of approximately 2 hours. Solids recovered during the pigging operation will be shipped to shore for treatment and disposal.

It is planned to pig the injection water line on a weekly basis, although the precise frequency is dependent on pipeline condition. This will generate a similar volume of discharge over a similar period to that generated by pigging the produced water line. The discharge from the injection water line will comprise produced water, a small amount of pigging solids and seawater. The relative amounts of produced water and seawater will depend on the volume required to maintain injection rates at the DWG and WC-PDQ platforms. The presence of seawater will, however, result in lower salinity and lower concentrations of produced water components compared to the discharge from the produced water line.

The composition, depth and rate of discharges from pigging operations are similar to the discharge scenario considered in Section 11.5.5 for non-routine produced water discharge. The frequency of pigging discharge is higher (up to 2 discharge events per week), but the duration is likely to be shorter compared to non-routine produced water discharge.

Table 11.37 presents the justification for assigning a score of 7, which represents a Medium Event Magnitude.

Table 11.37 Event Magnitude

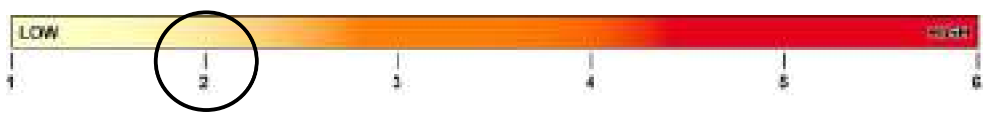
Parameter	Explanation	Rating
Extent/Scale	Dispersion modelling indicates that a produced water discharge of 460m^3/hr would be diluted to no effect concentrations within 500m of the source. This is also applicable to pigging discharges.	1
Frequency	Two events per week over the 13 year COP operational phase.	3
Duration	2 hours per event.	1
Intensity	Available data indicates that ACG produced water is low in toxicity and in non persistent compounds, but a conservative score of 2 assigned to take account of possible changes in composition over time.	2
Total		**7**

11.5.6.2 Receptor Sensitivity

Receptor sensitivity to pigging discharges is subject to the same considerations and criteria as applied to produced water discharge in Section 11.5.5.2. Table 11.38 presents the justification for assigning a score of 2, which represents a Low Receptor Sensitivity.

Table 11.38 Receptor Sensitivity

Parameter	Explanation	Rating
Resilience	No rare, unique or endangered species at significant risk of exposure. Plankton most likely to be exposed for brief periods.	1
Presence	Toxicity and persistence of produced water are expected to be low. Any limited effects on individual planktonic organisms will not adversely affect local populations.	1
Total		**2**



11.5.6.3 Impact Significance

Table 11.39 summarises impacts to biological/ecological receptors from discharges associated with pigging discharges.

Table 11.39 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Pigging discharge	Medium	Low	**Minor Negative**

As for produced water, described in Section 11.5.5.1, the resulting Minor Negative impact from pigging discharge is considered to be acceptable and does not require additional mitigation beyond the existing controls described in Table 11.3.

11.5.7 Other Discharges

11.5.7.1 Existing Controls & Event Magnitude

Other discharges to sea as detailed within Chapter 5: Sections 5.8.6.12, 5.8.6.14 and 5.8.6.15 comprise:

- **Ballast Water –** Support vessels ballasting activities will include occasional uptake and discharge of ballast water during supply activities. Vessel ballast tanks are designed to ensure that ballast water does not come into contact with oil or chemicals. Uptake and discharge are not considered to present a significant environmental hazard.

- **Treated Black Water** – Platform sewage treatment package designed in accordance with PSA requirements such that black water effluent is treated to applicable USCG Type II standards[34] and discharged via the sewage discharge caisson (17m below sea level). Based on average 150 POB and an expected generation rate 0.1m^3/person/day, approximately 15m^3 of treated effluent will be discharged per day. The flow rate is low, so the effluent will be rapidly diluted close to the point of discharge. Total suspended solids at the proposed treatment level do not pose any risk of significant environmental impact.

- **Grey Water** – Platform grey water will be discharged in accordance with PSA requirements[35]. Grey water (from showers, laundry etc) will contain only dilute cleaning agents (soaps, detergents) and the impact of the discharge will be minimal. Environmental factors are considered prior to selection of any chemical for use across the ACG facilities, including cleaning fluids such as detergents.

- **Galley Waste** - Platform galley waste system will be designed to treat food wastes to applicable MARPOL 73/78 Annex V: Prevention of Pollution by Garbage from Ships particle size standard prior to discharge[36] via the sewage discharge caisson.

- **Drainage** – The platform hazardous area open drains will be routed to the open drains caisson, designed to ensure that no visible sheen on sea surface. The non-hazardous area open drains will be routed to the CRI well via oily drains tank. If the oily drains tank or the CRI well is unavailable, the non-hazardous area liquids will be discharged to sea via the open drains caisson, provided no visible sheen is observable (Refer to Chapter 5 Section 5.8.6.11). Helideck drainage and deluge from deck drain boxes is discharged directly to sea.

Event Magnitude is summarised in Table 11.40.

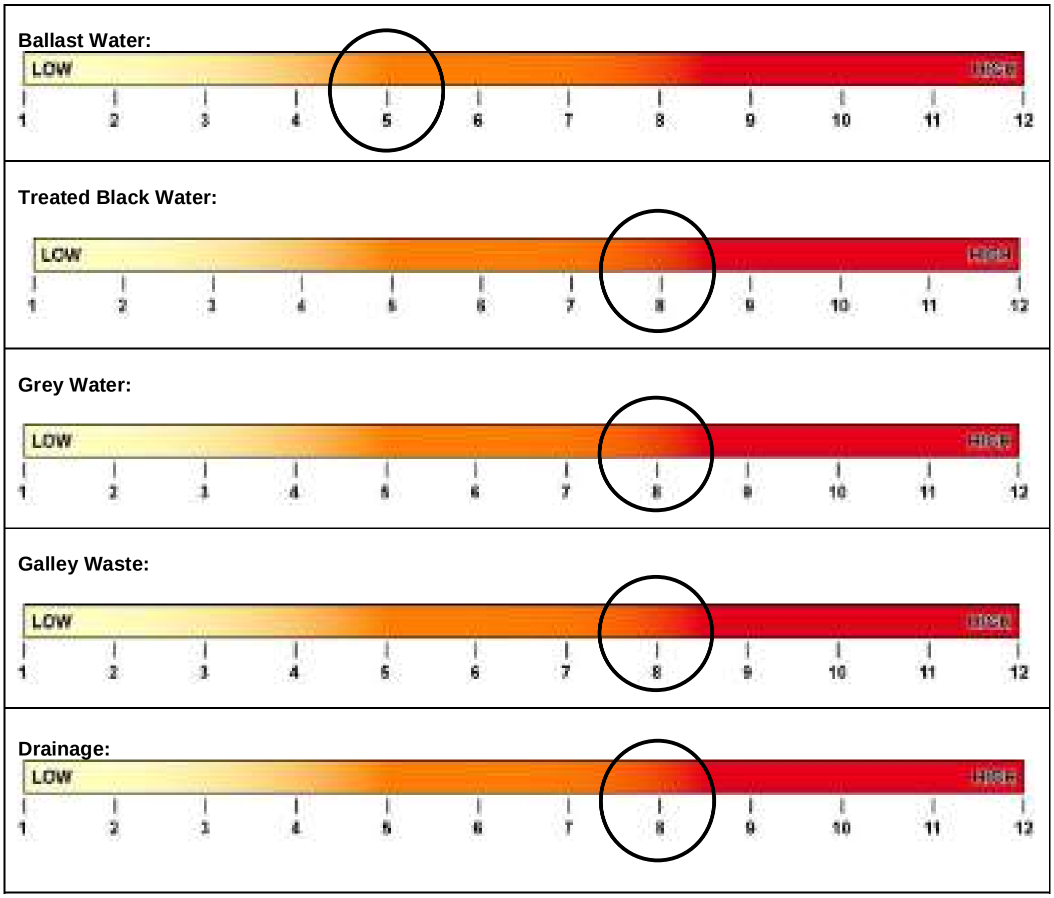
[34] Sanitary waste may be discharged from a U.S. Coast Guard certified or equivalent Marine Sanitation Device (MSD) to meet USCG Type II standards of total suspended solids of 150mg/l and fecal coliforms of 200MPN (most probable number) per 100ml

[35] Grey water may be discharged as long as no floating matter or visible sheen is observable.

[36] Macerated to particle size less than 25mm.

Table 11.40 Event Magnitude

Event Parameter / Discharge	Ballast Water	Treated Black Water	Grey Water	Drainage
Extent/Scale	1	1	1	1
Frequency	2	3	3	3
Duration	1	3	3	3
Intensity	1	1	1	1
Event Magnitude	**5**	**8**	**8**	**8**



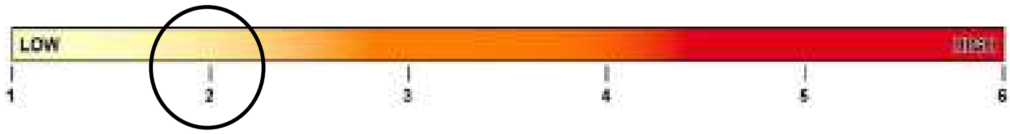
11.5.7.2 Receptor Sensitivity

All of the discharges are low in volume, do not contain toxic or persistent process chemicals and are considered to pose no significant threat to the environment or the identified biological/ecological receptors.

Table 11.41 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 11.41 Receptor Sensitivity (All Receptors)

Parameter	Explanation	Rating
Resilience	The extremely low level of exposure is equivalent to high resilience.	1
Presence	There is no significant presence of rare, unique or endangered species (i.e. the risk of exposure for any such species is close to zero).	1
Total		**2**



11.5.7.3 Impact Significance

Table 11.42 summarises the impact of other discharges to sea on seals, fish, zooplankton, phytoplankton and benthic invertebrates based on the impact significance criteria presented in Chapter 3: Impact Assessment Methodology.

Table 11.42 Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Other Discharges to Sea **Ballast Water**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Treated Black Water**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Grey Water**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Galley Waste**	Medium	(All Receptors) Low	**Minor Negative**
Other Discharges to Sea **Drainage**	Medium	(All Receptors) Low	**Minor Negative**

It is considered that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 11.3) and no additional mitigation is required.

11.6 Summary of COP Operations Phase Residual Environmental Impacts

For all operations phase environmental impacts assessed it has been concluded that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures (see Table 11.3) and no additional mitigation is required. However, in order to enable cooling water discharge temperature to be monitored, a temperature probe at the discharge point will be connected to a system for recording temperature at regular intervals. The primary purpose will be to confirm that the discharge temperature is sufficiently low that the edge of the cooling water mixing zone will not exceed ambient by more than 3ºC. Modelling has demonstrated this is extremely unlikely as the discharge temperature would need to be 75ºC or more for this to occur, which is beyond the operating parameters of the cooling water system.

Table 11.43 summarises the residual environmental impacts for the operations phase of the project.

Table 11.43 Summary of Operations Residual Environmental Impacts

	Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from offshore platform power generation and non-routine flaring	Medium	Low	**Minor Negative**
	Emissions from support vessel engines	Medium	Low	**Minor Negative**
	Emissions from onshore combustion plant and flaring	Medium	(Humans) Medium	**Moderate Negative**
			(Biological / Ecological) Low	**Minor Negative**
Marine Environment	Underwater noise from drilling, hammering and vessel movements	Medium	Low	**Minor Negative**
	Platform cuttings and WBM discharge	Medium	Low	**Minor Negative**
	Platform cement discharge	Medium	Low	**Minor Negative**
	Platform non routine produced water discharge	Medium	Low	**Minor Negative**
	Platform water intake and cooling water discharge	Medium	Low	**Minor Negative**
	Platform pigging discharges (produced water and injection water infield pipelines)	Medium	Low	**Minor Negative**
	Support vessel ballast water discharge	Medium	Low	**Minor Negative**
	Platform and support vessel treated black water discharge	Medium	Low	**Minor Negative**
	Platform and support vessel grey water discharge	Medium	Low	**Minor Negative**
	Platform and support vessel galley waste discharge	Medium	Low	**Minor Negative**
	Platform and support vessel drainage discharge	Medium	Low	**Minor Negative**

12 Socio-Economic Impact Assessment, Mitigation & Monitoring

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12.1 Introduction

This Chapter of the Chirag Oil Project (COP) Environmental and Social Impact Assessment (ESIA) presents the assessment of the socio-economic impacts associated with all Phases of the COP.

Indicators used to measure potential socio-economic impacts include, but are not necessarily limited to, training and employment opportunities with associated changes in income levels, changes in community demographics, demand for public services and changes in the aesthetic / quality of life of the community. Where possible quantitative measures have been used within the socio-economic impact assessment.

12.2 Impact Assessment

Socio-economic impacts begin to be realised on public announcement of a project. Changes in social structure and interactions among community members may occur once a project is proposed to a community. In addition, real, measurable and sometimes significant impacts on the human environment can begin to take place as soon as there are changes in social or economic conditions.

The COP is predominantly an offshore development. Other than a relatively short onshore construction programme, the majority of COP related Activities occur offshore and use existing operational onshore infrastructure capacities (e.g. Sangachal Terminal, Baku Deep Water Jacket Factory (BDJF), Logistics Supply Base). As such, negative socio-economic impacts are likely to be minor and most will generally be positive arising from those Events identified in Table 12.1.

Table 12.1 Socio-Economic Events Leading to Impacts

COP Phase	Event
Predrill Construction Installation, Hook Up & Commissioning Operations	Employment Creation
	Employment Retrenchment
	Training and Skills Development
	Increased Economic Flows
	Community Disturbance

Community Health and Safety has been scoped out of the socio-economic impact assessment due to well-established existing controls. The AIOC Community Advisory Plan[1] (CAP) outlines procedures for the management of community relations and provision of information on ACG project related works and activities. Additionally interference with commercial fishing activity has been scoped out based on limited fishing activity in the vicinity of shipping routes to and from the Contract Area and on existing marine management controls which aim to minimise inference with other sea users[2].

Additional training and skills development to be provided through the COP is likely to increase the resource of technical and managerial skills and experience within the local economy. In addition, the COP is likely to provide some additional stimulus to the local economy by prolonging the demand for goods and services, as instigated via earlier ACG Phases, in the local area.

12.2.1 Employment

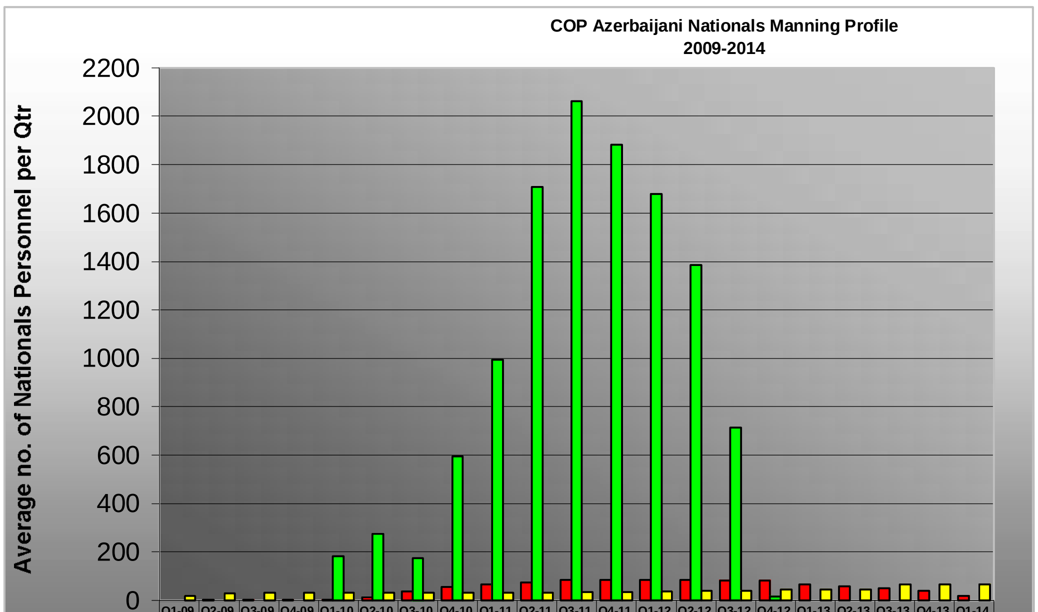
As discussed in Chapter 7: Socio-Economic Description, AIOC construction activities and project operations have had a significant impact on employment in the local area. Total direct construction employment from combined AIOC projects in Azerbaijan peaked at

[1] The CAP was under development at the time of writing. It builds on the existing Community Liaison Management Plan as developed for the ACG Phase 1 construction programme.
[2] Refer to Chapter 6 Section 6.5.2.8

approximately 5,500 workers in mid-2004 and for ACG Phase 3 peaked at around 2,500 staff (onshore and offshore construction) in 2006[3]. Following completion of these construction programmes however, there has been a decrease in employment opportunities associated with the AIOC projects.

Figure 12.1 presents current estimates for the number of Azerbaijani citizens likely to be employed over the duration of the COP. This indicates that the national workforce is expected to peak at just over 2,000 early in 2011, and that the workforce will exceed 1,000 for a period of approximately 18 months. For comparison, Figure 12.2 summarises the total workforce employed on jacket and topsides construction for ACG Project Phases 1 (CA-PDQ and C&WP platforms), 2 (EA and WA platforms) and 3 (DWG-DUQ and PCWU platforms); this indicates that peak employment levels ranged from just under 1,500 (CA-C&WP) to approximately 2,300 (WA). Peak employment for the EA project (the development most similar to the COP) was approximately 1,600. The COP is therefore expected to generate employment opportunities similar to those arising from previous project phases. Because the construction process and facilities are now relatively mature, the duration of the COP construction phase will be short compared to the first ACG platforms, and similar to the duration for more recent platforms.

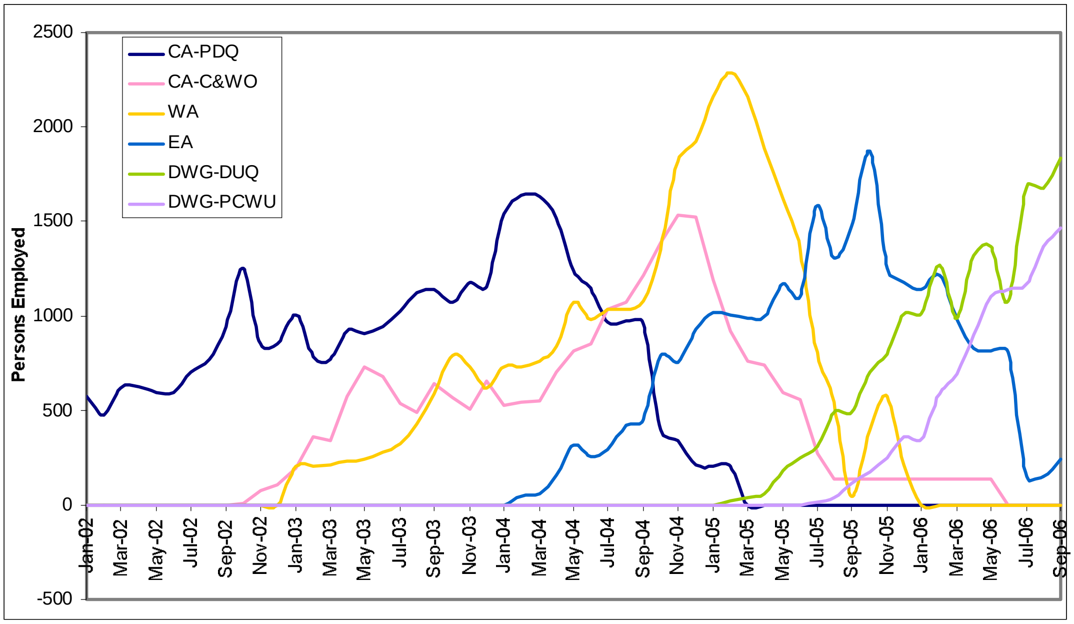
Figure 12.1 Estimates for the Number of Azerbaijani Citizens Likely to be Employed Over the Duration of the COP



	Q1-09	Q2-09	Q3-09	Q4-09	Q1-10	Q2-10	Q3-10	Q4-10	Q1-11	Q2-11	Q3-11	Q4-11	Q1-12	Q2-12	Q3-12	Q4-12	Q1-13	Q2-13	Q3-13	Q4-13	Q1-14
Client PMT Nationals	0	2	3	3	4	12	38	55	67	75	84	84	84	84	83	82	66	60	51	41	20
Contractor Nationals	0	0	0	0	182	274	176	595	994	1707	2062	1883	1680	1386	713	17	0	0	0	0	0
Operations Nationals	19	29	31	32	32	32	32	32	32	32	34	34	38	39	40	45	45	45	65	67	67

[3] Based on employment records maintained by the ACG Phase 1-3 construction contractors.

Figure 12.2 Total Workforce Employed on Jacket and Topsides Construction for ACG Project Phases 1 (CA-PDQ and C&WP), 2 (EA and WA) and 3 (DWG-DUQ and PCWU)



The operations phase will require relatively few personnel, and will therefore generate only limited new employment opportunities.

Employment impacts are likely to be distributed within the local area and potentially in the greater Baku region depending, to some degree, on the final selection of construction yard(s). It is anticipated that employment will not require establishment of workforce accommodation or significant migration of populations to the construction areas.

Particular objectives for the COP concerning employment will include preferential hiring of local residents and advertising employment opportunities within the local labour market. In addition, COP will actively pursue, and will require its contractors to pursue, a Nationalisation Policy which aims to replace expatriate personnel with Azerbaijani nationals by means of a Nationalisation Plan which will address the associated training requirements and staff development plans.

The majority of employees are expected to be recruited from the local Garadagh region, an area with a population of approximately 100,000, of which about 50,000 reside in the towns of Sahil and Lokhbatan. Assuming, conservatively, that each COP employee has three dependents, then approximately 8-10% of the regional population could benefit directly from the COP construction phase. Local commodity and service providers will benefit indirectly, although the extent of such benefit depends on the relative proportions of salaries which are allocated to increased discretional expenditure and on savings.

The Garadagh area is undergoing a broader economic development at present. A large market has been relocated from Heydar Aliyev airport to Lohkbatan, and plans are being developed for substantial expansion of cement production in the area. These developments may to some extent compete with the COP for skilled workers.

Employment creation, particularly throughout the Construction, Installation and Hook Up & Commissioning phases is considered to be a positive socio-economic impact.

12.2.2 End of Construction Phase Workforce Reduction

Assuming that demanning of the COP construction workforce occurs at the end of the COP construction phase, the cessation of economic input via salaries and project related spending on goods and services will impact household incomes of contracted workers and on the local economy, respectively. Figure 12.1 shows that there will be an initial period during which the workforce will decline steadily from the peak to a level of about 700, followed by a more abrupt final stage (currently estimated to occur in Q3-Q4 2012). The initial gradual phase of demanning will take place over a period of approximately one year, which will, to some extent, minimise competition for alternative employment.

To minimise impacts of demanning, planning for the conclusion of contracts will begin at the outset of the construction phase and related activities. Staff communications will ensure the workforce is aware of project progress and completion dates and staff will be provided with financial planning advice to encourage them to make provision for after the construction period. Training programmes will be developed to address skills shortages within the contractor and BP workforce and the employees who receive such training will therefore be in a better position to seek employment once their contract ends.

A register of construction phase employees will be established prior to demanning, and will attempt (as far as practicable, and contingent on the cooperation of departing staff) to track progress in securing subsequent employment. The register will be maintained for the duration of the construction phase.

12.2.3 Training and Skills Development

Many trained personnel engaged in the ACG Phases 1, 2 and 3 construction programmes have now moved on to new jobs in the national and international employment markets[4]. The COP Construction, Installation and Hook-Up & Commissioning phases are likely to require some investment in supplementing technical, managerial and administrative skills of the workforce. Training and skills development will provide a positive impact in developing the construction workforce skills and qualifications and in expanding the human capital available within the local economy.

12.2.4 Economic Activity

The COP will contribute economically directly, through direct employment and contracting, and indirectly, by increasing demand for goods and services in the local area. This will have a positive impact on the local economy, the magnitude of which will depend on the extent to which:

- The COP salaries result in a net increase in regional disposable income (taking into account that salaries are agreed with SOCAR to conform to national rates); and
- The COP recruitment has a positive impact on unemployment levels (that is, the extent to which the COP recruits personnel who are unemployed or who are currently in employment).

Direct and indirect expenditure might also provide some temporary stimulus to local businesses for the duration of the construction phase.

Economic developments in the Garadagh region (noted above) are likely to also increase employment levels, disposable income and demand for goods and services. While it is not presently possible to estimate with confidence the timescale over which this might occur, it is possible that such developments will reduce the proportional impact of the COP, during the construction phase and after the construction phase is completed.

[4] As reported by the ACG Phase 1-3 construction contractors

Positive impacts will be maximised by promoting the use of local rather than international companies to the extent that this remains consistent with BP procurement policies, HSE requirements and the Code of Conduct. On balance, increased economic flows will result in a positive impact.

12.2.5 Community Disturbance

12.2.5.1 Construction Yards

At the time of writing, a final decision on which construction yard(s) will be used had not been made. Similarly, it was not known whether the yard(s) will / would need to be upgraded and / or expanded. In either case, it is considered that as all candidate yards are existing industrial sites with very limited residential premises in near proximity, the potential for significant disturbance associated with upgrade/expansion works is limited. In the event that site expansion is required, it is highly unlikely that this will include the need to acquire residential land rather will be simply limited to the acquisition of adjacent industrial land via a “willing seller / willing buyer” arrangement. It will be the responsibility of the construction contractor to complete any necessary land acquisition process.

An assessment of potential noise and air quality impacts from the COP construction phase activities including the associated existing controls and mitigation is provided in Chapter 10.

In accordance with the procedures developed during previous construction phases, there will be no discharge to the environment of liquid effluent unless it is approved by the regulatory authorities or is approved through inclusion in this ESIA document. Sewage will either be transported to a licensed municipal treatment works, or will be treated to standards specified by the regulatory authorities in on-site plant with all necessary licenses and permits.

All waste generated at the main fabrication and installation sites will only be managed by licensed waste management contractors. Solid non-hazardous waste which cannot be treated, re-used or recycled will be securely handled and transported and will be disposed of in landfill sites that comply with national legislation.

It is considered that implementation by the COP, during the construction phase, of the practices and procedures developed during previous project phases will ensure that emissions and wastes will have no negative impact on local residents and communities, or on the resources on which they depend.

12.2.5.2 Traffic

Increased road traffic during the COP construction and operation phase has the potential to disrupt communities and businesses along the routes used through increased noise and traffic flows. Peak traffic loads will be experienced during the COP construction phase, associated with the transportation of the construction workforce on a daily basis. BP and its main construction contractors implemented a successful driving and vehicle management plan during the previous ACG Projects which will be adopted for the COP.

The effectiveness of the driving and vehicle management plan can be summarised briefly. Between 2002 and 2008 ACG Project vehicles covered approximately 153,000,000km. During peak activity (2003-2007) there were on average approximately 50 incidents per year involving Project vehicles, of which 85% were classified as involving only slight damage. In 70% of incidents, the project vehicle involved was hit from the side or behind by another vehicle (i.e. the project vehicle was the victim not the likely cause of the incident). Only 8% of incidents occurred on the open highway, 68% in urban areas and 24% on the construction sites. These statistics demonstrate that both driver training and vehicle maintenance achieved high standards of safety, protecting both project employees and the general public.

The key principles of the driving and vehicle management plan will be to ensure driver competence, monitoring of driver hours and performance, vehicle quality standards are maintained and road route assessment are undertaken. These and other supporting principles will be detailed in driving and vehicle management plans for the construction as well as operational phases of the COP. To reduce the number of vehicles, the use of buses to transport the construction workforce to site will be maximised.

The road system in and around Baku is continually being improved and completed improvements will provide benefit to the transportation of the COP construction workforce. Approved road traffic routes used to transport the main construction workforce will be established and a review mechanism established by the construction contractor(s) to ensure that the safest routes are used and disturbance to communities and businesses is minimised.

Increased economic activity in the Garadagh region (Lokhbatan market, cement plant developments) are likely to lead to an increase in general traffic density, and to a corresponding increase in traffic incidents. Rigorous implementation of BP's driving policies by all contractors will play a key role in minimising the exposure of the COP-related traffic to this increased risk.

Overall the impact to communities and businesses from the increased traffic is considered to be negligible.

13 Cumulative and Transboundary Impacts and Accidental Events

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13.1 Introduction

This Chapter of the COP Environmental and Social Impact Assessment (ESIA) discusses:

- Cumulative and Transboundary Impacts; and
- Accidental Events that could potentially occur during the construction, installation and hook-up & commissioning and operation phases of the Chirag Oil Project (COP) and the control, mitigation and response measures designed to minimise event likelihood and impact.

13.2 Cumulative and Transboundary Impacts

As discussed within Chapter 3, cumulative impacts arise from:

- Interactions between separate COP activities and/or impacts; and
- Interactions between COP activities and activities associated with other AIOC (ACG and Shah Deniz (SD)) activities.

As outlined in Chapter 1, the COP constitutes the next stage of development of the ACG Contract Area. The development has, so far, been undertaken in a phased approach comprising four discrete investment steps, as follows:

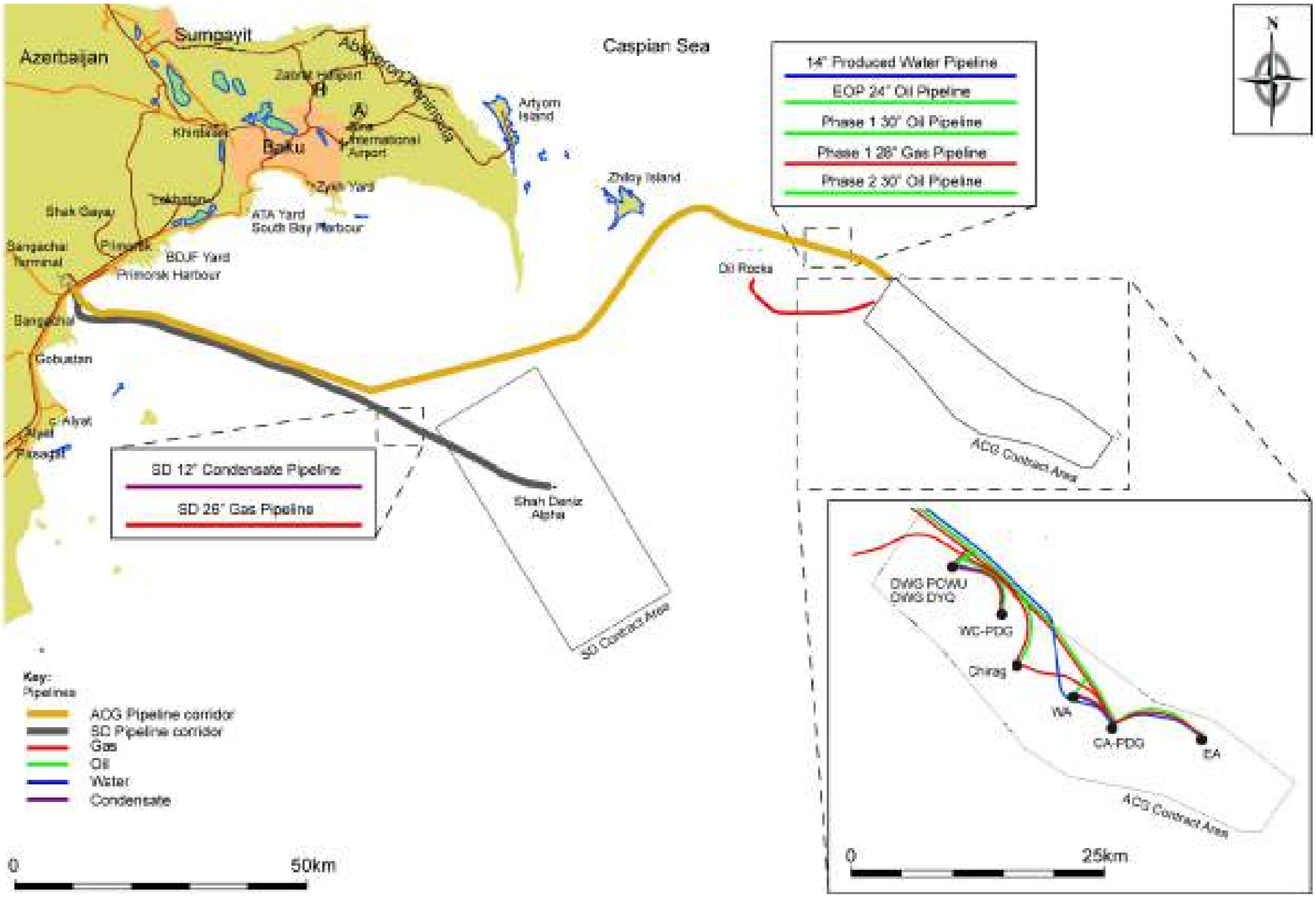
- The Early Oil Project (EOP) Chirag-1 platform which came on stream in November 1997;
- ACG Phase 1 that will deliver the recoverable reserves in the central section of the Azeri Field including the Central Azeri (CA) platforms that produced first oil in 2005;
- ACG Phase 2 that will deliver the recoverable reserves in the West and East sections of the Azeri Field including the East and West Azeri (EA and WA) platforms that produced first oil in 2006; and
- ACG Phase 3 that will deliver the recoverable reserves in the Deep Water Gunashli (DWG) Field including the two DWG platforms that produced first oil in May 2008.

The EOP included the construction of the oil receiving facilities at Sangachal Terminal, which were subsequently expanded for ACG Phases 1, 2 and 3. The COP will not require any additional expansion or upgrade works at the Terminal rather will make use of ullage within the existing processing facilities.

Figure 13.1 shows the location of the offshore ACG facilities (including the COP facilities) and the Sangachal Terminal. In addition, the offshore facilities within the SD gas / condensate Contract Area (located approximately 55km southeast of the ACG Contract Area), which commenced production in the first quarter of 2007, are depicted.

ESIAs for each phase of development have been undertaken and the impact associated with emissions and discharges have been assessed. The potential for cumulative impacts between these releases is discussed in the following sections with reference, where relevant, to modelling studies undertaken.

Figure 13.1 Location of ACG and SD Offshore Facilities



13.3 Marine Environment: Cumulative Impacts

Potential cumulative impacts on the marine environment resulting from interaction between separate COP activities or between COP and other ACG activities include:

- Physical presence (area occupied by platform and pipelines);
- Drilling discharges;
- Black and grey water discharges;
- Cooling water discharges; and
- Non-routine produced water discharges.

Interactions with SD activities are not considered likely during normal operations given the distance between the SD and ACG Contract Areas (approximately 75km) and the limited geographic scope of the above ACG events as discussed below.

13.3.1 Physical Presence

The area occupied by each platform and the pipelines (existing and proposed) within the ACG Contract Area is presented in Table 13.1.

Table 13.1 Areas Occupied by ACG Offshore Facilities (Platforms and Pipelines)

	Area (km^2)	% of ACG Contract Area	% of Caspian Sea
Chirag-1	0.09	0.021	0.000024
CA facilities (PDQ & C&WP)	0.12	0.028	0.000032
WA	0.06	0.014	0.000016
EA	0.07	0.016	0.000019
DWG facilities (DUQ & PCWU)	0.17	0.039	0.000046
WC-PDQ	0.06	0.014	0.000016
All Platforms	**0.57**	**0.132**	**0.000153**
ACG Existing Pipelines	**3.83**	**0.885**	**0.001032**
COP Infield Pipelines			
30” Oil Pipeline	0.03	0.007	0.000008
14” Gas Pipeline	0.01	0.002	0.000003
18” Water Injection Pipeline	0.02	0.005	0.000005
16” Produced Water Pipeline	0.02	0.005	0.000005
All Pipelines	**3.91**	**0.904**	**0.001053**
Total	**4.48**	**1.036**	**0.002413**

As Table 13.1 illustrates, the area occupied by the ACG platforms is relatively small (0.57km^2). The COP requires the installation of short lengths of pipelines (refer to Chapter 5: Project Description for dimensions) to connect to the main oil and gas export lines and between the WC-PDQ and DWG platforms. These will occupy a small area of approximately 0.08km^2.

The key points with respect to physical presence are:

- Cumulative area occupied by platforms and pipelines is extremely small in relation to similar habitats both locally and regionally;
- Neither COP or any other ACG installation occupies habitat which is critical for local ecosystem function; and
- The physical presence of COP and other ACG installations will affect only habitat within the immediate footprint, and will not affect immediately adjacent habitat.

13.3.2 Drilling Discharges

Drilling discharges during the COP and for all other ACG phases consist of:

- Cuttings, seawater and gel sweeps from the predrilled conductor sections of each well (during predrilling); and
- Cuttings and water based mud (WBM) from the surface-hole sections of each well (during predrilling and platform drilling).

Dispersion and settlement modelling for successive ESIA, including the COP, has demonstrated that deposition of drill cuttings and seawater and gel sweeps and WBM will primarily occur within 200m of the source.

Monitoring at existing platforms (i.e. CA, WA, EA and DWG) has shown that the cumulative effects of predrilling and platform drilling at each location are minor, confirming the predictions of the Phase 1, 2 and 3 ESIA. Drilling activities during the Phase 1, 2 and 3 developments have resulted in an identifiable barium “footprint” arising primarily from barite in predrill WBM discharges but have not caused other identifiable chemical contamination[1]. Small changes in the concentration of other heavy metals have been observed in some instances but these are associated with the natural composition of the drilled rock and are not derived from drilling fluids.

Biological impacts have been limited to a slight reduction in the number of species within 300-500m of platforms but these changes are considered minor and the biological communities around the Phase 1, 2 and 3 platforms remain healthy and diverse[1]. The limited areas within which cuttings are deposited and the minor impacts within these areas (up to 500m at most), lead to the conclusion that there will be no interaction of impacts between drilling discharges from adjacent platforms. Consequently, the cumulative effects of ACG drilling discharges will be limited to a total area very similar to that defined by the sum of the 500m safety exclusion zones around each platform (representing 6km^2 or 1% of the Contract Area).

13.3.3 Grey and Black Water Discharges

Chapters 9, 10 and 11 of this ESIA have shown that neither black nor grey water discharges from COP activities will have a significant impact and that both will be diluted to environmentally acceptable levels within a few metres of the point of discharge. These discharges comprise primarily organic material, which has little potential for interaction with the contents of other discharges. Consequently, it is considered that these discharges will not make a significant contribution to cumulative impacts either within the COP development or in combination with existing platform operations.

13.3.4 Cooling Water Discharges

Cooling water will be discharged from the MODU during predrill activities. The discharge will take place just above the sea surface at a rate of approximately 78l/s and it has been estimated that a dilution of 27-fold would be sufficient to eliminate any impact from the biocide used to protect the cooling system[2]. This dilution will occur within a few tens of metres at most, ensuring that the exposure risk for organisms near the sea surface will be very low and that the impact of the MODU cooling water discharge will not interact with other existing ACG platform cooling water discharges and therefore, will not contribute to any cumulative impacts.

Cooling water discharge from the COP WC-PDQ platform at a depth of 45m has two aspects: temperature and the presence of copper and chlorine ions. The concentrations of copper and chlorine in the discharge are very low (close to, or below, international environmental quality standards). Both ionic species will react very quickly following discharge. Copper ions will rapidly combine with chloride and organic material and chlorine will very rapidly be converted

[1] Refer to Chapter 6: Environmental Description for further detail
[2] Refer to Chapter 9 Section 9.5.5

to chloride in the process of oxidising natural organic material. The consequence of these reactions is that the free ion forms (i.e. the toxic forms) of these elements will only persist for a very short period of time. The complexed and oxidised forms are of relatively low toxicity.

Modelling has shown that temperature is mitigated to acceptable levels within metres of the discharge point and that there is thus no potential for interaction with discharges from other platforms. Consequently, although the cooling water discharges are large in volume, the plume within which water temperature would exceed ambient by more than 3ºC would extend less than 30m. This means that the impact would be sufficiently small that there would be no cumulative interaction with other COP discharges and no overall significant cumulative impact of the combined discharges from the COP and other ACG platforms.

13.3.5 Produced Water Discharges

While it is not planned to discharge produced water routinely, there will be occasions for all ACG offshore facilities where it may be necessary to discharge produced water in accordance with the PSA for limited periods of time.

Studies have been carried out on the composition and toxicity of produced water and discharge scenarios have been developed and modelled. At the present time, no ACG platforms are routinely separating water offshore and estimates of potential environmental impact are therefore based on data obtained from separators at the Sangachal Terminal. This data is for water, which had not been treated to the offshore standards specified in the PSA and therefore, represent a worst-case scenario.

The results of toxicity testing indicated that a dilution of 120-fold would be sufficient to reduce the discharge to no-effect concentrations and modelling of the produced water plume shows that a dilution of 300-fold would be achieved within 100m under dominant current conditions[3]. If produced water is treated to a concentration of 29mg/l oil-in-water (monthly average), then a dilution of 600-fold would be sufficient to reduce hydrocarbon concentrations to a typical ambient level of 50µg/l. The impact of produced water discharges is, therefore, limited to a small area close to each platform (within approximately 50m based on modelling undertaken for the COP) and there is thus no risk of interaction of impacts between discharges from different platforms, even if these occur simultaneously. Produced water discharges are also typically of short duration (i.e. hours) and take place at a different depth (46m below sea level) to other COP discharges and there is very limited potential for cumulative interaction between the COP discharges.

13.3.6 Conclusion

A key aspect of assessing the impact of discharges was to determine whether each discharge had the potential for:

- **Additive effect**: Due to releasing into the environment persistent pollutants which could have a chronic impact, the effects of which might continue after the discharge had ceased, or beyond the immediate vicinity of the discharge; or
- **Interaction effect:** Due to mixing with other discharges to give rise to an impact greater than predicted for either discharge alone.

For each of the discharges, the composition was taken into account, and where appropriate the chemical selection process has ensured that no chemicals which are persistent or are associated with chronic effects are used.

13.3.6.1 Additive Effects

For each of the discharges, the assessments presented within Chapters 9, 10 and 11 of the ESIA as discussed in Sections 13.3.2 – 13.3.5 above, confirmed that any minor impacts

[3] Refer to Chapter 11 Section 11.5.4

would be confined to small volumes of water, and that there would be no persistent effects at a greater distance or after the discharge had ceased. The consequence of this is that the impact of each discharge can genuinely be considered transient, that is, there will be the potential for very limited effects within a small mixing zone, but that these will:

- not represent a significant reduction in local ecological health or productivity; and
- have no longer-term ecological consequences after discharge has ceased .

In summary, this means that the potential sequence of discharges will not, cumulatively, lead to any degree of progressive environmental degradation over time due to additive effects. Each represents a minor interaction which is confined to within a few tens or hundreds of metres from the point of discharge, and from which ecological recovery will be rapid and complete.

13.3.6.2 Interaction Effects

Taking into account the location, depth and behaviour of discharges (Refer to Table 1 Appendix 13A) the only potential for cumulative effects associated with interactions would arise from the concurrent discharge from the platform of:

- Cooling water and produced water;
- Cooling water and pigging water; and
- Cooling water, produced water and pigging water.

During early platform life, pigging of the injection lines will utilise produced water, and potential interactions will therefore be similar to those for produced water. During later platform life, pigging discharges will use inhibited seawater in which chemical dosage has been carefully managed and minimised to ensure that impacts are effectively mitigated. Concurrent discharge of produced water and pigging water (via the same caisson) will therefore generate a slightly larger mixing plume, but will have no more impact than the discharge of produced water alone.

The most probable interaction scenario therefore involves cooling water (a continuous routine discharge) and produced water (an intermittent non routine discharge). Figure 13.2 illustrates the relative positions of the discharge caissons. Under conditions of typical current direction and velocity, it is unlikely that the discharge plumes will interact significantly – i.e., any mixing will occur after both have been highly diluted and at some considerable distance from the platform.

The most likely interaction scenario for cooling water and produced water is under stagnant current conditions. Both discharges are warm (approximately 25^{o}C) and will rise vertically in the absence of any significant current, spreading at the surface in winter and at the bottom of the thermocline in summer. Combined dispersion models were run to assess the degree of interaction between the plumes[4]. Both discharges are predicted to have diluted to the point where temperature does not exceed ambient by >3^{o}C before they reach the point where they could begin to mix, and any mixing will therefore have no consequences in terms of complying with the IFC temperature requirements.

The cooling water contains very low concentrations of antifouling agents, and is not on its own predicted to have any toxicity impact; there will thus be no chemical interaction with the produced water. The combined dispersion modelling predicts that the only consequence of interaction will be the horizontal displacement of the produced water plume as a result of the spreading of cooling water at the sea surface (Figure 13.3). The area of the surface produced water plume, and the dilution contours, are not materially affected. The conclusion is that concurrent discharge of cooling water and produced water would not result in any cumulative impact.

[4] Refer to Appendices 11E and 11F for modelling assumptions and input data.

Figure 13.2 WC-PDQ Platform Discharge Locations

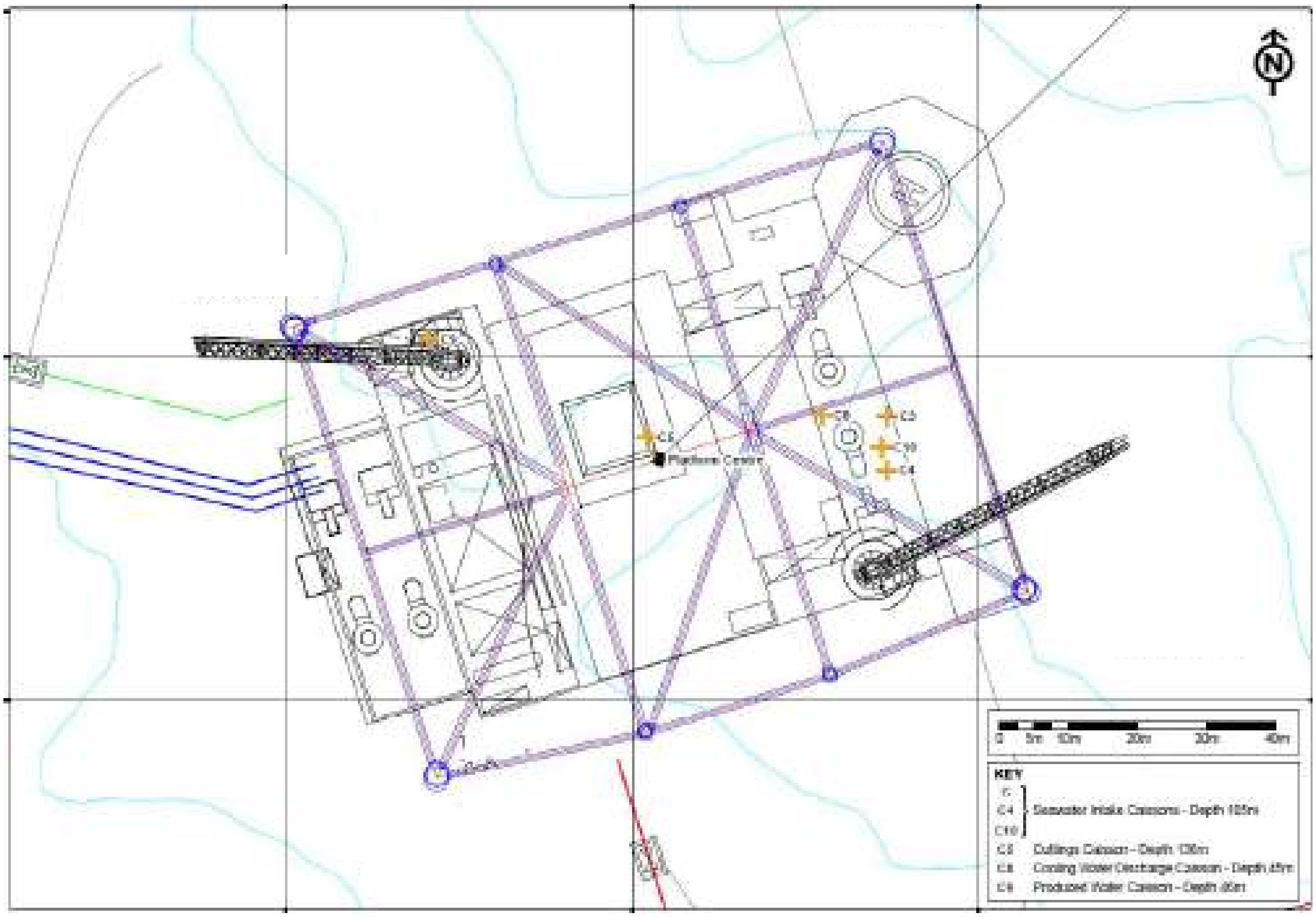
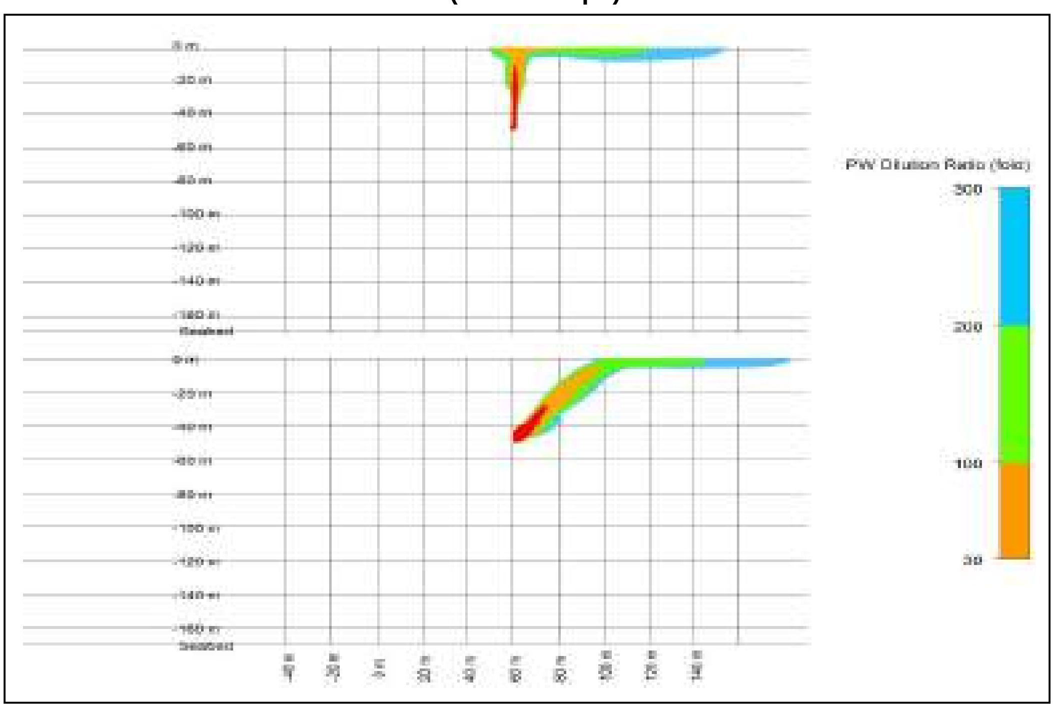


Figure 13.3 Horizontal Displacement of Produced Water Plume by Cooling Water in the Absence of a Thermocline under Stagnant (Upper Graph) and Predominant Current (Lower Graph) Conditions



Planned or unplanned discharges from the COP will be, as with other platforms, of limited impact. Each discharge will make a small incremental contribution to the ACG total but the platform discharges will be isolated from each other and the total itself represents a very small fraction of the assimilative capacity of the Contract Area. Consequently, it is considered that these discharges represent a sustainable situation in which there will be no measurable or progressive deterioration of the marine environment attributable to ACG operations. All of these discharges will be dispersed and diluted to concentrations below the threshold of impact within (at most) a few hundred metres of the source and therefore have no potential for cumulative impacts.

13.3.6.3 Mitigation and Monitoring

Control measures to mitigate impacts to the marine environment from routine and non routine discharges associated with the COP and associated reporting requirements are detailed within Chapters 9, 10 and 11 of this ESIA. These include design and operating principles (e.g. no planned discharge of non-WBM), facility maintenance regimes, appropriate chemical selection and monitoring to confirm effective operation and/or confirm compliance with standards.

Monitoring and reporting procedures and documentation requirements for each ACG phase are included within BP Azerbaijan's Health, Safety, Security and Environment (HSSE) Policy (Refer to Chapter 14). Once operational, COP will become a component of the AzSPU Offshore Organisation (ACG Performance Unit) and will develop a set of project specific monitoring, management and reporting procedures based on, and consistent with, the procedures already in use on existing ACG platforms.

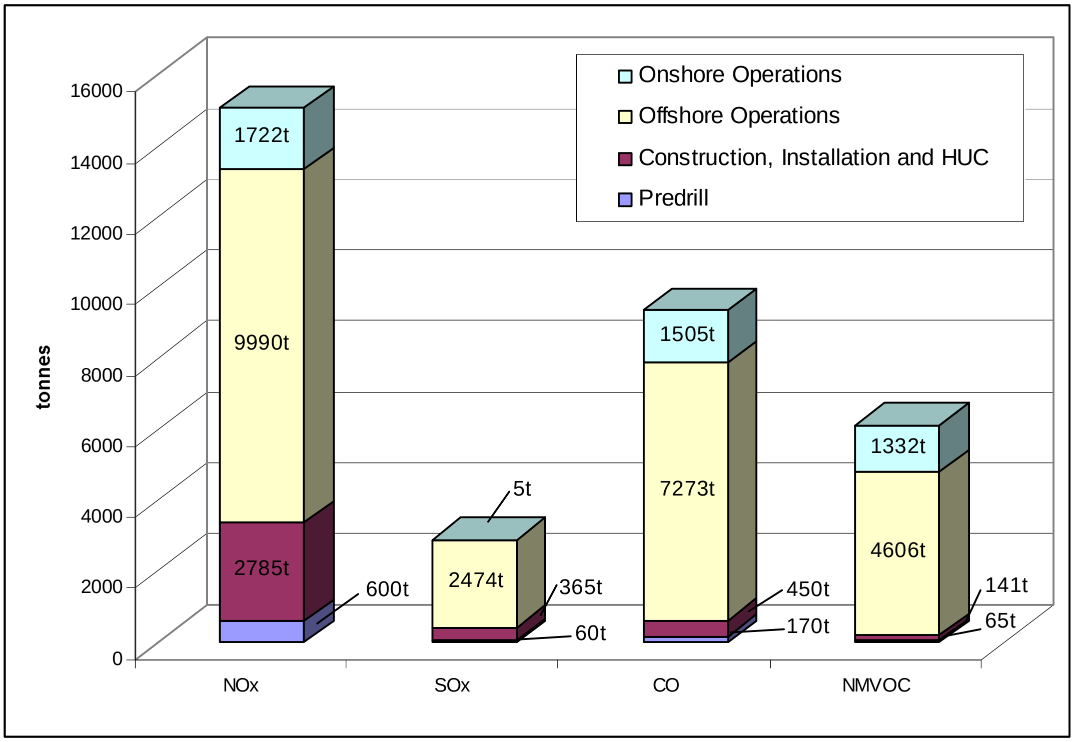
13.4 Non-Greenhouse Gas Atmospheric Emissions: Cumulative Impacts

Atmospheric emissions will arise from each COP phase due to:

- The operation of power generation plant;
- Transportation (e.g. vessels and helicopters);
- Flaring; and
- Fugitive emissions from existing tanks at the terminal.

Figure 13.4 presents volumes of the non-greenhouse gas (non-GHG) emissions nitrous oxides, sulphur oxides, carbon monoxide and non methane hydrocarbons, for each phase of the COP.

Figure 13.4 COP Non-GHG Emissions Per Project Phase



NO_X, which comprises nitrous oxide (NO) and nitrogen dioxide (NO_2), is the main atmospheric pollutant of concern, based on the larger predicted emission volumes as compared to non-GHG emissions and the potential to impact human health and the environment.

13.4.1 Onshore Non-Greenhouse Gas Atmospheric Emissions

Chapters 9, 10 and 11 of this ESIA have shown that NO_2 emissions associated with each COP phase will not result in any significant impact to human and biological / ecological receptors. Specifically emissions from offshore activities for all phases were shown to result in no discernable change in NO_2 concentrations at relevant onshore receptors. Emissions arising from COP derived oil and gas being received at the Terminal, were not predicted to exceed the forecast peak emissions associated with the combined EOP and ACG Phases 1, 2 and 3 due to the predicted reduction in emissions at the Terminal over the COP lifetime as production from other projects declines.

Modelling of onshore air emissions for previous ACG ESIA, assuming both reasonable normal and worst case plant conditions (i.e. normal operation and emergency / upset worst case flaring conditions), showed that ambient air quality concentrations of all pollutants complied with relevant ambient air quality standards at the nearest residential receptors to the Terminal. It is considered therefore, that cumulative impacts to receptors associated with non-GHG emissions from the Terminal will be insignificant.

BP currently undertakes a program of ambient air quality monitoring at locations around the Terminal and stack emissions monitoring from the major power generation (>500 HP) units. The program is designed to confirm the air quality in the surrounding communities and benchmark the Terminal's effect on air quality. Results from the most recent air quality monitoring programmes (2006 and 2007) are presented in Chapter 6 of this ESIA. No exceedances of relevant long-term standards or short term exceedances attributable to Terminal operations at locations in and around the Terminal have been recorded.

Existing control measures at the Terminal to minimise non GHG atmospheric emissions are detailed within Chapter 11.

13.4.2 Offshore Non Greenhouse Gas Atmospheric Emissions

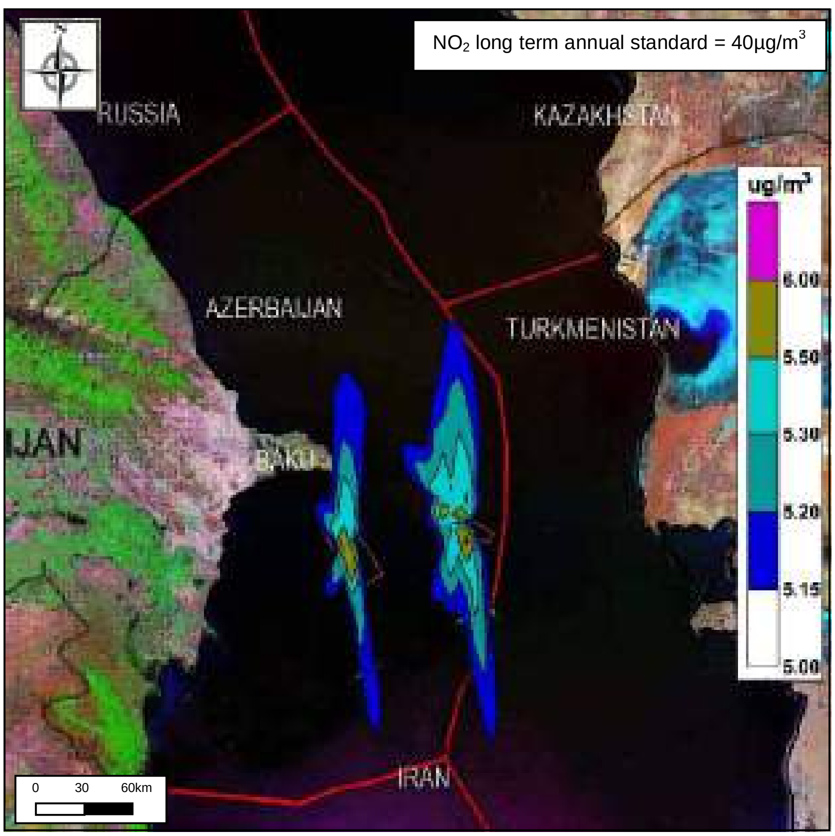
Modelling has been undertaken to establish the cumulative effect from non-GHG emissions due to the operation of the EOP, ACG Phases 1, 2 and 3 and the COP offshore facilities on NO_2 concentrations onshore. A number of scenarios were modelled to represent typical and worst case operating conditions including:

- Normal routine operation of all offshore platforms; and
- Emergency depressurisation and flaring of complete inventory at COP offshore facilities due to restricted gas export with normal routine operation at all other ACG and SD platforms.

For each scenario, the NO_2 emissions from both the existing platforms and proposed WC-PDQ platform were modelled to determine the future contribution of emissions to the air quality onshore. Concentrations taking into account existing background levels[5] were compared against relevant long term (annual average) and short term (1hour peak) air quality standards for the protection of human health[6],.

The modelling demonstrated that during routine operation, NO_2 emissions disperse rapidly and the increase in long term NO_2 concentrations due to all ACG and SD offshore operations are likely to be indiscernible from background levels (Figure 13.5).

Figure 13.5 NO_2 Long Term Concentrations (Normal Operations at All Platforms)



[5] Refer to Chapter 6: Environmental Description for background levels
[6] Applicable 1 hour average (short term) and annual average (long term) standards for NO_2 are 200µg/m^3 and 40µg/m^3 respectively

Under reasonable worst case conditions when emergency depressurisation of the COP facilities may be necessary, which is expected to occur over approximately 1 hour, the short term increase in NO_2 concentrations onshore are likely to be insignificant. Figures 13.6 and 13.7 presents the short term modelling results obtained for normal routine operations of all platforms and the worst case scenario when the inventory of the COP facilities are flared.

Figure 13.6 NO_2 Short Term Concentrations (Normal Operations at All Platforms)

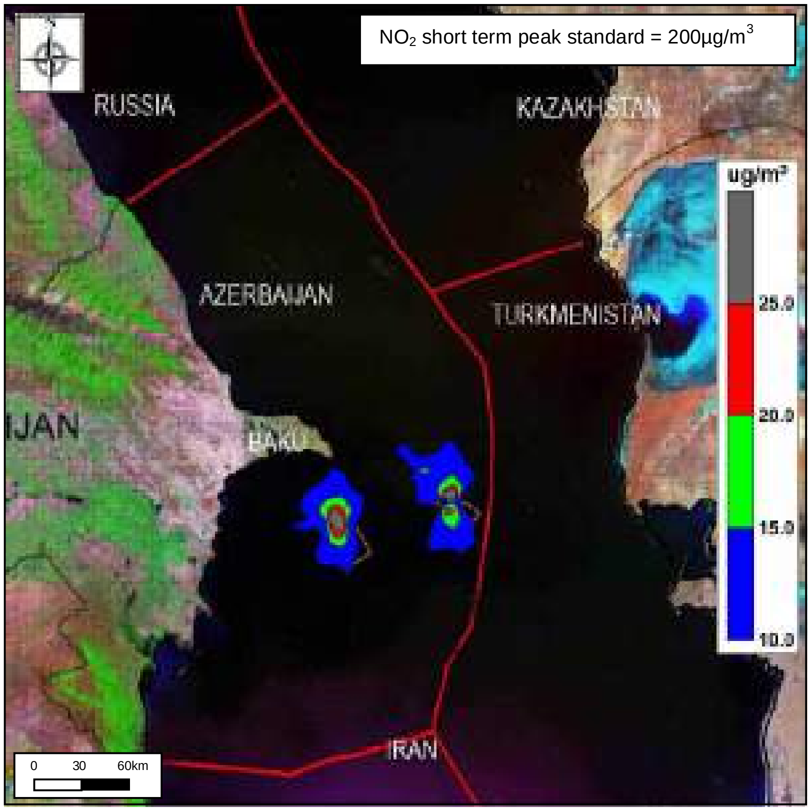
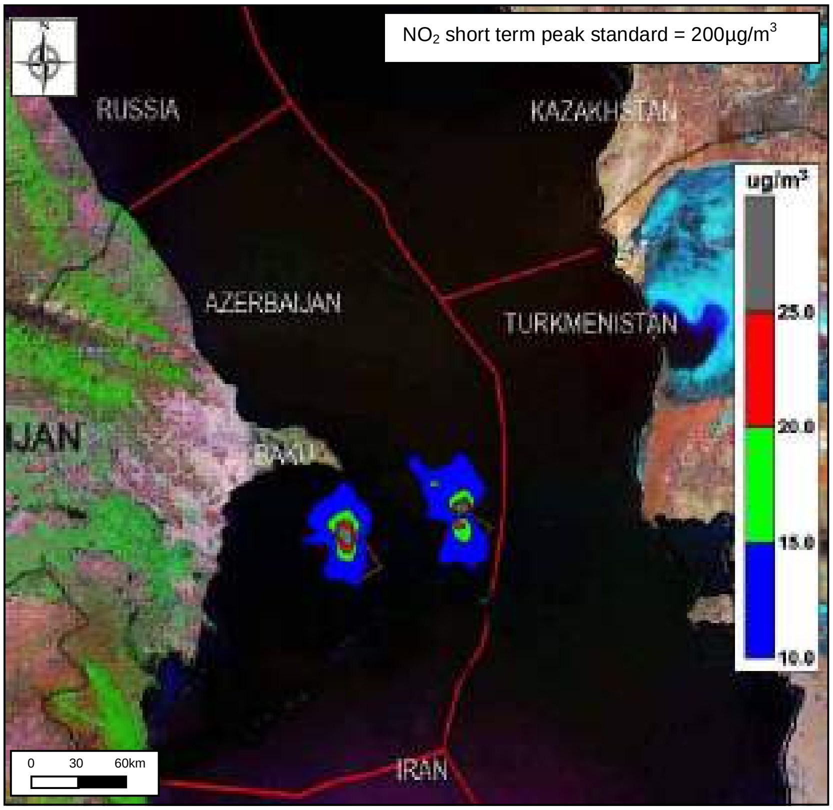


Figure 13.7 NO_2 Short Term Concentrations (West Chirag Emergency Depressurisation, Other Platform Normal Operations)



Figures 13.5, 13.6 and 13.7 demonstrate that:

- Emissions from the ACG and SD offshore facilities disperse rapidly in the predominant wind directions (north and south);
- Changes in NO_2 concentrations onshore associated with offshore operations are predominantly due to SD operations;
- Short term NO_2 concentrations reduce to more than 20 times less than the applicable standard before the emission plume reaches onshore[7]; and
- Changes in short term NO_2 concentrations onshore due to offshore operations, even under worst-case conditions, are likely to be indiscernible from background concentrations.

13.4.3 Conclusion

The assessment above demonstrates that it is unlikely that the COP in combination with the EOP, ACG Phases 1, 2 and 3 and SD projects will result in any significant cumulative effects to air quality at relevant onshore receptors.

As for platform discharges, control measures to mitigate impacts to the atmosphere from routine and non routine emissions associated with the COP and associated reporting requirements are detailed within Chapters 9, 10 and 11 of this ESIA. These include design and operating principles (e.g. no continuous routine flaring or venting at the platforms under

[7] Historically in Azerbaijan ambient concentrations of NO_2, SO_2, CO and PM_{10} have also been assessed against specific 24 hour and 1 hour standards. These standards were not derived using the same health based criteria as the IFC, WHO and EU guideline values and the standards derived are not widely recognised. However, Appendix 11B (Annex 1) includes an assessment of expected air quality concentrations against these standards for completeness. The modelling demonstrated that none of these standards would be exceeded.

normal conditions), facility maintenance regimes and monitoring to confirm effective operation and / or confirm compliance with standards.

13.5 Non-Greenhouse Gas Atmospheric Emissions: Transboundary Impacts

The potential for transboundary impacts associated with non-GHG emissions are dependant on the environmental / health effects associated with the pollutant, residence time (i.e. atmospheric lifetime) and the expected dispersion characteristics of the pollutant in the atmosphere in addition to the location of potential receptors.

As discussed in Section 13.4.2 above, the most significant pollutant in terms of health impacts is NO_2. It has been demonstrated that emissions associated with COP offshore activities alone and emissions from worst-case cumulative ACG and SD offshore activities are not expected to result any discernable changes in onshore NO_2 concentrations. Based on the limited geographic scope of pollutant species, which will disperse rapidly in the atmosphere, no transboundary impacts associated with air quality and human health are predicted.

As discussed within Chapter 11 of this ESIA, impacts to air quality in the vicinity of the Terminal, taking into account all ACG Phases across the PSA period, demonstrated no significant impact to nearby residential receptors. No transboundary impacts to air quality from onshore emissions are therefore, predicted.

For both onshore and offshore activities, the volumes of emissions released (including visible particulates) due to the COP are expected to result in very small increases in pollutant concentrations in the atmosphere and in any washout from rainfall, which will not be discernable to biological / ecological receptors. SO_2 emissions will be minimised through the planned use of low sulphur diesel and are expected to disperse rapidly due to appropriate equipment design. Contribution of COP SO_2 emissions to acid rain generation is therefore, expected to be insignificant.

The movements of vessels bringing construction materials from overseas will occur over a large geographic area and emissions will be relatively short in duration and are expected to disperse rapidly. No significant transboundary impacts from non-GHG emissions from the COP are therefore predicted.

13.6 Greenhouse Gas Atmospheric Emissions: Cumulative and Transboundary Impacts

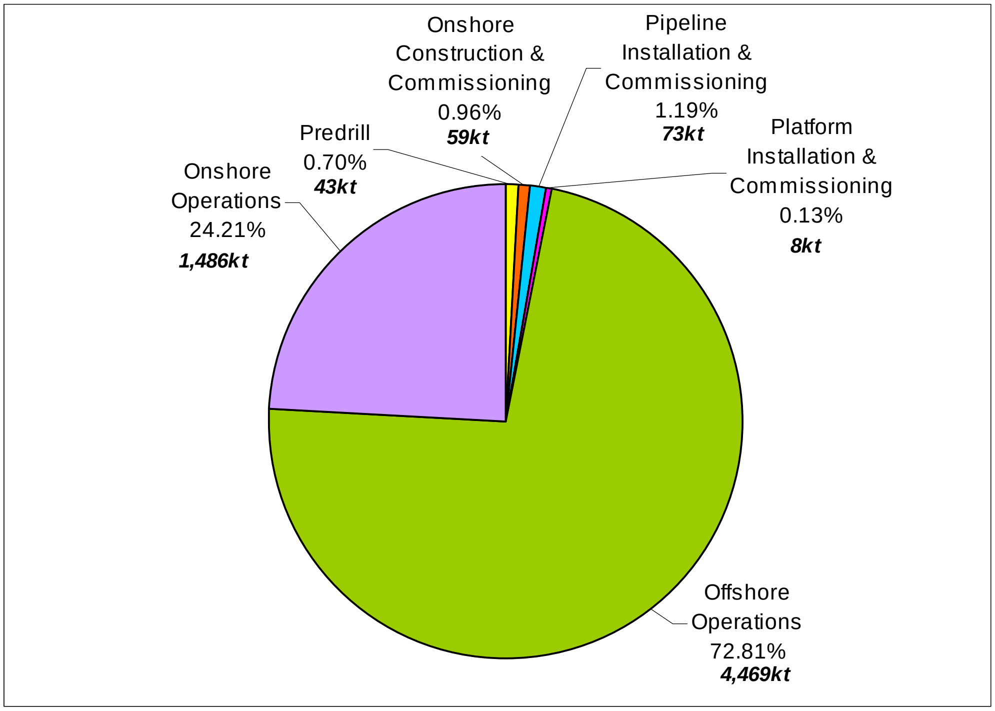
Increases in man made GHG (including carbon dioxide and methane) are widely accepted as contributing to changes in the energy balance of the world's climate system, creating an overall increase in average global temperatures[8].

The framework for international efforts to address the challenge of climate change due to anthropogenic GHG emissions is the UN Framework Convention on Climate Change (UNFCCC), signed in 1992. In 1997, the Third Conference of the Parties to the UNFCCC adopted the Kyoto Protocol to the Convention. This Protocol, which entered into force on 16 February 2005, commits industrialised nations (Annex 1 countries) to reduce their GHG emissions by an average of 5.2% of 1990 levels by the 5-year commitment period 2008-2012. The Republic of Azerbaijan is not listed in Annex I of the protocol and is therefore not formally required to meet specific reduction targets for GHG emissions.

Expected greenhouse gas emissions from COP activities are presented in Chapter 5 of this ESIA for all phases of the project. Figure 13.8 shows the predicted contribution per phase.

[8] Fourth Assessment Report of the United Nations Intergovernmental Panel on Climate Change - Climate Change 2007, IPCC, 2007.

Figure 13.8 COP Greenhouse Gas Emissions Per Phase



The majority (97%) of GHG result from COP onshore and offshore operational activities. Figure 13.9 presents the volume of the COP operational GHG emissions relative to the previously forecast GHG emissions for the EOP, ACG Phases 1, 2 and 3 and SD projects.

Figure 13.9 COP Operational GHG Emissions Relative to Forecast GHG Emissions from EOP, ACG 1, 2 & 3 and SD Projects (2012 –2024)

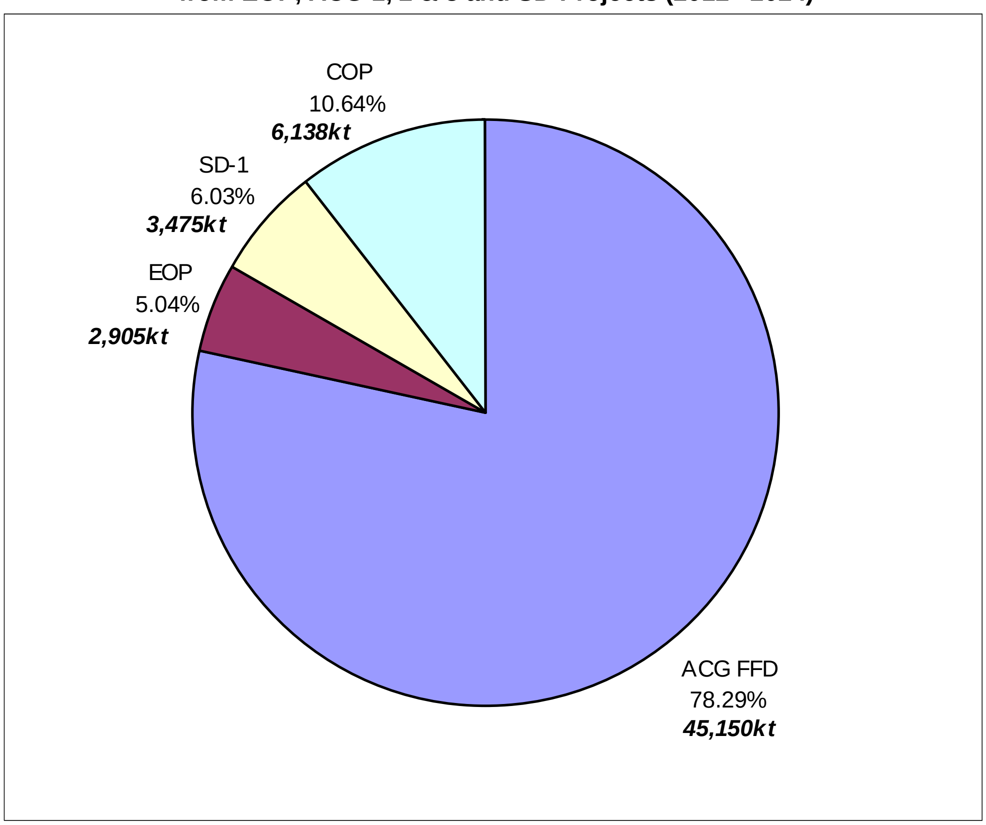


Figure 13.9 demonstrates that the COP will contribute approximately 11% of the total forecast GHG emissions over the PSA period.

The most recent forecast of GHG emissions in Azerbaijan[9] indicates that by 2020 total GHG emissions may be approximately 109,895 kt with the majority resulting from fuel combusted in the energy industry. As a proportion COP forecast GHG emissions for 2020 are expected to contribute approximately 0.5% to the national total.

The UNFCCC was approved by Decree by the Milli Mejlis (Parliament) of the Azerbaijan Republic in 1995. Following the signing of the UNFCCC, a Convention State Commission on Problems of Climate Change was established in 1997 by Decree of the then President of Azerbaijan Republic, G.A. Aliyev to implement commitments under the Convention. The chairman of the State Committee on Hydrometeorology was appointed deputy chairman of the Commission. The chairman of the State Committee on Hydrometeorology was replaced with the Minister of Ecology and Natural Resource in the Commission by Decree of the President in 2003. The Climate Change and Ozone Centre was established in 2005 within the Ministry of Ecology and Natural Resources. The aim of the Centre is to ensure the implementation of the Convention, coordinate various activities within the climate change sector and to act as an implementing arm of the State Commission.

The Republic of Azerbaijan is active in developing strategies to abate greenhouse gas emissions and is considering measures including opportunities for use of alternative sources of energy which do not emit carbon and participation in the clean development mechanism, whereby developed countries can invest in clean technologies in developing and transition countries, resulting in a benefit to the developing country and award of GHG credits for the developed country to offset against their agreed GHG quota[10].

13.6.1 Conclusion

The principal sources of GHG emissions from ACG and SD operations, including the COP, are associated with power generation, gas compression and water injection, process heating at the terminal and non-routine flaring of gas required for safety reasons. AIOC is committed to assessing and, where practical, reducing the GHG emissions. As each project has come forward, the following principles have been followed:

- Evaluate options to reduce flaring - develop and implement an operational flare policy;
- Maximise energy efficiency in line with BPEO;
- Challenge and justify well testing requirements;
- Minimise combustion and fugitive emissions; and
- Avoid venting.

Design measures across the developments that contribute to GHG savings include:

- Onshore flare gas recovery;
- Onshore inert purge gas;
- Centralised power offshore for the Azeri Field;
- No continuous flaring for production;
- Gas re-injection (as opposed to flaring) at the Azeri Field;
- External floating roof tanks at the Terminal;
- Use of aero-derivative turbines; and
- Electric motor driven export compression on Phase 3 and COP.

In addition to these measures, the ACG Project participates in a gas management strategy whereby the majority of associated gas produced by the ACG developments is routinely re-injected into the subsurface reservoir, and the remaining gas used for offshore platform power generation in the main gas turbines and exported to Sangachal Terminal.

[9] First National Communication of Azerbaijan on Climate Change, May 23, 2000
[10] UNDP (2009), 'Azerbaijan Clamps Down on Greenhouse Gas Emissions'.

As described within Chapter 4: Options Assessed, energy efficiency and GHG reduction was a key aspect taken into account during the development of the COP design, contributing to the selection of the electric deck with all power to the platform, including the gas export compressors, provided by the main power generation turbines. Analysis demonstrated that this technology selection resulted in a saving of approximately 300,000t of CO_2 emissions across the project's lifetime.

As for non-GHG emissions, GHG monitoring and reporting procedures and documentation requirements for each ACG phase are included within BP Azerbaijan's Health, Safety, Security and Environment (HSSE) Policy (see Chapter 14). Once operational, COP will become a component of the AzSPU Offshore Organisation (ACG Performance Unit) and will develop a set of specific GHG monitoring, management and reporting procedures based on and consistent with the procedures already in use on existing ACG platforms.

13.7 Accidental Events

13.7.1 Overview

Accidental Events are considered separately from routine and non-routine COP activities as they only arise as a result of a technical failure, human error or as a result of natural phenomena such as a seismic event.

This section addresses the likelihood of potential offshore and onshore spills of various types occurring and the potential impacts, taking into account aspects such as persistence and the potential for intervention or response. Different approaches are adopted for different spill types, determined principally by the following considerations:

- A spill of crude oil will be the most persistent pollutant during the COP and the fate of crude oil spills has therefore been the subject of weathering studies and dispersion modelling;
- Other chemicals or materials that could be spilled will either sink or disperse in the water column and mitigation measures therefore focus on spill prevention; and
- Spills, including type, size and cause, during previous ACG projects have been thoroughly documented, giving an indication of where spill prevention measures will be focused for the COP.

13.7.2 Previous Crude and Diesel Spill Modelling Relevant to COP

13.7.2.1 COP Crude Oil Properties

Since oil has yet to be produced from COP, no crude oil has been available for characterisation. However, COP crude oil is expected to be equivalent to a 50/50 blend of Chirag and DWG crude oils. Chirag (Azeri Light) and DWG crude oils have broadly similar properties, in terms of likely spilled oil behaviour:

- They are of similar density (0.8500 at 15ºC) and viscosity (4 to 5 cSt at 50ºC);
- They have similar degrees of implied evaporative loss:
    - Approximately 20% of the crude oil volume is distilled off at 175ºC and 30% volume at 250ºC; and
    - The volume distilled at 175ºC is indicative of evaporative loss after approximately 4 hours on the sea and the volume distilled at 250ºC of evaporative loss after 1 to 5 days on the sea. The precise equivalence depends on the prevailing sea temperature and wind speed; and
- They have low asphaltene contents, indicating a relatively low tendency to form highly stable water-in-oil emulsions.

The major difference between the two crude oils is the Pour Point; the lowest temperature at which the crude oil will just flow when determined under specific laboratory conditions (ASTM D5853 / D97). The Pour Point is a reflection of the wax content. Stabilised DWG crude oil has a Pour Point of -27ºC according to 2009 analysis by Intertek Azeri Ltd. The sample of Chirag crude oil provided for the 1997 AEAT weathering study had a Pour Point of -6ºC while the 2003 assay of Azeri Light gives the Pour Point of -9ºC.

The Pour Point of a crude oil is of considerable relevance to the spilled oil behaviour, even before the changes caused by weathering of the oil are considered. The Pour Point is not the temperature at which spilled oil will sharply change from a liquid to a solid; crude oils do not freeze or melt like water at a single, well-defined temperature. Solid wax starts to precipitate at temperatures well above the Pour Point. As the temperature is decreased and approaches the Pour Point more wax is precipitated and forms a gel-like structure that renders the oil semi-solid. Oil near its Pour Point with precipitated wax will exhibit non-Newtonian flow behaviour it will exhibit a much higher viscosity at low shear rates (such as those experienced by spilled oil at sea) than at higher shear rates.

13.7.2.2 Weathering of Spilled Crude Oils

Weathering is the term used to describe the changes in physical properties of spilled crude oils that occurs over time. The major processes contributing to oil weathering behaviour are:

- **Loss of more volatile oil components by evaporation**
  Spilled crude oil rapidly spreads out to form a thin oil slick on the sea surface. The more volatile components then evaporate at a rate proportional to their individual volatilities (associated to boiling points) and the prevailing temperature. The loss of these oil components decreases the volume of oil that remains at sea. Crude oils with a higher proportion of volatile components will decrease in volume more than crude oils that contain less volatile components. Evaporation slows and eventually stops as the volatile components are progressively lost. The oil that remains at sea will have a higher viscosity than the original oil because the volatile components that are lost by evaporation are of low viscosity.

- **Incorporation of water into the oil to form w/o (water-in-oil) emulsions**
  Most crude oils will form w/o emulsions when spilled at sea. W/o emulsification is caused by the prevailing wave action; spilled oils will emulsify faster in rougher seas than in calm conditions as water droplets become incorporated into the oil by the action of breaking waves. W/o emulsions are inherently unstable and will rapidly revert to oil and water unless they are stabilised by asphaltenes precipitated from the crude oil. The precipitated asphaltenes form an elastic skin around the water droplets in the oil and prevent them from coalescing and separating from the oil. Crude oils with a high asphaltene content form more stable emulsions than crude oils with low asphaltene content. The formation of w/o emulsions greatly increases the volume of the emulsified oil on the sea surface. Emulsified oils typically contain a maximum of 60% to 75% volume of water and this causes a 3- to 4-fold increase in volume, compared to that of the volume of oil from which the emulsion is formed. Emulsification ceases when the maximum water content has been achieved.

- **Natural dispersion**
  Natural dispersion is another process driven by breaking waves. As a breaking wave crest passes through the oil slick, the oil is broken into oil droplets of various sizes and pushed into the water column. The larger oil droplets rapidly float back to the surface, but the very smallest oil droplets are retained in the water column by the prevailing turbulence. The rate of natural dispersion is driven by the prevailing sea state and limited by the viscosity of the emulsified oil; rough seas cause a high rate of natural dispersion, but high emulsified oil viscosity resists this process.

The relative rates of evaporation, w/o emulsification and natural dispersion depend on the prevailing conditions (temperature, wind speed and sea state) and the properties of the spilled oil (as described by the boiling point curve, density, viscosity and asphaltene content).

13.7.2.3 Previous Weathering Studies on Chirag and DWG Crude Oils

Weathering studies, where laboratory procedures are used to simulate the different aspects of the weathering processes, have been performed on samples of:

- Chirag crude oil[11] for the EOP (Early Oil Project).
- DWG (Deep Water Gunashli) crude oil[12] for ACG Phase 3.

The methodology adopted in these studies was to prepare the oil residues from distillation to 175ºC and 250ºC. These simulate the oil residues that would result from evaporative loss after approximately 4 hours and 1 - 5 days at sea. Emulsions are then produced from each of these residues by mixing them with seawater in a standardised test method.

The weathered (evaporated and emulsified) residues produced from Chirag crude oil have higher viscosities, particularly at low temperature, than the emulsified residues produced from DWG crude oil. This is most probably a reflection of the Pour Points of the crude oils. From results obtained with other crude oils, the Pour Points of the 175ºC and 250ºC residues can reasonably be expected to be approximately 15ºC to 25ºC higher, respectively, than the Pour Point of the 'parent' crude oil. The estimated Pour Points of the 175ºC and 250ºC residues are shown in Table 13.2.

Table 13.2 Estimated Pour Points of Crude Oil Residues

	DWG crude oil	Chirag crude oil	COP crude oil
Fresh crude oil	-27ºC	-6ºC	-18ºC
175ºC residue	-12º	+11º	-3ºC
250ºC residue	0ºC	+19ºC	+3ºC

The important factor is the difference between the Pour Point of the oil residue and the prevailing sea temperature. The prevailing winter sea temperature at the location of the WC-PDQ platform is +6ºC. The Pour Points of the Chirag crude oil residues are above this temperature while the Pour Points of the DWG and COP oil residues are below this temperature. On this basis, the 50/50 blend of DWG and Chirag that represents COP oil would have weathering behaviour that is closer to that of the DWG crude oil than of the simple mean of that of DWG and Chirag crude oils.

13.7.2.4 Persistence of Spilled Crude Oils on the Sea Surface

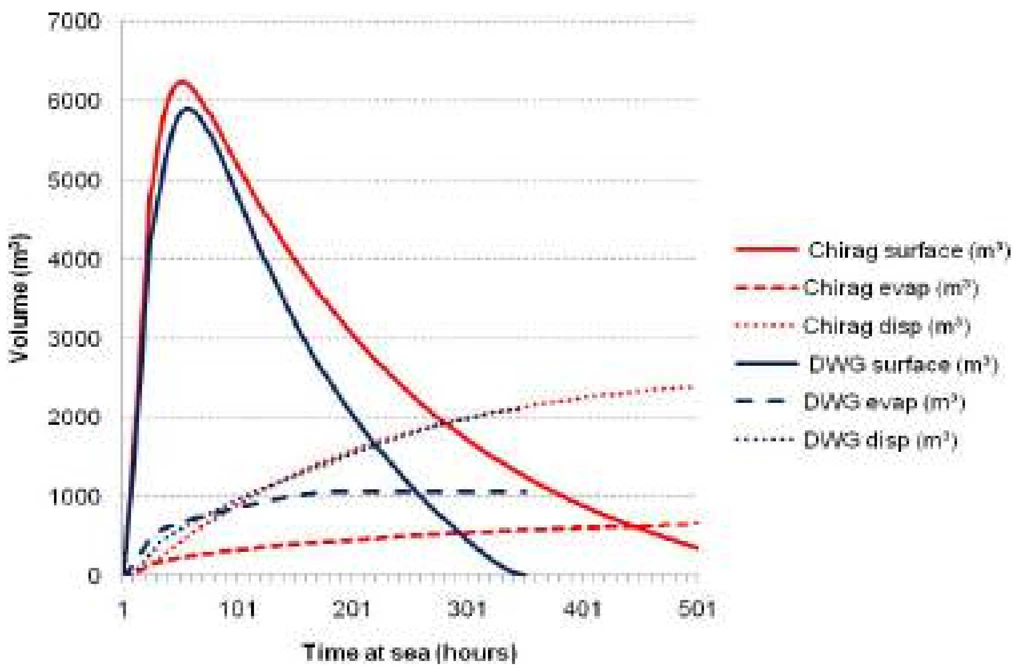
Figures 13.10 and 13.11 illustrate the changes in the amount of spilled Chirag and DWG crude oils on the sea surface, evaporated and dispersed with time. The oil release modelled was of 20,000 bpd (132.5m^3/hr for 24 hours) to produce a total oil release of 3,180m^3.

Figure 13.10 illustrates the changes in volumes at 5m/s wind speed, approximately 10 knots, and at a sea temperature of 6ºC. The volume of emulsified oil remaining on the sea surface for both the Chirag crude oil (solid red line) and DWG crude (solid blue line) follows a similar form:

- There is an initial increase in volume over the first 24 hours as the oil is spilled at 132.5m^3/hr;
- The oil volume increases beyond the total spilled oil volume of 3,180m^3 to a maximum of just over 6,000m^3 for Chirag and just below 6,000m^3 for DWG at approximately 70 hours as the oil incorporates water to form a larger volume of w/o emulsion; and
- The volume of emulsified oil on the sea surface then decreases as more evaporates (broken lines) and naturally disperses (dotted lines).

[11] AEA Technology Report AEAT 2299 Issue 1, October 1997
[12] AEA Technology Report AEA/ENV/R/2667/ Issue 1, August 2008

Figure 13.10 Volumes of Spilled Chirag and DWG Crude Oils in 5m/s Wind at 6ºC



It can be seen that the DWG crude oil loses more volume (about 1,000m^3 after 150 hours) by evaporation than Chirag crude oil (about 700m^3 after 500 hours). The rates and extent of natural dispersion are similar for both oils. All of the DWG crude oil has gone from the sea surface after 350 hours, but approximately 500m^3 of the emulsified Chirag oil remains after 500 hours at sea. The spilled Chirag oil is more persistent on the sea surface than the DWG oil.

Figure 13.11 Volumes of Spilled Chirag and DWG Crude Oils in 10m/s Wind at 6ºC

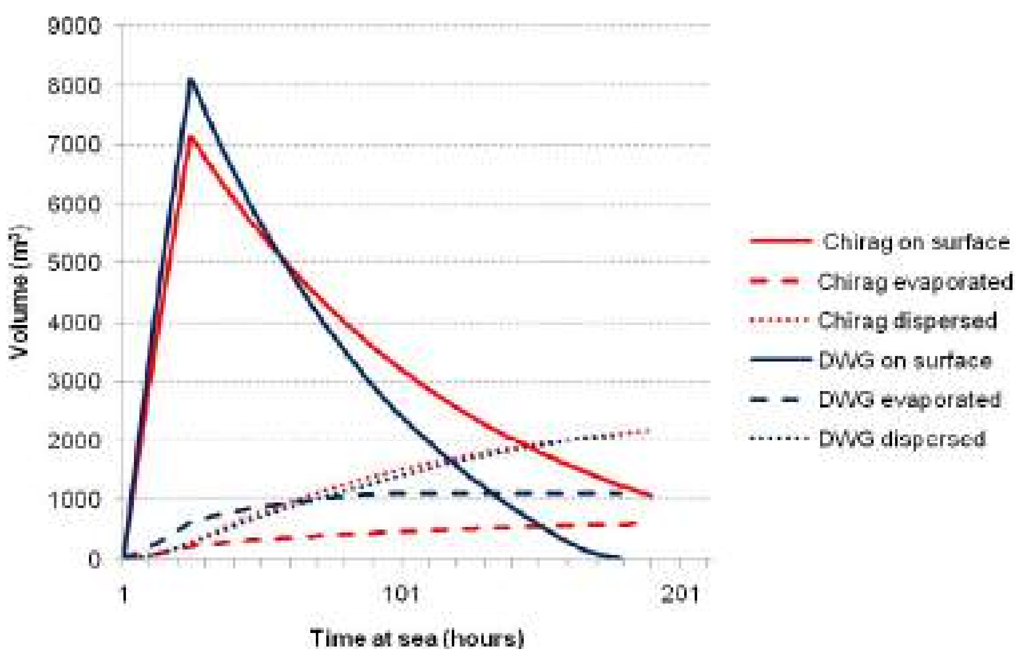


Figure 13.11 illustrates the same processes at the same temperature and a higher wind speed of 10m/s (approximately 20 knots). There is a similar rapid increase in emulsified oil volume on the sea surface, up to 8,000m^3 for the DWG oil and 7,000m^3 for the Chirag crude oil, followed by a more gradual decrease. All of the DWG oil has gone from the sea surface after 180 hours, but about 1,000m^3 of emulsified Chirag oil remains on the sea surface after 200 hours. The rate of emulsification is greater at the higher wind speed and a greater volume of emulsion is generated. However, the rate of natural dispersion is also greater at the higher wind speed, so the rate of removal of emulsified oil from the sea surface is also faster. In both cases the spilled Chirag crude oil is more persistent than the DWG crude oil.

From the previous analysis of crude oil properties and weathering behaviour, crude oil from COP will behave in an intermediate manner, but will behave more like DWG crude oil than a simple average of both oils.

Figures 13.12and 13.13 shows the volumes of emulsified oil on the sea surface with time for Chirag crude oil (solid red line), DWG crude oil (solid blue line) and COP oil (solid green line) for a wind speed of 5m/s (Figure 13.12) and with a wind speed of 10m/s (Figure 13.13). The values for COP oil have been estimated with a 25% contribution from the Chirag oil values and a 75% contribution from the DWG oil values. This takes account of the differences in Pour Point, and therefore viscosity exhibited at low shear at 6ºC, that would result from blending Chirag and DWG crude oils as a 50/50 blend.

Figure 13.12 Volumes of Chirag, DWG and COP crude oils in 5m/s Wind at 6ºC

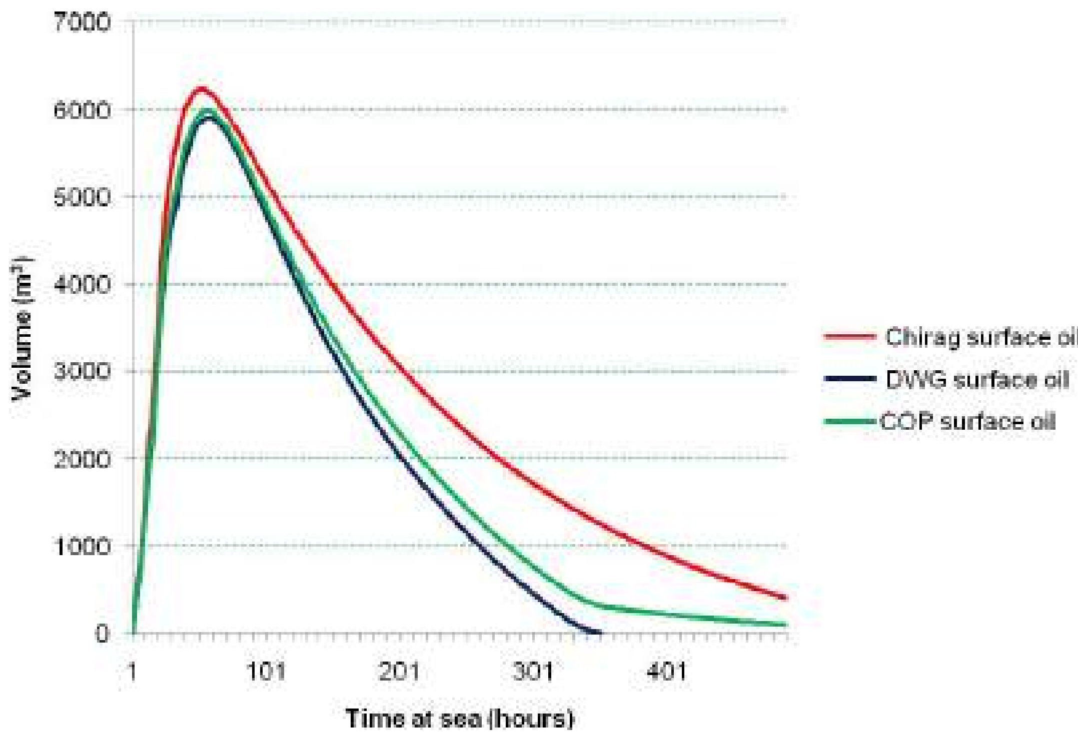
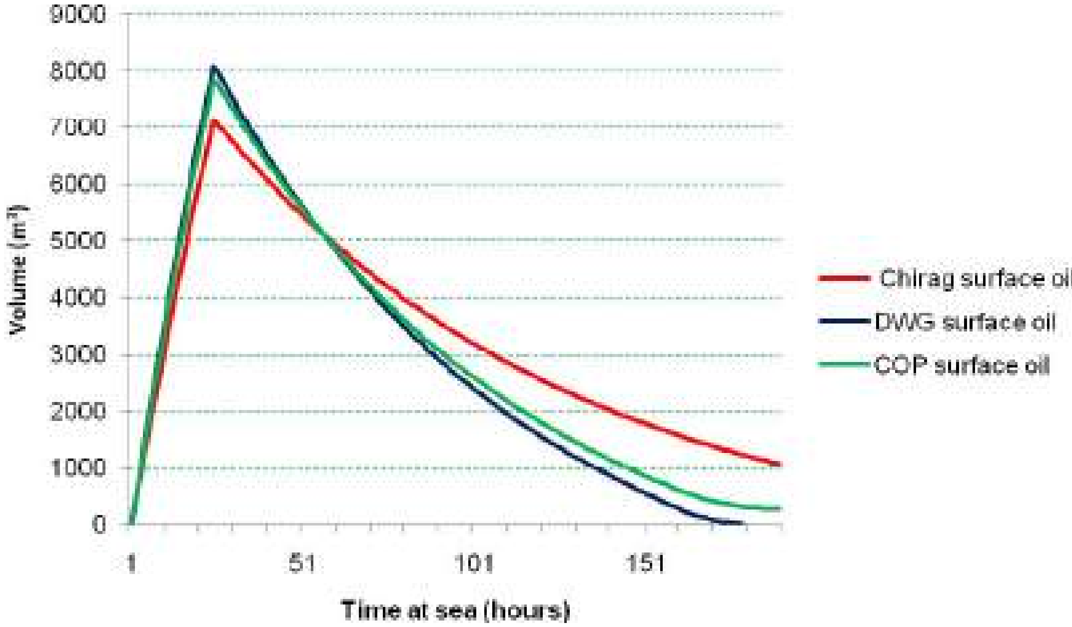


Figure 13.13 Volumes of Chirag, DWG and COP Crude Oils in 10m/s Wind at 6ºC



In both cases, the consequence is that COP oil behaves in an intermediate way to the DWG and Chirag crude oils, but more closely resembles DWG crude oil than Chirag crude oil. The simulated blend results in a 'tail' of emulsified COP oil that is more persistent than that from the DWG crude oil, but is of lower volume than that from the Chirag crude oil.

13.7.2.5 Spill Modelling

Table 13.3 summarises the oil spill scenarios for which modelling studies have been carried out for previous ACG Phases. These oil spill scenarios were devised to represent a wide range of events that could lead to an oil spill from relatively minor releases of $100m^3$ of diesel fuel up to the most major events such as an uncontrolled well blow-out for a prolonged period, or a total rupture of the 30" sub-sea pipeline near the Sangachal Terminal.

Samples of DWG Crude were not available when modelling was undertaken, and the modelling used available data for Azeri crude. Subsequently, it has become apparent that DWG crude is less persistent than Azeri crude, and as COP Crude is expected to behave in a similar way to DWG crude the modelling results have been adapted to reflect this.

Table 13.3 Summary of Oil Spill Scenarios Modelled for Previous ACG Projects

Oil Spill Scenario	ACG Phase 3	ACG Phase 2		ACG Phase 1
Report	BMT 2004	BMT 2003	BMT 2002	BMES 2001
Oil used	Azeri	Azeri	Chirag	Iranian Light
Blow-out				
Outflow rate (bpd)	30,000	30,000	30,000	30,000
Duration (days)	42	42	42	42
Oil spilled (m^3)	200,324	200,324	200,324	200,324
Pipeline rupture				
Loss rate (m^3/hr)	6,000	308	692	3,451
Duration (hours)	2	26	26	26
Oil spilled (m^3)	12,000	8,008	17,992	89,197
Diesel spill				
Duration	Instantaneous	Not modelled	Not modelled	Instantaneous
Oil spilled (m^3)	100			100
Small leak in export line				
Loss rate (m^3/hr)	1	Not modelled	1	1
Duration (hours)	720		720	720
Oil spilled (m^3)	720		720	720
Small process leak				
Loss rate (m^3/hr)	140	Not modelled	Not modelled	140
Duration (hours)	1			1
Oil spilled (m^3)	140			140

Blowouts

Blowouts are statistically very rare events and the probability of such extreme situations is very low. Some experts estimate 1 incident for 10,000 wells. Blowouts have been too infrequent on the UKCS for a meaningful analysis of frequency based on historic data. Probabilities of blowout occurrence have been calculated for major projects using the SINTEF and Scandpower databases that estimate blowout frequency at various stages in the development and take into account some reservoir characteristics. Probabilities are presented in Table 13.4. The development drilling category is considered to be most relevant to COP.

Table 13.4 Estimated Blowout Frequencies for a Range of Drilling Activities

Activity	Frequency for Oil Well	
Exploration drilling	2.8×10^{-4}	per well
Wildcat drilling	2.5×10^{-4}	per well
Appraisal drilling	3.2×10^{-4}	per well
Development drilling	7.1×10^{-5}	per well
Completion	6.6×10^{-5}	per operation
Wireline	5.1×10^{-6}	per operation
Coiled tubing	1.1×10^{-4}	per operation
Snubbing	2.6×10^{-4}	per operation
Workover	1.9×10^{-4}	per operation
Producing wells	2.3×10^{-6}	per well-year
Producing wells external causes	3.9×10^{-5}	per well-year

Modelling of a blowout at COP scenario was undertaken (refer to Appendix 13B) using the weathering information and OSIS constants available for both Chirag and DWG crude oils. The likely behaviour of COP oil was interpolated between the two sets of results with a 25% from the results obtained with Chirag crude oil and a 75% contribution from the results obtained with DWG crude oil. The inputs for the COP blowout scenario are contained in Table 13.5.

Table 13.5 Inputs for COP Blowout Scenario

Location	WC-PDQ Easting: 519,004m Northing: 4,443,785m
Sea temperature	6ºC
Oil release rate	20,000 bpd (132.5m^3/hr for 24 hours, a total of 3,180m^3)
Oils	Chirag crude oil DWG crude oil
Wind speeds	5m/s (approximately 10 knots) 10m/s (approximately 20 knots)
Wind directions	110º (towards nearest coast of Azerbaijan) 45º (towards nearest coast of Iran) 270º (towards nearest coast of Turkmenistan)

Blowout (Wind from ESE Towards Nearest Coast of Azerbaijan)

Previous oil spill studies for ACG have used a wind direction of 110º which will cause the oil to drift towards the Absheron Peninsula. The influence of currents in the Caspian Sea is slight, the current speeds being generally low, but there is a counter-clockwise current that will cause the spilled oil to drift slightly to the south of the wind-driven drift direction.

The drift of spilled COP from a blowout is very sensitive to precise wind direction:

- A 5m/s wind from 110º causes all the spilled oil to impact on the Oil Rocks (Figure 13.14) approximately 25km from the WC-PDQ, 75 hours after it was spilled. The modelling indicates that all the spilled oil would be retained on the structures on the Oil Rocks. This is unlikely; in reality a high proportion of the spilled oil would continue to drift past the Oil Rocks towards the tip of the Absheron Peninsula.

- The same speed wind from 105º causes the oil to drift south of the Oil Rocks (Figure 13.15), past the southern tip of the Shadili Spit and into the bay, impacting the coast of Azerbaijan south of Sangachal, near Gobustan, approximately 130 km from the site of the blowout.

- A 5m/s wind from 115º causes the oil to drift north of the Oil Rocks (Figure 13.16), impacting the coast of Azerbaijan on the Absheron Peninsula, approximately 70 km from the site of the blowout.

As illustrated in Figure 13.12 the amount of spilled and emulsified COP crude oil on the sea surface in a 5m/s wind initially increases and then decreases with time. The amount of spilled oil that comes ashore depends on the drift time of the oil before it beaches and this depends on the distance to shore and the prevailing wind speed.

Figure 13.14 Drift of Spilled COP Oil from Blowout in 5m/s Wind from 110º

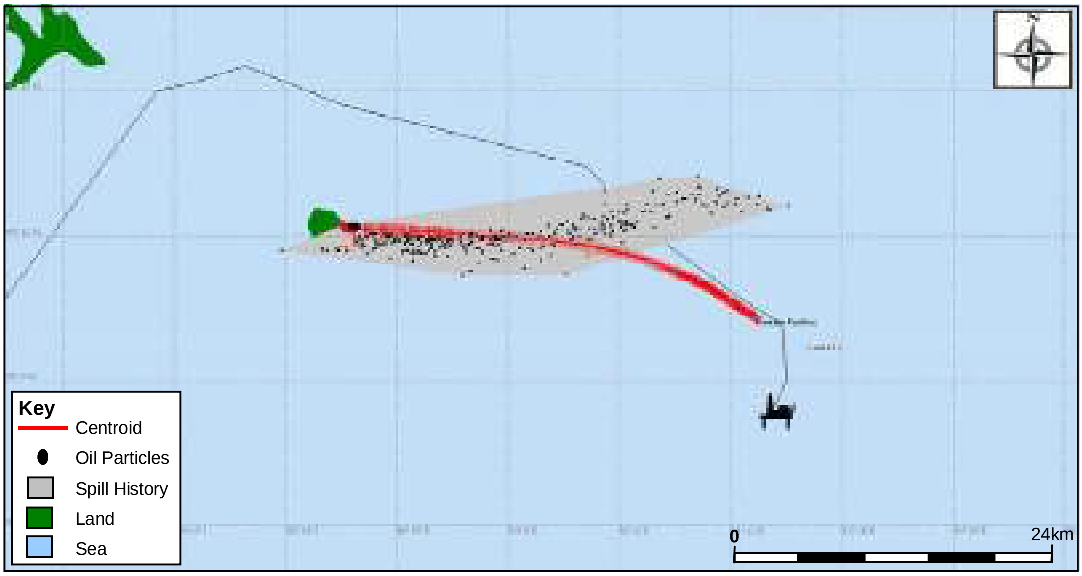


Figure 13.15 Drift of Spilled COP Oil from Blowout in 5m/s Wind from 105º

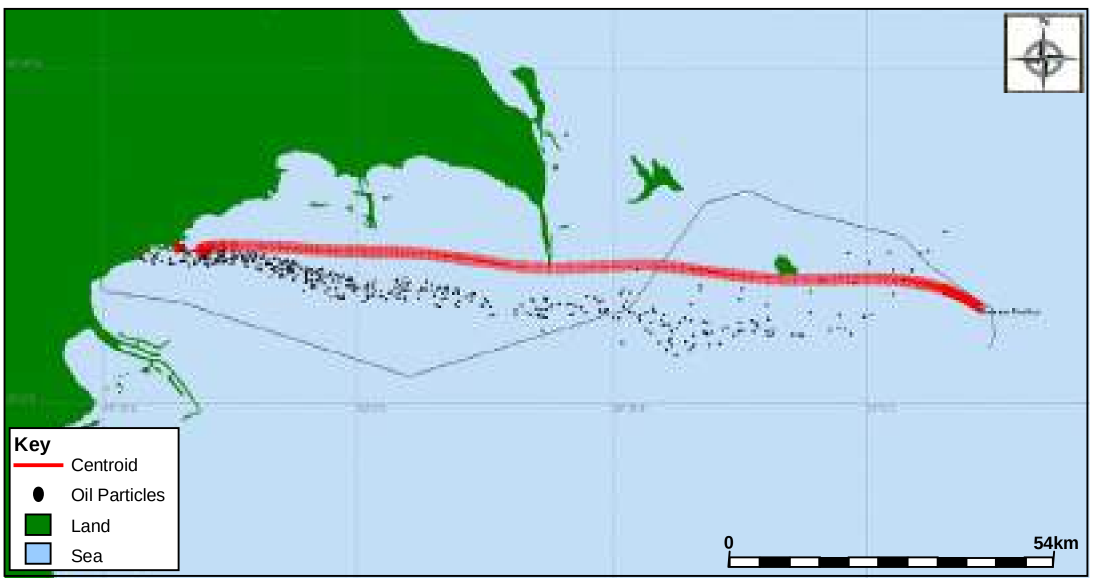


Figure 13.16 Drift of Spilled COP Oil from Blowout in 5m/s Wind from 115º

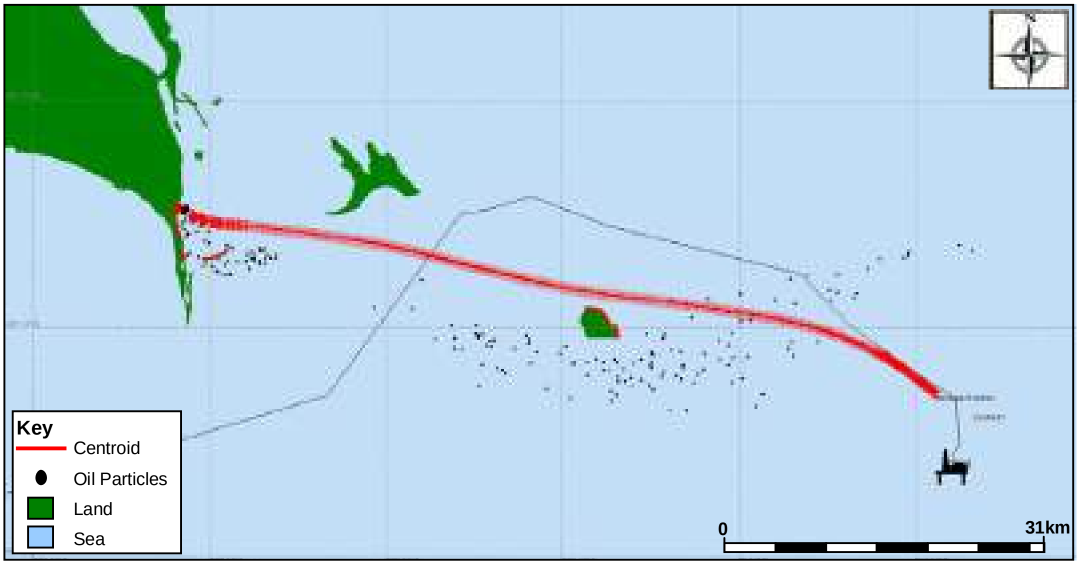


Table 13.6 summarises the amount of spilled oil that will come ashore at the different locations for each day of the blowout of 3,180m^3 of oil, and the total amount that would come ashore at these locations for the time before well control is regained and the blowout ceases. It should be noted that these are alternatives; the spilled oil will come ashore at the different locations under the influence of the wind direction (105º, 110º or 115º) of the prevailing wind from the ESE at 5m/s.

Table 13.6 Blowout: Locations and Amounts of Oil Coming Ashore in Azerbaijan

Duration of blowout	Spilled COP oil on coast of Azerbaijan (m^3)		
	5m/s wind at 110º COP oil impacts Oil Rocks after drift time of 75 hours	5m/s wind at 105º COP oil impacts in Sangachal Bay after drift time of 300 hours	5m/s wind at 115º COP oil impacts Absheron Peninsula after drift time of 140 hours
1 day	5,118	1,900	3,414
10 days	51,180	19,000	34,140
20 days	102,360	38,000	68,280
40 days	204,720	76,000	136,560
60 days	307,080	114,000	204,840

COP oil released from a blowout in a 10m/s wind from 110º would follow an almost identical drift to that shown in Figure 13.14 because the higher wind speed would counteract the slight southerly drift caused by the current. Because of the more rapid drift the oil spill (10m/s 100 ^{o} scenario) would impact the coast of the Absheron Peninsula 70 hours after being spilled (refer to Figure 9 of Appendix 13B). Despite the higher rate of natural dispersion caused by the rougher sea at the higher wind speed, more oil would persist on the sea surface to come ashore and the amounts of oil would be approximately 20% higher than shown in Table 13.6 for 5m/s at 115º case.

Blowout (Wind from NE Towards the Nearest Coast of Iran)

A wind direction from 45º will cause the spilled oil to drift towards the nearest coast of Iran which is approximately 280 km from the WC-PDQ location.

Modelling of the behaviour of Chirag and DWG crude oils indicates that spilled Chirag crude oil would persist long enough for relatively minor amounts of oil to come ashore, but all of the DWG crude oil would evaporate and be naturally dispersed before it could impact the coast of Iran. The persistence of COP oil is intermediate to that of Chirag and DWG crude oils, but closer to that of DWG crude oil at both 5m/s (Figure 13.12) and 10 m/s (Figure 13.13) wind speeds. Spilled COP oil from the blowout would drift towards the nearest coast of Iran as illustrated in Figure 13.17.

Figure 13.17 Drift of Spilled COP Oil from Blowout in Wind from 45º

A very large proportion of the COP oil that was spilled and subsequently emulsifies would be naturally dispersed during the long drift towards the nearest coast of Iran. Relatively small quantities would persist long enough to come ashore. Table 13.7 summarises the amounts of emulsified COP oil that would come ashore on the nearest coast of Iran following a blowout of different durations.

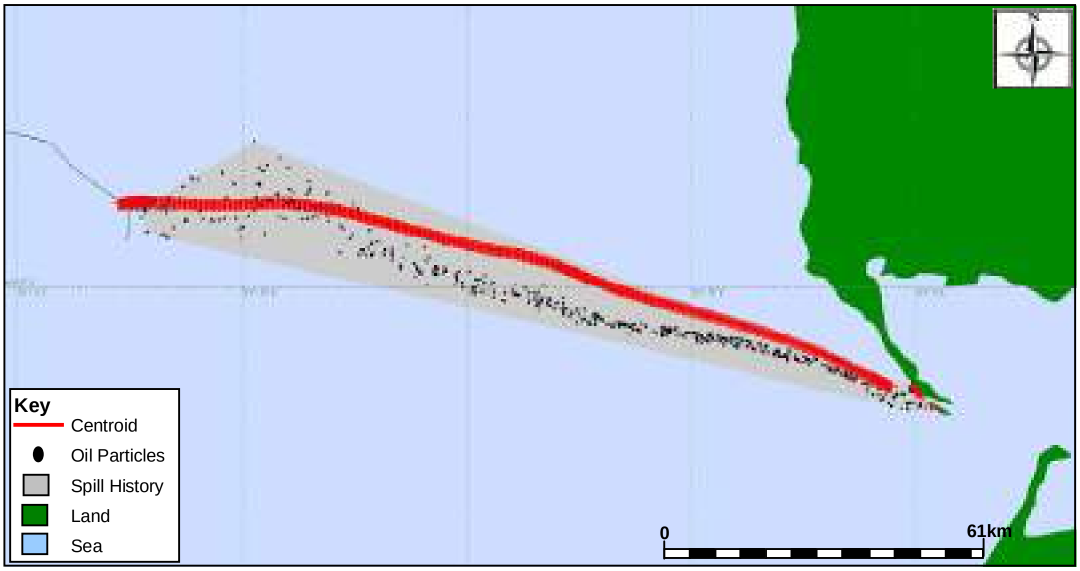
Table 13.7 Blowout: Locations and Amounts of Oil Coming Ashore in Iran

Duration of blowout	Spilled COP oil on nearest coast of Iran (m^3)	
	Wind speed 5m/s Drift time 523 hours	Wind speed 10m/s Drift time 211 hours
1 day	40	175
10 days	400	1,750
20 days	800	3,500
40 days	1,600	7,000
60 days	2,400	10,500

Blowout (Wind from W Towards Nearest Coast of Turkmenistan)

A wind direction from 270º will cause the spilled oil to drift towards the nearest coast of Turkmenistan which is approximately 140 km from the WC-PDQ, as illustrated in Figure 13.18 for a 5m/s wind.

Figure 13.18 Drift of Spilled COP Oil from Blowout in 5m/s Wind from 270º



The spilled COP oil drifts to the east on the wind and is deflected slightly to the south by the water current and comes ashore on the Turkmenistan coast on the Kizyl spit.

With a 10m/s wind from the same direction, the oil again drifts to the east on the wind, but is less deflected to the south by the water current because the effect of the dominant wind. The spilled oil comes ashore on the Turkmenistan coast, more to the north, between the towns of Tarta and Avazy.

Table 13.8 summarises the amounts of emulsified COP oil that would come ashore on the nearest coast of Turkmenistan following a blowout of different durations.

Table 13.8 Blowout: Locations and Amounts of Oil Coming Ashore in Turkmenistan

Duration of blowout	Spilled COP oil on nearest coast of Turkmenistan (m^3)	
	Wind speed 5m/s Drift time 300 hours	Wind speed 10m/s Drift time 115 hours
1 day	700	2,200
10 days	7,000	22,000
20 days	14,000	44,000
40 days	28,000	88,000
60 days	42,000	132,000

Summary of Results of COP Blowout Scenario Modelling

A blowout at COP would result in a major oil spill; one of the largest that has ever occurred. The release of 20,000 bpd (3,180m^3) of COP crude oil each day for a prolonged period would result in massive quantities of oil on the sea surface.

The spilled oil would double in volume to 6,000m^3 for each day of the blowout after 3 days at sea due to the formation of water-in-oil emulsions. This volume increase would occur despite the loss of nearly one-third of the original oil volume by evaporation of the more volatile components. The spilled oil volume on the sea would then decrease with time as the oil drifted due to natural dispersion. The rate of natural dispersion depends on the prevailing wind speed and is higher at higher wind speeds.

The amount of spilled oil that comes ashore at any location will depend on the drift time from the site of the blowout. The drift time is a function of the distance to the shore and the prevailing wind speed. Most oil would come ashore closest to the blowout site.

Pipeline Rupture

There is no pipeline break oil spill scenario that applies specifically to only COP. The crude oils produced from all Phases of the ACG development are transported from the fields by the two existing 30" Phase 1 and 30" Phase 2 pipelines to the Sangachal Terminal and production from COP will be transported through these pipelines.

The risks to the Phase 1 and Phase 2 30" pipelines that could result in the release of oil have been comprehensively considered in the Quantitative Risk Assessment (QRA of 30" Phase 1 Oil Transport Pipeline. The probability of pipeline rupture in the open sea was calculated as 1.9×10^{-6} per year, well within the acceptance criteria of 1×10^{-4}. The probability of pipeline rupture in the vicinity of the shipping channel near to shore was calculated to be 4.3×10^{-6} per year.

The possibility of a catastrophic rupture of either of the pipelines was considered in detail in ACG Phases 1 to 3. The oil spill modelling was conducted with spill locations close to the shore because the greatest risk, although very slight, of catastrophic damage being caused to the pipeline was considered to be from an impact by a deep-draught vessel. In ACG Phase 3 modelling the pipeline break oil spill scenarios from a location (40° 10' 8.86"N 49°30' 7.51"E) approximately 4km south-east of the pipeline landfall where the Phase 1 and Phase 2 pipelines pass the 8m water depth contour. This location is used in the consideration of the consequences for the addition of COP crude oil to these pipelines.

The inputs for the pipeline rupture oil spill scenario are contained in Table 13.9. Two temperatures, 27ºC and 6ºC have been used to represent summer and winter conditions. Two wind directions are used, namely, easterly, which would cause spilled oil to drift towards the Azerbaijan coast in Sangachal Bay (5km from the modelled pipeline rupture location) and westerly, which would cause spilled oil to drift towards the Turkmenistan coast (290km from the pipeline rupture location). Two wind speeds, 5m/s (10 knots) and 10m/s (20 knots) are used.

Table 13.9 Pipeline Rupture Scenario Inputs

Location:	4 km south-east of the pipeline landfall			
Oil Spilled:	Azeri (CA/EA) and COP			
Oil Volume Released:	7,500 m^3/hr			
Duration:	2 hours			
Total Volume of Oil Released:	15,000m^3			
Season:	Summer		Winter	
Sea Temperature:	27ºC		6ºC	
Wind Speeds:	10 knots (5m/s)	20 knots (10m/s)	10 knots (5m/s)	20 knots (10m/s)
Wind Direction:	E (90º)	W (270º)	E (90º)	W (270º)

The generic OSIS modelling in the oil weathering studies for Azeri and DWG Crude oils were then consulted to determine the amount of these crude oils that would be present on the sea surface at the relevant times under the defined prevailing conditions of temperature and wind speed (Table 13.10). In view of the uncertainty about the precise blend of crude oils and their individual physical properties, the mean of the volumes of spilled DWG and Azeri Crude oils remaining on the sea were taken as being indicative of the minimum volume of the crude oil from the pipeline that would come ashore, while the volume of Azeri Crude oil that would come ashore was taken as a maximum. The calculated amounts are shown in Table 13.11.

Table 13.10 Volumes of Oil Remaining on the Sea Surface after a 1,000m^3 Oil Spill

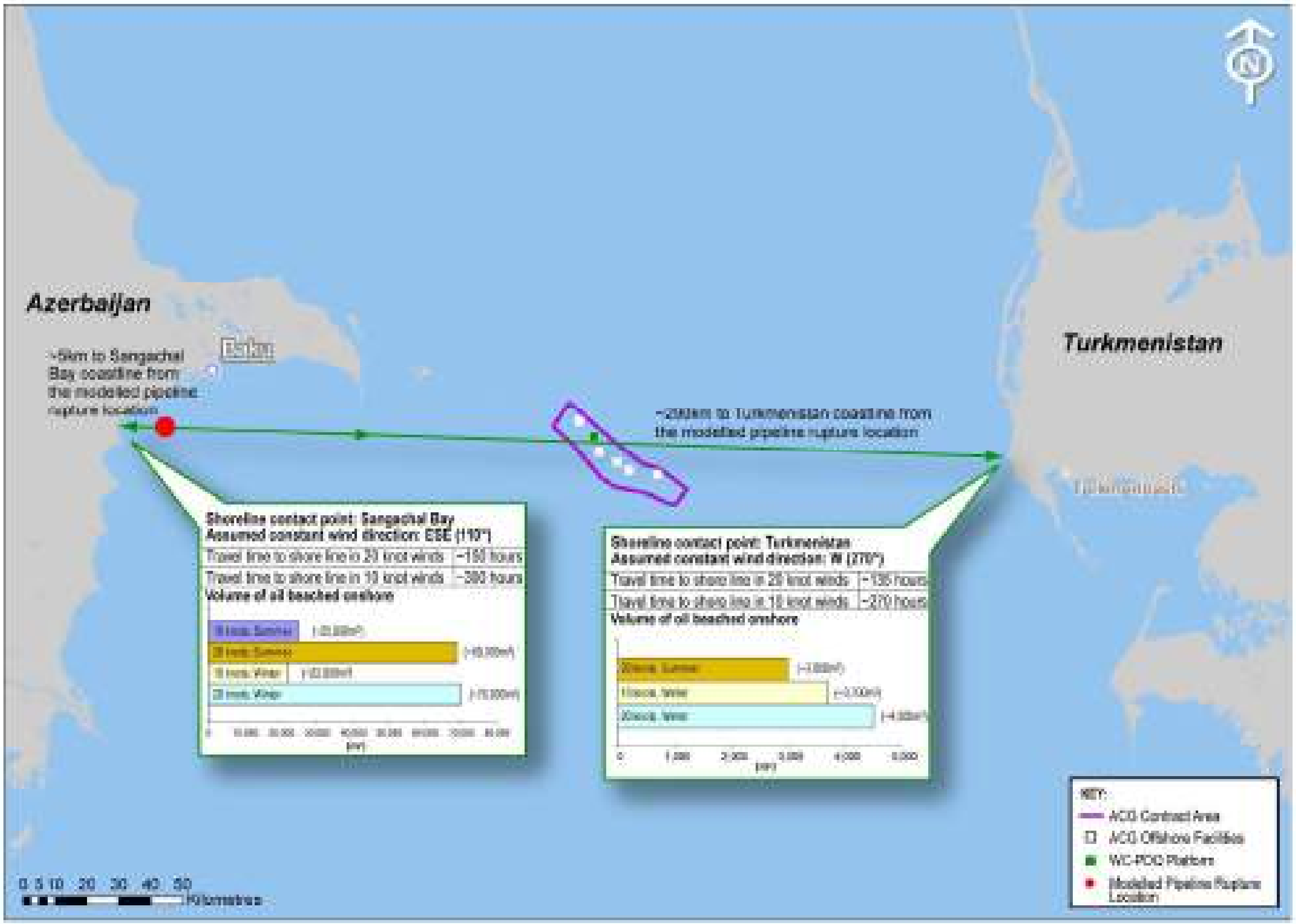
Volume of Spilled Oil Remaining from a 1000m^3 Spill		After 5 hours @ 20 knots	After 10 hours @ 10 knots	After 290 hours @ 20 knots	After 580 hours @ 10 knots
Summer 27ºC	**10 knots**		1400m^3 DWG 1700m^3 Azeri		None
	20 knots	2900m^3 DWG 4600m^3 Azeri		0m^3 DWG 200m^3 Azeri	
Winter 6ºC	**10 knots**		1250m^3 DWG 1450m^3 Azeri		0m^3 DWG 250m^3 Azeri
	20 knots	3050m^3 DWG 4900m^3 DWG		0m^3 DWG 300m^3 Azeri	

Table 13.11 Pipeline Rupture: Locations and Amounts of Spilled Oil Coming Ashore

Wind Direction		East (90º)	West (270º)
Wind speed	**Season (sea temperature)**	**Impact on Coast of Sangachal Bay**	**Impact on Coast of Turkmenistan**
10 knots (5m/s)	**Summer (27ºC)**	23,000 - 25,000m^3	None
	Winter (6ºC)	20,000 - 22,000m^3	2,000 - 3,700m^3
20 knots (10 m/s)	**Summer (27ºC)**	56,000 - 69,000m^3	1,500 - 3,000m^3
	Winter (6ºC)	60,000 - 70,0000m^3	2,300m - 4,500m^3

Figure 13.19 illustrates the directions and distance of spilled oil drift and the volume of spilled oil coming onshore for pipeline rupture scenario.

Figure 13.19 Pipeline Rupture: Directions and Distance of Spilled Oil Drift and the Volume of Spilled Oil Coming Onshore (m^3)



Separator Failure and Diesel Spill

A release of 81m^3 of COP Crude oil from a platform separator failure was also modelled. The inputs for the COP separator failure scenario are contained in Table 13.12).

Table 13.12 Inputs for the COP Separator Failure Scenario

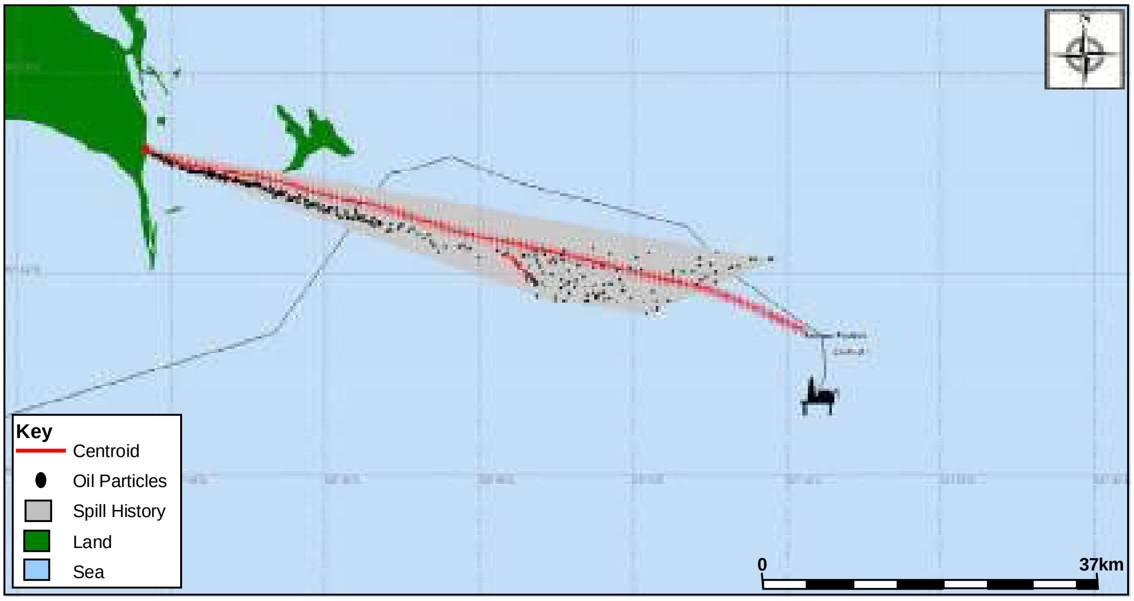
Location	WC-PDQ	Easting: 519,004m Northing: 4,443,785m
Sea temperature	6ºC	
Oil release	81m^3 instantaneous release	
Oils	Chirag crude oil DWG crude oil	
Wind speeds	5m/s (approximately 10 knots) 10m/s (approximately 20 knots)	
Wind directions	110º (towards nearest coast of Azerbaijan)	

The 81m^3 of COP oil spilled from the WC-PDQ Platform in a 5m/s wind from 110º would drift in an identical manner to the much larger quantity of oil released from the blowout scenario and illustrated in Figure 13.12. The spilled COP oil would drift, emulsify and 120m^3 of emulsified oil would come ashore on the structures on Oil Rocks.

It is possible that this relatively small volume of spilled oil would be retained on the surfaces of the structures on the Oil Rocks, although it is still likely that some spilled oil would drift past the Oil Rocks and eventually impact on the shore of the Absheron Peninsula. The volume of oil at sea would be decreased by the natural dispersion experienced during the longer drift time to shore of 140 hours. The amount of emulsified COP oil coming ashore would then be approximately 60m^3.

The drift trajectory of the spill of 81m^3 of COP oil spilled from the WC-PDQ Platform in a 10m/s wind from 110º is illustrated in Figure 13.20. As with the drift of the much larger quantity of oil from the blowout scenario, the higher wind speed counteracts the southerly drift caused by the currents and the oil drifts to the north of Oil Rocks and the oil comes ashore on the Absheron Peninsula.

Figure 13.20 Drift of Spilled COP Oil from Separator Failure in 10m/s Wind from 110º



The amounts of COP oil coming ashore after separator failure on the WC-PDQ Platform at the different locations is shown in Table 13.13.

Table 13.13 Separator Failure: Locations and Amounts of Spilled Oil Coming Ashore

Separator failure	Spilled COP oil on coast of Azerbaijan (m^3)	
	Wind speed 5m/s Oil Rocks (Drift time 53 hours)	Wind speed 10m/s Absheron Peninsula (Drift time 49 hours)
	120	86

In contrast, modelling of a spill of 180m^3 of diesel from the platform concluded that no spilled diesel would reach the shoreline at either wind speed; all the diesel fuel would evaporate and naturally disperse in 8 hours in winter and more rapidly in summer.

13.7.3 Impact of Oil Spills

Comprehensive information on the generic potential of an oil spill on the offshore environment of the Caspian Sea has been provided in the ACG Phase 1 Chapter 10[13] and Phase 2 Chapter 8[14] ESIA, and is not reproduced here. The section below summarises the impacts of a potential oil spill from the COP.

The principle areas of concern with respect to oil spills are:

- Impacts on plankton, fish and seals in open water; and
- Impacts on coastal habitats (including bird populations) should oil reach a shoreline.

The potential ecological threats in open water may include physical damage (e.g. through oiling of skin or gills of fish) and toxic effects (e.g. due to uptake of volatile toxic components of the crude). Toxic effects would be greatest on plankton, which have limited ability to either avoid the oil or to control uptake. Toxic effects would however, also be quickly mitigated by the rapid evaporation of the most acutely toxic components such as low molecular weight aromatic compounds.

As the toxic volatile components of an oil spill rapidly evaporate on entering the marine environment, the most likely impact of any oil spill will be one of physical smothering and coating by oil. Oil dispersed in the water column however, would have a detrimental impact on seagrass and its associated communities through toxic effects.

Impacts on the nearshore feeding area for fish and birds may be increased through adverse impacts on the benthos. Benthic organisms may be impacted as a result of oil sinking onto the seabed due to the direct toxicity of the oil. Shoreline benthos may also be physically smothered by the oil in the case of shoreline stranding. Impacts are likely to be greatest in the immediate area of the spill and these effects will be greater for oil such as Azeri Crude, which is persistent due to its high viscosity.

Evaluation of the potential risk to seals and fish in previous ACG Phase ESIA concluded that these organisms would be able to avoid oil slicks in open water and thus minimise risk of exposure. The most vulnerable period for seals is during the pupping season. This event occurs however, on winter ice sheets in the North Caspian, which is not at high risk of impact from an oil release in the ACG Contract Area. Previous ACG Phase ESIA noted that, although no long-term impact on fish populations was anticipated, there may be some localised “tainting” of fish that, while not an ecological issue, could temporarily affect the economics of the local fishing industry.

The South Caspian contains a number of potentially sensitive coastal habitats and in general the coastal environment is considered more vulnerable than open water to oil spill impact. As oil approaches the shore:

- There is an increased risk to the benthic environment as wave and wind action can more easily cause contact between oil and sediment in shallow water;
- The opportunities for intervention are more limited; for example, the use of dispersants would offer less benefit and have the potential to exacerbate the effects; and
- The beaching of oil and its incorporation into coastal sediments and soils can result in longer-term persistence and damage to sensitive habitats.

The most sensitive shoreline areas identified are the coastal wetlands, the most extensive of which are to be found in the Kyzyl-Agach[15] region towards the south of Sangachal Bay. These areas are highly productive ecosystems, hosting large concentrations of birds and the shallow waters also act as feeding grounds for many fish species.

[13] Refer to ESIA Phase 1 Chapter 10 Section 10.6.1
[14] Refer to ESIA Phase 2 Chapter 8 Section 8.4.2
[15] Refer to Chapter 6 Section 6.4.6.1

In addition, the shallow waters and seagrass habitat identified along the Shahdili spit[12], now declared the Absheron National Park, make this area a biologically productive region. It is also of importance for fish and bird species, including resident, migrating, nesting and breeding species at various times of the year.

In addition to potential impacts on flora and fauna in Sangachal Bay and on the Absheron Peninsula, there is the potential for oil to reach the coastline of neighbouring countries resulting in a transboundary impact. The coastlines of Iran and Turkmenistan are of known importance for their coastal wetlands and include a number of designated sites of national and international importance, particularly for their bird populations. Most birds inhabiting this region are waterfowl or shore birds, with sensitive times of the year including spring, summer and autumn (encompassing migration, nesting, fledging and moulting periods) which can be classified as a time of high sensitivity for birds in this area.

According to the oil spill modelling results it is expected that some oil will reach the coastline of Turkmenistan. There is one site of international importance along Turkmensitan's coastline (Krasnovodsk & North-Cheleken Bays), located behind, and therefore protected by, the Kizyl-Su peninsula. The modelling has demonstrated that no significant amounts of oil are expected to reach the Iranian coastline in the winter. However, typically, amounts of highly weathered crude oil in the form of tar balls and scattered small patches can be found along an affected coastline over a period of weeks and months after a spill. The precise location would be dependant on fluctuations in wind speed and direction.

Considering the scenarios assessed in the preceding sections, the following conclusions can be drawn with regard to the impact of oil spills on the marine environment:

- A blowout has the greatest potential for environmental impact;
- A nearshore pipeline rupture has the potential to impact the Azerbaijan coastal zone, and Sangachal Bay in particular; and
- Process system losses and diesel spillages will have little impact and will be either rapidly dispersed or easily recovered.

Because the trajectory, area and persistence of a large spill depend on weather conditions (temperature, wind direction and strength), it is not possible to predict impacts precisely or quantitatively. Consequently, mitigation through comprehensive spill response preparedness is of high importance (refer to Section 13.7.5).

13.7.4 Oil Spill Prevention and Response Planning

13.7.4.1 Spill Root Causes and Prevention

A review of spill incidents during the ACG Project construction phases and during the operation of the Chirag, CA, WA, EA and DWG platforms has been carried out to determine root causes and to identify appropriate improvement plans. Spills have been initially classified into two main categories:

- Equipment failure (hoses, valves, gaskets etc); and
- Human error.

Within construction yards, equipment failure (predominantly hydraulic hoses) is the most common cause of spills. Human error is primarily associated with:

- Errors in loading, lifting and transportation (e.g. by causing damage to tanks and valves);
- Errors in setting valves; and
- Errors in overfilling tanks and reservoirs

Offshore, error is an important factor in spills involving hoses, tanks and valves and failure is an important factor in spills involving flanges, hoses, pipework and welds.

Root cause analysis therefore indicates similar patterns onshore (during construction) and offshore (during operations). In both cases, spills of hydraulic fluid resulting from hose failure account for a greater proportion of spills than any other single source.

Specific prevention measures, applicable to the COP, include:

- Chemical selection procedures to minimise chemical use and restricting use to low toxicity chemicals, whenever possible;
- Bunding and segregated drainage for fuels and chemical storage areas;
- Refuelling procedures;
- Regular preventative maintenance to prevent leaks by repairing or replacing equipment such as hoses and tanks;;
- Staff training in hazardous materials management, refuelling and waste management procedures as applicable to their roles;
- Reporting of all minor spills to detect underlying trends, and task risk assessment; and
- Provision of appropriate spill response and containment equipment at specific locations based on risk assessment. This will allow rapid response should a spill occur.

These prevention and response initiatives will be integrated into the AzSPU HSSE Management System, as described in Chapter 14.

13.7.4.2 Pipeline Rupture Spill Prevention

The pipelines of the ACG field are managed in accordance with the Pipeline Integrity Management System (PIMS). PIMS has four distinct integrity areas:

- Operations and Safety Systems;
- Integrity Management - Internal;
- Integrity Management - External; and
- Management of Change.

Pipeline integrity protection systems involve passive protection, monitoring, corrosion protection, active protection, inspection, emergency response, management of change and assurance.

Passive protection of pipelines entails the following:

- Pipeline specifications which take into consideration local geohazards, seawater and seabed conditions, fluid properties, process conditions and external influencing factors, to ensure that the production fluids remain in the pipeline with minimal maintenance for the design life;
- Routing of pipelines to ensure minimal disturbance from seawater surface activities, vessels and sub sea geohazards;
- Near shore pipeline sections which are located in water less than 8m will be buried 1m under the sea floor to prevent disturbance of the pipeline;
- Crossing structures will be used to minimise the impact of any two pipelines;
- Pipelines will have an external concrete coating to ensure that they stay in position, to control buoyancy and to provide protection against physical damage; and
- Buckling mitigation will be provided through as–laid profile combined with seabed supports at critical points to relieve stresses. Pipeline movements shall be identified by periodic surveillance monitoring.

Active protection of pipelines includes:

- Valves and/or SSIVs checked at high risk sections close to the platforms to protect pipeline inventory; and
- Sub sea valves located in numerous areas along the pipeline network to isolate sections of the pipeline if required.

Corrosion Control is achieved through:

- Identifying, understanding and mitigating against, where practicable, the corrosion threats to the pipelines;
- Regular review and assessment of the process fluids;
- Definition of the corrosion monitoring plans;
- Review and analysis of the corrosion monitoring results;
- Review of potential and realised metallurgical failure modes;
- Installation of a cathodic protection system on the pipelines to prevent galvanic corrosion; and
- Injection of chemical corrosion inhibitors.

Monitoring of the pipelines entails the following:

- Continuous pressure and flow monitoring is conducted at numerous points around the pipeline network. Significant changes in normal operating pressure or flow levels result in the activation of control system alarms and isolation of affected sections;
- Production fluids are sampled offshore and at the pipeline terminal for chemical contaminants such as CO_2, H_2S and H_2O which increase corrosion, and sand and particulates that increase erosion. Where possible, these contaminants are removed up stream by chemical or physical separation systems;
- Routine pigging is carried out at various frequencies in the field to ensure no stagnant fluids remain in the pipe work which can cause corrosion; and
- Tracking systems will be developed to monitor trends in pipeline condition to ensure early identification of problem areas.

Inspection schemes are developed by the Independent Inspection Authority (IIA). The IIA also ensures that inspection and monitoring tasks are performed in a timely manner. Active Emergency plans are compiled, ensuring that teams and equipment are on standby ready to minimise the scale and impact of any leak.

The COP infield pipelines will be incorporated into PIMS to ensure integrity of the pipelines.

13.7.4.3 Response Planning

BP, as operator of AIOC, has developed and maintains a range of Oil Spill Response Plans (OSRP) in place for its offshore and onshore operations in Azerbaijan. These plans encompass all phases for ACG development and establish the notification, response and followup actions that must be implemented should an accidental event occur. The relevant plans will be further expanded to include the operational WC-PDQ platform.

As detailed in Chapter 14, the main fabrication and installation contractors working for BP will be required to develop OSRPs for their activities and these will fit within the frame work of the existing BP OSRP for operational facilities.

BP has adopted the internationally recognised tiered response concept to oil spill response:

- Tier 1 spills are defined as small operational spills that can be can be handled immediately by on-site personnel. In most cases, the response would be to clean up using on site resources.
- Tier 2 spills are defined as spills that require additional local (in-country) resources and manpower that are not available on the site that the spill occurs. The site response team would carry out cleanup, aided by the dedicated Tier 2 oil spill contractor.
- Tier 3 spills are very large, possibly ongoing spills, which will require additional resources from outside the country of spill origin. Such spills are very rare and would only occur through events such as a well blowout or full diameter pipe rupture. All available spill contractors (from within and outside Azerbaijan) would carry out the physical response,

with extensive support from the Incident Management Team and the Business Support Team.

As oil spill modelling scenarios presented in the previous subsections have identified the remote possibility of a transboundary spill from a Tier 3 event, there is the need for a framework to provide international action in response to such a rare event. The Caspian littoral states (i.e. Azerbaijan, Kazakhstan, IR Iran, Russian Federation and Turkmenistan) are developing regional cooperation arrangements to facilitate mutual support in the cases of major oil spill incidents. A Framework Convention, promoting cooperation within the littoral states was signed by Azerbaijan and a number of these Littoral States on the 4th November 2003, and entered into force on 12th August 2006. The Convention envisages a Protocol Concerning Preparedness and Response to Oil Pollution Incidents (OPI) which is expected to be signed in near future.

At the national level, BP is working very closely with the Azerbaijan government to help develop national systems. Once the national plan for the country of Azerbaijan is in place, the relevant BP plans will be updated to reflect any impacts this change may have. Despite the absence of a formal National Plan, BP has a process for notifying the Azerbaijan government in the event of an incident such as a spill.

BP's overall Oil Spill Response Plan sits within the structure of the BP Incident Management System, which determines the organisational and resource requirements for all incidents, assigns roles and responsibilities, and provides detailed response procedures.

The Oil Spill Response Plan is organised by type and location of asset, with specific documents and procedures for:

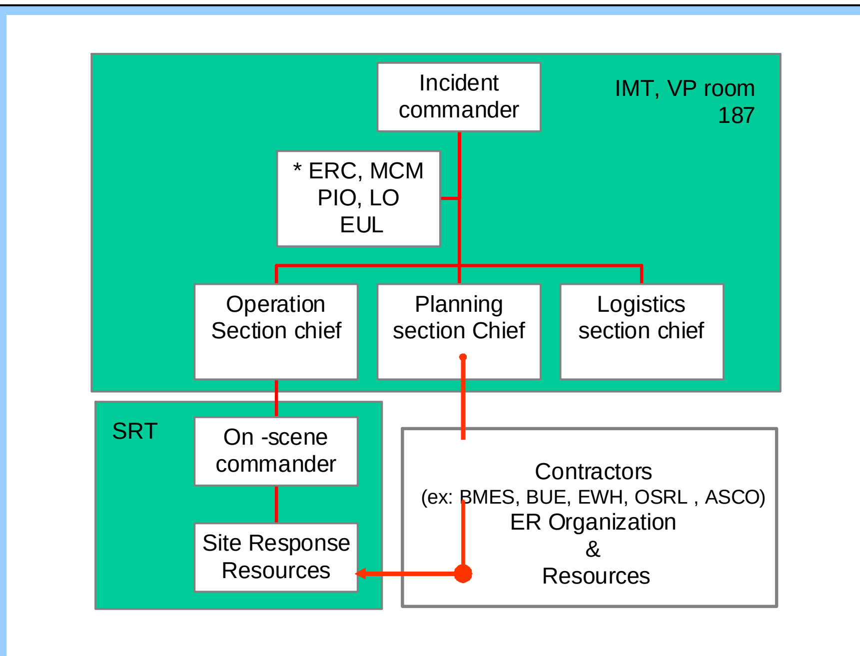
- Offshore oil spill (platforms and infield pipelines)
- Upstream (subsea export pipelines)
- Sangachal Terminal (limited to the boundary where the main onshore export lines leave the terminal)
- Onshore export pipelines

The individual spill plans contain detailed information on methodology for estimating the size (and therefore Tier category) of a spill, together with site-specific information on the characteristics of the spilled material (eg weathering rate) and on the estimation of slick trajectory and probable beaching time and location (in the case of offshore spills). The plans also provide guidance on the identification and implementation of the appropriate control and recovery strategy, taking into account the spill characteristics, location, weather conditions and environmental vulnerability and sensitivity[16]. A separate document defines the procedures for internal and external reporting of incidents, including the timescale (dependent on spill size) for reporting incidents to the Ministry of Environment and Natural Resources.

The OSRPs define a precise sequence of actions following an incident, with formal assignment of responsibility as indicated in Figure 13.21 BP maintains contracts with a number of specialist oil spill response contractors, who are equipped to provide 24-hour availability of containment and recovery services, and whose actions are controlled by the BP Incident Management Team On-Site Commander.

[16] Sensitivity mapping undertaken by AzSPU has been incorporated into the AzSPU OSRPs.

Figure 13.21 OSRP – Responsibility



* ERC - Emergency Response Coordinator MCM – Medical Case Manager PIO – Public Information Officer LO – Liaison Officer EUL – Environmental Unit Leader

13.7.5 Reporting

All non-approved releases (liquids, gases or solids) including releases exceeding approved limits or specified conditions during all phases of the COP will be internally reported and investigated. External notification requirements agreed with the MENR are:

- For liquid releases to the environment exceeding a volume of 50L, notification will be made within 24 hours after the incident verbally and within 72 hours in the written form; and
- If the release to the environment is less than 50L, then information about the release will be included into the BP AzSPU Report on Unplanned Releases and sent to the MENR on a monthly basis.

Appropriate environmental reports to the MENR also can contain information about spill reports but they do not replace the BP AzSPU Report on Unplanned Releases.

14 Environmental and Social Management

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14.1 Introduction

Under the ACG PSA, BP as Operator for AIOC is responsible for the environmental and social management of the Chirag Oil Project (COP), for ensuring that project commitments are implemented, and that the project's performance complies with applicable environmental and social legal, regulatory and corporate requirements.

This Chapter provides an overview of the system that will be used to manage the environmental and social issues associated with the COP.

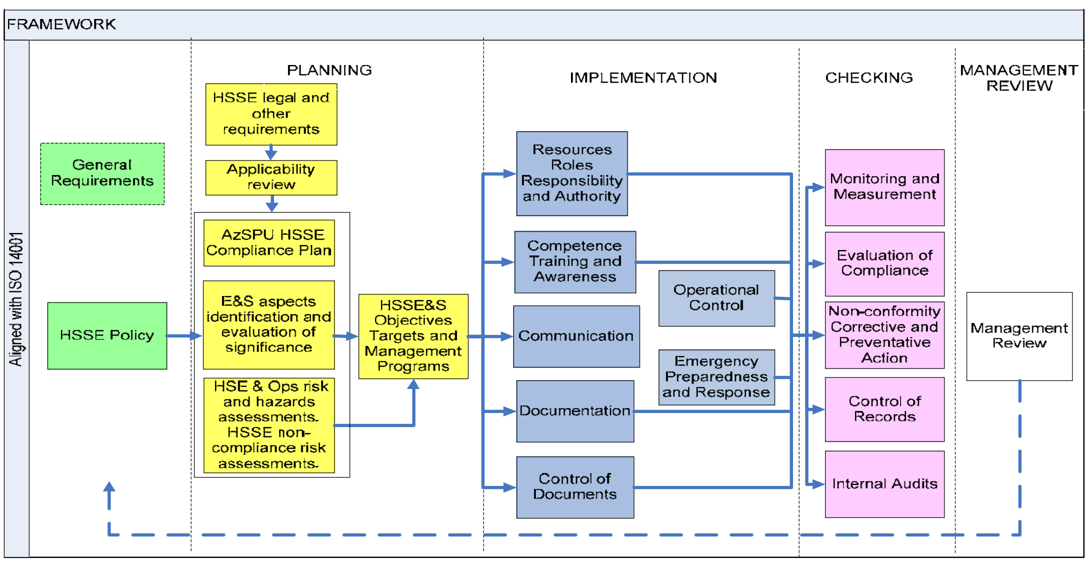
In 2005, BP's Azerbaijan Strategic Performance Unit (AzSPU) developed an integrated Health, Safety, Security and Environmental (HSSE) Management System[1]. The purpose of the system is to design, document and embed processes to ensure the AzSPU consistently manages HSSE risks and opportunities and delivers regulatory compliance, together with any relevant BP Group requirements.

Activities associated with the COP will be undertaken in accordance with the intent of the AzSPU HSSE Management System requirements.

14.2 Overview of AzSPU HSSE Management System

The AzSPU HSSE Management System provides a structured framework to manage the HSSE performance of the organisation (see Figure 14.1) and includes continuous improvement as an integral part of the philosophy (see Figure 14.2).

Figure 14.1 AzSPU Integrated HSSE Management System Framework



The stages in Figure 14.1 can be described as follows:

Planning: Processes are developed in order to formulate objectives, targets and management programmes in accordance with the HSSE Policy, significant environmental and social aspects and impacts, health and safety risks and compliance issues.

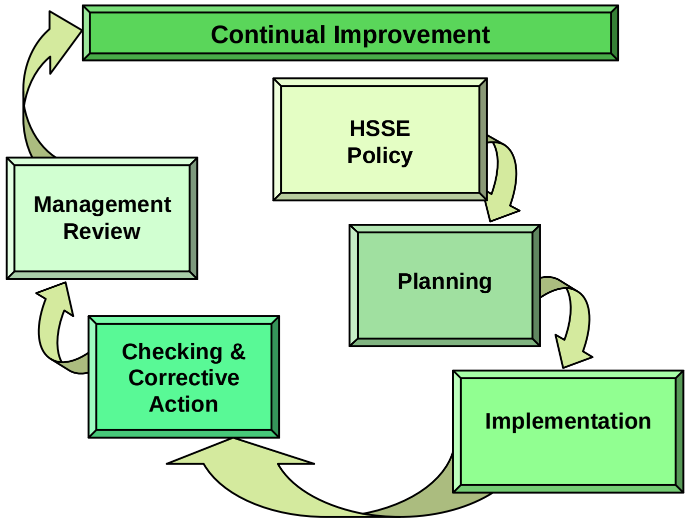
Implementation: Processes to execute the objectives, targets and management programmes are developed and implemented.

[1] It should be noted that social issues are embedded within the environmental portion of the AzSPU HSSE Management System.

Checking: The processes are monitored and measured against the HSSE Policy; procedures; objectives and targets; and legal and other requirements. The results are then reported.

Management Review: Actions are taken to continually improve the HSSE performance of the organisation.

Figure 14.2 Continuous Improvement Philosophy



It should be noted that the environmental portion of the AzSPU HSSE Management System for operations is certified to ISO 14001, the leading international standard on environmental management. External certification of all new operations (including the COP WC-PDQ platform) to ISO 14001 within 12 months of becoming operational is a BP requirement.

14.2.1 Documentation

The following documents govern the structure and content of the AzSPU HSSE Management System:

- Applicable legal and other requirements;
- BP Group standards;
- BP Code of Conduct;
- BP Global HSSE Compliance Framework;
- BP getting HSE right;
- AzSPU HSSE Policy; and
- ISO 14001: 2004 EMS Standard.

In addition, the following have particular relevance to the COP:

- The COP ESIA and associated environmental permission documents;
- BP Group Environmental and Social Group Defined Practice (GDP) for Major Projects, Major Exploration Projects, Non-Major Projects in Aquifer Areas and Acquisition Activities; and
- Contractor Environmental & Social Management Systems (refer to Section 14.3.2.1).

The AzSPU HSSE Management System is based on a hierarchy of documents reflecting the organizational structure of the company (see Table 14.1).

Tier 1 documents apply to all BP activities and operations throughout the world. Tier 2 documents apply across the entire AzSPU and are essential to the operation of the HSSE

Management System. Only where there are more site-specific requirements are Tier 3-5 procedures developed for individual performance units, assets, facilities and projects.

Table 14.1 AzSPU HSSE Management System Tier Structure

Level	Business Unit	Description	Example
Tier 1	BP Corporate	Key BP Group policy, programmes, practices, frameworks, standards and regulations	BP Group Environmental & Social Group Defined Practice
Tier 2	Azerbaijan Strategic Performance Unit	Key AzSPU policy, procedures, standards and regulations	AzSPU Integrated Internal Audit Plan
Tier 3	Onshore Organisation, Offshore Organisation, Renewals and Major Projects	Common procedures and management plans at organisation level	Offshore Waste Management Procedure
Tier 4	Performance Unit, New Projects, Major / Minor Modifications	PU specific documentation, procedures and operational controls	ACG PU Seeps & Leaks Management Procedure
Tier 5	Asset / Facility / Project	Asset / Facility / Project specific documentation, procedures and operational controls	Central Azeri Emissions and Discharges Flow Diagram Contractor Environmental & Social Management System procedures

14.3 Emphasis of AzSPU HSSE Management System during COP Phases

Figure 14.3 lists the key management processes applicable to the different phases of the COP and the two main “transitions” between these phases.

A number of different BP teams and contractors will be involved in managing and executing the work as the COP progresses through design, pre-drill, and construction, installation and HUC, towards the WC-PDQ platform becoming an operational facility.

Management system documentation and tools will be periodically reviewed and updated as necessary to reflect changing management responsibilities and priorities as the COP progresses through the different phases of the project

Key documentation covered by the reviews, where relevant and available, will include:

- Aspect and Impact Registers and any associated mitigation and management procedures / plans;
- Waste forecasts – compared against actual waste arising;
- Emissions and discharge inventories and sampling reports – to confirm performance standards are being achieved;
- Monitoring and baseline data / survey reports; and
- Technical documents (i.e. engineering basis of design, specifications, vendor / supplier documents, engineering drawings, etc.).

Figure 14.3 Key Management Processes During COP Phases

Design & Procurement		Pre-Drilling	Construction, Installation & HUC		Operations
• Design standards, specifications and acceptance controls. • Reliability and operability reviews. • Qualification and selection of suppliers and vendors. • Discharge, emission and waste identification, quantification, reduction, and modelling. • Interaction with existing AzSPU construction and operations teams. • ESIA preparation, review and approval. • ESIA consultation & disclosure.	Transition	• Contractor qualification and selection of pre-drilling contractor. • Pre-drilling HSSE assurance programme. • Development of MS bridging documents, site-specific procedures. • Pre-drill programme review to confirm adoption of well design and manage deviations. • Monitoring & reporting – environmental and operational. • Contractor audit. • Community engagement. • ESIA commitment management.	• Contractor qualification and selection of construction contractors. • Contractor Environmental & Social Management Systems. • Development of Contractor Procedures and control of work systems, MS bridging documents, site-specific procedures. • Construction reviews to confirm adoption of design and manage deviations. • Construction contractor community engagement. • Monitoring & reporting – environmental and operational. • Contractor audit. • Community engagement. • ESIA commitment management.	Transition	• Support & supply contractor qualification, selection and HSSE assurance management. • Development of site-specific operating procedures. • Monitoring & reporting – environmental and operational. • AzSPU internal auditing. • Community engagement. • ESIA commitment management. • Operational excellence. • ISO 14001 certification.

Common Elements
• COP Commitments Register • Integrated Environmental Monitoring Programme • Waste management • Spill Prevention and Response / Incident Management System • AzSPU HSSE Management System • Lessons learned from previous ACG and Shah Deniz projects

14.3.1 Design & Procurement

The focus of the AzSPU HSSE Management System during the design phase of the project is on ensuring that the COP platform and subsea pipelines design is such that operational performance standards can be achieved.

Key issues that have been considered include:

- Emissions and discharges identification, quantification and reduction;
- System configuration / optimisation;
- Energy efficiency;
- Facility vendor qualification;
- Bunding and containment; and
- Drainage.

The ESIA process is critical for this phase of the COP as it tests the Base Case design in terms of its environmental and social impact and highlights where improvements are necessary.

14.3.2 Pre-Drilling and Construction, Installation and HUC

COP pre-drilling and construction, installation and HUC phases will be undertaken at a number of locations, at/on facilities that are generally not BP managed. These include:

- Contractor operated Mobile Offshore Drilling Unit (MODU) in the Azerbaijani sector of the Caspian Sea;
- Contractor managed construction yards in Azerbaijan;
- Contractor managed installation and support vessels; and
- Vendor / supplier factories.

BP will ensure that contractors manage their activities in a manner consistent and compliant with AzSPU standards and expectations, using the continuous improvement cycle shown in Figure 14.2. This is described in the sections below.

14.3.2.1 Planning

Contractor Selection

A rigorous contractor selection process will be in place to ensure that key contractors used during the COP have effective Environmental & Social (E&S) Management Systems that align with BP expectations and are bridged (linked) to the AzSPU HSSE Management System.

Companies invited to tender for pre-drilling, construction, installation and HUC contracts will be provided with detailed information on BP and AzSPU environmental and social expectations and standards The environmental and social capability of the companies and their ability to comply with the expectations and standards will be an element in tender evaluation and award. Companies will be required to present detailed proposals for establishing and operating a compliant E&S Management System throughout the duration of their contracts.

Environmental Aspects and Impact Identification

To ensure environmental aspects and impacts are identified and appropriate mitigation and management procedures are in place, periodic Environmental Impact Identification (ENVIID) workshops will be undertaken during the COP predrilling and construction, installation and HUC phases, led by the contractors and attended by BP representatives. These will be conducted at quarterly intervals in order to review and confirm the validity of the Aspects and Impacts Registers, and to ensure that mitigation and management procedures remain effective.

ENVIID workshops were also completed during the COP design stage to complement the environmental assurance work and to support the development of the ESIA.

14.3.2.2 Implementation

The principle pre-drilling, and construction, installation & HUC contractors will be required to prepare and submit for audit their own E&S Management System and to demonstrate, to BP’s satisfaction, that it is fit for purpose before start of work. The predrill MODU contractor planned to be used for the COP has previously prepared and submitted their E&S Management System to BP. Following approval, bridging documentation between the MODU contractor’s system and the AzSPU system has been developed. The Construction and Installation Contractors E&S Management System, to be developed by the appointed contractor, will address where applicable:

- **Atmospheric Emissions:**
  - Contractors will be required to demonstrate that they have appropriate plant and effective maintenance, monitoring and reporting procedures.
- **Waste Management:**
  - Contractors will be required to demonstrate that they have an effective system and resources for waste minimisation and segregation.
  - Contractors will be required to maintain accurate records of all waste generated and all waste movements and to report these on a regular basis to BP.
  - BP will manage the collection, transportation, treatment, disposal and storage of waste via approved waste management contractors.
- **Discharges:**
  - Contractors will be required to ensure that any necessary management and mitigation measures are in place for all discharges identified in the ESIA.
  - Contractors will be required to notify BP of any changes to discharges approved in the ESIA, and of any new discharges, and the MoC process described in Section 5.1.1 will apply.
- **Chemical Management:**
  - Contractors will be required to maintain an accurate inventory of all chemicals required for their activities and to establish containment and handling practices, in accordance with legal requirements, to avoid or minimise the risk of environmental pollution.
  - Contractors will be required to notify BP of new chemicals proposed for use and the MoC process described in Section 5.1.1 will apply.
- **Spill Management and Response:**
  - Contractors will be required to demonstrate that they have thoroughly reviewed spill risks and that they have in place appropriate spill containment, response, clean-up equipment and procedures, including spill reporting.
- **Community Consultation and Employment:**
  Contractors will be required to demonstrate that:
  - They have a grievance process in place whereby community complaints can be received, logged and responded to.
  - They have a process whereby employment of local community / nationals meets BP's expectations for local / national content[2].
- **Transportation:**
  Contractors will be required to prepare:
  - Transportation plans and to assess and where necessary mitigate potential impacts on the transport infrastructure, other users of the infrastructure, residential premises and on any economic or social activities adjacent to transport routes.
  - Ballast water management plans for shipping of freight and movement of vessels into and within the Caspian Sea.
- **Reporting:**
  - BP will agree with each contractor a detailed set of reporting requirements to demonstrate compliance with the above, specifying the level of detail and the reporting process and frequency. BP will collate reports from all contractors and deliver them to the appropriate regulatory agencies at agreed intervals.
- **Training & Competency:**
  - Contractors will be required to demonstrate that they have adequate systems in place to provide training in all HSE areas applicable to their activities and to assess competence.

Each contractor will be required to prepare procedures as part of their E&S Management System which implement the requirements summarised above. BP will review the procedures and will approve them once their compliance with BP expectations and alignment with the AzSPU HSSE Management System has been confirmed.

[2] Refer to Chapter 12 regarding local/national content.

14.3.2.3 Checking & Management Review

BP will conduct formal audits and inspections of contractor operations at regular intervals to assess contractor environmental and social performance and compliance with contract requirements, ESIA commitments, and their E&S Management System (aligned with and linked to the AzSPU HSSE Management System). Where appropriate, the audit and inspection process will be complemented by practical measures such as spill response exercises and sampling and analysis of discharges and emissions.

In cases of non-compliance or unsatisfactory performance, it will be a contractual requirement that the contractor remedy deficiencies in a timely and efficient way. The time permitted for implementing a remedy will be determined in accordance with the severity of the deficiency and with any applicable legal requirements. Whilst BP will provide support and assistance in such cases, the contractor will retain primary responsibility for remedial action and for the subsequent maintenance of compliant operations.

During the final stages of the construction and commissioning phase of the COP WC-PDQ platform, a review of the facilities will be carried out to capture any design changes relevant to the scope of the AzSPU HSSE Management System that occurred during construction. This will ensure that any associated changes to environmental management requirements can be identified and incorporated into operational procedures.

14.3.3 Operations

Once construction, installation and offshore HUC are complete and the WC-PDQ platform is “hydrocarbon live”, it becomes an operational facility, managed directly by BP.

14.3.3.1 Planning

An ENVIID Workshop will be held in order to replace the existing contractor owned pre-drill and construction Aspect and Impacts Registers, with a BP one specific to the operation of the WC-PDQ platform. Significant aspects and impacts identified as a result of this exercise will have objectives, targets and management programmes developed for them in order to drive continual improvement.

In addition the Register for Sangachal Terminal will also be reviewed in order to capture any potential aspects and impacts resulting from the additional WC-PDQ hydrocarbons being delivered to the facility.

14.3.3.2 Implementation

As stated in Section 14.2.1, the AzSPU HSSE Management System is based on a hierarchy of documentation. Tier 2 policies, procedures and plans are applicable across the entire AzSPU and outline requirements and processes for roles and responsibilities, competency and training, communication, documentation, operational control (e.g. chemicals and hazardous materials management, waste management, etc), and emergency preparedness and response.

In addition, site-specific environmental and social management procedures based on, and consistent with, the procedures already in use on existing ACG platforms and the AzSPU Tier 2 procedures will be developed and followed for the WC-PDQ platform operations.

14.3.3.3 Checking & Management Review

AzSPU monitoring is carried out in accordance with the Integrated Environmental Monitoring Programme (IEMP), see Section 14.5.2. The results of both environmental and operational monitoring are reported to the MENR in the form of IEMP survey reports, End of Well Reports, Statistical Committee Reports (water and resource utilisation, waste streams, atmospheric pollution), spill reporting, etc, in accordance with the AzSPU External Environmental Reporting Procedure.

In terms of operations auditing, AzSPU has an integrated internal audit programme in place which includes the following:

- Management system audits - establish the effectiveness of the operations management system against AzSPU procedures and the ISO 14001 standard, in order to verify that the required systems and processes are functioning effectively;
- Compliance audits - determine the compliance status of AzSPU operations against HSSE legal & other requirements; and
- Subject matter audits – involve reviewing selected sites in respect of a single parameter, e.g. waste, air emissions, health, etc.

As stated previously, the WC-PDQ platform will begin the process of working towards ISO 14001 certification as soon as the platform becomes “hydrocarbon live”. Internal management system audit of the platform will be carried out, to ensure readiness, prior to the external audit by an independent certification body.

In terms of management review, an AzSPU-wide HSSE Management Review Meeting is held on an annual basis to assess the continuing suitability, adequacy and effectiveness of the system. Possible need for changes in policy, objectives and targets, and other elements of the HSSE Management System are addressed in order to achieve continual improvement. Performance Review Meetings are also held periodically, according to operational needs.

14.4 Common Elements

As presented in Figure 14.3, there are a number of environmental and social management processes common to all phases of the COP project, including:

- Commitments Register;
- Integrated Environmental Monitoring Programme;
- Waste management; and
- Spill prevention and response planning.

An overview of each element is presented below. Spill prevention and response planning is discussed in Chapter 13.

14.4.1 Commitments Register

The COP ESIA represents the culmination of an extensive and rigorous process to identify the potential environmental and social impacts associated with the project, assess their significance and recommend mitigation measures, where applicable.

The ESIA process ran parallel to the project design phase to ensure that significant environmental and social aspects were taken into account throughout the design process.

Additional mitigation and management to minimise the risk of significant impacts in the project construction and operational phases have been extracted from the COP ESIA and formalised in the COP Commitments Register.

The Commitments Register helps to ensure:

- Transparency in translating commitments into actions;
- Clear identification of responsibilities;
- Resourcing and budget allocation to achieve commitments; and
- Required actions are implemented on a timely basis.

The actions in the Commitments Register will be communicated to contractors and BP personnel through a number of mechanisms as described below.

During pre-drilling and construction, installation & HUC (contractor managed):

- Contract provisions; and
- HSSE Compliance Tasks. The BP AzSPU has a 'Compliance Task Manager' database which manages compliance tasks extracted from applicable legal documents (including the ESIA) and links them to accountable/responsible positions and operational controls. During this phase of the project contractor personnel will be responsible for the majority of Compliance Tasks and BP personnel will be accountable. The contractor may be required to update his procedures to ensure that the operational controls are effective.

During WC-PDQ platform operation (BP managed):

- HSSE Compliance Tasks. During this phase of the project BP personnel will be responsible and accountable for the majority of Compliance Tasks; and
- AzSPU procedures, checklists, work orders, job descriptions, etc may need to be developed/updated in order to ensure that operational controls are effective.

14.4.2 Integrated Environmental Monitoring Programme (IEMP)

BP's AzSPU has implemented an Integrated Environmental Monitoring Programme (IEMP) designed to provide a consistent, long-term set of data, with the objective of ensuring an accurate picture of potential impacts of AzSPU activities on the surrounding environment so that they can be managed and mitigated as effectively as possible.

The IEMP follows a 10 year schedule - detailed monitoring plans are prepared for the next 3 years, with outline planning for the following 7 years. This approach allows a progressive and systematic modification of the programme to take into account the results and conclusions of the programme to date.

Offshore marine monitoring can be separated into the following categories:

- Baseline surveys – provide a general understanding of the physical, chemical and ecological parameters at a particular location before development commences. Any unusual or sensitive ecological features, which might affect the design of a development, can also be identified;
- Post-drill surveys – carried out following drilling operations in order to assess the impact of drilling discharges on the surrounding environment;
- Routine environmental monitoring surveys – provide an assessment of the impact of AzSPU operations, aiding responsible environmental management; and
- Regional surveys – carried out to assist in the understanding of background environmental trends. Sampling is undertaken at locations remote from AzSPU activities, providing information on changes in the marine environment that have resulted from natural processes, or other third party activities. This helps to distinguish potential impacts resulting from AzSPU activities from natural background environmental changes and other anthropogenic sources.

All of the above have been conducted as part of the ACG Contract Area development, with the primary focus being the benthic environment (sediments and their associated biological communities are widely considered to be the source of the most reliable indicators of ecological status and impact), although periodic water quality sampling is also carried out.

The area in the vicinity of the WC-PDQ platform will be included within the scope of periodic environmental monitoring as part of the IEMP. Baseline survey data will be collected in 2009, to augment that collected previously in 2003. Post-drill and routine environmental monitoring will be conducted as the project progresses and moves into operations. The surveys will follow the standardised IEMP design to maximise the usefulness of comparisons over time and between locations.

In terms of onshore operations, much effort has been devoted to environmental monitoring in the vicinity of Sangachal Terminal (in the form of terrestrial ecosystem monitoring, bird surveys, ambient air quality monitoring, and groundwater and surface water quality monitoring). In addition, nearshore fish monitoring and biomonitoring has been conducted within Sangachal Bay. Future surveys will be conducted in accordance with the 10 year schedule.

The ambient environmental monitoring programme is currently being expanded to integrate operational monitoring of key discharges carried out by the AzSPU. This will allow a more complete understanding of the potential impacts of AzSPU operations.

The aim of regular monitoring is to establish an understanding of trends over time, taking into account results of concurrent regional surveys and initial baseline data. Combined with operational discharge monitoring, this approach provides a robust basis for assessing the impact of COP operations, and for comparing the observed impact with that predicted in the ESIA.

14.4.3 Waste Management

Waste management during all phases of the COP will benefit from accumulated experience and facilities constructed for the previous ACG and Shah Deniz projects, including:

- Effective and reliable procedures for on-site segregation and management of waste;
- A non-hazardous landfill disposal site which is constructed and operated to EU standards; and
- An effective process for identifying and utilising opportunities for waste recovery and recycling.

All wastes generated on the pre-drilling MODU, by key construction, installation and HUC contractors, and operations on the WC-PDQ platform will be identified and managed in accordance with the following requirements:

- Site specific waste management plans will be prepared for each of the main fabrication yards, the MODU and the WC-PDQ platform, installation vessels will also be included within the scope of the waste management plan(s);
- Waste minimisation;
- All waste streams identified and classified;
- Waste segregation at source;
- Workforce awareness and training;
- AzSPU Approved Waste Contractors List;
- AzSPU Waste Streams Register; and
- AzSPU Waste Management Strategy.

In accordance with internationally recognised best practice, the waste hierarchy, coupled with the AzSPU Best Practicable Environmental Option (BPEO) assessment of available waste disposal / treatment technologies which was conducted in 2006 and AzSPU Waste Management Strategy and supporting documentation, will be adopted as the basis for guiding waste management decisions. This is intended to ensure that wastes are managed in the most sustainable way and in compliance with all applicable AzSPU standards whilst ensuring they are recovered or disposed of efficiently without endangering human health and minimising environmental and social impacts.

Waste Management Processes and Procedures

Waste management and minimisation plans will be developed and maintained to cover all stages of the COP to match the anticipated waste streams, likely quantities and any special handling requirements.

A schedule of internal audits will be developed to objectively monitor the performance of the waste management systems during all stages of the COP and to ensure that all corrective actions and improvements are identified and implemented.

To support the waste management plan, employees at the construction yards, installation vessels, the MODU, and onboard the WC-PDQ platform will receive waste management training covering:

- Identification of waste types and potential associated hazards;
- Waste minimisation;
- Waste segregation; and
- Waste transfer documentation (if involved in waste movement).

All new waste disposal routes are routinely assessed prior to use and must be compliant with applicable local laws and regulations. Waste will only be routed to those waste disposal facilities that have been approved for use by the AzSPU.

All reasonably foreseeable wastes will be identified in the AzSPU Waste Streams Register and classified as non-hazardous or hazardous. The construction, installation and HUC contractors, the MODU operator and relevant operations personnel shall be provided with this register and shall be required to adopt the descriptions and AzSPU compliant colour-coding scheme, or equivalent.

Waste Segregation and Transfer

Liquid and solid wastes will be segregated. Further segregation will depend on the hazard categorisation. The following minimum segregation will be adopted:

- Non-hazardous liquid;
- Hazardous liquid;
- Non-hazardous solid; and
- Hazardous solid.

Waste streams will be segregated at source to permit reuse/recycling and to avoid contact between incompatible materials. The segregation requirements will be clearly indicated by the use of containers with clear signage denoting the waste types that are suitable for the containers provided.

The site-specific waste management plans will identify the location of waste collection points, including recycling points, and the type of containers in use. All waste containers, designed, constructed and deployed to ensure adequate containment and prevent scavenging and infestation, will be regularly inspected whilst in use to ensure they remain fit for purpose and that waste segregation procedures are observed.

The waste management plan will clearly identify the type of container required for each waste type and each site will maintain sufficient containers of each type to accommodate the waste quantities generated.

All waste transfers will be accompanied by the relevant documentation. This includes individual waste transfer notes, confirming the waste type, quantity, waste generator, consignee (if different from the generator), consignor and in the case of hazardous wastes, both Waste Passports and, where required, MSDS documentation. A final visual inspection of all waste consignments will be made prior to transfer note sign-off and uplift. Coloured copies of the waste transfer documentation together with other relevant information e.g.

MSDS, Waste Passports, will be retained by the waste generator. All parties involved in transporting wastes will retain a copy of the waste transfer note. All documents required by applicable local regulations and applicable international conventions will also be retained and archived by the waste generator as required by the waste management plan procedures.

Depending upon the nature of the waste and the approved method of recycling/disposal, wastes may be routed via a Central Waste Accumulation Area (CWAA), waste transfer station or similar facility, or alternatively may be routed directly to their final approved destination.

15 Residual Impacts and Conclusion

Contents

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15.1 Introduction

This section summarises the residual impacts and conclusions of the COP ESIA.

15.2 Design, Construction and Operation

The COP WC-PDQ platform and the associated infield pipelines are based on established and proven designs and will be constructed and installed by experienced contractors using established facilities and a well-trained workforce. The selected design option (single platform, supported by water injection from the DWG-PCWU platform and implementing an “electric deck” option) will minimise the physical footprint of the installation and will also minimise atmospheric emissions.

15.3 Socio-Economic Impact

The majority of COP related Activities (with the exception of the construction phase) occur offshore and use existing operational onshore infrastructure capacities (e.g. Sangachal Terminal, the Baku Deep Water Jacket Factory (BDJF)). With reference to the experience gained on from the previous ACG Phases, the following key socio-economic issues were assessed:

- Employment creation;
- End of construction phase workforce reduction;
- Training and skills development;
- Economic activity; and
- Community disturbance.

The assessment concluded that the national workforce to be employed during the COP construction phase is likely to peak at approximately 2,000 and will likely exceed 1,000 for a period of approximately 18 months. Additional and new employment during the operations phase will be less in terms of new positions. Employment impacts are likely to be distributed within the local area with the majority of employees expected to be recruited from the local Garadagh area. It is anticipated therefore that employment will not require establishment of workforce accommodation or significant migration of populations to the construction areas.

Although the jobs created during the construction phase will not be required once the COP construction phases are complete, training and skills development, similar to that undertaken during the previous ACG projects, will provide a positive impact in developing the construction workforce skills and qualifications.

As the construction phase will only deliver temporary employment, planning for the conclusion of contracts will begin at the outset of the construction phase and related activities. Staff communications will ensure the workforce is aware of project progress and completion dates and staff will be provided with financial planning advice to encourage them to make provision for after the construction period.

The overall socio-economic impacts of the COP, particularly from employment creation throughout the construction, installation and hook-up and commissioning phases were assessed as positive.

Increased road traffic during the COP construction and operation phases has the potential to disrupt communities and businesses along the routes used through increased noise and traffic flows. BP and its main construction contractors implemented a successful driving and vehicle management plan during earlier ACG projects and this will be adopted for the COP to ensure that this impact is adequately mitigated. Overall the residual impact to communities and businesses from the increased traffic is considered to be minimal and significantly outweighed by the employment and business opportunities gained.

Economic developments in the Garadagh area since the completion of previous ACG projects include the relocation of the airport market to Lokhbatan, the proposed expansion of existing cement production facilities and the construction of new cement production facilities. These developments will have an impact on both local employment and traffic and will tend to reduce the relative magnitude of the impact of the COP development.

15.4 Environmental Impacts

Environmental impacts have been assessed separately for the pre-drill, construction (including hook-up and commissioning) and operational phases of the COP. Cumulative impacts, transboundary impacts and accidental events have also been assessed.

15.4.1 Predrill

Table 15.1 summarises the outcome of impact assessment for the predrill phase of the project.

Emissions associated with mobile drilling rig power generation, well test flaring and the activity of support vessels will all occur offshore and disperse into the atmosphere. Modelling was undertaken to determine the concentration of key pollutants associated with these activities at receptor locations (i.e. onshore) and hence event magnitude. Based on existing good air quality relative to recognised standards for the protection of health, receptor sensitivity was considered to be low and the impact of atmospheric emissions was considered to be minor.

Table 15.1 Summary of Predrill Residual Environmental Impacts

	Event	Receptor	Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from mobile drilling rig power generation	Onshore communities (people) Birds Seals and fish	Medium	Low	**Minor Negative**
	Emissions from well test flaring		Medium	Low	**Minor Negative**
	Emissions from support vessel engines		Medium	Low	**Minor Negative**
Marine Environment	Underwater noise from drilling and vessel movements	Seals and fish	Medium	Low	**Minor Negative**
	Drilling discharges	Seals and fish Zooplankton Phytoplankton Benthic Invertebrates	Medium	Low	**Minor Negative**
	Vessel and drilling rig cooling water intake and discharge	Seals and fish Zooplankton Phytoplankton	Medium	Low	**Minor Negative**
	Vessel and drilling rig ballast water discharge		Medium	Low	**Minor Negative**
	Vessel and drilling rig treated black water discharge		Medium	Low	**Minor Negative**
	Vessel and drilling rig grey water discharge		Medium	Low	**Minor Negative**
	Vessel and drilling rig drainage discharges		Medium	Low	**Minor Negative**
	Cement discharges	Benthic Invertebrates	Medium	Low	**Minor Negative**
	Seabed disturbance from anchor handling		Low	Low	**Negligible**

During predrilling, the largest discharges to the marine environment by volume are drilling discharges, specifically the discharge of drill cuttings and water based drilling mud, and the discharge of cooling water from the mobile drilling rig generators. Modelling of the drilling discharges was undertaken to confirm the extent and scale of mud and cuttings predicted to be deposited on the seabed during COP predrilling. This was compared to trends observed during pre- and post- drilling surveys at existing platforms undertaken as part of the IEMP. These surveys have shown that such discharges, which are required to meet applicable standards prior to discharge, have a very limited ecological impact to marine receptors. Based on the predicted event magnitude, receptor characteristics and observed sensitivities the impact was assessed as minor.

Small quantities of cement may be discharged to the seabed whilst cementing well casings into place. These will remain close to the well-head in the same area as drill cuttings are deposited. The impact to benthic invertebrates, which were evaluated as having a low sensitivity to cement discharges, was therefore assessed as minor.

Cooling water discharges are estimated to have a zone of influence (i.e., where temperature and trace biocide concentrations might have a minor effect) of only a few metres and are also considered to have a minor impact upon biological receptors in the water column (i.e. zooplankton, phytoplankton, seals and fish).

The remaining discharges to sea (ballast water, black water, grey water and deck drainage) are all small in volume (relative to drilling and cooling water discharges) and do not contain components of high environmental concern. These discharges, which are monitored in accordance with existing procedures to ensure applicable project standards are met, will be rapidly diluted and are all assessed as having a minor impact upon biological receptors in the water column.

Seabed disturbance associated with anchor handling during positioning of the mobile drilling rig will cause temporary disturbance to the surface layers of the sediment. The assessment concluded that benthic communities in the area are not, however, sensitive to this form of disturbance and the impact was therefore assessed as negligible.

For all predrill phase environmental impacts assessed it has been concluded that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures and no additional mitigation is required.

15.4.2 Construction, Hook-Up and Commissioning

Table 15.2 summarises the interactions assessed for the construction, hook-up and commissioning phase, and the results of the impact assessment for each interaction.

Table 15.2 Summary of Construction, Installation, Hook-Up and Commissioning Residual Environmental Impacts

	Event	Receptor	Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from yard generators and engines	Onshore communities (people) Birds	Medium	Medium	**Moderate Negative**
	Emissions from onshore platform generator commissioning		Medium	Medium	**Moderate Negative**
	Emissions from support vessel engines		Medium	Low	**Minor Negative**
Onshore Noise	Noise from construction yard plant	Onshore communities (people) Birds	Medium	Medium	**Moderate Negative**
	Noise from onshore platform generator commissioning		Medium	Medium	**Moderate Negative**
Marine Environment	Underwater noise from jacket foundation piling and vessel movements	Seals and fish	Medium	Low	**Minor Negative**
	Cooling water discharge from onshore commissioning of topside	Seals and fish Zooplankton Phytoplankton	Medium	Low	**Minor Negative**
	Pipeline hydrotest discharge		Medium	Low	**Minor Negative**
	Discharge of oil line wye spool water		Low	Low	**Negligible**
	Support vessel ballast water discharge		Medium	Low	**Minor Negative**
	Support vessel treated black water discharge		Medium	Low	**Minor Negative**
	Support vessel grey water discharge		Medium	Low	**Minor Negative**
	Support vessel drainage discharge		Medium	Low	**Minor Negative**
	Jacket foundation pile cement discharge	Benthic Invertebrates	Low	Low	**Negligible**
	Seabed disturbance from anchor handling and pipe-lay		Low	Low	**Negligible**

During the construction phase, impacts to onshore communities and birds from atmospheric emissions and noise arising from construction yard plant operation and onshore generator commissioning were modelled based on planned activities and were assessed as having moderate impact.

Underwater noise sources include jacket piling activities and movement of vessels used during platform and pipeline installation. Piling activities will generate the greatest sound volume but the sound will occur intermittently and over a short period. Vessel noise will be more persistent but will be at a much lower level than piling noise. Underwater noise modelling, undertaken to determine the extent of the noise impacts, coupled with an assessment of the associated avoidance behaviour reactions recorded in fish and seal populations, demonstrated that the activities would result in a minor impact.

During onshore commissioning of the platform generators, it will be necessary to operate a temporary cooling water system that will abstract water from and discharge to the construction yard harbour. This water will be at a higher temperature than the receiving waters and will contain neutralised disinfectant at trace concentrations. Similar discharges have been modelled and subject to environmental assessment during previous ACG projects and on the basis of those assessments and the existing controls and monitoring in place, the discharge was assessed as having a minor impact to biological receptors.

During offshore installation, hook-up and commissioning, the largest total volume of discharge to the marine environment will be associated with hydrotesting the oil and gas infield pipelines which connect the platform to the main ACG pipeline network pipelines and the produced and injection water infield pipelines. These discharges (comprising seawater dosed with dye and chemicals to prevent corrosion and biological growth) will take place intermittently over approximately one year and at different depths. Individual events have been evaluated to have a minor impact and, given the spatial and temporal distribution of the discharges, the overall impact was also assessed as minor to biological receptors. Additional measures to monitor and control hydrotest discharges will comprise:

- Preparation and maintenance of a hydrotest management plan, which will include a regularly updated schedule of hydrotest events together with a detailed set of commissioning procedures;
- Recording of chemical dosage rates and water flow rates during all pipeline hydrotest activities;
- Recording of the volume of treated water released during each hydrotest discharge event; and
- Preparation of laboratory samples, which will be stored onshore under simulated pipeline conditions and periodically subject to chemical analysis and toxicity testing in order to measure the rate of chemical degradation and associated toxicity reduction.

Based on previous ACG experience, these measures are considered to provide effective and practicable monitoring and assurance during hydrotesting and are designed to ensure that the impact to the marine environment is of no more than minor significance.
The impacts of jacket foundation cementing discharges and physical disturbance associated with anchor handling upon benthic invertebrates will be similar to those evaluated for the predrill programme and were assessed as minor.

Aqueous discharges (ballast water, grey water, black water and drainage) will also be similar in magnitude and impact to those for the predrill programme and were assessed as having a minor impact upon biological receptors.

A small volume of water (approximately $65m^3$) with a low level of residual hydrocarbon (less than 100ppm) may be released to sea during hydrotesting of the wye section that will connect the COP oil export pipeline to the DWG oil export pipeline. This volume will be released at the seabed and will dilute and disperse rapidly. The impact upon biological receptors was assessed to be negligible.

Overall, the majority of residual impacts were assessed as minor or negligible. The only moderate impacts were those arising from air emissions and noise associated with construction yard activity and onshore platform commissioning. These activities will not however, result in the exceedence of ambient air quality or noise standards for the protection of human health. Community liaison and engagement, similar to that undertaken for the previous ACG projects, will be a key element throughout the construction phase to ensure these impacts are minimised. Construction activities will be managed in accordance with previously established practice and AzSPU procedures and impacts are considered to be controlled and mitigated to an acceptable level.

15.4.3 Operations

Table 15.3 summarises the interactions assessed for the operations phase, and the results of the impact assessment for each interaction.

Table 15.3 Summary of Operations Residual Environmental Impacts

	Event	Receptor	Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Emissions from offshore platform power generation and non-routine flaring	Onshore communities (people) Birds	Medium	Low	**Minor Negative**
	Emissions from support vessel engines		Medium	Low	**Minor Negative**
	Emissions from onshore combustion plant and flaring		Medium	(Humans) Medium	**Moderate Negative**
				(Biological /Ecological) Low	**Minor Negative**
Marine Environment	Underwater noise from drilling, hammering and vessel movements	Seals and fish	Medium	Low	**Minor Negative**
	Platform drilling discharges	Seals and fish Zooplankton Phytoplankton Benthic Invertebrates	Medium	Low	**Minor Negative**
	Platform pigging discharges (produced water and injection water infield pipelines)		Medium	Low	**Minor Negative**
	Platform cement discharge	Benthic Invertebrates	Medium	Low	**Minor Negative**
	Platform non routine produced water discharge	Seals and fish Zooplankton Phytoplankton	Medium	Low	**Minor Negative**
	Platform water intake and cooling water discharge		Medium	Low	**Minor Negative**
	Support vessel ballast water discharge		Medium	Low	**Minor Negative**
	Platform and support vessel treated black water discharge		Medium	Low	**Minor Negative**
	Platform and support vessel grey water discharge		Medium	Low	**Minor Negative**
	Platform and support vessel galley waste discharge		Medium	Low	**Minor Negative**
	Platform and support vessel drainage discharge		Medium	Low	**Minor Negative**

The majority of operational interactions are similar to those already considered for predrill and construction activities. Each interaction was assessed based on event magnitude and receptor sensitivity and the impact significance found to be the same as for the previous phases. Events include offshore emissions, underwater noise, drilling discharges (water based mud and cuttings discharge), cement discharge, cooling water discharge and aqueous discharges (i.e. ballast water, black water, grey water, galley waste, drainage). Only air emissions (onshore plant and flaring) were assessed as having a moderate impact. Emissions from onshore plant and flaring associated with the COP will not however, result in exceedences of internationally recognised ambient air quality standards for the protection of health at onshore receptors.

During routine operations, produced water will be reinjected into the reservoir. Discharge of produced water which meets applicable project standards will only occur due to failure of the reinjection system or if produced water is incompatible with seawater that is injected into the reservoir for pressure maintenance purposes. Pigging (i.e. i.e. cleaning of the produced water and injection water pipelines) is planned to occur once a week and discharge of pigging fluids will be of short duration (i.e. hours).

Produced water and pigging fluids have been the subject of chemical analysis, toxicity testing and dispersion modelling. The results of these studies have been used to estimate the degree of dilution required to reach a “no effect” level and the size of the dispersion plume within which such dilution would occur. Both types of discharge will be intermittent and of short duration (i.e. hours) and the plumes will dissipate within a few hours of the end of each discharge event. Based on the modelling conducted the volume of seawater potentially affected by these discharges is limited to a narrow plume of less than 600m in length. Based on the sensitivity of the receptors in the water column to the event and its limited magnitude,

produced water and pigging fluid discharges were assessed as having a minor impact upon biological receptors.
Overall, the majority of residual impacts from operations are assessed as minor or negligible (with the exception of onshore air emissions). The expected moderate negative impact associated with onshore operations at the Sangachal Terminal will also be mitigated through existing community liaison and engagement supported by the IEMP ambient monitoring undertaken in and around the Terminal. All activities will be managed in accordance with previously established practice and AzSPU procedures and impacts are considered to be controlled and mitigated to an acceptable level.

15.5 Cumulative, Transboundary and Accidental Events

Cumulative impacts, potential transboundary impacts and the impacts of accidental events associated with the COP were also assessed. The routine and non-routine discharges to sea from the COP will be, as with other ACG projects, of limited impact. It was concluded that each discharge will make a small incremental contribution to the ACG total but the platform discharges will be isolated from each other and the total itself represents a very small fraction of the assimilative capacity of the Contract Area. Consequently, it is considered that these discharges represent a sustainable situation and it is predicted that there will be no measurable deterioration of the marine environment attributable to ACG operations.

For both onshore and offshore activities, the volumes of atmospheric emissions released (including visible particulates) due to the COP are expected to result in very small increases in pollutant concentrations in the atmosphere and in any washout from rainfall, which will not be discernable to biological/ecological receptors. SO_2 emissions are minimised through the planned use of low sulphur diesel and preferential use of gas as a fuel for the operation of the WC-PDQ platform and are expected to disperse rapidly due to appropriate equipment design and fuel use. Contribution of COP SO_2 emissions to acid rain generation is therefore expected to be insignificant.

It was estimated that 97% (5,995,000 tonnes) of the COP GHG emissions (comprising carbon dioxide and methane) will be generated from the operational phase activities onshore and offshore. The annual contribution of COP in the year 2020 to the predicted national Azerbaijan forecast[1] was estimated to be approximately 0.5%.

Energy efficiency and GHG reduction was a key aspect taken into account during the development of the COP design, contributing to the selection of the electric drive concept with all power to the platform, including the gas export compressors, being provided by the main power generation turbines. Analysis demonstrated that this technology selection resulted in a saving of approximately 300,000 tonnes of CO_2 emissions across the project's lifetime, when compared to direct drive gas turbine technology. This is a more than 40% reduction.

A review and assessment of accidental events was carried out as part of the COP ESIA. This considered a number of accidental events scenarios that included well blowout and pipeline failure as well as lower magnitude events (e.g. spills). Modelling was undertaken to illustrate the expected behaviour of an oil spill for the blowout and pipeline rupture scenarios for COP. The results were similar to those obtained within previous ACG ESIAs as the the COP crude oil is expected to be more persistent than Azeri oil but less persistent than the Chirag oil.

A platform blowout or major pipeline rupture are the only events with the potential to become regional transboundary events. The precise nature of the impact would depend on the prevailing weather conditions at the time of the spill, the time required for deploying spill response measures and their effectiveness.

BP, as operator of AIOC, has developed and maintains a range of Oil Spill Response Plans (OSRP) in place for its offshore and onshore operations in Azerbaijan. These plans encompass all phases of ACG development and establish the notification, response and followup actions that must be implemented should an accidental event occur. In addition BP

[1] First National Communication of Azerbaijan on Climate Change, May 23 2000.

has developed a system to manage pipeline integrity across the ACG pipeline network including monitoring and auditing procedures.

Analysis of onshore construction and offshore operation spill data focused on classifying the root causes, types, and quantities of spills. The principal outcome of this analysis was to identify the areas for improvement in equipment specification, training, operating procedures and maintenance procedures to be implemented for the COP. The established procedures for spill recording, investigation and corrective action will also be maintained.

The ESIA predicts that accidental events will be low in frequency, given the preventative measures in place, and if they do occur will be discrete (i.e. have a very low likelihood of overlapping in time and space). With the exception of a major loss of oil containment (i.e., blowout or pipeline rupture) they are also not persistent and such events will, therefore, have no cumulative impact.

15.6 Environmental and Social Management

Each phase of the COP will be subject to formal environmental and social (E&S) management planning under the framework of the integrated AzSPU HSSE Management System.

During the predrill and construction, installation and HUC phases the key contractor companies will be required, under the terms of their contracts, to develop and implement E&S Management Systems that align with the BP expectations and are bridged to the AzSPU HSSE Management System.

Once the WC-PDQ platform is “hydrocarbon live” it will become an operational facility, managed directly by AzSPU. External certification of the platform to ISO 14001 (the leading international standard on environmental management) within 12 months of becoming operational is a BP requirement.

The environmental and social management process during all phases of the COP will benefit from accumulated experience and ‘lessons learned’ from executing the three previous ACG projects. Major benefits of previous project experience include the development of:

- Effective and reliable procedures for on-site segregation and management of waste;
- A non-hazardous landfill site designed and constructed to EU standards; and
- An effective process for identifying and utilising opportunities for waste recovery and recycling.

15.7 Conclusions

The COP has benefited, to a considerable extent, from the experience gained by AIOC in designing, constructing, installing and operating the ACG Phase 1, 2 and 3 facilities. The basic design concept has been well-tested and proven and over five years of environmental monitoring have demonstrated that the basic design concept is environmentally sound. Nevertheless, the COP has identified opportunities for improvement, most notably the selection of an electric drive concept that substantially reduces emissions and a more reliable sewage treatment plant. COP is committed to implementing these during project execution.

The COP will also benefit from the fact that the predrilling, construction and installation teams now have extensive practical experience in offshore ACG activities and that these teams can execute the planned activities reliably.

The environmental management process is underpinned by the IEMP. Since 2004, this programme has focused on establishing and executing a regular and structured programme of ambient environmental monitoring around planned, new and operating installations. By 2008, all the ACG Phase 1, 2 and 3 installations were operational and the focus of the IEMP is now shifting towards integration of operational monitoring. Increasingly, the IEMP will concentrate on the results of discharge/emission sampling from operational installations with the aim of confirming design performance and of identifying deviations in over time to minimise adverse effects.

In conclusion, the COP is based on proven design concepts and engineering standards and has benefited from lessons learned during previous ACG project. These previous projects have been the subject of extensive environmental monitoring and the results of this monitoring provide confidence that the environmental impact of the COP design will be acceptable and effectively controlled.

APPENDIX 2A

COP – Appendix IX of PSA

PSA ACG

XƏZƏR DƏNİZİNİN AZƏRBAYCAN SEKTORUNDA AZƏRİ, ÇIRAQ YATAQLARININ VƏ GÜNƏŞLİ YATAĞININ DƏRİNLİKDƏ YERLƏŞƏN HİSSƏSİNİN BİRGƏ İŞLƏNMƏSİ VƏ NEFT HASİLATININ PAY BÖLGÜSÜ HAQQINDA SAZİŞ

ХƏЗƏР ДƏНИЗИНИН АЗƏРБАЈЧАН СЕКТОРУНДА АЗƏРИ, ЧЫРАГ ЈАТАГЛАРЫНЫН ВƏ КУНƏШЛИ ЈАТАҒЫНЫН ДƏРИНЛИКДƏ ЈЕРЛƏШƏН ҺИССƏСИНИН БИРКƏ ИШЛƏНМƏСИ ВƏ НЕФТ ҺАСИЛАТЫНЫН ПАЈ БӨЛКУСУ ҺАГГЫНДА САЗИШ

СОГЛАШЕНИЕ О СОВМЕСТНОЙ РАЗРАБОТКЕ И ДОЛЕВОМ РАСПРЕДЕЛЕНИИ ДОБЫЧИ ПО МЕСТОРОЖДЕНИЯМ АЗЕРИ, ЧЫРАГ И ГЛУБОКОВОДНОЙ ЧАСТИ МЕСТОРОЖДЕНИЯ ГЮНЕШЛИ В АЗЕРБАЙДЖАНСКОМ СЕКТОРЕ КАСПИЙСКОГО МОРЯ

AGREEMENT ON THE JOINT DEVELOPMENT AND PRODUCTION SHARING FOR THE AZERI AND CHIRAG FIELDS AND THE DEEP WATER PORTION OF THE GUNASHLI FIELD IN THE AZERBAIJAN SECTOR OF THE CASPIAN SEA

XƏZƏR DƏNİZİNİN AZƏRBAYCAN CEKTORUNDA AZƏRİ, ÇIRAQ YATAQLARININ VƏ GÜNƏŞLİ YATAĞININ DƏRİNLİKDƏ YERLƏŞƏN HİSSƏSİNİN BİRGƏ İŞLƏNMƏSİ VƏ NEFT HASİLATININ PAY BÖLGÜSÜ HAQQINDA

AZƏRBAYCAN RESPUBLİKASININ DÖVLƏT NEFT ŞİRKƏTİ

ilə

AMOKO KASPİAN Sİ PETROLEUM LİMİTED

Bİ-Pİ EKSPLOREYŞN (KASPİAN Sİ) LİMİTED

DELTA NİMİR XƏZƏR LİMİTED

DEN NORSKE STATS OLYESELSKAP a.s

LUKoyl SƏHMDAR CƏMİYYƏTİ

MakDERMOTT AZƏRBAYCAN, İNK.

PENNZOYL KASPİAN KORPOREYŞN

REMKO XƏZƏR ENERCİ LİMİTED

TÜRKİYE PETROLLERİ A.O.

YUNOKAL XƏZƏR, LTD.

arasında

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ХӘЗӘР ДӘНИЗИНИН АЗӘРБАЈЧАН СЕКТОРУНДА АЗӘРИ, ЧЫРАГ ЈАТАГЛАРЫНЫН ВӘ КҮНӘШЛИ ЈАТАҒЫНЫН ДӘРИНЛИКДӘ ЈЕРЛӘШӘН ҺИССӘСИНИН БИРКӘ ИШЛӘНМӘСИ ВӘ НЕФТ ҺАСИЛАТЫНЫН ПАЈ БӨЛКҮСҮ ҺАГГЫНДА

АЗӘРБАЈЧАН РЕСПУБЛИКАСЫНЫН ДӨВЛӘТ НЕФТ ШИРКӘТИ

илә

АМОКО КАСПИАН СИ ПЕТРОЛЕУМ ЛИМИТЕД

БИ-ПИ ЕКСПЛОРЕЈШН (КАСПИАН СИ) ЛИМИТЕД

ДЕЛТА НИМИР ХӘЗӘР ЛИМИТЕД

ДЕН НОРСКЕ СТАТС ОЛЈЕСЕЛСКАП а.с

ЛУКојл СӘҺМДАР ЧӘМИЈЈӘТИ

МакДЕРМОТТ АЗӘРБАЈЧАН, ИНК.

ПЕННЗОЈЛ КАСПИАН КОРПОРЕЈШН

РЕМКО ХӘЗӘР ЕНЕРЧИ ЛИМИТЕД

ТҮРКИЈЕ ПЕТРОЛЛЕРИ А.О.

ЈУНОКАЛ ХӘЗӘР, ЛТД.

арасында

С А З И Ш

СОГЛАШЕНИЕ О СОВМЕСТНОЙ РАЗРАБОТКЕ И ДОЛЕВОМ РАСПРЕДЕЛЕНИИ ДОБЫЧИ ПО МЕСТОРОЖДЕНИЯМ АЗЕРИ, ЧЫРАГ И ГЛУБОКОВОДНОЙ ЧАСТИ МЕСТОРОЖДЕНИЯ ГЮНЕШЛИ В АЗЕРБАЙДЖАНСКОМ СЕКТОРЕ КАСПИЙСКОГО МОРЯ

МЕЖДУ

ГОСУДАРСТВЕННОЙ НЕФТЯНОЙ КОМПАНИЕЙ АЗЕРБАЙДЖАНСКОЙ РЕСПУБЛИКИ

И

АМОКО КАСПИАН СИ ПЕТРОЛЕУМ ЛИМИТЕД

БИ-ПИ ЭКСПЛОРЭЙШН (КАСПИАН СИ) ЛИМИТЕД

ДЕЛЬТА НИМИР ХАЗАР ЛИМИТЕД

ДЕН НОРСКЕ СТАТС ОЛЬЕСЕЛСКАП а.с

АКЦИОНЕРНЫМ ОБЩЕСТВОМ ЛУКойл

МакДЕРМОТТ АЗЕРБАЙДЖАН, ИНК.

ПЕННЗОЙЛ КАСПИАН КОРПОРЭЙШН

РЭМКО ХАЗАР ЭНЕРДЖИ ЛИМИТЕД

ТУРКИЕ ПЕТРОЛЛЕРИ А.О.

ЮНОКАЛ ХАЗАР, ЛТД.

AGREEMENT ON THE JOINT DEVELOPMENT AND PRODUCTION SHARING FOR THE AZERI AND CHIRAG FIELDS AND THE DEEP WATER PORTION OF THE GUNASHLI FIELD IN THE AZERBAIJAN SECTOR OF THE CASPIAN SEA

AMONG

THE STATE OIL COMPANY OF THE AZERBAIJAN REPUBLIC

AND

AMOCO CASPIAN SEA PETROLEUM LIMITED

BP EXPLORATION (CASPIAN SEA) LIMITED

DELTA NIMIR KHAZAR LIMITED

DEN NORSKE STATS OLJESELSKAP a.s

LUKOIL JOINT STOCK COMPANY

MCDERMOTT AZERBAIJAN, Inc.

PENNZOIL CASPIAN CORPORATION

RAMCO HAZAR ENERGY LIMITED

TURKIYE PETROLLERI A.O.

UNOCAL KHAZAR, LTD.

XXVI MADDƏ

ƏTRAF MÜHİTİN MÜHAFİZƏSİ VƏ TƏHLÜKƏSİZLİK

26.1 Əməliyyatların aparılması. Podratçı beynəlxalq neft sənayesinin hamılıqla qəbul olunmuş standartlarına sə'ylə əməl edərək bütövlükdə ətraf mühitin, o cümlədən, məhdudiyyət qoymadan, yerin üstünün, yerin təkinin, dənizin, havanın, göllərin, çayların, flora və faunanın, kənd təsərrüfatı bitkilərinin, digər təbii ehtiyatların və əmlakın vəziyyətinin hər hansı potensial pozuntularını minimuma endirmək üçün yuxarıda göstərilən standartlara müvafiq surətdə bütün zəruri tədbirləri görərək, Neft-qaz əməliyyatlarını lazımi səmərə ilə və təhlükəsiz aparır. Tədbirlərin növbəliliyi bu sıra ilə müəyyən edilir: həyatın mühafizəsi, ətraf mühitin mühafizəsi və əmlakın mühafizəsi.

26.2 Qəza vəziyyətləri. Ətraf mühitə zərər vuran və ya zərər vura bilən qəza vəziyyətlərində və ya bədbəxt hadisələr, o cümlədən, lakin bunlarla məhdudlaşmayaraq, partlayışlar, püskürmələr, sızmalar və başqa hadisələr zamanı Podratçı həmin hallar barəsində dərhal ARDNŞ-i xəbərdar edir və vəziyyətin düzəldilməsi üçün gördüyü təcili tədbirlər və əldə edilmiş nəticələr haqqında mə'lumat verir. Podratçı təcili tədbirlər görmək, qəza vəziyyətini nəzarət altına almaq və insan tələfatının, itkilərin və əmlaka zərər dəyməsinin qarşısını almaq, habelə təbii ehtiyatlara və bütövlükdə ətraf mühitə zərər dəyməsinin qarşısını almaq üçün hər cür lazımi sə'ylər göstərir. Podratçı həmçinin görülmüş tədbirlər haqqında ARDNŞ və müvafiq hökumət orqanları qarşısında hesabat verir.

26.3 Qanunlara tabelik. Podratçı Azərbaycan Respublikasının səhiyyəyə, təhlükəsizlik texnikasına, ətraf mühitin mühafizəsinə və bərpasına dair hamılıqla tətbiq edilə bilən mövcud və gələcək qanunlarına, yaxud qərarlarına tabe olur, bu şərtlə ki, həmin qanunların və ya qərarların tələbləri Saziş bağlanarkən qüvvədə olan normaların və beynəlxalq neft sənayesi praktikasının, yə'ni IX Əlavədə göstərilmiş, Podratçının tabe olduğu normaların və praktikanın tələblərindən sərt olmasın. Əgər IX Əlavədə bu və ya digər məsələ barəsində birdən artıq norma/ standart verilirsə, Podratçı Xəzər dənizinin ekoloji sistemi baxımından daha münasib olan normanı tətbiq edir. Əgər müvafiq yurisdiksiyası olan hər hansı regional və ya

XXVI МАДДӘ

ӘТРАФ МҮҺИТИН МҮҺАФИЗӘСИ ВӘ ТӘҺЛҮКӘСИЗЛИК

26.1 Әмәлијјатларын апарылмасы. Подратчы бејнәлхалг нефт сәнајесинин һамылыгла гәбул олунмуш стандартларына сә'јлә әмәл едәрәк бүтөвлүкдә әтраф мүһитин, о ҹүмләдән, мәһдудијјәт гојмадан, јерин үстүнүн, јерин тәкинин, дәнизин, һаванын, ҝөлләрин, чајларын, флора вә фаунанын, кәнд тәсәррүфаты биткиләринин, диҝәр тәбии еһтијатларын вә әмлакын вәзијјәтинин һәр һансы потенсиал позунтуларыны минимума ендирмәк үчүн јухарыда ҝөстәрилән стандартлара мүвафиг сурәтдә бүтүн зәрури тәдбирләри ҝөрәрәк, Нефт-газ әмәлијјатларыны лазыми сәмәрә илә вә тәһлүкәсиз апарыр. Тәдбирләрин нөвбәлилији бу сыра илә мүәјјән едилир: һәјатын мүһафизәси, әтраф мүһитин мүһафизәси вә әмлакын мүһафизәси.

26.2 Гәза вәзијјәтләри. Әтраф мүһитә зәрәр вуран вә ја зәрәр вура билән гәза вәзијјәтләриндә вә ја бәдбәхт һадисәләр, о ҹүмләдән, лакин бунларла мәһдудлашмајараг, партлајышлар, пүскүрмәләр, сызмалар вә башга һадисәләр заманы Подратчы һәмин һаллар барәсиндә дәрһал АРДНШ-и хәбәрдар едир вә вәзијјәтин дүзәлдилмәси үчүн ҝөрдүјү тә'ҹили тәдбирләр вә әлдә едилмиш нәтиҹәләр һаггында мә'лумат верир. Подратчы тә'ҹили тәдбирләр ҝөрмәк, гәза вәзијјәтини нәзарәт алтына алмаг вә инсан тәләфатынын, иткиләрин вә әмлака зәрәр дәјмәсинин гаршысыны алмаг, һабелә тәбии еһтијатлара вә бүтөвлүкдә әтраф мүһитә зәрәр дәјмәсинин гаршысыны алмаг үчүн һәр ҹүр лазыми сә'јләр ҝөстәрир. Подратчы һәмчинин ҝөрүлмүш тәдбирләр һаггында АРДНШ вә мүвафиг һөкумәт органлары гаршысында һесабат верир.

26.3 Ганунлара табелик. Подратчы Азәрбајҹан Республикасынын сәһијјә, тәһлүкәсизлик техникасына, әтраф мүһитин мүһафизәсинә вә бәрпасына даир һамылыгла тәтбиг едилә билән мөвҹуд вә ҝәләҹәк ганунларына, јахуд гәрарларына табе олур, бу шәртлә ки, һәмин ганунларын вә ја гәрарларын тәләбләри Сазиш бағланаркән гүввәдә олан нормаларын вә бејнәлхалг нефт сәнајеси практикасынын, јә'ни IX Әлавәдә ҝөстәрилмиш, Подратчынын табе олдуғу нормаларын вә практиканын тәләбләриндән сәрт олмасын. Әҝәр IX Әлавәдә бу вә ја диҝәр мәсәлә барәсиндә бирдән артыг норма/ стандарт верилирсә, Подратчы Хәзәр дәнизинин еколожи системи бахымындан даһа

СТАТЬЯ XXVI

ПРИРОДООХРАННЫЙ КОНТРОЛЬ И БЕЗОПАСНОСТЬ

26.1 Ведение операций. Подрядчик должен вести Нефтяные операции с надлежащей эффективностью и безопасностью, добросовестно следуя общепринятым стандартам международной нефтяной промышленности и принимая все разумные меры в соответствии с вышеизложенными стандартами, чтобы свести к минимуму любые потенциальные нарушения состояния окружающей среды в целом, включая, без ограничения, поверхность земли, недра, море, воздух, озера, реки, флору и фауну, сельскохозяйственные культуры, другие природные ресурсы и имущество. Очередность действий определяется в следующем порядке: охрана жизни, охрана окружающей среды и охрана имущества.

26.2 Аварийные ситуации. При аварийных ситуациях или при несчастных случаях, включая, без ограничения, взрывы, выбросы, утечки и иные происшествия, наносящие или могущие нанести ущерб окружающей среде, Подрядчик немедленно ставит ГНКАР в известность о таких обстоятельствах и сообщает о принятых им немедленных мерах, направленных на исправление ситуации, и полученных результатах. Подрядчик прилагает все разумные усилия, чтобы принять незамедлительные меры, взять под контроль аварийную ситуацию и предотвратить человеческие жертвы, потери и ущерб имуществу, а также предотвратить нанесение ущерба природным ресурсам и окружающей среде в целом. Подрядчик также отчитывается перед ГНКАР и соответствующими Правительственными органами власти о принятых мерах.

26.3 Подчинение законам. Подрядчик подчиняется общеприменимым действующим и будущим законам или постановлениям Азербайджанской Республики по здравоохранению, технике безопасности, защите и восстановлению окружающей среды, в той мере, в какой требования этих законов или постановлений не являются более жесткими, чем требования действующих на то время норм и практики международной нефтяной промышленности, то есть, тех, которые на дату заключения настоящего Соглашения приведены в Приложении IX, и которым подчиняется Подрядчик. Если Приложение IX содержит более одной нормы/стандарта в отношении того или иного вопроса, то Подрядчик

ARTICLE XXVI

ENVIRONMENTAL PROTECTION AND SAFETY

26.1 Conduct of Operations. Contractor shall conduct the Petroleum Operations in a diligent, safe and efficient manner in accordance with generally accepted international Petroleum industry standards and shall take all reasonable actions in accordance with said standards to minimize any potential disturbance to the general environment, including without limitation the surface, subsurface, sea, air, lakes, rivers, animal life, plant life, crops, other natural resources and property. The order of priority for actions shall be the protection of life, environment and property.

26.2 Emergencies. In the event of emergency and accidents, including but not limited to explosions, blow-outs, leaks and other incidents which damage or might damage the environment, Contractor shall promptly notify SOCAR of such circumstances and of its first steps to remedy this situation and the results of said efforts. Contractor shall use all reasonable endeavours to take immediate steps to bring the emergency situation under control and protect against loss of life and loss of or damage to property and prevent harm to natural resources and to the general environment. Contractor shall also report to SOCAR and appropriate Government authorities on the measures taken.

26.3 Compliance. Contractor shall comply with present and future Azerbaijani laws or regulations of general applicability with respect to public health, safety and protection and restoration of the environment, to the extent that such laws and regulations are no more stringent than the then current international Petroleum industry standards and practices being at the date of execution of this Contract those shown in Appendix IX, with which Contractor shall comply. If Appendix IX specifies more than one standard with respect to a matter, Contractor will use the standard most appropriate relative to the ecosystem of the Caspian Sea. In the event any regional or multi-governmental authority having jurisdiction enacts or promulgates environmental hökumətlərarası orqan Kontrakt sahəsinə aid olan ətraf mühitin mühafizəsi normalarını qəbul edirsə və ya müzakirəyə verirsə, Tərəflər onların layihəyə göstərə biləcəyi tə'siri müzakirə edir. Bu Saziş üzrə Podratçının hüquqlarına və ya mənafelərinə mənfi tə'sir göstərə bilən hər hansı bu cür normalara Podratçının tabe olması, yaxud tabe olmağa cəhd göstərməsi barəsində 23.2 bəndinin müddəaları tətbiq olunur.

26.4 Ətraf mühitin vəziyyətinin bazis tədqiqi. Ətraf mühitin fasiləsiz nəzarət.

(a) Qüvvəyəminmə tarixi üçün Kontrakt sahəsinin hüdudları daxilində ətraf mühitin cari vəziyyətini müəyyən etmək məqsədilə Podratçı ətraf mühitin mühafizəsi məsələləri üzrə beynəlxalq miqyasda tanınmış məsləhətçi şirkət tərəfindən ətraf mühitin vəziyyətinin bazis tədqiqinin aparılmasını təşkil edir (X Əlavəyə əsasən Məcburi işlərin minimum proqramı çərçivəsində). Podratçının seçdiyi həmin şirkət ARDNŞ üçün məqbul olmalıdır. ARDNŞ həmin şirkətlə və Podratçının nümayəndələri ilə əməkdaşlıq şəraitində tədqiqatın hazırlanmasında iştirak etmək üçün öz nümayəndələrini təklif edir. Bu tədqiqatı Podratçı maliyyələşdirir; ARDNŞ-in tə'yin etdiyi nümayəndələrlə əlaqədar bütün xərcləri özünün ödəməsi istisna olmaqla. Bu tədqiqatla çəkilən məsrəflər XI Maddəyə müvafiq surətdə ödənilir. Podratçı öz əməliyyatlarına fasiləsiz ekoloji nəzarət qoyur. Tullantılar üzrə hər hansı metodların və ya standartların yenidən nəzərdən keçirilməsinin zəruriliyini müəyyənləşdirmək məqsədilə toplanmış mə'lumatlar heç olmasa ildə bir dəfə təhlil edilir. IX Əlavədə göstərilmiş Ətraf mühitin mühafizəsi strategiyasında Podratçının (əgər 10.3 bəndində göstərildiyi kimi, Çıraq-1 platformasında işlər, yaxud 15.2 (e) bəndinə uyğun olaraq Üçüncü tərəflə birlikdə və ya onsuz işlər görəcəksə, həm də ARDNŞ-in) Kontrakt sahəsində Neft-qaz əməliyyatları apararkən rəhbər tutacağı Ətraf mühitin mühafizəsi proqramının ümumi çərçivələri səciyyələndirilir. Fasiləsiz nəzarət proqramı prosesində toplanmış mə'lumatların qiymətləndirilməsi, habelə bazis tədqiqatı mə'lumatları belə bir məsələnin həlli üçün əsas olacaqdır ki, ətraf mühitə hər hansı qeyri-məqbul tə'sir Neft-qaz əməliyyatları zamanı Podratçının hərəkətlərinin nəticəsidir (bunun üçün Podratçı

мүнасиб олан нормалары тәтбиг едир. Әкәр мүвафиг јурисдиксијасы олан һәр һансы реҝионал вә ја һөкумәтләрарасы орган Контракт саһәсинә аид олан әтраф мүһитин мүһафизәси нормаларыны гәбул едирсә вә ја мүзакирәјә верирсә, Тәрәфләр онларын лајиһәјә кәстәрә биләҹәји тә'сири мүзакирә едир. Бу Сазиш үзрә Подратчынын һүгугларына вә ја мәнафеләринә мәнфи тә'сир кәстәрә билән һәр һансы бу ҹүр нормалара Подратчынын табе олмасы, јахуд табе олмаға ҹәһд кәстәрмәси барәсиндә 23.2 бәндинин мүддәалары тәтбиг олунур.

26.4 Әтраф мүһитин вәзијјәтинин базис тәдгиги. Әтраф мүһитә фасиләсиз нәзарәт.

(а) Гүввәјәминмә тарихи үчүн Контракт саһәсинин һүдудлары дахилиндә әтраф мүһитин ҹари вәзијјәтини мүәјјән етмәк мәгсәдилә Подратчы әтраф мүһитин мүһафизәси мәсәләләри үзрә бејнәлхалг мигјасда танынмыш мәсләһәтчи ширкәт тәрәфиндән әтраф мүһитин вәзијјәтинин базис тәдгигинин апарылмасыны тәшкил едир (IX Әлавәјә әсасән Мәҹбури ишләрин минимум програмы чәрчивәсиндә). Подратчынын сечдији һәмин ширкәт АРДНШ үчүн мәгбул олмалыдыр. АРДНШ һәмин ширкәтлә вә Подратчынын нүмајәндәләри илә әмәкдашлыг шәраитиндә тәдгигатын һазырланмасында иштирак етмәк үчүн өз нүмајәндәләрини тәклиф едир. Бу тәдгигаты Подратчы малијјәләшдирир; АРДНШ-ин тә'јин етдији нүмајәндәләрлә әлагәдар бүтүн хәрҹләри өзүнүн өдәмәси истисна олмагла. Бу тәдгигатла чәкилән мәсрәфләр XI Маддәјә мүвафиг сурәтдә өдәнилир. Подратчы өз әмәлијјатларына фасиләсиз екологи нәзарәт гојур. Туллантылар үзрә һәр һансы методларын вә ја стандартларын јенидән нәзәрдән кечирилмәсинин зәрурилијини мүәјјәнләшдирмәк мәгсәдилә топланмыш мә'луматлар һеч олмаса илдә бир дәфә тәһлил едилир. IX Әлавәдә кәстәрилмиш Әтраф мүһитин мүһафизәси стратекијасында Подратчынын (әкәр 10.3 бәндиндә кәстәрилдији кими, Чыраг-1 платформасында ишләр, јахуд 15.2 (е) бәндинә ујғун олараг Үчүнҹү тәрәфлә бирликдә вә ја онсуз ишләр ҝөрәҹәксә, һәм дә АРДНШ-ин) Контракт саһәсиндә Нефт-газ әмәлијјатлары апараркән рәһбәр тутаҹағы Әтраф мүһитин мүһафизәси програмынын үмуми чәрчивәләри сәҹијјәләндирилир. Фасиләсиз нәзарәт

принимает норму, особенно касающуюся по отношению с экосистемы Каспийского моря. В случае, если какой-либо региональный или межправительственный орган, имеющий соответствующую юрисдикцию, принимает или выносит на обсуждение нормы защиты окружающей среды, относящиеся к Контрактной площади, то Стороны обсудят их возможный эффект на проект. В отношении подчинения или попытки подчинения Подрядчиком каких-либо таких норм, имеющих отрицательный эффект на права или интересы Подрядчика по настоящему Соглашению, применяются положения п. 23.2.

26.4 Базисное исследование состояния окружающей среды. Непрерывный мониторинг окружающей среды.

(а) В целях определения текущего состояния окружающей среды в пределах Контрактной площади на Дату вступления в силу Подрядчик организует проведение базисного исследования состояния окружающей среды (в рамках Минимальной программы обязательных работ согласно Приложению X) международно признанной консультативной компанией по вопросам охраны окружающей среды. Такая выбранная Подрядчиком компания должна быть приемлемой для ГНКАР. ГНКАР для участия в подготовке исследования в сотрудничестве с такой компанией и представителями Подрядчика назначит своих представителей. Это исследование финансируется Подрядчиком, за исключением того, что ГНКАР оплачивает все расходы, связанные с назначенными ею представителями. Затраты на это исследование подлежат Возмещению затрат в соответствии со Статьей XI. Подрядчик ведет непрерывный экологический мониторинг собственных операций. В целях определения необходимости пересмотра каких-либо методов или стандартов по выбросам собранные данные подлежат анализу по крайней мере раз в год. В Стратегии охраны окружающей среды, приведенной в Приложении IX, характеризуются общие рамки программы охраны окружающей среды, которой Подрядчик (и ГНКАР, если им будут выполняться работы на платформе Чираг-1, как это оговорено в п. 10.3 или работы вместе с Третьей стороной, или без нее, согласно подпункту 15.2 (е)) будет руководствоваться при выполнении Нефтяных операций на Контрактной площади. Оценка данных, собранных в процессе непрерывной программы мониторинга, а также данные базисного

standards relating to the Contract Area, the Parties will discuss the possible impact thereof on the project. The provisions of Article 23.2 shall apply to any compliance or attempted compliance by Contractor with any such standards which adversely affect the rights or interests of Contractor hereunder.

26.4 Baseline Study and Ongoing Environmental Monitoring

(a) In order to determine the state of the environment in the Contract Area at the Effective Date, Contractor shall cause an environmental base line study (under the Minimum Obligatory Work Programme as referred to in Appendix X) to be carried out by a recognized international environmental consulting firm selected by Contractor, and acceptable to SOCAR. SOCAR shall nominate representatives to participate in preparation of the study in collaboration with such firm and Contractor representatives. The costs of such study shall be borne by Contractor, except that SOCAR shall be liable for all costs associated with the representatives nominated by SOCAR. The costs associated with this study shall be subject to Cost Recovery in accordance with Article XI. Contractor shall conduct ongoing environmental monitoring of its operations. Data collected will be evaluated at least annually to determine if any practices and discharge standards need to be revised. The Environmental Strategy included in Appendix IX outlines the environmental program that Contractor (and SOCAR in the event it carries out operations on the Chirag-1 platform pursuant to Article 10.3 or operations with or without a Third Party pursuant to Article 15.2(e)) will follow during the course of Petroleum Operations within the Contract Area. The evaluation of data collected during the ongoing monitoring program, together with the baseline study, will provide a basis for determining whether any unacceptable environmental impact has been caused by Contractor in the course of conducting Petroleum Operations and for which Contractor may be liable under Article 20.2, or whether the conditions leading to such impact existed prior to the commencement of Petroleum Operations or

20.2 bəndi üzrə məs'uliyyət daşıya bilər), yaxud bu vəziyyət Neft-qaz əməliyyatları başlanınadək mövcud olmuş və Podratçının deyil, hər hansı başqa tərəfin fəaliyyətindən irəli gəlmişdir. ARDNŞ və Podratçı ətraf mühitin vəziyyətinin baza tədqiqini təhlil edəcək və əvvəllər mövcud olmuş belə vəziyyətin nəticəsində meydana gələn və ya meydana gəlmiş hər hansı tə'sirin nəticələrini yüngülləşdirmək üçün hər hansı bərpa tədbirləri görülməsinin tələb edilib-edilmədiyi və əgər tələb edilərsə, Podratçının bərpa işləri proqramını həyata keçirə bilib-bilməyəcəyi barəsində məsləhətləşəcəklər, lakin Tərəflər arasında belə bir razılaşma olmalıdır ki, Podratçı bu cür bərpa proqramı üzrə çəkilmiş xərclər üçün məs'uliyyət daşımır. Hər hansı belə bərpa proqramına Ətraf mühitin mühafizəsinin strategiyası çərçivəsindən kənara çıxan proqram kimi baxılır və o, ARDNŞ ilə Podratçı arasında ayrıca sazişin şərtləri üzrə həyata keçirilir.

програмы [illegible] [illegible] мә'луматларыны тәрјүмәләндирмәлидир, һабелә базис тәдгигаты мә'луматлары белә бир мәсәләнин һәлли үчүн әсас олмалыдыр ки, әтраф мүһитә һәр һансы гејри-мәтбуә тә'сир Нефт-газ әмәлијјатлары заманы Подратчынын һәрәкәтләринин нәтиҹәсидир (буна ҝөрә Подратчы 20.2 бәнди үзрә мәс'улијјәт дашыја биләр), јахуд бу вәзијјәт Нефт-газ әмәлијјатлары башланынадәк мөвҹуд олмуш вә Подратчынын дејил, һәр һансы башга тәрәфин фәалијјәтиндән ирәли ҝәлмишдир. АРДНШ вә Подратчы әтраф мүһитин вәзијјәтинин базис тәдгигатыны тәһлил едәҹәк вә әввәлләр мөвҹуд олмуш белә вәзијјәтин нәтиҹәсиндә мејдана ҝәлән вә ја мејдана ҝәлмиш һәр һансы тә'сирин нәтиҹәләрини јүнҝүлләшдирмәк үчүн һәр һансы бәрпа тәдбирләри ҝөрүлмәсинин тәләб едилиб-едилмәдији вә әҝәр тәләб едиләрсә, Подратчынын бәрпа ишләри програмыны һәјата кечирә билиб-билмәјәҹәји барәсиндә мәсләһәтләшәҹәкләр, лакин Тәрәфләр арасында белә бир разылашма олмалыдыр ки, Подратчы бу ҹүр бәрпа програмы үзрә чәкилмиш хәрҹләр үчүн мәс'улијјәт дашымыр. Һәр һансы белә бәрпа програмына Әтраф мүһитин мүһафизәсинин стратеҝијасы чәрчивәсиндән кәнара чыхан програм кими бахылыр вә о, АРДНШ илә Подратчы арасында ајрыҹа сазишин шәртләри үзрә һәјата кечирилир.

исследования будут служить основанием для решения относительно того, является ли какое-либо неправомерное воздействие на окружающую среду результатом действий Подрядчика при выполнении Нефтегазовых операций, за которое Подрядчик может нести ответственность по п. 20.2, или же результатом того, что такое состояние уже существовало до начала Нефтегазовых операций и было обусловлено деятельностью какой-либо другой стороны, а не Подрядчика. ГНКАР и Подрядчик проанализируют базисное исследование состояния окружающей среды и посоветуются относительно того, требуется ли принятие каких-либо восстановительных мер для смягчения последствий любого воздействия, возникающего или возникшего в результате такого ранее существовавшего состояния, и если да, то может ли программа восстановительных работ быть проведена Подрядчиком, при условии договоренности между Сторонами, что Подрядчик не будет нести ответственность за расходы по такой восстановительной программе. Любая такая восстановительная программа рассматривается как выходящая за рамки Стратегии охраны окружающей среды и осуществляется по условиям отдельного соглашения между ГНКАР и Подрядчиком.

otherwise from activities conducted by a party other than Contractor. SOCAR and Contractor shall review the environmental base line study and consult to determine whether any remedial action is warranted to mitigate the effects of any impact which occurs or has occurred from such prior conditions, and if so, whether a programme of remediation could be carried out by Contractor, it being agreed among the Parties that Contractor shall not be liable for any of the expense of such a remedial programme. Any such remedial program undertaken will be considered outside the scope of the Environmental Strategy and will be conducted pursuant to the terms of a separate agreement between SOCAR and Contractor.

(b) 15.2 (c) bəndinə müvafiq surətdə Sərbəst təbii qaz çıxarılması üçün, 10.3 bəndində göstərildiyi kimi, Çıraq-1 platformasının ARDNŞ-in qüvvələri ilə istismar edildiyi vəziyyətdə hər hansı başqa obyektlər/ vəsaitlər ARDNŞ-in və/yaxud hər hansı Üçüncü tərəfin qüvvələri ilə istismar edildiyi halda Podratçının ixtiyarı vardır ki, fasiləsiz nəzarət proqramı ilə əlaqədar olaraq Çıraq-1 platformasını və bu cür başqa obyektləri/vəsaitləri və ARDNŞ-in və/yaxud hər hansı Üçüncü tərəfin bunlarla bağlı əməliyyatlarını müntəzəm surətdə yoxlasın, o cümlədən, lakin bununla məhdudlaşmayaraq nəzarət aparatları qoysun və nəzarət proqramına aid nümunələr toplasın. Podratçının apardığı yuxarıda göstərilən yoxlamalar, nümunələrin seçilməsi və nəzarət aparatlarının qoyulması işlərini Podratçı elə tərzdə görür ki, Çıraq-1 platformasında və ya bu cür başqa obyektlərdə/ vəsaitlərdə ARDNŞ-in və/yaxud hər hansı Üçüncü tərəfin əməliyyatlarına əsassız maneçilik törədilməsin.

(b) 15.2 (c) бәндинә мүвафиг сурәтдә Сәрбәст тәбии газ чыхарылмасы үчүн, 10.3 бәндиндә ҝөстәрилдији кими, Чыраг-1 платформасынын АРДНШ-ин гүввәләри илә истисмар едилдији вәзијјәтдә һәр һансы башга објектләр/ васитәләр АРДНШ-ин вә/јахуд һәр һансы Үчүнҹү тәрәфин гүввәләри илә истисмар едилдији һалда Подратчынын ихтијары вардыр ки, фасиләсиз нәзарәт програмы илә әлагәдар олараг Чыраг-1 платформасыны вә бу ҹүр башга објектләри/васитәләри вә АРДНШ-ин вә/јахуд һәр һансы Үчүнҹү тәрәфин бунларла бағлы әмәлијјатларыны мүнтәзәм сурәтдә јохласын, о ҹүмләдән, лакин бунунла мәһдудлашмајараг нәзарәт апаратлары гојсун вә нәзарәт програмына аид нүмунәләр топласын. Подратчынын апардығы јухарыда ҝөстәрилән јохламалар, нүмунәләрин сечилмәси вә нәзарәт апаратларынын гојулмасы ишләрини Подратчы елә тәрздә ҝөрүр ки, Чыраг-1 платформасында вә ја бу ҹүр башга објектләрдә/ васитәләрдә АРДНШ-ин вә/јахуд һәр һансы Үчүнҹү тәрәфин

(b) В случае эксплуатации платформы Чираг-1 силами ГНКАР, как это оговорено в п. 10.3, и/или в случае эксплуатации каких-либо других объектов/средств силами ГНКАР и/или какой-либо Третьей стороны в отношении разработки Свободного природного газа в соответствии с подпунктом 15.2 (c), Подрядчик вправе, в связи с непрерывной программой мониторинга, проводить регулярные инспекции платформы Чираг-1 и таких других объектов/средств, и операций, которые ГНКАР и/или какая-либо Третья сторона ведет относительно их, включая, но не ограничиваясь этим, установку аппаратуры мониторинга и сбор проб, относящихся к программе мониторинга. Указанные выше проводимые Подрядчиком инспекции, отбор проб и установка аппаратуры мониторинга выполняются им таким образом, чтобы не мешать безосновательно операциям ГНКАР и/или какой-либо Третьей стороны на платформе Чираг-1 или таких других объектах/средствах.

(b) In the event SOCAR operates the Chirag-1 platform as provided pursuant to Article 10.3 and/or SOCAR and/or any Third Party operates any other facilities with respect to development of Non-Associated Natural Gas pursuant to Article 15.2(c), then in connection with performance of the ongoing monitoring program Contractor shall have the right to make periodic inspections of the Chirag-1 platform and such other facilities and SOCAR's and/or any Third Party's operations with respect thereto, including, but not limited to, the placement of monitoring devices and collection of samples relevant to the monitoring program. Contractor's above referenced inspections, sampling and placement of monitoring devices shall be performed by Contractor in a manner which does not unreasonably interfere with SOCAR's and/or any such Third Party's operations on the Chirag-1 platform or such other facilities.

26.5 Ətraf mühitə ziyan vurulması

(a) Podratçı onun Azərbaycan Respublikasının müvafiq məhkəməsi tərəfindən müəyyən edilmiş təqsiri üzündən ətraf mühitin hər hansı şəkildə çirklənməsi nəticəsində Üçüncü tərəfin (Hökumət istisna olmaqla) mə'ruz qaldığı birbaşa itkilər və ya ziyan üçün məs'uliyyət daşıyır. Podratçının təqsiri üzündən ətraf mühit çirkləndiyi və ya ona ziyan vurulduğu halda Podratçı beynəlxalq neft-qaz sənayesində hamılıqla qəbul olunmuş metodlara müvafiq surətdə ətraf mühitin bu cür çirklənməsinin və ya vurulmuş ziyanın tə'sirini azaltmaq üçün lazımi sə'ylər göstərir.

(b) Podratçı bu Sazişin Qüvvəyəminmə tarixindən əvvəl mövcud olan, o cümlədən, lakin bunlarla məhdudlaşmayan halların səbəbkarı olmadığı hər hansı ekoloji çirklənmə və ya ətraf mühitə dəyən digər ziyan üçün, yaxud yaranmış ekoloji vəziyyətə və ya problemlərə görə, eləcə də 10.3 bəndinə əsasən Çıraq-1 platformasının ARDNŞ tərəfindən istismarı və 15.2 (e) bəndinə əsasən ARDNŞ-in və/yaxud hər hansı Üçüncü tərəfin Sərbəst təbii qazı çıxarması nəticəsində hər hansı bir ekoloji çirklənmə və ya ətraf mühitə dəyən digər ziyana və yaranmış ekoloji vəziyyətə, yaxud problemlərə görə cavabdeh deyil və onlardan irəli gələn, yaxud onlarla bağlı iddialar, ziyan və itkilər üçün heç bir xərc çəkmir, ödənc vermir və maddi məs'uliyyət daşımır; və ARDNŞ Podratçını, onun Subpodratçılarını, onun və onların məsləhətçilərini, agentlərini, işçilərini, qulluqçularını və direktorlarını yuxarıda deyilənlərlə əlaqədar olaraq hər cür və bütün məsrəflərdən, xərclərdən və məs'uliyyətdən azad edir və onlara kompensasiya verir.

(c) Ətraf mühitin çirklənməsinə və ya ona ziyan dəyməsinə görə Podratçıya qarşı irəli sürülən hər hansı iddialar, tələblər, məhkəmə tə'qibləri, yaxud məhkəmə başlanı nəticəsində və ya bunlarla əlaqədar olaraq Podratçının mə'ruz qaldığı hər hansı zərər, məs'uliyyət, itkilər, məsrəflər və xərclər (Podratçının Qərəzli xətası nəticəsində baş verən belə çirklənmə və ya dəyən belə zərər

мәсләһәтчиләринин әсасы манчынмыс тәрәддүтсенә.

26.5 Әтраф мүһитә зијан вурулмасы

(а) Подратчы онун Азәрбајҹан Республикасынын мүвафиг мәһкәмәси тәрәфиндән мүәјјән едилмиш тәгсири үзүндән әтраф мүһитин һәр һансы шәкилдә чиркләнмәси нәтиҹәсиндә Үчүнҹү тәрәфин (Һөкумәт истисна олмагла) мә'руз галдығы бирбаша иткиләр вә ја зијан үчүн мәс'улијјәт дашыјыр. Подратчынын тәгсири үзүндән әтраф мүһит чиркләндији вә ја она зијан вурулдуғу һалда Подратчы бејнәлхалг нефт-газ сәнајесиндә һамылыгла гәбул олунмуш методлара мүвафиг сурәтдә әтраф мүһитин бу ҹүр чиркләнмәсинин вә ја вурулмуш зијанын тә'сирини азалтмаг үчүн лазыми сә'јләр көстәрир.

(b) Подратчы бу Сазишин Гүввәјәминмә тарихиндән әввәл мөвҹуд олан, о ҹүмләдән, лакин бунларла мәһдудлашмајан һалларын сәбәбкары олмадығы һәр һансы еколожи чиркләнмә вә ја әтраф мүһитә дәјән дикәр зијан үчүн, јахуд јаранмыш еколожи вәзијјәтә вә ја проблемләрә көрә, еләҹә дә 10.3 бәндинә әсасән Чыраг-1 платформасынын АРДНШ тәрәфиндән истисмары вә 15.2 (е) бәндинә әсасән АРДНШ-ин вә/јахуд һәр һансы Үчүнҹү тәрәфин Сәрбәст тәбии газы чыхармасы нәтиҹәсиндә һәр һансы бир еколожи чиркләнмә вә ја әтраф мүһитә дәјән дикәр зијана вә јаранмыш еколожи вәзијјәтә, јахуд проблемләрә көрә ҹавабдеһ дејил вә онлардан ирәли кәлән, јахуд онларла бағлы иддиалар, зијан вә иткиләр үчүн һеч бир хәрҹ чәкмир, өдәнҹ вермир вә мадди мәс'улијјәт дашымыр; вә АРДНШ Подратчыны, онун Субподратчыларыны, онун вә онларын мәсләһәтчиләрини, агентләрини, ишчиләрини, гуллугчуларыны вә директорларыны јухарыда дејиләнләрлә әлагәдар олараг һәр ҹүр вә бүтүн мәсрәфләрдән, хәрҹләрдән вә мәс'улијјәтдән азад едир вә онлара компенсасија верир.

(c) Әтраф мүһитин чиркләнмәсинә вә ја она зијан дәјмәсинә көрә Подратчыја гаршы ирәли сүрүлән һәр һансы иддиалар, тәләбләр, мәһкәмә тә'гибләри, јахуд мәһкәмә башланы нәтиҹәсиндә вә ја бунларла әлагәдар олараг Подратчынын мә'руз галдығы һәр һансы зәрәр, мәс'улијјәт, иткиләр, мәсрәфләр вә хәрҹләр (Подратчынын Гәрәзли хәтасы нәтиҹәсиндә

26.5 Ущерб окружающей среде

(a) Подрядчик несет ответственность за те прямые убытки или ущерб, понесенные Третьей стороной (за исключением Правительства), причиной которых явилось какое-либо загрязнение окружающей среды, происшедшее по вине Подрядчика, установленной соответствующим судом Азербайджанской Республики. В случае загрязнения окружающей среды или причинения ей вреда по вине Подрядчика, Подрядчик прилагает разумные усилия, в соответствии с общепринятыми в международной нефтегазовой промышленности методами, для уменьшения эффекта такого загрязнения или вреда, причиненного окружающей среде.

(b) Подрядчик не отвечает за, и не несет какие-либо затрат, расходов или материальной ответственности по искам, ущербу или потерям, вытекающим из или относящимся к какому-либо экологическому загрязнению или другому ущербу окружающей среды, к состоянию окружающей среды или проблемам, причиной которых он не является, в том числе, но не только, по условиям, существовавшим до Даты вступления в силу настоящего Соглашения; Подрядчик также не отвечает за какое-либо загрязнение окружающей среды или иной нанесенный окружающей среде ущерб, или состояние или проблемы, возникшие в результате эксплуатации ГНКАР платформы Чираг-1, как это оговорено в п. 10.3, а также в результате разработки ГНКАР и/или какой-либо Третьей стороной Свободного природного газа согласно подпункту 15.2 (d); и ГНКАР возмещает ответственность и компенсирует Подрядчика, его Субподрядчиков, его и их консультантов, агентов, работников, служащих и директоров от любых и всех затрат, расходов и ответственности, возникающих в связи с ними.

(c) Какой-либо ущерб, ответственность, убытки, затраты и расходы, понесенные Подрядчиком в результате или в связи с какими-либо исками, претензиями, судебными преследованиями или разбирательствами, возбужденными против Подрядчика, а также затраты на какие-либо восстановительные и очистительные работы, осуществляемые Подрядчиком из-за загрязнения

26.5 Environmental Damage

(a) Contractor shall be liable for those direct losses or damages incurred by a Third Party (other than the Government) arising out of any environmental pollution determined by the appropriate court of the Azerbaijan Republic to have been caused by the fault of Contractor. In the event of any environmental pollution or environmental damage caused by the fault of Contractor, Contractor shall reasonably endeavour, in accordance with generally acceptable international Petroleum industry practices, to mitigate the effect of any such pollution or damage on the environment.

(b) Contractor shall not be responsible and shall bear no cost, expense or liability for claims, damages or losses arising out of or related to any environmental pollution or other environmental damage, condition or problems which it did not cause, including but not limited to those in existence prior to the Effective Date of this Contract, as well as any environmental pollution or other environmental damage, condition or problems arising out of SOCAR's operation of the Chirag-1 platform pursuant to Article 10.3 and SOCAR's and/or any Third Party's development of Non-Associated Natural Gas pursuant to Article 15.2(d); and SOCAR shall indemnify and hold harmless Contractor, its Sub-contractors and its and their consultants, agents, employees, officers and directors from any and all costs, expenses and liabilities relating thereto.

(c) Any damages, liability, losses, costs and expenses incurred by the Contractor arising out of or related to any claim, demand, action or proceeding brought against Contractor, as well as the costs of any remediation and clean-up work undertaken by Contractor, on account of any environmental pollution or environmental damage (except for such pollution or damage resulting from the Contractor's istisna olunmaqla), habelə Podratçının apardığı hər hansı bərpa və təmizləmə işlərinə çəkilən məsrəflər Neft-qaz əməliyyatlarına çəkilən məsrəflərə daxil edilir.

баш вермә белә чиркләнмә вә ја зијан истисна олунмагла), һабелә Подратчынын апардығы һәр һансы бәрпа вә тәмизләмә ишләринә чәкилән мәсрәфләр Нефт-газ әмәлијјатларына чәкилән мәсрәфләрә дахил едилир.

окружающей среды или нанесенного ей ущерба (за исключением такого загрязнения или ущерба в результате Преднамеренного проступка Подрядчика), причиненных Подрядчиком, входит в Затраты на Нефтегазовые операции.

Wilful Misconduct) caused by the Contractor shall be included in Petroleum Costs.

IX ƏLAVƏ

ƏTRAF MÜHİTİN MÜHAFİZƏSİNİN STANDARTLARI VƏ METODLARI

I. Ətraf mühitin mühafizəsi üzrə köməkçi komitə

A. Ətraf mühitin mühafizəsi üzrə köməkçi komitənin tə'sis edilməsi və təşkilati strukturu Podratçının təklifində şərh olunur; təklif təsdiq olunmaq üçün Rəhbər komitəyə təqdim edilir. Rəhbər komitə tərəfindən təsdiq edildikdən sonra ətraf mühitin mühafizəsi üzrə köməkçi komitə təsdiq olunmuş tövsiyələrə uyğun yaradılır və Podratçı tərəflərin, ARDNŞ-in, Dövlət "Dənizneftqazlayihə" İnstitutunun, başqa tədqiqat institutlarının, habelə Azərbaycan Respublikası Dövlət Ekologiya və Təbiətdən İstifadəyə Nəzarət Komitəsinin nümayəndələrindən ibarət olur.

B. Ətraf mühitin mühafizəsi üzrə köməkçi komitənin vəzifələri

(i) - Müəyyən edilmiş ekoloji parametrlərə nəzarət üçün illik nəzarət proqramını tərtib etmək

- İllik nəzarət proqramını əlaqələndirmək
- Nəticələri nəzərdən keçirmək və tövsiyələr vermək
- İllik hesabatı dərc etdirmək

(ii) Elmi tədqiqat proqramlarının seçilməsi

- Ətraf mühitin mühafizəsi üzrə elmi tədqiqat pro-qramlarını idarə etmək
- Hər hansı İllik iş proqramında və Büdcədə bu məqsəd üçün nəzərdə tutulmuş fondlar ayırmaq
- İşlərin gedişinin icmalını vermək
- Nəticələri dərc etdirmək

IX ӘЛАВӘ

ӘТРАФ МҮҺИТИН МҮҺАФИЗӘСИНИН СТАНДАРТЛАРЫ ВӘ МЕТОДЛАРЫ

I. Әтраф мүһитин мүһафизәси үзрә көмәкчи комитә

A. Әтраф мүһитин мүһафизәси үзрә көмәкчи комитәнин тә'сис едилмәси вә тәшкилат структуру Подратчынын тәклифиндә шәрһ олунур; тәклиф тәсдиг олунмаг үчүн Рәһбәр комитәјә тәгдим едилир. Рәһбәр комитә тәрәфиндән тәсдиг едилдикдән сонра әтраф мүһитин мүһафизәси үзрә көмәкчи комитә тәсдиг олунмуш тәвсијәләрә ујғун јарадылыр вә Подратчы тәрәфләрин, АРДНШ-ин, Дөвләт "Дәнизнефтгазлајиһә" Институтунун, башга тәдгигат институтларынын, һабелә Азәрбајҹан Республикасы Дөвләт Еколоҝија вә Тәбиәтдән Истифадәјә Нәзарәт Комитәсинин нүмајәндәләриндән ибарәт олур.

B. Әтраф мүһитин мүһафизәси үзрә көмәкчи комитәнин вәзифәләри

(i) - Мүәјјән едилмиш еколожи параметрләрә нәзарәт үчүн Иллик нәзарәт програмыны тәртиб етмәк

- Иллик нәзарәт програмыны әлагәләндирмәк
- Нәтиҹәләри нәзәрдән кечирмәк вә тәвсијәләр вермәк
- Иллик һесабаты дәрҹ етдирмәк

(ii) Елми тәдгигат програмларынын сечилмәси

- Әтраф мүһитин мүһафизәси үзрә елми тәдгигат про-грамларыны идарә етмәк
- Һәр һансы Иллик иш програмында вә Бүҹәдә бу мәгсәд үчүн нәзәрдә тутулмуш фондлар ајырмаг
- Ишләрин ҝедишинин иҹмалыны вермәк
- Нәтиҹәләри дәрҹ етдирмәк

ПРИЛОЖЕНИЕ IX

СТАНДАРТЫ И МЕТОДЫ ОХРАНЫ ОКРУЖАЮЩЕЙ СРЕДЫ

I Подкомитет по охране окружающей среды

A. Формирование и организационная структура подкомитета по охране окружающей среды излагаются в предложении Подрядчика, которое представляется Руководящему комитету для утверждения. После утверждения Руководящим комитетом подкомитет по охране окружающей среды создается в соответствии с утвержденными рекомендациями и включает представителей Подрядных сторон, ГНКАР, Гипроморнефтегаза, других исследовательских институтов, а также Государственного Комитета Азербайджанской Республики по экологии и контролю за природопользованием.

B. Обязанности подкомитета по охране окружающей среды

(i) - Составление ежегодной программы мониторинга для отслеживания определенных экологических параметров

- Координация ежегодной программы мониторинга
- Рассмотрение результатов и внесение предложений
- Публикация годового отчета

(ii) Отбор научно-исследовательских программ

- Администрирование научно-исследовательских программ по охране окружающей среды
- Ассигнование фондов, предусмотренных для этой цели в любой Главной рабочей программе и Бюджете
- Обзор хода работ
- Публикация результатов

APPENDIX IX

ENVIRONMENTAL STANDARDS AND PRACTICES

I. Environmental Sub-Committee

A. The formation and organization of an environmental sub-committee shall be set forth in a proposal of Contractor which will be submitted to the Steering Committee for approval. Once approved by the Steering Committee, the environmental sub-committee shall be formed in accordance with the approved recommendation and shall be composed of environmental representatives of Contractor Parties and SOCAR, Gipromorneftegaz, other research institutes, and State Committee of the Azerbaijan Republic on Ecology and Control over the Use of Natural Resources.

B. Responsibilities of the environmental sub-committee

(i) - Design Annual Monitoring Program for monitoring of selected environmental parameters

- Coordinate Annual Monitoring Program
- Review results and propose recommendations
- Publish annual report

(ii) Select research projects

- Administer environmental protection research projects
- Allocate funding as designated for this purpose in any Annual Work Programme and Budget
- Review progress
- Publish results

II. Ətraf mühitin mühafizəsi strategiyası

Ətraf mühitin mühafizəsi üçün 26.4 bəndinə uyğun surətdə riayət ediləcək olan strategiya aşağıdakılardan ibarətdir:

A. İlkin ekoloji şərait (bazis mə'lumatı)

1. Ədəbiyyatın icmalı
2. Beynəlxalq standartların icmalı
3. Aparılan və aparılmış işlərin yoxlanması
4. Ekoloji mə'lumatın toplanması
   - Atmosferin vəziyyəti haqqında
   - Suyun keyfiyyəti haqqında
   - Dənizdibi mühit haqqında
   - Flora və fauna haqqında
   - Meteorologiya və okeanoqrafiya haqqında
   - Çöküntülər haqqında
   - Fon şüalanması haqqında

B. Ətraf mühitə tə'sirin qiymətləndirilməsi (mövcud obyektlər/vasitələr, mə'dən fəaliyyəti, yeni obyektlər/vasitələr.)

1. Layihənin təsviri
2. Ekoloji şəraitin təsviri
3. İstifadə olunan texnologiyanın qiymətləndirilməsi
4. Atmosfera püskürtülərin kadastrı
   - Dispersiyanın modelləşdirilməsi
   - Ətraf mühitə tə'sirin qiymətləndirilməsi
5. Suyun atılmasının kadastrı
   - Suyun atılmasının nəticələrinin proqnozlaşdırılması
   - Ətraf mühitə tə'sirin qiymətləndirilməsi
   - Dənizdə təmizləmə və axıdılma
   - Quruda təmizləmə və axıdılma
   - Quruda və şelfdə su vurulması
6. Tullantıların kadastrı

II. Әтраф мүһитин мүһафизәси стратегијасы

Әтраф мүһитин мүһафизәси үчүн 26.4 бәндинә ујғун сурәтдә риајәт едиләси олан стратегија ашағыдакылардан ибарәтдир:

A. Илкин еколожи шәраит (базис мә'луматы)

1. Әдәбијјатын ичмалы
2. Бејнәлхалг стандартларын ичмалы
3. Апарылан вә апарылмыш ишләрин јохланмасы
4. Еколожи мә'луматын топланмасы
   - Атмосферин вәзијјәти һаггында
   - Сујун кејфијјәти һаггында
   - Дәниздиби мүһит һаггында
   - Флора вә фауна һаггында
   - Метеоролоҝија вә океанографија һаггында
   - Чөкүнтүләр һаггында
   - Фон шүаланмасы һаггында

B. Әтраф мүһитә тә'сирин гијмәтләндирилмәси (мөвчуд објектләр/васитәләр, мә'дән фәалијјәти, јени објектләр/васитәләр.)

1. Лајиһәнин тәсвири
2. Еколожи шәраитин тәсвири
3. Истифадә олунан технолоҝијанын гијмәтләндирилмәси
4. Атмосферә пүскүртүләрин кадастры
   - Дисперсијанын моделләшдирилмәси
   - Әтраф мүһитә тә'сирин гијмәтләндирилмәси
5. Сујун атылмасынын кадастры
   - Сујун атылмасынын нәтичәләринин прогнозлашдырылмасы
   - Әтраф мүһитә тә'сирин гијмәтләндирилмәси
   - Дәниздә тәмизләмә вә ахыдылма
   - Гуруда тәмизләмә вә ахыдылма
   - Гуруда вә шелфдә су вурулмасы
6. Туллантыларын кадастры

II. Стратегия по охране окружающей среды

Стратегия по охране окружающей среды, которой надлежит следовать согласно п. 26.4, представляет собой следующее:

A. Исходная экологическая ситуация (базисные данные)

1. Обзор литературы
2. Обзор международных стандартов
3. Инспекция проводимых работ и правил их осуществления
4. Сбор экологических данных
   - по состоянию атмосферы
   - по качеству воды
   - по бентической среде
   - по флоре и фауне
   - по метеорологии и океанографии
   - по отложениям
   - по фоновым излучениям

B. Оценка воздействия на окружающую среду (существующие объекты/средства, промысловая деятельность и новые объекты/средства)

1. Описание проекта
2. Описание экологической ситуации
3. Оценка используемой технологии
4. Кадастр выбросов в атмосферу
   - Моделирование дисперсии
   - Оценка воздействия на окружающую среду
5. Кадастр сброса воды
   - Прогнозирование последствий сброса воды
   - Оценка воздействия на окружающую среду
   - Система очистки и сброса в море
   - Система очистки на суше и сброс отходов
   - Нагнетание воды на суше и на шельфе
6. Кадастр отходов

II. Environmental Strategy

The environmental strategy to be pursued pursuant to Article 26.4 shall be as follows:

A. Baseline Data

1. Literature review
2. International standards review
3. Audit of existing operations and practices
4. Environmental data collection
   - Atmospheric
   - Water Quality
   - Benthic
   - Flora and Fauna
   - Meteorological and Oceanographic
   - Sediment
   - Background Radiation

B. Environmental Impact Assessment (existing facilities, exploration and production activities and new facilities)

1. Project description
2. Environment description
3. Technology assessment
4. Air emission inventory
   - Dispersion modelling
   - Impact evaluation
5. Water discharge inventory
   - Fate and effects modelling
   - Impact evaluation
   - Treat and discharge offshore
   - Treat onshore and discharge
   - Injection onshore or offshore
6. Waste Inventory

- Ləğvetmənin mümkün variantları
- Ətraf mühitə tə'sirin qiymətləndirilməsi

- Şelfdə tullantıların təmizlənməsi və ləğv edilməsi
- Quruya daşınması və ləğv edilməsi

7. Ləğvetməyə dair tədqiqatlar

- Ləğvetmə variantları və sərəncamlar
- Ətraf mühitə tə'sirin qiymətləndirilməsi

8. Məsrəfin və mənfəətin təhlili

9. Üstünlük verilən variantların ekoloji cəhətdən əsaslandırılması üstünlük verilməsinə dair bəyanat

C. <u>Neft dağılanda baş verən qəzalarla bağlı işlərin planlaşdırılması</u>

1. Ekoloji xəritələşdirmə

- Təbii məskunlaşma mühiti
- Balıq vətəgələri
- Quşlar
- Heyvanlar aləmi
- Dənizdibi orqanizmlər
- Dəniz florası

2. Riskin qiymətləndirilməsi

3. Proqnozlaşdırılan variantların modelləşdirilməsi

4. Avadanlığın və materialların mənbələri

5. Kimyəvi təmizləmə üsullarının qiymətləndirilməsi

6. Qəza xidməti

7. Neftlə və kimyəvi maddələrlə çirklənmiş materialların təmizlənməsi və ləğv edilməsi

III. Çirkli sulara nəzarət üzrə normativlər

Aşağıda neft və Təbii qaz kəşfiyyatı və hasilatı sahəsində tullantılar üzrə ümumi və konkret normativlər verilmişdir.

A. Ümumi normativlər

- Ләғветмәнин мүмкүн вариантлары
- Әтраф мүһитә тә'сирин гијмәтләндирилмәси
- Шелфдә туллантыларын тәмизләнмәси вә ләғв едилмәси
- Гуруја дашынмасы вә ләғв едилмәси

7. Ләғветмәјә даир тәдгигатлар

- Ләғветмә вариантлары вә сәрәнҹамлар
- Әтраф мүһитә тә'сирин гијмәтләндирилмәси

8. Мәсрәфин вә мәнфәәтин тәһлили

9. Үстүнлүк верилән вариантларын еколожи ҹәһәтдән әсасландырылмасы үстүнлүк верилмәсинә даир бәјанат

C. <u>Нефт дағыланда баш верән гәзаларла бағлы ишләрин планлашдырылмасы</u>

1. Еколожи хәритәләшдирмә

- Тәбии мәскунлашма мүһити
- Балыг вәтәгәләри
- Гушлар
- Һејванлар аләми
- Дәнииздиби организмләр
- Дәниз флорасы

2. Рискин гијмәтләндирилмәси

3. Прогнозлашдырылан вариантларын моделләшдирилмәси

4. Аваданлығын вә материалларын мәнбәләри

5. Кимјәви тәмизләмә үсулларынын гијмәтләндирилмәси

6. Гәза хидмәти

7. Нефтлә вә кимјәви маддәләрлә чиркләнмиш материалларын тәмизләнмәси вә ләғв едилмәси

III. <u>Чиркли сулара нәзарәт үзрә нормативләр</u>

Ашағыда нефт вә Тәбии газ кәшфијјаты вә һасилаты саһәсиндә туллантылар үзрә үмуми вә конкрет нормативләр верилмишдир.

A. <u>Үмуми нормативләр</u>

- Возможные варианты удаления
- Оценка воздействия на окружающую среду

- Очистка на шельфе и сброс

- Транспортировка и удаление на суше

7. Исследования по ликвидации

- Варианты ликвидации и распоряжения
- Оценка воздействия на окружающую среду

8. Анализ издержек и прибыли

9. Экологическое обоснование предпочтительных вариантов.

C. <u>Планирование аварийных работ при разливах нефти</u>

1. Экологическое картирование

- Естественная среда обитания
- Рыбные промыслы
- Пернатые
- Животный мир
- Бентические организмы
- Морская флора

2. Оценка риска

3. Моделирование прогнозируемых вариантов

4. Источники оборудования и материалов

5. Оценка химических способов очистки

6. Аварийная служба

7. Очистка и удаление материалов, загрязненных нефтяными и химическими веществами

III. <u>Нормативы по контролю за сточными водами</u>

Ниже приведены общие и конкретные нормативы по сбросам, связанным с деятельностью по разведке и добыче нефти и природного газа.

A. <u>Общие нормативы</u>

- Disposal options
- Impact evaluation

- Offshore treatment and disposal

- Transportation and onshore disposal

7. Abandonment studies

- Disposal options
- Impact evaluation

8. Cost benefit analysis

9. Environment statement of preferred options

C. <u>Oil Spill Response Planning</u>

1. Sensitivity mapping

- Habitats
- Fisheries
- Birds
- Animals
- Benthic organisms
- Marine flora

2. Risk Assessment

3. Prediction modelling

4. Equipment and material resourcing

5. Evaluation of chemical treatments

6. Response organizations

7. Treatment and disposal of oil and chemical contaminated material

III. <u>Effluent Guidelines</u>

The following are general and specific guidelines relating to discharges associated with oil and natural gas exploration and production activities.

A. <u>General Guidelines</u>

1. Aşağıdakı normativlərdə göstərilənlər istisna edilməklə e'mal olunmuş neft, quyulardan çıxan qum, lay suyu, buruq məhlulu, buruq şlamı, yaxud kəşfiyyat və hasilat meydançalarındakı başqa tullantılar axıdılmır.

2. İcazə olmadan bilavasitə dəniz səthinə tullantı qadağandır. Bu cür normativlərə yol verilən bütün tullantılara kessonlara buraxılma yolu ilə nəzarət edilir; kessonların açıq ucları daim dəniz səthindən azı altmış (60) sm. dərinlikdə yerləşdirilir.

B. Tullantı normaları və tullantıya nəzarət

1. Çıxarılan lay suyu

a) Əgər Xəzər dənizinin suyu ilə lay suyunun uyuşmasını aydınlaşdırmaq üçün standart sınağın yekunları göstərsə ki, bu iki su axınının qarışması nəticəsində Karbohidrogenlər hasilatının ümumi səviyyəsinin aşağı düşməsinə səbəb olan lay zədələnməsi baş verməyəcək, onda Podratçı lay təzyiqini saxlamaq üçün lay suyundan istifadə etməyə çalışacaqdır. Əgər bu iki su axını bir-birinə uyuşsa, Podratçı ilkin qaydada təmizlənmiş suyu yalnız lay təzyiqini saxlamaq üçün tələb edilən ümumi miqdardan çox olan həcmdə və ya qəza vəziyyəti yarandıqda, avadanlıq sındıqda, yaxud mexaniki cəhətdən nasaz olduqda Xəzər dənizinə ata bilər. Əgər yuxarıda göstərilən sular uyuşmasa, Podratçı çıxan lay suyunu ilkin qaydada təmizlədikdən sonra Xəzər dənizinə ata bilər. Lay suyunun təmizlənməsi neftin və yağın sutkalıq qatılığının 72 mq/l-dən çox olmayan səviyyəyə, orta aylıq qatılığının isə 48 mq/l-ə çatmasını tə'min etməlidir. Neftin və yağın qatılığını ölçmək üçün EPA 413.1(79) üzrə qravimetrik (ekstraksiya) təyinetmə metodlarından istifadə olunur.

1. Ашағыдакы нормативләрдә көстәриләнләр истисна едилмәклә е'мал олунмуш нефт, гујулардан чыхан гум, лај сују, бурут мәһлулу, бурут шламы, јахуд кәшфијјат вә һасилат мејданчаларындакы башга туллантылар атылмыр.

2. Иҹазә олмадан билаваситә дәниз сәтһинә туллантı гадағандыр. Бу ҹүр нормативләрә јол верилән бүтүн туллантылара кессонлара бурахылма јолу илә нәзарәт едилир; кессонларын ачыг уҹлары даим дәниз сәтһиндән азы алтмыш (60) см дәринликдә јерләшдирилир.

B. Туллантı нормалары вә туллантыја нәзарәт

1. Чыхарылан лај сују

а) Әкәр Хәзәр дәнизинин сују илә лај сујунун уjушмасыны ајдынлашдырмаг үчүн стандарт сынағын јекунлары көстәрсә ки, бу ики су ахынынын гарышмасы нәтиҹәсиндә Карбоһидрокенләр һасилатынын үмуми сәвијјәсинин ашағы дүшмәсинә сәбәб олан лај зәдәләнмәси баш вермәјәҹәк, онда Подратчы лај тәзјигини сахламаг үчүн лај сујундан истифадә етмәјә чалышаҹагдыр. Әкәр бу ики су ахыны бир-биринә уjушса, Подратчы илкин гајдада тәмизләнмиш сују јалныз лај тәзјигини сахламаг үчүн тәләб едилән үмуми мигдардан чох олан һәҹмдә вә ја гәза вәзијјәти јарандыгда, аваданлыг сындыгда, јахуд механики ҹәһәтдән насаз олдугда Хәзәр дәнизинә ата биләр. Әкәр јухарыда көстәрилән сулар уjушмаса, Подратчы чыхан лај сујуну илкин гајдада тәмизләдикдән сонра Хәзәр дәнизинә ата биләр. Лај сујунун тәмизләнмәси нефтин вә јағын суткалыг гатылығынын 72 мг/л-дән чох олмајан сәвијјәјә, орта ајлыг гатылығынын исә 48 мг/л-ә чатмасыны тә'мин етмәлидир. Нефтин вә јағын гатылығыны өлчмәк үчүн EPA 413.1(79) үзрә гравиметрик (екстраксија) тәјинетмә методларындан истифадә олунур.

1. Сброс отработанной нефти, вынесенного из скважин песка и попутно добываемой воды, бурового раствора, бурового шлама или иных отходов с площадок проведения разведки и добычи не производится, за исключением сброса в соответствии со нижеследующими нормативами.

2. Несанкционированный непосредственный сброс на морскую поверхность запрещается. Все допускаемые такими нормативами сбросы контролируются путем сброса в морские кессоны, открытые концы которых постоянно погружены на глубину не менее шестидесяти (60) сантиметров от поверхности моря.

B. Нормативы и текущий контроль за сбросом

1. Попутно добываемая вода

а) Подрядчик будет стремиться использовать попутную воду для поддержания пластового давления, если результаты стандартного испытания на совместимость с водой Каспийского моря покажут, что при этом не произойдет повреждения пласта, ведущего к уменьшению общего уровня добычи углеводородов, как следствие смешения этих двух потоков воды. В случае совместимости этих двух потоков воды Подрядчик может сбрасывать в Каспийское море предварительно очищенную добываемую воду только в том объеме, какой превышает общее количество воды, требуемое для поддержания пластового давления, или в случае аварийной ситуации, поломки или механической неисправности оборудования. Если упомянутые потоки воды окажутся несовместимыми, Подрядчик может сбрасывать попутно добываемую воду в Каспийское море после очистки. Очистка попутной воды должна обеспечить суточную концентрацию нефти и масла, не превышающую 72 мг/л, а среднемесячную - 48 мг/л. Для измерения концентрации нефти и масла применяются гравиметрические (экстракционные) методы определения по EPA 413.1(79).

1. There shall be no discharge of waste oil, produced water and sand, drilling fluids, drill cuttings or other wastes from exploration and production sites except in accordance with the following guidelines.

2. There shall be no unauthorized discharges directly to the surface of the sea. All discharges authorized by these guidelines shall be controlled by discharging into a caisson whose open end is submerged, at all times, a minimum of sixty (60) centimeters below the surface of the sea.

B. Discharge Guidelines and Monitoring

1. Produced Water

(a) Contractor will endeavor to utilize produced water for reservoir pressure maintenance if, through standard compatibility testing with Caspian Sea water, no damage to the reservoir resulting in a reduction in overall hydrocarbon recovery would occur by mixing the two water streams. In the event that the two water streams are compatible, Contractor may only discharge a volume of produced water after treatment to the Caspian Sea that exceeds the total volume required for reservoir pressure maintenance or in the event of an emergency, accident or mechanical failure. In the event that the two water streams are not compatible, Contractor may discharge produced water to the Caspian Sea after treatment. Treatment of produced water will result in an oil and grease concentration that does not exceed 72 mg/l on a daily basis or 48 mg/l on a monthly average. The gravimetric (extraction) test method EPA 413.1 (79) shall be used to measure the oil and grease concentration.

2. Buruq şlamı və buruq məhlulları

a) Az zəhərli buruq məhlulları və bioloji cəhətdən parçalanan buruq məhlulları istisna olmaqla, neft mənşəli buruq məhlullarını atmaq qadağandır.

b) Az zəhərli buruq məhlullarından və bioloji cəhətdən parçalanan buruq məhlullarından istifadə nəticəsində alınan buruq şlamı istisna olmaqla, neft mənşəli buruq məhlullarından istifadə nəticəsində alınmış buruq şlamının, tərkibində "yağlı su" tipli emulsiya olan buruq məhlullarının və tərkibində işlənmiş mühərrik yağı, soyuducu yağ, transmissiya yağı və neft mənşəli hər hansı sürtkü yağları olan buruq məhlullarının atılması qadağandır.

c) Əgər buruq məhlulu sistemində xloridlərin maksimum qatılığı "qəbuledici" suyun tərkibindəki qatılıqdan dörd (4) dəfədən çoxdursa, buruq şlamının və buruq məhlullarının atılması qadağandır.

d) Qazma proqramının yerinə yetirilməsinə başlamazdan əvvəl buruq məhlulunun dövretmə sistemi tərtib olunur; həmin sistem laboratoriyada misid dəniz xərçəngindən istifadə etməklə güclü zəhərlilik 96 saat yoxlanması üsulu ilə sınaqdan keçirilir (EPA, ABŞ). LC50 kəmiyyəti üzrə qatılıq dərəcəsi milyon hesabı ilə 30000 hissədən yuxarı olan buruq məhlullarını qazma proqramı həyata keçirilərkən atmağa icazə verilir.

e) Zəhərliliyi Xəzər dənizi üçün müəyyən olunmuş üsullarla təyin etməkdən ötrü qazma zamanı mütəmadi surətdə buruq məhlulunun sınaq nümunələri seçilib götürüləcəkdir.

f) Buruq məhlulunun dövretmə sisteminin tərkibi qazma əməliyyatlarının

3. Буруг шламы вә буруг мәһлуллары

a) Аз зәһәрли буруг мәһлуллары вә биоложи чәһәтдән парчаланан буруг мәһлуллары истисна олмагла, нефт мәншәли буруг мәһлулларыны атмаг гадағандыр.

b) Аз зәһәрли буруг мәһлулларындан вә биоложи чәһәтдән парчаланан буруг мәһлулларындан истифадә нәтиҹәсиндә алынан буруг шламы истисна олмагла, нефт мәншәли буруг мәһлулларындан истифадә нәтиҹәсиндә алынмыш буруг шламынын, тәркибиндә "јағлы су" типли емулсија олан буруг мәһлулларынын вә тәркибиндә ишләнмиш мүһәррик јағы, сојудуҹу јағ, трансмиссија јағы вә нефт мәншәли һәр һансы сүртҝү јағлары олан буруг мәһлулларынын атылмасы гадағандыр.

c) Әҝәр буруг мәһлулу системиндә хлоридләрин максимум гатылығы "гәбуледиҹи" сујун тәркибиндәки гатылыгдан дөрд (4) дәфәдән чохдурса, буруг шламынын вә буруг мәһлулларынын атылмасы гадағандыр.

d) Газма програмынын јеринә јетирилмәсинә башламаздан әввәл буруг мәһлулунун дөвретмә системи тәртиб олунур; һәмин систем лабораторијада мисид дәниз хәрчәнҝиндән истифадә етмәклә ҝүҹлү зәһәрлилик 96 саат јохланмасы үсулу илә сынагдан кечирилир (EPA, АБШ). LC50 кәмијјәти үзрә гатылыг дәрәҹәси милјон һесабы илә 30000 һиссәдән јухары олан буруг мәһлулларыны газма програмы һәјата кечириләркән атмаға иҹазә верилир.

e) Зәһәрлилији Хәзәр дәнизи үчүн мүәјјән олунмуш үсулларла тәјин етмәкдән өтрү газма заманы мүтәмади сурәтдә буруг мәһлулунун сынаг нүмунәләри сечилиб ҝөтүрүләҹәкдир.

f) Буруг мәһлулунун дөвретмә системинин тәркиби газма әмәлијјатларынын

1. Буровой шлам и буровые растворы

a) Запрещается сбрасывать буровые растворы на нефтяной основе, за исключением буровых растворов низкой токсичности и биологически разрушаемых буровых растворов.

b) Запрещается сбрасывать буровой шлам, полученный в связи с использованием буровых растворов на нефтяной основе, буровые растворы с эмульсией типа "вода в масле" и буровые растворы, содержащие отработанное машинное масло, охлаждающее масло, трансмиссионное масло и любые смазочные масла на нефтяной основе, за исключением бурового шлама, полученного в связи с использованием буровых растворов низкой токсичности и биологически разрушаемых буровых растворов.

c) Запрещается сбрасывать буровой шлам и буровые растворы, если максимальная концентрация хлоридов в системе бурового раствора более чем в четыре (4) раза превышает окружающую концентрацию в "принимающей" воде.

d) До начала выполнения программы бурения будет составлена циркуляционная система бурового раствора, подлежащая испытанию в лаборатории методом 96-часовой проверки EPA, США, на острую токсичность с использованием мизидовой креветки. Буровые растворы, у которых величина LC_{50} достигается при концентрации свыше 30000 частей на млн, будет разрешено сбрасывать во время проведения программы бурения.

e) Во время бурения будет проводиться периодический отбор проб бурового раствора для определения токсичности по процедурам, установленным для Каспийского моря.

f) Состав циркуляционной системы бурового раствора может быть

3. Drill Cuttings and Drilling Fluids

(a) There shall be no discharge of oil based drilling fluids, other than low toxicity and biodegradable drilling fluids.

(b) There shall be no discharge of drill cuttings generated in association with the use of oil based drilling fluids, invert emulsion drilling fluids, or drilling fluids that contain waste engine oil, cooling oil, gear oil, or other oil based lubricants, other than cuttings generated in association with the use of low toxicity and biodegradable drilling fluids.

(c) There shall be no discharge of drill cuttings or drilling fluids if the maximum chloride concentration of the drilling fluid system is greater than four (4) times the ambient concentration of the receiving water.

(d) Prior to the start of the drilling programme, a drilling mud system will be designed and laboratory tested under the U.S. EPA 96-hour acute toxicity test using mysid shrimp. Those muds that achieve an LC_{50} value in concentrations of more than 30,000 ppm will be authorised for discharge during the drilling programme.

(e) During drilling operations, mud samples will be collected periodically to determine toxicity using procedures established for the Caspian Sea.

(f) The composition of the mud system may be altered as necessary to meet changes dəyişmələrdən irəli gələn tələblərə uyğun olaraq təshih edilə bilər. Məhluldan neft, duzluluq və zəhərlilik üzrə yuxarıda göstərilən limitlərdən kənara çıxmadığı müəyyən edilərsə, dövretmə sisteminin dəyişilmiş buruq məhlulu atıla bilər.

3. Başqa tullantılar

(a) Üzən bərk maddələr (gözlə görünən) olmadıqda, tərkibində, ümumiyyətlə, 0,5 mq/l-dən çox, lakin 2,0 mq/l-dən az qalıq xloridləri olan çirkli məişət sularını ABŞ-ın Sahil mühafizəsindən və ya ekvivalent dəniz sanitariya nəzarəti qurğusundan vəsiqəsi olan sanitariya təmizləmə sistemi vasitəsilə təmizlədikdən sonra atmağa icazə verilir. Qalıq xloru ölçmək üçün Hach metodu ilə CN-66- DPD sınağı keçirilir.

(b) Tərkibində gözlə görünən üzən bərk maddələr olmadıqda təsərrüfat tullantıları və çirkli məişət sularını atmağa icazə verilir.

(c) Üzən bərk maddələrin olub-olmaması çirkli məişət sularının axıldığı rayonda "qəbuledici" suyun səthini gündüz işığında vizual müşahidə etmək yolu ilə yoxlanır. Müşahidələr səhər və ya günorta yeməyindən sonra, gün işığında və hesablamalara görə atım maksimum həddə çatdığı zaman aparılır.

(d) Duzsuzlaşdırıcı qurğunun tullantıları atılır.

(e) Göyərtə suları və parıltı görünməyən çirkabı atmağa icazə verilir.

(f) Dənizə zibil atmaq qadağandır. Zibil tullantılar üçün nəzərdə tutulan müvafiq sahil qurğusuna daşınır.

әмәлләриниң өзгермегинден гелип чыкан талаплара лайыклыкда тәсһих эдилип билнер. Мәлим болса, нефт, дузлулык ве зәһерлилик боюнча юкарда гөркезилен чәклерден чыкмаяндыгы, айланма системасының үйтгедилен буравлайыш эредиси атылып билнер.

3. Башга галындылар

(a) Үзүп йөрән маддалар (гөзе гөрүнйән) олмадыгында, таркибинде, умумыйетде, 0,5 мг/л-ден чох, ләкин 2,0 мг/л-ден аз галык хлорлары олан черкли мәишет сувларыны АБШ-ың Кенар муһафазасындан ве я эквивалент деңиз санитарија нәзарети гурлушындан шәһадатнамасы олан санитарија тәмизлейиш системасы васытасы билен тәмизләнденсоң атмага ыгтыяр берилйәр. Галык хлоруны өлчемек үчин Hach методу ила CN-66- DPD сынагы гечирилйәр.

(b) Таркибинде гөзе гөрүнйән үзүп йөрән маддалар олмадыгында тәсәррүфат галындыларыны ве черкли мәишет сувларыны атмага ыгтыяр берилйәр.

(c) Үзүп йөрән маддаларың олуп-олмаяндыгы черкли мәишет сувларының атылдыгы районда "кабул эдиҗи" сувуң сатһыны гүндиз визуал мүшаһида этмек йолы билен барланыляр. Мүшаһидалар сәһер ве я гүндизки нахардан соңра, гүн ышыгында ве һасаплamalара гөрә атым максимум дереҗә етен вагтында гечирилйәр.

(d) Дузсузландырыҗы гурлушың галындылары атыляр.

(e) Палуба сувларыны ве парлак гатлак гөрүнмейән черкаби атмага ыгтыяр берилйәр.

(f) Деңизе зибил атмак гадагандыр. Зибил галындылар үчин ниетленен лайык кенар гурлушына дашаляр.

откорректирован в соответствии с требованиями при изменении буровых операций. Измененный буровой раствор циркуляционной системы может быть сброшен, если будет установлено, что он не превышает вышеуказанные лимиты по нефти, солености и токсичности.

3. Другие отходы

a) Разрешается сбрасывать хозяйственные отходы с общим содержанием остаточных хлоридов более 0,5 мг/л, но менее 2,0 мг/л и при условии отсутствия в них видимых плавающих твердых веществ, после обработки системой санитарной очистки, имеющего удостоверение Береговой охраны США или эквивалентного устройства морского санитарного контроля. Для измерения остаточного хлора проводится испытание CN-66-DPD по методу Hach.

b) Разрешается сбрасывать хозяйственные отходы и бытовые сточные воды при условии отсутствия в них видимых плавающих твердых веществ.

c) Проверка на плавающие твердые вещества проводится при дневном свете путем визуального наблюдения поверхности "принимающей" воды в районе выпуска хозяйственных и бытовых отходов. Наблюдения проводятся после утреннего или дневного приема пищи, в период при дневном свете и в тот момент, когда по расчетам сброс максимальный.

d) Отходы из установки для обессоливания сбрасываются.

e) Палубные стоки и промывочные воды разрешается сбрасывать при условии отсутствия в них видимого блеска.

f) Запрещается сбрасывать в море мусор. Мусор транспортируется на соответствующую береговую установку для удаления отходов.

in the drilling operations. The modified mud system may be discharged if it has been shown to meet the above limits on oil, salinity and toxicity.

3. Other Wastes

(a) Sanitary waste may be discharged from a U.S. Coast Guard certified or equivalent Marine Sanitation Device (MSD) with total residual chlorine content greater than 0.5 mg/l but less than 2.0 mg/l as long as no floating solids are observable. The Hach method CN-66-DPD test shall be used to measure the residual chlorine.

(b) Domestic wastes and gray water may be discharged as long as no floating solids are observable.

(c) Monitoring of floating solids shall be accomplished during daylight by visual observation of the surface of the receiving water in the vicinity of the sanitary and domestic waste outfalls. Observations shall be made following either the morning or midday meals and at a time during daylight and maximum estimated discharge.

(d) Desalinization unit wastes shall be discharged.

(e) Deck drainage and wash water may be discharged as long as no visible sheen is observable.

(f) Trash shall not be discharged offshore. Trash shall be transported to an appropriate land-based disposal facility.

4. Nəzarət

(a) Çıxarılan lay suyu

1) Çıxarılan lay suyunun atılma həcminə və atılan maddələrdəki neftin və yağın qatışığına hər gün nəzarət edilir.

2) Neftin və yağın sutkalıq və orta aylıq maksimum qatışığı barədə hesabatlar hər ay verilir.

(b) Buruq şlamı və buruq məhlulları

1) Buruq məhlulları aşqarlarının və onların maye sisteminə əlavə edilən həcmlərinin, yaxud kütlələrinin uçotu hər quyu üçün aparılır.

2) Buruq məhlullarının xassələrinə, o cümlədən neftin həcm faizinə və xloridlərin qatılığına hər gün hər quyu üçün nəzarət edilir.

3) Atılan buruq şlamının və buruq məhlullarının hesablanmış həcmi hər gün qeydə alınır və bu barədə hər ay mə'lumat verilir.

(c) Başqa tullantılar

1. Atılan başqa tullantıların hesablanmış həcmi hər gün qeydə alınır, bu barədə hər ay mə'lumat verilir və aşağıdakılar göstərilir:

(i) çirkli məişət suları;
(ii) məişət tullantıları;
(iii) göyərtə suları və çirkab

4. Назарат

(а) Чыкарылан лај сују

1) Чыкарылан лај сујунун атылан һәҹмине вә атылан маддаларындакы нефтин вә јағын гатышыгына һәр күн нәзарәт едиләр.

2) Нефтин вә јағын суткалыг вә орта ајлыг максимум гатышыгы барада һесабатлар һәр ај берләр.

(b) Бурут шламы вә бурут мәһлуллары

1) Бурут мәһлуллары ашгарларынын вә оларын мајә системинә әлавә едилән һәҹмлеринин, јахуд күтләләринин учоту һәр гују үчүн апарылыр.

2) Бурут мәһлулларынын хассәләринә, о чүмләдән нефтин һәҹм фаизинә вә хлоридләрин гатылыгына һәр күн һәр гују үчүн нәзарәт едиләр.

3) Атылан бурут шламынын вә бурут мәһлулларынын һесабланмыш һәҹми һәр күн гејдә алыныр вә бу барада һәр ај мә'лумат берләр.

(c) Башга туллантылар

1. Атылан башга туллантыларын һесабланмыш һәҹми һәр күн гејдә алыныр, бу барада һәр ај мә'лумат берләр вә ашағыдакылар көстәрилир:

(i) чиркли мәишәт сулары;
(ii) мәишәт туллантылары;
(iii) көјәртә сулары вә чиркаб.

4. Мониторинг

(a) Попутно добываемая вода

1. Объем сброса попутно добываемой воды и концентрация содержащихся в сбросах нефти и масла контролируется ежедневно.

2. Отчеты о максимальной суточной и среднемесячной концентрации нефти и масла делаются ежемесячно.

(b) Буровой шлам и буровые растворы

1) Учет присадок для буровых растворов и их объемов или масс, добавленных к системе промывочной жидкости, ведется для каждой скважины.

2) Свойства буровых растворов, включая объемный процент нефти и концентрацию хлоридов, контролируются ежесуточно для каждой скважины.

3) Подсчитанный объем сброшенного бурового шлама и буровых растворов регистрируется ежедневно и докладывается ежемесячно.

(c) Другие отходы

1. Подсчитанный объем других сбрасываемых отходов регистрируется ежедневно и докладывается ежемесячно с указанием:

(i) хозяйственных отходов;
(ii) бытовых отходов;
(iii) палубных стоков и промывочной воды.

4. Monitoring

(a) Produced water

1. The volume of produced water discharged and concentration of oil and grease contained in the discharge will be monitored daily.

2. The daily maximum and monthly average oil and grease concentration will be reported monthly.

(b) Drill Cuttings and Drilling Fluids

1. An inventory of drilling fluids additives and their volumes or mass added to the drilling fluid system will be maintained for each well.

2. Drilling fluid properties, including volume percent oil and concentration of chlorides, will be monitored daily for each well.

3. The estimated volume of drill cuttings and drilling fluids discharged shall be recorded daily and reported monthly.

(c) Other Wastes

The estimated volume of other wastes discharged shall be recorded daily and reported monthly to include:

(i) Sanitary waste
(ii) Domestic waste
(iii) Deck drainage and wash water

IV. Atmosfera püskürtülər üzrə normativlər və nəzarət

Podratçıya qazı atmosferə buraxmağa icazə verilir. Belə püskürtülər olmalı və ona aşağıdakı qaydada nəzarət edilməlidir:

A. Fərdi çirkləndirici maddə hesabı ilə (ildə 250 qısa ton) ildə 227 metrik tona (İ/MT) bərabər və ya bundan çox miqdarda azot oksidləri (NOx), kükürd dörd oksid (SOx), karbon oksidi (SO), uçucu üzvi birləşmələr (VOC) və ya hissəciklər (RT) atılan və ya atıla bilən hər hansı binalarda, tikililərdə, obyektlərdə və ya qurğularda tullantıları atan bütün avadanlıq üçün belə avadanlığın tipinə və vəziyyətinə uyğun gələn ən mükəmməl nəzarət texnologiyası nəzərdə tutulur. Əgər mənbədən ildə 227 metrik tondan (İ/MT) çox ayrılarsa, həssas obyektlərə potensial tə'siri tə'yin etmək üçün tullantılar modelləşdiriləcəkdir. Obyektlərə mənfi tə'sir göstərən tullantıların həcmi obyektlər çirklənmə mənbəyinə yaxın olan hallarda az ola bilər (QEYD: Avadanlığın ildə 23 metrik tondan (İ/MT) (ildə 25 qısa tondan) az tullayan hər hansı ayrı-ayrı hissələri və ya tə'sir gücü 500 at qüvvəsindən az olan daxili yanacaq mühərrikləri (turbinlər bu tələbi yerinə yetirməkdən azad edilirlər). Obyektlərdə/vasitələrdə qaz məş'əlləri yandırılarkən tüstü olmayacaq, fasiləsiz yardımçı odluqlardan və ya ekvivalent yanma sistemlərindən istifadə edilir.

B. Karbohidrogenlər və ya kondensat saxlanmağı üçün istifadə olunan 1590 kubmetrdən çox (10000 barel) hər hansı çəndə tullantıların minimuma endirilməsi məqsədilə lazımi nəzarət aparatları nəzərdə tutulur.

C. Gücü 500 at qüvvəsindən çox olan daxili yanacaq mühərrikləri/turbinlər NOx və CO tullantılarının göstərilən hədlər daxilində saxlanmasını tə'min etmək üçün hər il nəzarətdən keçirilməlidir. Hər dəfə sınaq keçirilməzdən əvvəl NOx və CO səviyyələrinə nəzarət edən portativ analizatorlar mə'lum etalon qaz nümunəsinin köməyi ilə

IV. Атмосферә пүскүртүләр үзрә нормативләр вә нәзарәт

Подратчыја газы атмосферә бурахмаға иҹазә верилир. Белә пүскүртүләр олмалы вә она ашағыдакы гајдада нәзарәт едилмәлидир:

A. Фәрди чиркләндиричи маддә һесабы илә (илдә 250 гыса тон) илдә 227 метрик тона (İ/MT) бәрабәр вә ја бундан чох мигдарда азот оксидләри (NOx), күкүрд дөрд оксид (SOx), карбон оксиди (CO), учуҹу үзви бирләшмәләр (VOC) вә ја һиссәҹикләр (PT) атылан вә ја атыла билән һәр һансы биналарда, тикилиләрдә, објектләрдә вә ја гурғуларда туллантылары атан бүтүн аваданлыг үчүн белә аваданлығын типинә вә вәзијјәтинә ујғун ҝәлән ән мүкәммәл нәзарәт технолоҝијасы нәзәрдә тутулур. Әҝәр мәнбәдән илдә 227 метрик тондан (İ/MT) чох ајрыларса, һәссас објектләрә потенсиал тә'сири тә'јин етмәк үчүн туллантылар моделләшдириләҹәкдир. Објектләрә мәнфи тә'сир ҝөстәрән туллантыларын һәҹми објектләр чиркләнмә мәнбәјинә јахын олан һалларда аз ола биләр (ГЕЈД: Аваданлығын илдә 23 метрик тондан (İ/MT) (илдә 25 гыса тондан) аз туллајан һәр һансы ајры-ајры һиссәләри вә ја тә'сир ҝүҹү 500 ат ҝүввәсиндән аз олан дахили јанаҹаг мүһәррикләри (турбинләр бу тәләби јеринә јетирмәкдән азад едилирләр). Објектләрдә/васитәләрдә газ мәш'әлләри јандырыларкән түстү олмајаҹаг, фасиләсиз јардымчы одлугларын вә ја еквивалент јанма системләриндән истифадә едилир.

B. Карбоһидроҝенләр вә ја конденсат сахланмасы үчүн истифадә олунан 1590 кубметрдән чох (10000 баррел) һәр һансы чәндә туллантыларын минимума ендирилмәси мәгсәдилә лазыми нәзарәт апаратлары нәзәрдә тутулур.

C. Ҝүҹү 500 ат ҝүввәсиндән чох олан дахили јанаҹаг мүһәррикләри/турбинләр NOx вә CO туллантыларынын ҝөстәрилән һәдләр дахилиндә сахланмасыны тә'мин етмәк үчүн һәр ил нәзарәтдән кечирилмәлидир. Һәр дәфә сынаг кечирилмәздән әввәл NOx вә CO сәвијјәләринә нәзарәт едән портатив

IV. Нормативы по контролю за выбросами в атмосферу и мониторинг

Подрядчику разрешается производить выбросы в атмосферу. Такие выбросы должны быть ограниченными и подлежат контролю следующим образом:

A. В любых зданиях, сооружениях, объектах или установках, из которых выбрасываются или из которых вероятны выбросы оксидов азота (NOx), двуокиси серы (SOx), окиси углерода (CO), летучих органических соединений (VOC) или частиц (PT) в количестве, равном или превышающем 227 метрических тонн в год (МТГ) на индивидуальное загрязняющее вещество (250 коротких тонн в год), должна быть предусмотрена наиболее совершенная технология контроля для всего оборудования, производящего выбросы, отвечающая типу такого оборудования и его расположению. Если источник выделяет более 227 мтг, будет проведено моделирование выбросов для определения потенциального воздействия на чувствительные объекты. Такой объем выброса, оказывающий отрицательное воздействие на объекты, может быть меньше в случаях близости объектов к источнику загрязнения. (ПРИМЕЧАНИЕ: Любые отдельные части оборудования, выбрасывающие менее 23 мтг (25 коротких т/г) или двигатели внутреннего сгорания/турбины с эффективной мощностью менее 500 л.с. освобождаются от соблюдения этого требования). Аварийные факелы на объектах/средствах будут рассчитаны на работу без дыма и с непрерывными вспомогательными горелками или эквивалентными системами зажигания.

B. Для любой емкости для хранения объемом более 1590 куб.метров (10 000 баррелей), используемой под Углеводороды или конденсат, должна быть предусмотрена необходимая аппаратура контроля для сведения выбросов к минимуму.

C. Двигатели внутреннего сгорания/турбины свыше 500 л.с. должны проходить ежегодный контроль на предмет обеспечения выдерживания уровней выбросов NOx и CO в указанных пределах. Перед проведением каждого испытания портативные анализаторы для контролирования уровней NOx и CO должны быть

IV. Air Emission Guidelines and Monitoring

Contractor is authorized to discharge air emissions. Such discharges will be limited and monitored as follows:

A. Any building, structure, facility, or installation that emits or may emit nitrogen oxides (NOx), sulphur dioxides (SOx), carbon monoxide (CO), volatile organic compounds (VOCs), or particulate (PT) in an amount equal to or greater than 227 metric tons per year (MTPY) per individual pollutant (250 short tons per year) shall install the best available control technology on all equipment creating the emissions suitable for the equipment creating the emissions and its location. If the source is above 227 MTPY, screening modelling will be conducted to determine potential impacts on sensitive receptors. This trigger amount may be less in cases where sensitive receptors are in close proximity to the source. (NOTE: Any individual item of equipment emitting less than 23 MTPY (25 short TPY) or IC engines/turbines below 500 break horsepower would be exempt from this requirement.) Emergency flares on facilities will be designed to operate smokeless and with continuous pilots or equivalent ignition systems.

B. Any storage vessel with a capacity greater than 1,590 cubic meters (10,000 Barrels) used for Petroleum or condensate storage shall install necessary control technology to minimize emissions.

C. IC engines/turbines larger than 500 HP should be monitored on an annual basis to assure that the NOx and CO emissions are at the specified levels. Portable analyzers for monitoring the NOx and CO should be calibrated before each test using a known reference gas sample.

kalibrlənməlidir.

Bütün yeni obyektlər/vasitələr yuxarıda göstərilən standartlara uyğun olmalıdır. Kontrakt sahəsində Podratçının istifadə etdiyi mövcud obyektlər/vasitələr cədvəl əsasında bu standartlara uyğunlaşdırılır. Cədvəl həmin obyektlərin/vasitələrin vəziyyəti, tə'yinatı və rentabelliyi nəzərə alınaraq razılaşdırılır.

V. Təhlükəsizlik texnikası üzrə normativlər

Podratçı Sazişə uyğun olaraq Neft-qaz əməliyyatları aparırkən aşağıdakı beynəlxalq təhlükəsizlik texnikası və istehsalat gigiyenası normalarını nəzərə alır:

A. "Oil Industry International Exploration and Production Forum" (E&P Forum). "Hesabatlar - Təhlükəsizlik texnikası".

B. "International Association of Drilling Contractors" (IADC). "Qazma işlərinin təhlükəsizliyi texnikasına dair vəsait".

C. "International Association of Geophysical Contractors" (IAGC). "İstismar zamanı təhlükəsizlik texnikasına dair vəsait".

D. "American Conference of Governmental Industrial Hygienists"- "Ətraf mühitdə termada işləyərkən, kimyəvi maddələr üçün məhdud limit qiymətləri".

анализаторлар мә'лум еталон газ нүмунәсинин көмәји илә калибрләнмәлидир.

Бүтүн јени објектләр/васитәләр јухарыда көстәрилән стандартлара ујғун олмалыдыр. Контракт саһәсиндә Подратчынын истифадә етдији мөвҹуд објектләр/васитәләр ҹәдвәл әсасында бу стандартлара ујғунлашдырылыр. Ҹәдвәл һәмин објектләрин/васитәләрин вәзијјәти, тә'јинаты вә рентабеллији нәзәрә алынараг разылашдырылыр.

V. Тәһлүкәсизлик техникасы үзрә нормативләр

Подратчы Сазишә ујғун олараг Нефт-газ әмәлијјатлары апараркән ашағыдакы бејнәлхалг тәһлүкәсизлик техникасы вә истеһсалат ҝиҝијенасы нормаларыны нәзәрә алыр:

A. "Oil Industry International Exploration and Production Forum" (E&P Forum). "Һесабатлар - Тәһлүкәсизлик техникасы".

B. "International Association of Drilling Contractors" (IADC). "Газма ишләринин тәһлүкәсизлији техникасына дайр вәсаит".

C. "International Association of Geophysical Contractors" (IAGC). "Истисмар заманы тәһлүкәсизлик техникасына дайр вәсаит".

D. "American Conference of Governmental Industrial Hygienists". "Әтраф мүһитдә чалышаркән, кимјәви маддәләр үчүн меһдуд лимит гијмәтләри".

откалиброваны с помощью известной эталонной газовой пробы.

Все новые объекты/средства будут соответствовать вышеуказанным стандартам. Существующие объекты/средства в пределах Контрактной площади, эксплуатируемые Подрядчиком, будут приведены в соответствие с этими стандартами, согласно графику, который надлежит согласовать, принимая во внимание состояние, предназначение и рентабельность этих объектов/средств.

V. Нормативы по технике безопасности

При выполнении Нефтегазовых операций в соответствии с Соглашением Подрядчик учитывает следующие международные нормы техники безопасности и гигиены производства:

A. "Oil Industry International Exploration and Production Forum" (E&P Forum). Отчеты - Техника безопасности.

B. "International Association of Drilling Contractors" (IADC). Руководство по технике безопасности буровых работ.

C. "International Association of Geophysical Contractors" (IAGC). Руководство по технике безопасности при эксплуатации.

D. "American Conference of Governmental Industrial Hygienists" - "Пороговые ограниченные значения для химических веществ при работах в окружающей среде."

All new facilities will comply with the above standards. Existing facilities within the Contract Area being operated by Contractor will be brought into compliance with these standards according to a schedule to be negotiated, taking into account the condition, function and economic viability of the facilities.

V. Safety Guidelines

Contractor shall take into account the following international safety and industrial hygiene standards in conducting its Petroleum Operations under the Contract:

A. Oil Industry International Exploration and Production Forum (E&P Forum) Reports - Safety.

B. International Association of Drilling Contractors (IADC) - Drilling Safety Manual.

C. International Association of Geophysical Contractors (IAGC) - Operations Safety Manual.

D. American Conference of Governmental Industrial Hygienists - Threshold Limited Values for Chemical Substances in the Work Environment.

APPENDIX 5A

Emissions Estimate Assumptions

Appendix 5A
Onshore and Offshore Atmospheric Emissions Estimates

CONTENTS

1. Introduction

This Appendix provides supplementary information to the emissions calculations presented in Chapter 5: Project Description and includes pollutant emission factors and the basis of emissions estimates for each COP phase.

Emissions were calculated using internationally accepted emission factors that were calculated based on real time data collected over time. These were obtained from:

- E&P Forum Report No. 2.59/197 (Methods for Estimating Atmospheric Emissions from E&P Operations, Report No. 2.59/197; The Oil Industry International E&P Forum, September 1994); and
- EEMS Atmospheric Emission Calculations Issue 1.8 (UK Offshore Operators Association Ltd, 2004).

Table 1 presents the relevant emissions factors.

Table 1 Emission Factors

	Engine (Diesel)[2]	Engine (Gas)[2]	Helicopter (Diesel)[1]	Vessel (Diesel)[1]	Turbine (Diesel)[2]	Turbine (Gas)[2]	Heater (Gas)[2]	Heater (Diesel)[2]	Well Test Flaring (Gas)[2]	Well Test Flaring (Oil)[2]	Flaring (Associated Gas)[2]	External Floating Roof Tank (Oil)[2]
	(Tonne Emissions/Tonne of Fuel Used)								(Tonne Emission/Tonne of Fuel Flared)			(Tonne Emission/Tonne throughput)
CO2	3.2	2.86	3.2	3.2	3.2	2.86 (Onshore) Refer to 3 for Offshore	2.86	3.2	2.8	3.2	2.8	0
CO	0.0157	0.0076	0.0052	0.008	0.00092	0.0030	0.0006	0.00071	0.0067	0.0180	0.0067	0
NOx	0.0594	0.0576	0.0125	0.059	0.0135	0.0061	0.0024	0.0028	0.0012	0.0037	0.0012	0
SOx	0.004	0.0000128	0.008	0.008	0.004	0.0000128 (Onshore) Refer to 3 for Offshore	0.0000128	0.004	0.0000128	0.0000128	0.0000128	0
CH4	0.00018	0.0198	0.000087	0.00027	0.0000328	0.00092	0.000089	0.00000705	0.045	0.025	0.010	0.00000009
VOC	0.002	0.0032	0.0008	0.0024	0.000295	0.000036	0.0000099	0.0000282	0.005	0.025	0.010	0.00000081

Sources:
[1]E&P Forum - Report No. 2.59/197
[2]EEMS Atmospheric Emission Calculations Issue 1.8 UKOOA 2004
[3]Refer to Section 6 Offshore Operations and Production

2. Predrilling

2.1 Methodology

Estimated fuel usage for each emission source was multiplied by the relevant emission factor and the expected duration of the operation to estimate emissions.

Emissions associated with flaring due to the oil and gas flared during well testing (if undertaken) were calculated based on the number of well tests expected, the amount of oil and gas predicted to be flared and the relevant emission factors.

2.2 Basis of Estimate

Table 2 sets out the number of vessels planned to be used during predrilling including the estimated duration and diesel consumption of each vessel.

Table 2 Number of Vessels and Estimated Fuel Consumption During Predrilling

Source	No. of Vessels	Duration	Estimated Diesel Consumption
Support vessel engines (rig transfer/demobilisation)	3	6 days	6 tonnes/day
Supply vessels engines	1	Once return trip per day for 22 months	6 tonnes/day
MODU generator	1	Continuous for 22 months	9 tonnes/day
DBA	1	2 days	15 tonnes/day
Helicopters	5	3 hours return per trip (5 per week for 22 months)	0.24 tonnes/hours

It is assumed that two well tests will be undertaken. Each well test assumes 4,000 bbl oil flared and a gas-to oil ratio (GOR) of 1,250 scf/bbl.

3. Onshore Construction and Commissioning of Offshore Facilities

3.1 Methodology

Emission estimates were calculated based on historic ~~fuel~~ records from the Bibi Heybet and BDJF yards where previous ACG jackets and topsides were constructed. Estimated fuel usage per month for onsite generators and engines was multiplied by the relevant emission factor and duration of the construction periods to estimate emissions. Previous records showed that an average of approximately 0.47 tonnes of non methane VOC per month were estimated due to use of paint and solvents at the construction yards during the previous project phases.

Emissions during commissioning were estimated based on previous commissioning experience on the ACG projects. Estimates were made of duration of operation and approximate fuel consumption associated with key equipment that will be commissioned onshore; specifically the main platform generators, platform cranes, the emergency generator and the drilling module.

3.2 Basis of Estimate

Table 3 presents estimated fuel usage during construction and commissioning activities at yards and the planned duration of activities.

Table 3 Construction and Commissioning Emission Sources and Associated Estimated Fuel Consumption

Source	Diesel	Gasoline	Duration
Topside yard generators and engines[1]	130 tonnes/month	40 tonnes/month	31 months[2]
Jacket yard generators and engines	206 tonnes/month	40 tonnes/month	23 months
Drilling module yard generators and engines	206 tonnes/month	40 tonnes/month	17 months
Drilling module commissioning – temporary generator	6 tonnes/day	-	8 hours/day for 8 months
Platform main generators[2]	8 tonnes/hour	-	Refer to Note 2
Platform cranes	25 tonnes/hour	-	6 months
Platform emergency generator	0.1 tonnes/hour	-	2 weeks

[1] Records indicate that 65% of fuel used by yard generators and 35% by engines
[2] Includes duration that on site generators and engines will be used for construction and commissioning at the topside yard
[3] Commissioning of the main platform power generation system will incorporate 3 RB211 generators, comprising, i) each generator run separately and intermittently for a week, each for up to 8 hours a day at a maximum load of approximately 26% and ii) three synchronisation tests of eight hour duration, running two of the three generators together at a maximum load of approximately 26%. The generators will be run separately and intermittently during commissioning of, i) The compression system (up to 4 weeks for up to 8 hours per day); and ii) Topside utilities (up to 6 months for up to 8 hours per day).

4. In Field Pipeline Installation, Tie In and Commissioning

4.1 Methodology

Estimated fuel usage for each vessel planned to be used was multiplied by the expected number of vessels, the relevant emission factor and the expected duration of the activity to estimate emissions. A worst case scenario where vessels are being used continuously for the duration was assumed although vessel use will be intermittent.

4.2 Basis of Estimate

Table 4 lists the vessels that will be used during in field pipeline installation, tie in and commissioning, the duration of use for each vessel and estimated fuel consumption.

Table 4 Number of Vessels and Estimated Fuel Consumption During In Field Pipeline Installation, Tie In and Commissioning

Vessel	No. of Vessels	Duration (days)	Fuel Consumption
Pipe-lay barge	1	90	15 tonnes/day
Anchor handling vessel	4	90	6 tonnes/day
Pipe-haul barge	4	90	15 tonnes/day
Tugs	4	90	6 tonnes/day
Diving support vessel	1	90	6 tonnes/day
Survey vessel	1	90	6 tonnes/day
Commissioning support vessel	5	330	6 tonnes/day

5. Platform Installation, Hook Up and Commissioning

5.1 Methodology

Estimated fuel usage for each vessel planned to be used was multiplied by the expected number of vessels, the relevant emission factor and the expected duration of the activity to estimate emissions.

Emissions associated with commissioning activities on the platform (i.e. from platform generators and flaring) were included in the offshore operations estimate (Section 6 below).

5.2 Basis of Estimate

Table 5 lists the vessels that will be used during in field pipeline installation, tie in and commissioning, the duration of use for each vessel and estimated fuel consumption.

Table 5 Number of Vessels and Estimated Fuel Consumption During Platform Installation, Hook Up and Commissioning

Activity	Vessel	No.	Duration (days)	Fuel Consumption[1] (tonnes/day)
Installation of the jacket	Support vessel STB-01 DBA DSV	3 1 1 1	 45 1	6 15
Installation of the topside	Support vessel STB-01 DBA	4 1 1	 2 	6 15
WC-PDQ platform commissioning and DWG brownfield works	Support vessel DBA DSV	2 1 1	50 21 50	9

6. Offshore Operations and Production

6.1 Methodology and Basis of Estimate

Emissions to air were estimated using a combination of (i) emission forecasting software and (ii) spreadsheet-based manual calculations.

6.1.1 WC-PDQ Emissions

The emissions forecasting software was used to calculate CO_2 emissions from the main topside emission sources on the WC-PDQ platform during routine operations. CO, NO_x, CH_4, SO_4 and VOC emissions were calculated manually using the EEMS emission factors.

The source of the main data inputs were:

- Process data was obtained from the project heat and material balance
- Fuel Gas composition was taken from the project heat & material balance
- Equipment Details were obtained from the:
  - Electrical Load Summary
  - Equipment Lists
  - Equipment Load Profile
  - Electrical Load Profile
  - Electrical Load Lists
- Production Data was obtained from the latest production profile. Flare rates were estimated at 2% of total gas produced.

Model inputs are summarised in Table 6.

Table 6 Model Input to Calculate Emissions Associated with Offshore Operation and Production

Equipment	Model Inputs
Power Generation	No. of Units, make, model and ISO rating. If a specific vendor is not known or not present on the database, generic gas turbine options are available.
Compression	Driver type (motor). Maximum throughput, maximum power input.
MOL Pumps	Motor driven. Maximum train throughput, maximum train power input (shaft), motor rating.
Seawater Lift Pumps	Motor driven. Maximum train throughput, maximum train power input (shaft), motor rating.

All other items of equipment were modelled as 'miscellaneous electrical loads', including flash gas compression which cannot be modelled as an individual item within the current release of the software used. The miscellaneous electrical loads were varied over each year in order to simulate varying demands on the platform and the subsequent impacts on overall emissions/energy efficiency.

The model was run twice, once at 5°C and once at 25°C, in order to simulate summer and winter ambient meteorological conditions as the performance of the RB211 generator is affected by the ambient air temperature. Results from the two runs were averaged in order to provide the annual emissions estimates. This approach is the same as employed for all previous ACG phases.

Modelling was undertaken on an annual basis from 2013 until 2024, i.e. until the end of the PSA, with a shorted duration modelled in 2013 (275 days) to account for commencement of topsides operations in Q2 2013.

Diesel use was accounted for within the calculations. In year 1 of production (2013), diesel was assumed to be used for up to 2% of the time. In remaining years this was lowered to 1% of the time, with an additional allowance of up to 7 days every three years for shutdowns. This allowance was averaged to give an equivalent number of days per year using diesel to supply the gas turbine power generators.

Additional manual calculations were undertaken to quantify emissions from emergency generator and firewater pump testing and daily use of cranes on the West Chirag platform.

For the emergency generator and firewater pump testing, the calculations assumed that each item of equipment is tested for 1 hour per week under maximum fuel consumption rate. For the cranes, use estimates were obtained from BP operations and an assumption that engine specifications for West Chirag will be the same as East Azeri.

6.1.2 Contribution to DWG Emissions From COP

The contribution of the COP to the emissions associated with the DWG facilities were also calculated across the PSA period. Estimated emissions have been manually calculated by utilising the emissions estimate spreadsheets from Phase III and calculating the additional emissions contribution associated with produced water/injection water handling by DWG. Emission factor of CO_2 for DWG was retained at 2.7, as per basis used for previous calculations and fuel gas composition predicted for DWG at the time.

6.1.3 Platform Commissioning

Manually calculated emissions for the five month commissioning offshore topsides commissioning period were also included within the emissions estimates. The assumptions and calculations are provided as Appendix D.

The basis of the emissions estimates were as follows:

- 4x 1MW temporary generators will run 24 hours a day throughout the topsides offshore commissioning period
- One gas turbine will be brought online up to 6 weeks before the end of commissioning. The gas turbine will run for up to 4 weeks on diesel fuel and 2 weeks on fuel gas.
- The other two gas turbines will each be tested for one week on diesel fuel and one week on fuel gas prior to the end of commissioning.
- Emissions from firewater pump testing, emergency generator testing and crane use shall be as above, but pro-rated for an 8 week commissioning period. In 2013, it will be assumed that the testing regime will be maintained throughout the year and that crane used will as normal.

6.1.4 Non Routine Flaring

Routine flaring at the WC-PDQ platform will be associated with purge and pilot. Non routine flaring will be associated with upset/downtime events. It is assumed that 3% of the gas produced is flared with 2% flared offshore[1] and 1% onshore. Flaring emissions were included within the emissions forecasting modelling.

6.1.5 Helicopters/Supply Vessels

Emissions associated with supply vessels and helicopters were calculated manually using estimated fuel usage, expected number of vessels/helicopters, the relevant emission factor and the expected duration of the activity (Refer to Table 7).

Table 7 Number of Vessels/Helicopters and Estimated Fuel Consumption During Offshore Operations and Production

Vessel	No. of Vessels	Duration (days)	Fuel Consumption
Helicopters	5	3 hours return per trip (5 per week for 144 months)	0.24 tonnes/hr
Supply Vessels	2	2 trips per week for 144 months	6 tonnes/day

6.2 Emissions Data

Table 8 presents the estimated offshore combustion emissions during offshore operations and production including commissioning and start up emissions. Table 9 presents emissions associated with flaring, Table 10 emissions associated with helicopters and supply vessels, and Table 11 presents total estimated emissions during offshore operations and production associated with the COP.

[1] Derived from reliability/availability modelling of the WC-PDQ platform. Both offshore and onshore flaring estimates have been benchmarked against actual ACG flaring data.

Table 8 Offshore Combustion Emissions (Excluding Flaring)

Year		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
	CO_2													
COP	Gas Turbine Power Gen	13,855	149,026	316,955	243,798	252,922	291,594	278,678	265,696	191,098	236,811	214,587	185,071	2,613,091
DWG	Water Injection on DWG	0	4,048	15,220	40,922	28,640	41,145	67,976	75,626	95,510	77,288	70,505	65,799	582,677
COP	Emergency Generator Testing	38	19	19	19	19	19	19	19	19	19	19	19	249
COP	Firewater Pump Testing	78	93	93	93	93	93	93	93	93	93	93	93	1,105
COP	Crane Operation	666	800	800	800	800	800	800	800	800	800	800	800	9,463
COP	Temporary Generators Commissioning	17,395	0	0	0	0	0	0	0	0	0	0	0	17,395
COP	Gas Turbine Commissioning	37,555	0	0	0	0	0	0	0	0	0	0	0	37,555
Sum of CO_2 Emissions		**69,588**	**153,986**	**333,087**	**285,632**	**255,474**	**333,651**	**347,566**	**342,233**	**287,520**	**315,011**	**286,004**	**251,782**	**3,261,536**
	CO													
COP	Gas Turbine Power Gen – fuel gas	31	192	408	313	291	375	359	342	246	305	276	238	3,376
COP	Gas Turbine Power Gen - diesel	8.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	19
DWG	Water Injection on DWG	0	5	17	46	32	46	76	84	106	86	78	73	647
COP	Emergency Generator Testing	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	3
COP	Firewater Pump Testing	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5
COP	Crane Operation	3.3	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	46
COP	Temporary Generators Commissioning	85	0	0	0	0	0	0	0	0	0	0	0	85
Sum of CO Emissions		**128.6**	**201.9**	**430.3**	**364.8**	**328.1**	**426.5**	**439.7**	**431.5**	**357.6**	**396.2**	**360.1**	**316.9**	**4,182**
	NO_x													
COP	Gas Turbine Power Gen – fuel gas	63	390	829	638	591	793	729	695	500	620	561	484	6,864
COP	Gas Turbine Power Gen - diesel	119	15	15	15	15	15	15	15	15	15	15	15	283
DWG	Water Injection on DWG	0	9	34	92	65	93	154	171	216	175	159	149	1,316
COP	Emergency Generator Testing	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10
COP	Firewater Pump Testing	1.4	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	21
COP	Crane Operation	12	15	15	15	15	15	15	15	15	15	15	15	176
COP	Temporary Generators Commissioning	323	0	0	0	0	0	0	0	0	0	0	0	323
Sum of NO_x Emissions		**520.0**	**431.3**	**895.9**	**762.6**	**688.1**	**888.1**	**915.0**	**898.3**	**748.0**	**826.5**	**753.0**	**665.2**	**8,992**
	CH_4													
COP	Gas Turbine Power Gen – fuel gas	9	59	125	96	89	115	110	105	75	93	85	73	1,035
COP	Gas Turbine Power Gen - diesel	0.34	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	1
DWG	Water Injection on DWG	0	1	5	14	10	14	23	26	33	26	24	22	199
COP	Emergency Generator Testing	0.0011	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.03
COP	Firewater Pump Testing	0.0042	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.06
COP	Crane Operation	0.0377	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.53
COP	Temporary Generators Commissioning	1	0	0	0	0	0	0	0	0	0	0	0	1
Sum of CH_4 Emissions		**10.9**	**60.3**	**130.3**	**110.2**	**99.0**	**129.2**	**133.2**	**130.7**	**108.0**	**119.9**	**108.8**	**95.5**	**1,236**

Year		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
	SO_2													
COP	Gas Turbine Power Gen – fuel gas	15.7	95	203	156	145	187	178	170	122	152	137	118	1,679
COP	Gas Turbine power Gen - diesel	35	4	4	4	4	4	4	4	4	4	4	4	84
COP	Emergency Generator Testing	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.70
COP	Firewater Pump Testing	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	1.4
COP	Crane Operation	1	1	1	1	1	1	1	1	1	1	1	1	12
COP	Temporary Generators Commissioning	22	0	0	0	0	0	0	0	0	0	0	0	22
Sum of SO_2 Emissions		**73.5**	**100.9**	**208.4**	**161.6**	**150.1**	**192.2**	**183.9**	**175.6**	**127.9**	**157.1**	**142.9**	**124.0**	**1,798**
	VOC													
COP	Gas Turbine Power Gen – fuel gas	0.37	2.30	4.89	3.76	3.49	4.50	4.30	4.10	2.95	3.66	3.31	2.86	41
COP	Gas Turbine Power Gen - diesel	2.59	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	6.2
DWG	Water Injection on DWG	0	0.05	0.20	0.55	0.38	0.55	0.91	1.01	1.27	1.03	0.94	0.88	7.8
DWG	Emergency Generator Testing	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.3
COP	Firewater Pump Testing	0.04	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.7
COP	Crane Operation	0.42	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	5.9
COP	Temporary Generators Commissioning	10.9	0	0	0	0	0	0	0	0	0	0	0	10.9
Sum of VOC Emissions		**14.3**	**3.3**	**6.0**	**5.2**	**4.8**	**6.0**	**6.1**	**6.0**	**5.1**	**5.6**	**5.2**	**4.6**	**72**

Basis of Estimate:

- Lift gas passes through the export compressors resulting in the design total gas values from the production profiles being used in the PI-e2 calculations and no separate system or quantities included for gas lift/injection function.
- Emissions estimation in 2012 and 2013 was based on a conservative assumption that base electrical loads on the platform would be the same as during routine operation.
- The PI-e2 software calculates CO_2 (carbon dioxide) emissions only. As such, following completion of the modelling, results for fuel gas consumption rates were used to determine emission estimates for CO, NO_x , CH_4, SO_2 and VOC using standard emission factors.
- A manual check of the PI-e2 outputs for CO_2 was performed by undertaking a manual calculation of the CO_2 emission factor for fuel gas. The comparison showed a consistent difference of 1.8% between the PI-e2 results and manually calculated CO_2 emissions using a manually calculated emission factor (PI-e2 results being 1.8% higher than manually calculated CO_2 emissions). This is considered acceptable.
- SO_2 for emergency generator, firewater pump testing and cranes not calculated as sulphur content of diesel fuel not known.
- SO_2 for DWG pumping not calculated as sulphur content of fuel gas on DWG not known.

Note: SO_2 assumed to be equivalent to SO_x

Table 9 Offshore Flaring Emissions (Non Routine Flaring, Flare Purge and Pilot) (Tonnes)

Year	CO_2	CO	NO_x	CH_4	SO_2	VOC
2013	1,642	5	1	9	1	7
2014	57,969	170	30	326	38	254
2015	150,484	442	79	847	98	659
2016	110,925	326	58	624	73	486
2017	95,941	282	50	540	63	420
2018	118,645	348	62	667	78	520
2019	106,741	313	56	600	70	468
2020	99,561	292	52	560	65	436
2021	67,976	200	36	383	44	298
2022	81,542	240	43	459	53	357
2023	74,585	219	39	419	49	327
2024	64,385	189	34	362	42	282
TOTAL	**1,030,396**	**3,025**	**542**	**5,798**	**674**	**4,515**

Note: SO_2 assumed to be equivalent to SO_x

Table 10 Offshore Emissions from Helicopters/Supply Vessels (Tonnes)

	CO_2	CO	NO_x	CH_4	SO_2	VOC
Helicopters/Supply Vessels	27,556	66	456	69	2	19

Table 11 Total Offshore Operations Emissions (Tonnes)

	CO_2	CO	NO_x	CH_4	SO_2	VOC
Combustion	3,261,536	4,182	8,992	1,236	1,798	72
Flaring	1,030,396	3,025	542	5,798	674	4,515
Helicopters/Supply Vessels	27,556	66	456	69	2	19
TOTAL	**4,319,488**	**7,273**	**9,990**	**7,103**	**2,474**	**4,606**

Note: SO_2 assumed to be equivalent to SO_x

7. Terminal

7.1 Methodology and Basis of Estimate

7.1.1 Combustion Emissions

The COP will use the 6 existing ACG processing trains and it is assumed the oil and gas are equally split across these trains. To calculate emissions associated with power required for the processing of the COP oil and gas at the Terminal, the fuel demands for ACG Phases 1-3 alone and Phases 1-3 with COP were determined using the project production profiles. The fuel gas required to run the gas turbines (GT) at the required load was calculated according to the power profile; the amount of fuel gas required in the fired heaters (FH) and the dewpoint control units (DPCU) to heat the oil and gas to the required temperature according to the flow through each unit was calculated. Appropriate emission factors to the fuel gas usage were applied, giving tonnes of pollutant per tonne of fuel gas used. The emissions attributable to the COP were determined by subtracting emissions associated with ACG Phases 1-3 alone.

7.1.2 Flaring Emissions

Based on an analysis of ACG flaring to date it has been assumed that 3% of the gas produced is flared with 1% flared onshore. Emissions due to flaring at the Terminal were calculated for ACG Phases 1-3 alone and Phases 1-3 with COP using the project production profiles. The appropriate emission factors were applied to the tonnes of predicted gas flared to give the tonnes of each pollutant over the life of the PSA. The emissions attributable to the COP were determined by subtracting emissions associated with ACG Phases 1-3 alone.

7.1.3 Fugitive Emissions

Fugitive emissions will result from filling, emptying and “breathing losses” from the existing oil storage tanks at the terminal. Emissions were calculated based on the expected throughout associated with oil from ACG Phases 1-3 (using project production profiles) and ACG Phases 1-3 including COP. The COP fugitive emissions were calculated based on the difference. Fugitive emissions were estimated by multiplying expected throughput by the the appropriate emission factor.[2]

7.2 Emissions Data

Tables 12 and 13 present the predicted emissions for the operations phase at the Sangachal Terminal for ACG Phases 1-3 and for COP arising from combustion and flaring. Table 14 presents expected fugitive emissions and Table 15 presents total estimated onshore COP emissions.

[2] Estimated emissions calculated using the detailed TANKS 4 programme for Phase 3 were compared with the results using storage tank throughput (tonnes/hour) and multiplying by the appropriate EEMS emission factors. The results indicated a less than 2% difference in results. Therefore it was considered that using the EEMS emission factor was acceptable.

Table 12 Onshore Operations Combustion Emissions

Year	Atmospheric Emissions (Tonnes)													
	CO_2		NOx		CO		SOx		CH4		VOC		GHG	
	P 1-3	COP	P 1-3	COP	P 1-3	COP			P 1-3	COP	P 1-3	COP	P 1-3	COP
2009	821,219	-	1,211	-	511	-	3.7	-	143	-	7	-	824,216	-
2010	848,160	-	1,250	-	527	-	3.8	-	147	-	7	-	851,253	-
2011	808,895	-	1,189	-	501	-	3.6	-	140	-	6	-	811,830	-
2012	823,599	-	1,211	-	510	-	3.7	-	142	-	7	-	826,588	-
2013	825,070	7,962	1,213	12	511	5	3.7	0.0	143	1	7	0	828,067	7,991
2014	870,752	90,132	1,279	131	538	55	3.9	0.4	150	15	7	1	873,908	90,453
2015	792,414	135,793	1,165	198	490	83	3.5	0.6	137	23	6	1	795,288	136,276
2016	709,692	144,091	1,043	210	439	88	3.2	0.6	123	24	6	1	712,266	144,604
2017	650,295	117,741	957	171	403	72	2.9	0.5	113	20	5	1	652,658	118,159
2018	583,547	85,885	870	114	369	45	2.6	0.4	104	12	5	1	585,722	86,141
2019	582,089	80,685	869	107	369	42	2.6	0.4	103	11	5	1	584,262	80,921
2020	532,922	92,839	793	134	336	56	2.4	0.4	94	16	4	1	534,900	93,165
2021	490,699	84,639	737	119	314	49	2.2	0.4	88	13	4	1	492,553	84,918
2022	442,308	84,152	672	118	288	49	2.0	0.4	81	13	4	1	444,014	84,432
2023	400,034	89,793	607	133	260	56	1.8	0.4	73	16	3	1	401,574	90,123
2024	385,700	83,930	591	123	255	52	1.7	0.4	72	14	3	1	387,215	84,232
TOTAL	**10,567,395**	**1,097,642**	**15,655**	**1,569**	**6,619**	**650**	**47**	**4.9**	**1,853**	**180**	**84**	**8**	**10,606,313**	**1,101,414**

Table 13 Onshore Operations Flaring Emissions

Year	Atmospheric Emissions (Tonnes)													
	CO_2		NOx		CO		SOx		CH4		VOC		GHG	
	P 1-3	COP	P 1-3	COP	P 1-3	COP			P 1-3	COP	P 1-3	COP	P 1-3	COP
2009	300,415	-	129	-	719	-	0.0	-	1,073	-	1,073	-	322,946	-
2010	348,462	-	149	-	834	-	0.0	-	1,245	-	1,245	-	374,597	-
2011	323,244	-	139	-	773	-	0.0	-	1,154	-	1,154	-	347,487	-
2012	308,566	-	132	-	738	-	0.0	-	1,102	-	1,102	-	331,708	-
2013	341,866	1,734	147	1	818	4	0.0	0.0	1,221	6	1,221	6	367,506	1,864
2014	327,856	28,935	141	12	785	69	0.0	0.0	1,171	103	1,171	103	352,445	31,106
2015	308,530	54,166	132	23	738	130	0.0	0.0	1,102	193	1,102	193	331,670	58,228
2016	270,031	37,792	116	16	646	90	0.0	0.0	964	135	964	135	290,283	40,627
2017	278,334	33,727	119	14	666	81	0.0	0.0	994	121	994	121	299,209	36,257
2018	299,529	38,307	128	16	717	92	0.0	0.0	1,070	137	1,070	137	321,993	41,180
2019	328,095	31,424	141	13	785	75	0.0	0.0	1,172	112	1,172	112	352,702	33,781
2020	338,977	30,980	145	13	811	74	0.0	0.0	1,211	111	1,211	111	364,400	33,303
2021	328,393	28,658	141	12	786	69	0.0	0.0	1,173	102	1,173	102	353,022	30,808
2022	315,502	26,518	135	11	755	63	0.0	0.0	1,127	95	1,127	95	339,165	28,507
2023	307,905	23,010	132	10	737	55	0.0	0.0	1,100	82	1,100	82	330,998	24,735
2024	287,081	22,032	123	9	687	53	0.0	0.0	1,025	79	1,025	79	308,612	23,684
TOTAL	**5,012,787**	**357,283**	**2,148**	**153**	**11,995**	**855**	**0.0**	**0.0**	**17,903**	**1,276**	**17,903**	**1,276**	**5,388,746**	**384,080**

Table 14 Fugitive Emissions

Year	Atmospheric Emissions (tonnes)					
	CH4			VOC		
	P 1-3	COP	P 1-3 + COP	P 1-3	COP	P 1-3 + COP
2009	3.7	-	3.7	33.2	-	33.2
2010	3.8	-	3.8	34.3	-	34.3
2011	3.7	-	3.7	32.9	-	32.9
2012	3.7	-	3.7	33.5	-	33.5
2013	3.7	0.0	3.8	33.6	0.3	33.9
2014	3.9	0.4	4.4	35.5	3.8	39.3
2015	3.6	0.6	4.2	32.3	5.7	37.9
2016	3.2	0.7	3.9	28.9	6.0	34.9
2017	2.9	0.5	3.5	26.4	4.9	31.4
2018	2.6	0.5	3.0	23.0	4.2	27.3
2019	2.5	0.4	3.0	22.9	4.0	26.9
2020	2.3	0.4	2.8	21.1	3.9	25.0
2021	2.1	0.4	2.5	19.0	3.8	22.8
2022	1.9	0.4	2.3	16.7	3.8	20.5
2023	1.7	0.4	2.1	15.1	3.6	18.7
2024	1.6	0.4	2.0	14.2	3.4	17.7

Basis of Estimate:
- Assume all storage tanks comprise external floating roofs
- Assume throughput is equivalent to production rate

Table 15 Total Onshore COP Emissions

Year	Atmospheric Emissions (Tonnes)						
	CO_2	NO_x	CO	SOx	CH_4	VOC	GHG
2008	-	-	-	-	-	-	-
2009	-	-	-	-	-	-	-
2010	-	-	-	-	-	-	-
2011	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-
2013	9,696	12	9	0	8	7	9,855
2014	119,067	144	124	0	119	108	121,567
2015	189,959	221	212	1	217	200	194,518
2016	181,883	226	178	1	160	142	185,244
2017	151,469	185	152	1	141	126	154,427
2018	124,192	131	137	0	149	142	127,331
2019	112,109	120	117	0	124	117	114,711
2020	123,818	148	130	0	127	115	126,478
2021	113,297	131	117	0	116	107	115,734
2022	110,670	130	112	0	108	99	112,948
2023	112,803	143	111	0	98	87	114,866
2024	105,962	132	104	0	98	83	107,925
TOTAL	**1,454,925**	**1,722**	**1,505**	**5**	**1,461**	**1,332**	**1,485,604**

APPENDIX 5B

Approved CRI Waste Streams

Re-injection Waste Streams at ACG Platforms

As of end 2008

Approved through Phase 1/2/3 ESIAs (2001-2003)

- Non-water based muds (NWBM)
- Cuttings drilled out with NWBM
- Drilled-out cement
- Produced sand
- Oily water from oily drains tank

Approved through agreement with MENR (Nov 2006)

- Drilling brines
- Completion brines

Approved through ACG Down-Hole Waste Disposal Addendum to Phase1, 2 and 3 ESIAs (Aug 2008)

- Completion fluids; e.g. well clean up interface/suspension fluids, well completion brine wastes and associated additives, gels, pills, filtration solids;
- Work-over/Stimulation fluids, e.g. brine waste, coil tubing wastes, fracture flowback fluids, and associated additives, gels, pills;
- Tank bottoms/oily sludges, e.g. settled SOBM/OBM or oily residues/liquids from drilling/production tanks, pipes, drums, pits, sumps or pig traps;
- Surface and cleaning water contaminated with cuttings, SOBM/OBM or brine or their chemicals; rig drain materials;
- Dehydration/sweetening wastes, e.g. MEG tank residues;
- Clean up pills;
- Lube oils and samples; and
- Seawater anti-foulant and production back wash fluids.

bp

GUNTHER NEWCOMBE
DIRECTOR, HSSE
BP Group
Azerbaijan SPU
Hyatt Tower 2, 6th floor, 1033, Izmir str.
Switchboard- (994 12) 4979000
Direct line. (994 12) 4979442
Central Fax. (994 12) 4979602
Re: HSSE-GN-033/07

Date: **26th February, 2007**

To: **Mr. Huseyn Bagirov,**
Minister of Environment and Natural Resources of Azerbaijan Republic

CC: **Mr. Huseyn Mammadov,**
Head of the Department for Environmental Protection,
Ministry of Ecology and Natural Resources of Azerbaijan Republic

Mrs. Latifa Huseynova,
Chief of Caspian Complex Ecological Monitoring Administration,
Ministry of Environment and Natural Resources of Azerbaijan Republic

Mr. Khoshbakht Yusifzade,
First Vise-President, State Oil Company of Azerbaijan Republic

Mr. Agamahmud Sirajov,
Head of HSE Department, State Oil Company of Azerbaijan Republic

Mr. Soltan Aliyev,
Director of SOCAR Environmental Administration

Mr. Faig Askerov,
BP AzSPU Environmental Manager

SUBJECT: ADDENDUM TO THE AZERI CHIRAG AND DEEP WATER GUNESHLI (ACG) PHASE1, 2 AND 3 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENTS (ESIAs) FOR ACG DOWN-HOLE WASTE DISPOSAL

Dear Mr. Huseyn Bagirov,

The intent of this letter is to inform you on progress of the Ministry of Environment and Natural Resources of the Azerbaijan Republic (MENR) and BP Exploration (Caspian Sea) Ltd. Working Groups (WGs) discussion on re-injection of waste via Azeri Chirag and Deep Water Guneshli (ACG) platforms into CRI wells.

As you might be aware BP was seeking approval to commence downhole injection of waste brine. Two sets of technical information packs related to the issue were provided to MENR experts to support discussions and a number of meetings were organized between members of Working Groups to address concerns and questions. The trial demonstrating the slurrification process of materials before being injected was also arranged.

In addition, BP organized the business trip to the United Kingdom (throughout 23rd - 29th of October, 2006) for familiarization of WG members with an International recognized practice, where:

1. the CRI course was delivered and certificates provided;

2. meetings were set with Scottish Environmental Protection Agency and Department of Trade and Industry representatives; and
3. Obtained documentation from Regulatory Agencies were translated into Azerbaijani and submitted to MENR.

As a result of long–term negotiations we received the approval letter from MENR # 4/2552-17-15 dated the 20th of November 2006 for disposal of contaminated waste brine via Azeri field platforms, which now allows implementation of global scale operations in the Azerbaijani portion of Caspian Sea.

This is yet another great example of successful joint cooperation established between MENR and BP.

In the second technical note (letter # Re:HSSE/ACGOPS/GN-273(89) dated August 1st, 2006) we mentioned that BP intends to submit further application to MENR to inject other waste streams on ACG platforms (Phase1, 2 and 3) which are not covered in the ACG ESIA documents.

Therefore, please find enclosed the Addendum to the ACG Phase1, 2 and 3 Environmental and Social Impact Assessment (ESIA) for ACG Down-Hole Waste Disposal.

We would appreciate your understanding the extension of the scope of waste disposal operations across Azeri (CA PDQ & CWP as part of Phase1, WA PDQ & EA PDQ as part of Phase2) and Deep Water Gunashly (DWG PDUQ as part of Phase3) fields as platform design and re-injection facilities are essentially identical.

In conclusion, the addition of drilling and operational wastes to the existing CRI program will bring significant HSE and cost benefits to the ACG project as a whole and it is against this background that the permission is sought to add proposed waste to an already successful program.

If you have any questions regarding this letter, please do not hesitate to contact Mr. Rahim Rahimov, Environmental Technical Authority within Offshore PU on 497 98 87.

Sincerely,

Gunter Newcombe,
BP AzSPU HSSE Director

bp

GUNTHER NEWCOMBE
DIRECTOR, HSSE
BP Group
Azerbaijan SPU
Hyatt Tower 2, 5th floor, 1033, Izmir str.
Switchboard: (994 12) 4979000
Direct line: (994 12) 4979442
Central Fax: (994 12) 4979602
Re: HSSE-GN-033/07

Tarix: **26 fevral, 2007-ci il**

Kimə: **Azərbaycan Respublikasının Ekologiya və Təbii Sərvətlər Naziri canab Hüseyn Bağırov**

Surəti: **Azərbaycan Respublikası Ekologiya və Təbii Sərvətlər Nazirliyi Ətraf Mühitin Mühafizəsi Departamentinin rəhbəri cənab Hüseyn Məmmədov**

Azərbaycan Respublikası Ekologiya və Təbii Sərvətlər Nazirliyi Xəzər Kompleks Ekoloji Monitorinq İdarəsinin (XKEMİ) direktoru xanım Lətifə Hüseynova

Azərbaycan Respublikası Dövlət Neft Şirkətinin (ARDNŞ) birinci vitse-prezidenti cənab Xoşbəxt Yusifzadə

Azərbaycan Respublikası Dövlət Neft Şirkətinin (ARDNŞ) SƏTƏM şöbəsinin rəhbəri cənab Ağamahmud Siracov

Azərbaycan Respublikası Dövlət Neft Şirkətinin Ekoloji İdarəsinin reisi cənab Soltan Əliyev

BP AzŞİB-nün Ekologiya üzrə meneceri cənab Faiq Əsgərov

MÖVZU: **TULLANTILARIN AÇG YATAĞINDA QUYU DİBİNƏ VURULMAQLA UTİLİZASİYASI İLƏ BAĞLI AZƏRİ-ÇIRAQ-DƏRİNSULU GÜNƏŞLİ (AÇG) YATAĞININ FAZA 1, 2 VƏ 3 ÇƏRÇİVƏSİNDƏ ƏTRAF MÜHİT VƏ SOSİAL SAHƏYƏ TƏSİRİN QİYMƏTLƏNDİRİLMƏSİ (ƏMSSTQ) SƏNƏDİNƏ ƏLAVƏ**

Hörmətli cənab Bağırov,

Bu məktubu yazmaqda məqsəd Sizi tullantıların Azəri-Çıraq-Dərinsulu Günəşli (AÇG) yatağındakı platformalardan şlam vurucu quyular vasitəsi ilə utilizasiya edilməsi xüsusunda Azərbaycan Respublikası Ekologiya və Təbii Sərvətlər Nazirliyi (ETSN) və BP Eksploreyşn (Kaspian Si) Ltd şirkətinin nümayəndələrindən təşkil olunmuş İşçi Qruplarının (İQ) apardıqları danışıqların gedişi barədə məlumatlandırmaqdır.

Bildiyiniz kimi, vaxtı ilə BP şirkəti işlənmiş quyu tamamlama məhlullarının quyudibinə vurmaqla utilizasiyasına başlaya bilmək üçün icazə verilməsini xahiş etmişdi. Bu məsələ ətrafında aparılan müzakirələrə köməklik etmək məqsədi ilə müvafiq texniki məlumatları əks etdirən sənədlərdən ibarət iki paket ETSN-nın mütəxəssislərinə təqdim olunmuş və ifadə olunan narahatlıqları və digər əlaqədar sualları əhatə etmək üçün İşçi Qrupların nümayəndələri arasında bir neçə görüş təşkil olunmuşdu. Eyni zamanda, quyu dibinə vurulmazdan əvvəl materialların suspenziya halına necə gətirildiyini nümayiş etdirən sınaq prosesi də təşkil olunmuşdu.

Bundan əlavə, BP şirkəti İQ nümayəndələrini bu sahədə mövcud olan beynəlxalq təcrübə ilə tanış etmək üçün Birləşmiş Krallığa biznes səfərini təşkil etmişdi (2006-cı il oktyabr ayının 23-29). Bu səfər çərçivəsində:

1. Şlamların quyudibinə vurulması üzrə kurs keçirilmiş və sertifikatlar verilmişdir;
2. Şotlandiyanın Ətraf Mühitin Mühafizəsi Agentliyinin və Ticarət və Sənaye Nazirliyinin nümayəndələri ilə görüşlər təşkil olunmuşdur; və
3. Dövlət idarə orqanlarından əldə olunmuş sənədlər Azərbaycan dilinə tərcümə olunmuş və ETSN-ə təqdim olunmuşdur.

Uzun müddət aparılan danışıqların nəticəsində biz çirklənmiş quyu tamamlama məhlullarının Azəri yatağındakı platformalar vasitəsi ilə utilizasiyası üçün ETSN-dən 20 noyabr 2006-cı il tarixli 4/2552-17-15 saylı icazə məktubunu almışdıq. İndi bu proses Xəzər dənizinin Azərbaycana aid hissəsində qlobal miqyaslı əməliyyatlar aparmağa imkan verir.

Bu, ETSN ilə BP şirkəti arasında qurulmuş uğurlu birgə əməkdaşlığın daha bir bariz nümunəsidir.

Tərəfimizdən göndərilmiş 2006-cı il 01 avqust tarixli HHSE/ACGOPS/GN-273(B9) saylı ikinci texniki əlavə sənədində biz qeyd etmişdik ki, BP şirkəti AÇG platformalarında (Faza 1, 2 və 3) AÇG ƏMSSTQ sənədlərində əhatə olunmamış digər tullantı növlərinin də quyu dibinə vurulması üçün ETSN-ə əlavə sənəd təqdim olunacaqdır.

Bununla əlaqədar olaraq, Tullantıların AÇG yatağında quyu dibinə vurulmaqla utilizasiyası ilə bağlı Azəri-Çıraq-Dərinsulu Günəşli (AÇG) yatağının Faza 1, 2 və 3 çərçivəsində Ətraf mühit və sosial sahəyə təsirin qiymətləndirilməsi (ƏMSSTQ) sənədinə əlavəni bu məktuba qoşaraq diqqətinizə çatdırırıq.

Sizdən xahiş edirik ki, Azəri yatağında (Faza 1 çərçivəsində istismar olunan MA YBHQ platformasında və KSP-də), Faza 2 çərçivəsində istismar olunan QA və ŞA YBHQ platformalarında və Dərinsulu Günəşli yatağında (Faza 3 çərçivəsində istismar olunan YBHQKV platformasında) tullantıların utilizasiyası üzrə həyata keçirilən işlərin həcminin genişləndirilməsinə anlayışla yanaşasınız. Belə ki, platformaların layihə konstruksiyaları və tullantıların vurulması üçün istifadə olunan qurğular mahiyyət etibarı ilə oxşardır.

Sonda qeyd etmək istəyirik ki, qazma və istismar əməliyyatları nəticəsində yaranan tullantıların şlamların quyudibinə vurulması üzrə mövcud proqram çərçivəsində əhatə olunması ümumilikdə AÇG layihəsinə həm SƏTƏM, həm də məsrəflər baxımından çox faydalı olacaq və bununla əlaqədar olaraq, nəzərdə tutulmuş tullantıların artıq uğurlu olmuş bu proqrama əlavə edilməsi üçün tərəfinizdən icazə verilməsi xahiş olunur.

Bu məktub ilə bağlı hər hansı suallar meydana çıxarsa, Dənizdə Əməliyyatlar İcra Bölümün ətraf mühit məsələləri üzrə texniki rəhbəri Rəhim Rəhimovla əlaqə saxlanılması xahiş edilir (tel.: 494 98 87).

Hörmətlə,

Günter Nyukam,
BP AzSİB-nün SƏTTƏM şöbəsinin direktoru

Ministry of Ecology and Natural Resources

17/5

Date: 17 May 2007
Ref No: 4/1342-17-15

→ Faig

To: Mr. Gunther Newcombe
BP AzSPU HSSE Director

From: Mr. H. Mammadov
Director, Environment Protection Department

Mr. G. Khalilov
Chief, State Environmental Expertise Department

Mr. M. Ganbarov
Acting Director, Caspian Complex Environmental Monitoring Administration

Thought we had approval. Note suggests we need to provide more data & justification. Can you develop a response & discuss with me. Regards.

All, as a result of discussion our agreed actions are:
1) Draft response letter to MENR – Rahim
2) Arrange a meeting with MENR – Saadet
3) Send a finalised response letter to MENR
Thanks, Faig

Dear Mr. Newcombe,

The Ministry of Ecology and Natural Resources has reviewed BP's letter and documents accompanying it with regard to the "Addition to the Environmental and Social Impact Assessment document pertaining to the disposal of wastes through bottom hole re-injection at ACG contract area within the framework of Phases 1, 2 and 3 of Azer-Chirag-Guneshli (ACG) fields".

Our specialists have analyzed the initial risk assessment with regard to the environmental impact of bottom hole re-injection of waste at Central Azeri. Prior to the bottom hole re-injection of the proposed wastes at Central Azeri, we consider it appropriate to review the situation after an attitude has been expressed to the following issues:

- What specifically does the document imply by the definition of "other wastes" in addition to the cuttings, polluted brine, sand and oily water coming out of the well and slated for re-injection? It is necessary to submit information about qualitative and quantitative characteristics of these wastes to the Ministry of Ecology and Natural Resources;
- It is necessary to express an attitude to studying other more progressive methods of decontaminating these wastes proposed for injection;
- The document points to the re-injection method of waste disposal as being the most preferential from the environmental standpoint. It is necessary to disclose the criteria justifying the choice of this method;
- It is necessary to provide an explanation of the technological process of sand treatment sand, to justify and analyze the principle for reducing the content of oil in contaminated sand to 1%;

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- It is necessary to provide a technical and technological evaluation of transportation of the wastes to onshore facilities in the event of problems with bottom hole re-injection (what emergency and preventive measures are envisaged for such a scenario?);
- The submitted draft document says that the wastes currently disposed of onshore will be re-injected in the future. It is necessary to provide qualitative and quantitative characteristics of these wastes, disclose and provide detailed and complete information about the buffer liquid and other discharged wastes generated in the process of well completion, stimulation and cleaning, and in the additional flushing of well for cuttings re-injection;
- It is necessary to provide the results of physical-chemical, chemical, biological, eco-toxicological, micro-biological and hydro-biological analyses of the waste substances planned for re-injection;
- It is necessary to provide justification for method and technical parameters reflecting absence of contact (leakage, discharge, etc.) between injection wells receiving wastes and the water table (meeting boundary is implied);
- The option of onshore disposal of wastes being generated is also taken into account. Certain expenditure is even envisaged under the project, but there is no information as to how the wastes will be disposed of. It is necessary to provide information about a project to that effect;
- It is necessary to submit the permit issued by an appropriate state body with regard to the geological structure;
- It is necessary to justify mechanisms of control over the physical processes involved in preparation and re-injection of pulp – reservoir pressure, viscosity, density, size of particles, sedimentation, etc. (in other words, organization and maintenance of emergency control over these parameters);
- It is necessary to ensure air-tightness of the technological system during the transportation of cuttings and provide a scheme of prompt control against leaks on the rear part of the casing string;
- In order to prevent resurfacing of wastes, it is necessary to provide a scheme reflecting control over geological structures where the absorption well is located and regulating the process dynamics;
- It is necessary to submit an appropriate response plan in the event of natural cracks, breakages, plugging, loss of pumping capacity, etc.

Yours sincerely,

H. Mammadov
G. Khalilov
M. Ganbarov

AZƏRBAYCAN RESPUBLİKASININ
EKOLOGİYA VƏ TƏBİİ
SƏRVƏTLƏR NAZİRLİYİ

AZ1073 Azərbaycan,
Bakı, B.Ağayev Küç. 100 A
Tel: (99412) 492-59-07,
Faks (99412) 492-59-07

№ 4/1342-17-15
«14» 05 2007 il

«BP» Şirkətinin Sağlamlıq, Əməyin
Təhlükəsizliyi və Ətraf Mühit
məsələləri üzrə direktoru
cənab Günter Nyukama

Hörmətli Günter Nyukam,

BP Şirkəti tərəfindən daxil olmuş, «Tullantıların AGÇ yatağında quyu dibinə vurmaqla utilizasiyası ilə bağlı Azəri-Çıraq-Dərinsulu Günəşli (AÇG) yatağının Faza 1,2 və 3 çərçivəsində ətraf mühit və sosial sahəyə təsirin qiymətləndirilməsi (ƏMSSTQ) sənədinə əlavə» ilə bağlı məktubunuza və məktuba əlavə olunmuş sənədlərə Ekologiya və Təbii Sərvətlər Nazirliyində baxılmışdır.

Sənəddə Mərkəzi Azəri yatağında tullantıların quyu dibinə vurulmasında onun ətraf mühitə təsiri ilə bağlı riskin ilkin qiymətləndirilməsi mütəxəssislərimiz tərəfindən öyrənilmişdir. Nəzərdə tutulan tullantıların Mərkəzi Azəri yatağında quyu dibinə vurulmasından əvvəl aşağıda göstərilənlərə münasibət bildirildikdən sonra baxılmasını məqsədəuyğun hesab edirik:

- təqdim olunan sənəddə laya vurulması təklif olunan şlam, çirklənmiş duzlu məhlul, quyudan çıxan qum və neftli sudan başqa «digər tullantılar» dedikdə konkret olaraq hansı tullantılar nəzərdə tutulur? Nəzərdə tutulan bu tullantıların kəmiyyət və keyfiyyət göstəriciləri haqqında müvafiq məlumatların Ekologiya və Təbii Sərvətlər Nazirliyinə təqdim olunması;
- quyuya vurulması nəzərdə tutulan bu tullantıların daha mütərəqqi digər metodlarla zərərsizləşdirilməsinin öyrənilməsinə münasibətin bildirilməsi;

- təqdimatda seçilmiş metodun - quyuya vurulması nəzərdə tutulan tullantıların utilizasiya metodunun ekoloji-nöqteyi nəzərdən üstünlüyü qeyd olunur. Bu metodun üstünlüyünün əsaslandırma meyarlarının açıqlanması;
- tullantı kimi formalaşan qumun emalı sistemi üzrə texnoloji prosesin izahı və çirkli qumdakı neftin 1 % səviyyəsinə endirilməsinin texniki (digər) təyini prinsipinin əsaslandırılması və analizi;
- tullantıların laya vurma quyularından istifadəsində hər hansı problemlərin yaranacağı təqdirdə bu tullantıların sahilə daşınması mexanizminin texniki və texnoloji cəhətdən qiymətlənlirilməsi (belə vəziyyətdə hansı operativ və qabaqlayıcı tədbirlər tədbirlər nəzərdə tutulur?);
- təqdim olunan layihə sənədində hazırda quruda utilizasiya olunan tullantıların bundan sonra laya vurulması bildirilir. Bu tullantıların konkret olaraq kəmiyyət və keyfiyyət göstəriciləri, sənəddə quyuların tamamlanmasında, stimulyasiyasında, təmizləmə prosesində, şlamın laya vurulması üçün quyunun əlavə yuyulmasında formalaşan bufer maye və s. digər tullantılar kimi nəzrərdə tutulan atqı maddələrinin açıqlanması və onlar haqqında ətraflı, dolğun məlumatların verilməsi;
- quyu dibinə vurulması nəzərdə tutulan tullantıların uyğunluğunu təsdiqləyən maddələrin fiziki-kimyəvi, kimyəvi, bioloji, ekotoksikoloji, mikrobioloji və hidrobioloji təhlillərin nəticələrinin təqdim olunması;
- tullantıları qəbul edən injeksiya quyuları ilə dənizin su aynası (burada görüşmə sərhədi nəzərdə tutulur) səthinin əlaqəsiz (axma, sızma və s.) təminatını əks etdirən metodik və texniki parametrlərin əsaslandırılması;
- formalaşan tullantıların quruda utilizasiyası variantının mövcudluğu da nəzərə alınır. Layihədə bu məqsədlər üçün xərclər nəzərdə tutulur, lakin tullantıların hansı metodla utilləşdirilməsi haqqında məlumat verilmir. Bu istiqamətdə nəzərdə tutulan layihə haqqında müvafiq məlumatların verilməsi;
- geoloji struktur haqqında müvafiq dövlət qurumu tərəfindən verilmiş icazənin təqdim olunması;
- pulpanın hazırlanması və laya vurulmasında tələb olunan fiziki proseslər - lay təzyiqi, özlülük, sıxlıq, hissəciklərin ölçüsü, çökmə və s. parametrlərinə nəzarət mexanizminin əsaslandırılması (başqa sözlə bu parametrlərə operativ nəzarətin təşkili və nəzarətdə saxlanılması üsulları);
- texnoloji sistemdə şlamın nəql prosesində hermetikliyin gözlənməsinə və qoruyucu kəmərin arxa hissəsində sızmaya operativ nəzarət sxeminin verilməsi;

- tullantıların təkrar səthə çıxmasının qarşısını almaq məqsədi ilə uducu quyuların yerləşdiyi geoloji strukturlara nəzarət prosesini və inkişaf dinamikasını tənzimləyən sistem haqqında əldə olunan sxemin verilməsi;
- təbii çatlar, qırılmalar, tıxaclanma, vuruculuq qabiliyyətinin itirilməsi və s. halları ilə əlaqədar müvafiq tədbirlər planının təqdim olunması

Hörmətlə,

Ətraf Mühitin Mühafizəsi Departamentinin direktoru — H.Məmmədov

Dövlət Ekoloji Ekspertiza İdarəsinin rəisi — Q.Xəlilov

Xəzər Kompleks Ekoloji Monitorinq İdarəsinin rəis əvəzi — M.Qənbərov

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Date: **01 August 2008**
Ref: 4/1807-17-15

To: **Mr. Greg Mattson**
BP AzSPU HSE and TD Vice President

From: **Huseyn Mammadov,**
Director, Environmental Protection Department, MENR, Azerbaijan Republic

Mirsalam Ganbarov,
Acting Chief, Caspian Complex Environmental Monitoring Administration, MENR, Azerbaijan Republic

Gahraman Khalilov,
Chief, State Ecological Expertise Department, MENR, Azerbaijan Republic

Dear Mr. Mattson,

Please be informed that the Ministry of Ecology and Natural Resources has reviewed the documents regarding the implementation of drill cuttings disposal operation with the help of their bottom hole reinjection within the Azeri-Chirag-Deep Water Gunashli (ACG) Contract Area described in the Attachment to Phase 1, 2 and 3 Environmental and Social Impact Assessment (ESIA) documents submitted by BP Azerbaijan.

A number of meetings have been held between the MENR and BP experts with respect to the drill cuttings generated during the well drilling and completion operations at the Azeri-Chirag-Deep Water Gunashli (ACG) field, dehydration triethylene, glycol, tank bottom residues with annual 40 m^3 volume, lubricants and samples with annual 35 m^3 volume, reinjection to the bottom hole of anti-fouling washing fluids with annual 120 m^3volume, and MENR has put forward conditions for prevention of any adverse impacts on the marine environment during these drill cuttings disposal stage and in the future and agreement has been expressed to take these conditions into account during the operations process.

Taking the aforementioned into account, for prevention of potential adverse impacts on the marine ecosystem during the reinjection of drill cuttings to the bottom hole, we consider that it is possible to implement the disposal of the drill cuttings envisaged in the document as per the submitted scheme provided that all the actions required by MENR should be carried out; appropriate conditions should be created for taking samples from the fluid (pulp) prepared for disposal by way of reinjection to the bottom hole at least once a quarter; expeditions should be arranged for taking soil samples from different depths (horizons) of sea water and the seabed around the wells; regular monitoring should be conducted on the platforms with respect to the technical condition of the pumps injecting liquids to the wells and the results should be submitted to the Ministry of Ecology and Natural Resources.

Yours respectfully,

H. Mammadov
M. Ganbarov
G. Khalilov

AZƏRBAYCAN RESPUBLİKASININ
EKOLOGİYA VƏ TƏBİİ
SƏRVƏTLƏR NAZİRLİYİ

AZ1073 Azərbaycan,
Bakı, B.Ağayev Küç. 100 A
Tel: (99412) 492-59-07,
Faks (99412) 492-59-07

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BP AzSİB-nin SƏTƏM və Texniki
Məsələlər üzrə vitse prezidenti
cənab Qreq Mətsona

Hörmətli cənab Mətson,

BP şirkəti tərəfindən təqdim olunan Faza 1, 2 və 3 üzrə Ətraf Mühit və Sosial Sahəyə Təsirin Qiymətləndirilməsi (ƏMSSTQ) sənədlərinin Əlavəsində təsvir olunan Azəri-Çıraq-Dərinsulu Günəşli (AÇG) Müqavilə Sahəsində tullantıların quyu dibinə vurmaqla utilizasiyası əməliyyatının həyata keçirilməsi məsələsi ilə bağlı sənədlərə Ekologiya və Təbii Sərvətlər Nazirliyində baxılmışdır.

Azəri-Çıraq-Dərinsulu Günəşli (AÇG) yatağında quyu qazma və tamamlama işləri zamanı formalaşan tullantıların- həcmi ildə 40 m^3 olan dehidrasiya trietilen, qlikol, çən dibi qalıqlar; həcmi ildə 35 m^3 olan sürtkü yağları və nümunələr; həcmi ildə 120 m^3 olan dəniz otu əleyhinə yuyucu məhlulların quyu dibinə vurulması ilə əlaqədar ETSN və BP şirkətinin mütəxəssisləri arasınada bir neçə dəfə görüşlər keçirilmiş, bu tullantıların utilizasiyası mərhələsində və gələcəkdə dəniz mühitinə hər hansı mənfi təsirlərin baş verməməsi üçün ETSN tərəfindən şərtlər irəli sürülmüş və bu şərtlərin əməliyyat prosesində nəzərə alınması barədə razılıq bildirilmişdir.

Qeyd olunanları nəzərə alaraq, tullantıların quyu dibinə vurulmasında dəniz ekosisteminə ehtimal olunan mənfi təsirlərin qarşısını almaq üçün ETSN tərəfindən irəli sürülən bütün tədbirlərin yerinə yetirilməsi, o cümlədən quyu dibinə vurularaq utilizasiya edilmək üçün hazırlanmış məhluldan (pulpadan) rübdə bir dəfədən gec olmayaraq nümünə götürülməsinə müvafiq şəraitin yaradılması, quyular ətrafında dəniz suyunun müxtəlif dərinliklərdən (horizontlardan) və dəniz dibindən qurunt nümuinələrinin götürülməsi üçün ekspedisiyaların təşkil edilməsi, platformalarda quyulara məhlul vuran nasosların texniki vəziyyəti haqqında mütəmadi monitorinqlərin keçirilməsi və nəticələrin Ekologiya və Təbii Sərvətlər Nazirliyinə çatdırılmasını təmin etmək şərti ilə sənəddə nəzərdə tutulan tullantıların təqdim olunan sxem üzrə həyata keçirilməsini mümkün hesab edirik.

Hörmətlə,

Ətraf Mühitin Mühafizəsi
Departamentinin direktoru H.Məmmədov

Xəzər Kompleks Ekoloji Monitorinq
İdarəsinin rəis əvəzi M.Qənbərov

Dövlət Ekoloji Ekspertiza
İdarəsinin rəisi Q.Xəlilov

Faiq Əsgərov
BP Azərbaycan
Ekologiya üzrə menecer

bp
Hyatt Tower 2, 6-cı mərtəbə
İzmir küç., 1033, AZ1033
Bakı, Azərbaycan

Mərkəzi xətt: (994 12) 497 90 00
Birbaşa xətt : (994 12) 497 96 57
Mərkəzi faks: (994 12) 497 96 02
Birbaşa Faks: (994 12) 497 97 29

İstinad: HSE&TD-163/08

Tarix: **13 avqust, 2008-ci il**

Kimə: **Azərbaycan Respublikası Ekologiya və Təbii Sərvətlər Nazirliyi**
Ətraf Mühitin Mühafizəsi Departamentinin direktoru
cənab Hüseyn Məmmədova

Surəti: **Azərbaycan Respublikası Ekologiya və Təbii Sərvətlər naziri**
cənab Hüseyn Bağırova

BP Azərbaycan şirkətinin SƏTƏM və Texniki Məsələlər üzrə vitse-prezidenti
cənab Qreq Məttsona

Azərbaycan Respublikası Ekologiya və Təbii Sərvətlər Nazirliyi
Xəzər Kompleks Ekoloji Monitorinq İdarəsinin rəisi
cənab Mirsalam Qəmbərova

Azərbaycan Respublikası Ekologiya və Təbii Sərvətlər Nazirliyi
Dövlət Ekspertiza İdarəsinin rəisi
cənab Qəhrəman Xəlilova

MÖVZU: ETSN-NİN TULLANTILARIN ZƏRƏRSİZLƏŞDİRİLMƏSİ ÜÇÜN QAZMA ŞLAMLARININ LAYA VURULMASI QUYULARINDAN İSTİFADƏNİN GENİŞLƏNDİRİLMƏSİ İLƏ BAĞLI 1 AVQUST 2008-Cİ İL TARİXLİ İCAZƏ MƏKTUBU VƏ TƏLƏB OLUNAN TƏDBİRLƏRƏ AYDINLIQ GƏTİRİLMƏSİ

Hörmətli cənab Məmmədov,

Tullantıların utilizə olunması üçün dəniz qazma şlamları vurma quyularından utiluzının genishləndirilməsinə icazə verilən 1 avqust 2008-ci il tarixli, 4/1807-17-15 saylı məktubunuza görə Sizə təşəkkür edirik.

ETSN tərəfindən tələb olunan üç əlavə tədbirlə əlaqədar olaraq BP şirkəti aşağıdakı izahatı diqqətinizə çatdırmaq istəyir.

1) ***Ən azı rübdə bir dəfə quyudibinə vurulmaq yolu ilə utilizə edilmək üçün hazırlanmış məhluldan (pulpadan) nümunələrin götürülməsinə müvafiq şəraitin yaradılması***. Bir-birindən çox fərqlənən vurma maye axınlarından belə

nümunələrin götürülməsinin dəyəri sual altında olsa belə, ETSN tərəfindən platformalara səfərlər edilən zaman laya vurulan maye nümunələri götürüləcək və təqdim olunacaq.

2) ***Quyuların ətrafında dəniz suyunun müxtəlif dərinliklərindən (horizontlar) və dənizdibindən qrunt nümunələrinin götürülməsi üçün ekspedisiyalar təşkil olunmalıdır.*** Tələb olunan nümunələrin və monitorinq göstəricilərinin toplanması, o cümlədən ekoloji vəziyyət və hesabat nəticələrinin qiymətləndirilməsi məqsədilə davam edən Kompleks Ekoloji Monitorinq Proqramından istifadə olunacaq. Müvafiq illik ekoloji monitorinq hesabatlarının ETSN-ə təqdim olunması davam etdiriləcək.
3) ***Quyulara məhlul vuran nasosların texniki vəziyyəti ilə bağlı olaraq platformalarda müntəzəm monitorinq aparılmalı və nəticələr Ekologiya və Təbii Sərvətlər Nazirliyinə təqdim olunmalıdır.*** Vurucu nasosların yoxlanması və təmiri ilə bağlı həyata keçirilən proqramın nəticələri açıqlanan hesabatlar illik əsasda ETSN-ə təqdim olunacaq.

Əgər bu məktubla əlaqədar hər hansı suallar olarsa ətraf mühit məsələləri üzrə baş məsləhətçisi Səadət Qafarova ilə 497-93-11 nömrəli telefonla əlaqə saxlamaq olar.

Hörmətlə,

Faiq Əsgərov,
BP Azərbaycan şirkətinin
Ekologiya üzrə meneceri

Faig Askerov
BP Azerbaijan SPU
Environmental Manager

bp
Hyatt Tower 2, 6th floor
1033, Izmir str. AZ1003
Baku, Azerbaijan

Switchboard :	(994 12) 497 90 00
Direct Lines :	(994 12) 497 96 57
Central Facsimile:	(994 12) 497 96 02
Direct Fax:	(994 12) 497 97 29

File Ref: HSE&TD-163/08

Date: **13 August, 2008**

TO: **Mr. Huseyn Mammadov,**
Director of Environmental Protection Department of Ministry of Ecology and Natural Resources of the Azerbaijan Republic

CC: **Mr. Huseyn Bagirov,**
Minister of Ecology and Natural Resources of the Azerbaijan Republic

Mr. Greg Mattson,
BP Azerbaijan HSE and Technical Vice-President

Mr. Mirsalam Ganbarov,
Chief of Caspian Complex Environmental Monitoring Administration, Ministry of Ecology and Natural Resources of the Azerbaijan Republic

Mr. Gahraman Khalilov,
Chief of State Ecological Expertise Department of Ministry of Ecology and Natural Resources of the Azerbaijan Republic

SUBJECT: MENR APPROVAL LETTER OF 1 AUGUST 2008 FOR EXPANDED USE OF OFFSHORE CUTTING INJECTION WELLS FOR WASTE DISPOSAL AND CLARIFICATION OF REQUIRED ACTIONS

Dear Mr. Mammadov,

Thank you for your approval letter of 1 August 2008 with Ref No. 4/1807-17-15 authorizing the expanded use of offshore cuttings injection wells for waste disposal.

In regard to the three additional actions required by the MENR, BP would like to offer the following clarification.

1) ***Appropriate conditions should be created for taking samples from the fluid (pulp) prepared for disposal by way of injection to the bottom hole at least once per quarter.*** Samples of injected fluid will be collected and provided when ever MENR visits to the platforms are made; even though the value of such samples from a highly variable injection stream is questionable.

Environmental Monitoring Program will be utilized to collect required samples and monitoring data, as well as to assess the environmental condition and report outcomes. Relevant annual environmental monitoring reports will continue to be provided to the MENR.

3) ***Regular monitoring should be conducted on the platforms with respect to the technical condition of the pumps injecting liquids to the wells and the results should be submitted to the Ministry of Ecology and Natural Resources.*** Reports outlining the results of ongoing re-injection pump inspection and maintenance program will be provided to the MENR annually.

Saadat Gaffarova, Senior Environmental Officer can be contacted at 497-93-11 should MENR experts have any questions with regards to this letter.

Sincerely,

Faig Askerov,
BP Azerbaijan Environmental Manager

APPENDIX 5C

Composition and Function of COP Chemicals with Potential For Discharge

Tables 1 & 2 provide a list of the product name, chemical composition, function, and usage of products which will, or could, be discharged to sea during each phase of the COP project. The table also indicates the environmental rating of each product (either UK OCNS classification or MENR approval).

Chemicals with the most favourable available environmental rating have been selected for each project phase, with the aim of minimising the environmental impact of any unavoidable discharges. The composition and chemistry of each planned or potential discharge has been fully taken into account in the impact assessment process.

Table 1: Drilling and Cementing Chemicals

Product	Composition	Function	Volume used per well (tonnes)	Rating	Activity	Application	Discharge volume per well (tonnes)
Bentonite	Clay Ore	Viscosifier and removal of cuttings	20	E	MODU drilling	36" WBM	20
Sodium Bicarbonate	Sodium Bicarbonate	pH treatment and calcium ion separation	1	E	MODU drilling	36" WBM	1
Fluorescent Dye	Fluorescein	Cement tracer	0.1	GOLD	MODU drilling	36" WBM	0.1
Barite	Barium sulphate ore	Weighting agent	200	E	MODU drilling	26" WBM	Trace on cuttings
Bentonite	Clay ore	Viscosifier and removal of cuttings	20	E	MODU drilling	26" WBM	Trace on cuttings
KCL	Potassium chloride	Borehole stabiliser	15	E	MODU drilling	26" WBM	Trace on cuttings
Ultrahib	Polyether amine	Stabiliser / Shale Inhibitor	3	GOLD	MODU drilling	26" WBM	Trace on cuttings
Polypac	Polyanionic cellulose	Encapsulater	0.3	E	MODU drilling	26" WBM	Trace on cuttings
Flo-Trol	Cellulose polymer/ Modified starch	Fluid loss control and reduces the risk of drill string sticking	0.3	E	MODU drilling	26" WBM	Trace on cuttings
Duovis	Bio-polymer	Viscosifier	0.5	GOLD	MODU drilling	26" WBM	Trace on cuttings
UltraFree	Synthetic Alyphatic Hydrocarbon	Lubricant, prevents bit balling	2	GOLD	MODU drilling	26" WBM	Trace on cuttings
Ultracap	Polymer	Encapsulator	1	GOLD	MODU drilling	26" WBM	Trace on cuttings
Sodium Bicarbonate	Sodium bicarbonate	pH treatment and calcium ion separation	1	E	MODU drilling	26" WBM	Trace on cuttings
Citric acid	Citric acid	pH treatment and calcium ion separation	3	E	MODU drilling	26" WBM	Trace on cuttings
Class G cement	Cement	Cement	225	E	MODU cementing	Section casing cementing	11.4
D175 Antifoam	Dimethyl siloxanes, silicones and sorbitan stearate	Antifoam agent	0.4	Gold	MODU cementing	Section casing cementing	0.2
D185 Dispersant	Aliphatic acid copolymer	Dispersant	0.3	Gold	MODU cementing	Section casing cementing	0.1
D500 Gasblok LT	Organic polymer, Amine polymer, Hexahydro-1,3,5-tris(2-hydroxyethyl)-symtriazine	Cement additive	11.9	Gold	MODU cementing	Section casing cementing	0.9
D077 Liquid Acc. (CaCl2)	Calcium chloride	Cement additive	1.2	E	MODU cementing	Section casing cementing	0.1

Product	Composition	Function	Volume used per well (tonnes)	Rating	Activity	Application	Discharge volume per well (tonnes)
D075 Extender	Silicic acid, sodium salt	Cement extender	1.8	E	MODU cementing	Section casing cementing	0.2
D182 Mudpush II	Sulfonated organic polymer, glucoside polymer	Cement additive	0.4	Gold	MODU cementing	Section casing cementing	0.2
F103 Ezeflo	Surfactant: 2-butoxyethanol, Propan-2-ol, ethoxylated alcohol linear	Cement additive	0.6	Gold	MODU cementing	Section casing cementing	0
Barite	Barium sulphate ore	Weighting agent	17.6	Gold	MODU cementing	Section casing cementing	8.2
Barite	Barium sulphate ore	Weighting agent	200	E	PLATFORM drilling	26" WBM	Trace on cuttings
Bentonite	Clay ore	Viscosifier and removal of cuttings	20	E	PLATFORM drilling	26" WBM	Trace on cuttings
KCL	Potassium chloride	Borehole stabiliser	15	E	PLATFORM drilling	26" WBM	Trace on cuttings
Ultrahib	Polyether amine	Stabiliser / Shale Inhibitor	3	GOLD	PLATFORM drilling	26" WBM	Trace on cuttings
Polypac	Polyanionic cellulose	Encapsulater	0.3	E	PLATFORM drilling	26" WBM	Trace on cuttings
Flo-Trol	Cellulose polymer/ Modified starch	Fluid loss control/.reduces the risk of drill string sticking	0.3	E	PLATFORM drilling	26" WBM	Trace on cuttings
Duovis	Bio-polymer	Viscosifier	0.5	GOLD	PLATFORM drilling	26" WBM	Trace on cuttings
UltraFree	Synthetic Alyphatic Hydrocarbon	Lubricant, prevents bit balling	2	GOLD	PLATFORM drilling	26" WBM	Trace on cuttings
Ultracap	Polymer	Encapsulator	1	GOLD	PLATFORM drilling	26" WBM	Trace on cuttings
Sodium Bicarbonate	Sodium bicarbonate	pH treatment and calcium ion separation	1	E	PLATFORM drilling	26" WBM	Trace on cuttings
Citric acid	Citric acid	pH treatment and calcium ion separation	3	E	PLATFORM drilling	26" WBM	Trace on cuttings
Class G cement	Cement	Cement	162	E	PLATFORM cementing	Section casing cementing	5.1
D175 Antifoam	Dimethyl siloxanes, silicones and sorbitan stearate	Antifoam agent	0.3	Gold	PLATFORM cementing	Section casing cementing	<0.1
D185 Dispersant	Aliphatic acid copolymer	Dispersant	0.3	Gold	PLATFORM cementing	Section casing cementing	0
D500 Gasblok LT	Organic polymer, Amine polymer, Hexahydro-1,3,5-	Cement additive	8.3	Gold	PLATFORM cementing	Section casing cementing	0.6

Product	Composition	Function	Volume used per well (tonnes)	Rating	Activity	Application	Discharge volume per well (tonnes)
	tris(2-hydroxyethyl)-symtriazine						
D077 Liquid Acc. (CaCl2)	Calcium chloride	Cement additive	0.1	E	PLATFORM cementing	Section casing cementing	trace
D075 Extender	Silicic acid, sodium salt	Cement extender	1.6	E	PLATFORM cementing	Section casing cementing	<0.1
D182 Mudpush II	Sulfonated organic polymer, glucoside polymer	Cement additive	0.3	Gold	PLATFORM cementing	Section casing cementing	0.1
F103 Ezeflo	Surfactant: 2-butoxyethanol, Propan-2-ol, ethoxylated alcohol linear	Cement additive	0.6	Gold	PLATFORM cementing	Section casing cementing	trace
Barite	Barium sulphate ore	Weighting agent	15.7	Gold	PLATFORM cementing	Section casing cementing	6.3

Table 2: Commissioning and Production Chemicals

Product	Composition	Function	Volume used (tonnes)	Rating	Activity	Application	Concentration in Discharge/ Dosing Regime
Troskil 88	THPS	Hydrotest biocide	9.67	MENR	PLATFORM	Pipeline commissioning	30-300 ppm
TC-1000	Ammonium bisulphite	Hydrotest oxygen scavenger	3.22	MENR	PLATFORM	Pipeline commissioning	Dosed at 100 ppm, trace present in discharge
Seadye	Fluorescein	Tracer dye	3.22	MENR	PLATFORM	Pipeline commissioning	100 ppm
Gyptron SA960	Ethanediol 1-10% in water	Scale inhibitor	Depends on occurrence and frequency of discharge	E	PLATFORM	Production chemicals	20 ppm[2]
Cleartron EZB4416	Cationic polymer in suspension	Reverse demusifier		No rating	PLATFORM	Production chemicals	10 ppm[3]
Methanol (Well Equalisation)	Methanol	Hydrate and wax control		PLONOR[1]	PLATFORM	Production chemicals	3-4000 ppm[4]
Calcium nitrate	Calcium nitrate	Souring mitigator		E	PLATFORM	DWG Water injection chemicals	57 ppm[5]
OS2	Ammonimum bisulphite	Oxygen Scavenger		E	PLATFORM	DWG Water injection chemicals	5 ppm[6]
SA960	acrylic acid copolymer, monoethylene glycol	Scale inhibitor		Gold	PLATFORM	DWG Water injection chemicals	30 ppm[7]
AF400	2-butoxyethanol and fatty acid	Antifoam agent		Gold	PLATFORM	DWG Water injection chemicals	1 ppm[8]
CK956G	organic phosphate ester, imidazoline, quaternary ammonium, acetic acid, 2-butoxyethanol, Na thiosulphate, isopropyl alcohol	Corrosion inhibitor		Gold	PLATFORM	DWG Water injection chemicals	30 ppm[8]

NOTES:
1. PLONOR – listed by OSPAR as a substance or product Posing Little Or No Risk to the environment
2. Concentration basis: Produced water rate. Injection points - Individual wellheads and Inlet of produced water infield pipeline
3. Concentration basis: Produced water rate. Injection points - Water outlet from each low pressure separator and water outlet of test separator
4. Concentration basis: Methanol rate of 100l/hr if used. Injection points - Wellheads (during start up)
5. Injection points - Upstream of the deaerators and upstream of the produced water pumps
6.. Injection points - Each deaerator system recycle loop.
7. Injection points - Suction of each water injection pump.
8. Injection points - Inlet of each deaerator

APPENDIX 5D

Determination of Chemical Hazard Categories

CHARM

The OCNS conducts hazard assessments on chemical products that are used offshore. The CHARM model calculates the ratio of Predicted Effect Concentration against No Effect Concentration (PEC: NEC), and is expressed as a Hazard Quotient (HQ), which is then used to rank the product. The HQ is converted to a colour banding (see Table 1 below), which is then published in the Definitive Ranked Lists of Approved Products, Adobe Acrobat format (ZIP, 2.06 MB, updated 24 November 2009) PEC is estimated for a standard platform with a standard mixing zone and a standardised estimate of tidal advection. PEC also takes into account standard chemical usage rates and includes an estimate of the fraction released (based on oil-water partitioning data). NEC is derived from the results of standardised acute toxicity tests, using an application factor of 10-1000 (the selection of the application factor is built in to the model and reflects the type and quantity of toxicity data available). Data used in the CHARM assessment include toxicity, biodegradation and bioaccumulation, and the model is divided into 4 main algorithms: Production, Completion / Workover, Drilling, Cementing.

Although the current OCNS is based on hazard assessment, it remains primarily a ranking system; the actual HQ values are dependent on assumptions about the size of the mixing zone and on the rate of dispersion, and these assumptions will not be valid for the Caspian. However, the rankings remain valid for any consistent set of assumptions, and will therefore provide a reliable indication of relative environmental effects for all water bodies.

Table 1 The OCNS HQ and Colour Bands

Minimum HQ value	Maximum HQ value	Colour banding	
>0	<1	**Gold**	
≥1	<30	**Silver**	
≥30	<100	**White**	Lowest Hazard ↓
≥100	<300	**Blue**	Highest Hazard
≥300	<1000	**Orange**	
≥1000		**Purple**	

Non-CHARM (Old A-E OCNS ranking)

Products not applicable to CHARM model (i.e. inorganic substances, hydraulic fluids or chemicals used only in pipelines) are assigned an OCNS grouping A – E, with A being the greatest potential environmental hazard and E being the least (see below table)

This system awards the offshore chemical a letter grouping between A and E. (N.B. care should be taken not to confuse these values with the results of the Netherlands pre-screening scheme). Each individual substance in an offshore chemical should be ranked by applying the OCNS Ranking Scheme. The overall ranking is determined by that substance having the worst case OCNS ranking scheme assignment. The method of assignment of the OCNS letter grouping is described below.

Initial Grouping

The initial group is determined using Table 2. All submitted toxicity data for the product are compared with the table and the value giving the worst case 'Initial Grouping' (i.e. the test giving the most toxic response) is used as the Initial Group for the substance.

Table 2 Initial OCNS Grouping

Initial Grouping	A	B	C	D	E
Result for Aquatic toxicity data (ppm)	<1	>1-10	>10-100	>100-1,000	>1,000
Result for sediment toxicity data (ppm)	<10	>10-100	>100-1,000	>1,000-10,000	>10,000

- **Aquatic toxicity** refers to the Skeletonema costatum EC_{50}, Acartia tonsa LC_{50}, and Scophthalmus maximus (juvenile turbot) LC_{50} toxicity tests.
- **Sediment toxicity** refers to the Corophium volutator LC_{50} test.

Adjustment for Environmental Performance to Determine final Group

The final grouping is determined using Table 3 as a guide. Select the column that applies to the candidate product and adjust the initial Group accordingly. If the classification should theoretically move beyond Group A or E, the product will nevertheless be assigned to that particular Group.

Table 3: Adjustment criteria for OCNS grouping

Increase by 2 Groups e.g. From C to E	Increase by 1 Group e.g. From C to D	Do not adjust initial grouping	Decrease by 1 group e.g. From C to B	Decrease by 2 groups e.g. From C to A
Substance is readily biodegradable and is non-bioaccumulative	Substance is inherently biodegradable and is non-bioaccumulative	Substance is not biodegradable and is non-bioaccumulative or	Substance is inherently biodegradable and bioaccumulates	Substance does not biodegrade and bioaccumulates
		Substance is readily biodegradable and bioaccumulates		

Definitions of terms used in the classification table:

- **Readily biodegradable** - Results of >60% biodegradation in 28 days to an OSPAR HOCNF accepted ready biodegradation protocol.
- **Inherently biodegradable** - Results of >20% and <60% to an OSPAR HOCNF accepted ready biodegradation protocol or result of >20% by OSPAR accepted Inherent biodegradation study.

- **Not biodegradable** - Results from OSPAR HOCNF accepted ready biodegradation protocol or inherent biodegradation protocol are <20%.
- **Non-bioaccumulative/non-bioaccumulating** - Log Pow <3, or results from a bioaccumulation test (preferably using Mytilus edulis) demonstrates a satisfactory rate of uptake and depuration, or the molecular mass is > 700.
- **Bioaccumulative/Bioaccumulates** - Log Pow >3, or results from a bioaccumulation test (preferably using Mytilus edulis) demonstrates an unsatisfactory rate of uptake and depuration, and the molecular mass is < 700.
- **Aquatic toxicity test result** - LC/EC_{50} data for Skeletonema costatum, Acartia tonsa or Scophthalmus maximus (Juvenile turbot) (units = ppm or mg/litre)
- **Sediment toxicity test result** - LC_{50} data for Corophium volutator (units = ppm or mg/Kg).

Appendix 5E

Seismic Design of the WC-PDQ Platform

Seismic Loads and Seismic Design Criteria

Design Criteria

The seismic design and seismic design criteria shall be in accordance with API RP 2A.The API guidelines for seismic design are based on a two level design check.

Design Seismic Conditions

The design seismic conditions cover the following seismic events:

- Firstly, the platform is designed against an earthquake that has a relatively low likelihood of occurrence during the life of the platform. This event is referred to as the Strength Level Earthquake (SLE). The platform is expected to sustain little or no damage under the SLE. The return period of SLE was recommended to be 500 years.

- Secondly, the platform is checked against a rare event that has a very low likelihood of occurrence during the platform life. This event is referred to as the Ductility Level Earthquake (DLE). The platform can sustain local damage during the DLE event; however, it should not collapse or have high Health, Safety or Environmental consequences during the DLE. The return period of DLE was recommended to be 3000 years.

Seismic Analysis

Platform location specific seismic SLE and DLE design criteria has been developed in accordance with API RP 2A. Table A and, Figures A and B below show horizontal and vertical acceleration response spectra corresponding to the 500-year return period SLE and 3000-year return period DLE events at the proposed Platform site.

According to comparisons made between AIOC seismic criteria and Azerbaijan offshore seismic design criteria contained in “Field Construction Standards. Offshore Stationary Platforms Design. SIN 0136002-57-98. BY SOCAR. Baku 1998”, AIOC SLE and DLE criteria is comparable to SOCAR & GIPRO intensity (Richter scale) of about 8 and 9 respectively.

Table A

	500 year Return Strength Level Earthquake (SLE)		3000 year Return Ductility Level Earthquake (DLE)	
Period (Sec)	**Horizontal Acceleration (g)**	**Vertical Acceleration (g)**	**Horizontal Acceleration (g)**	**Vertical Acceleration (g)**
PGA	0.196	0.157	0.426	0.341
0.030	0.196	0.157	0.451	0.361
0.050	0.279	0.251	0.586	0.527
0.075	0.351	0.316	0.740	0.666
0.100	0.413	0.372	0.877	0.790
0.150	0.486	0.340	1.065	0.745
0.200	0.494	0.247	1.095	0.547
0.300	0.435	0.218	0.980	0.490
0.500	0.326	0.163	0.778	0.389
0.750	0.238	0.119	0.589	0.295
1.000	0.205	0.102	0.521	0.260
1.500	0.174	0.087	0.445	0.222
2.000	0.150	0.075	0.394	0.197
3.000	0.099	0.050	0.270	0.135
4.000	0.067	0.034	0.188	0.094
5.000	0.047	0.023	0.132	0.066
6.000	0.034	0.017	0.095	0.047
7.000	0.025	0.012	0.070	0.035
8.000	0.019	0.010	0.053	0.027
9.000	0.015	0.008	0.042	0.021
10.000	0.012	0.006	0.034	0.017

Figure A

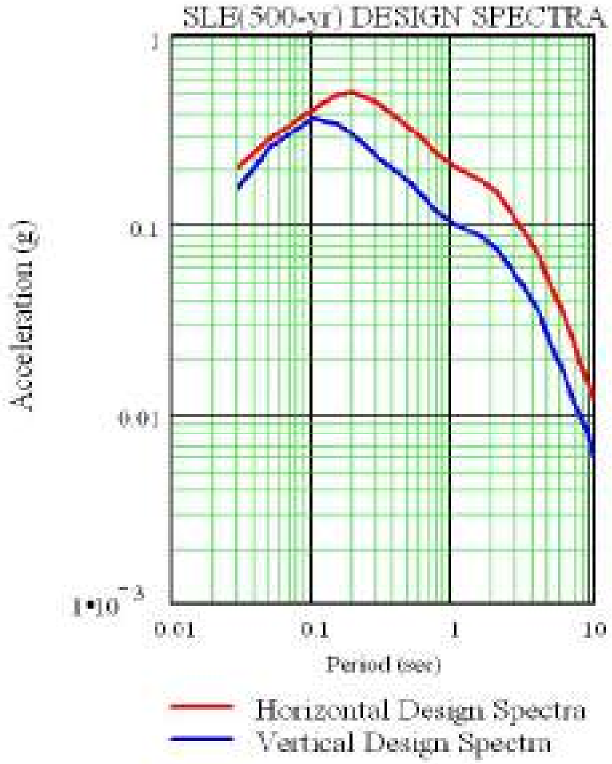
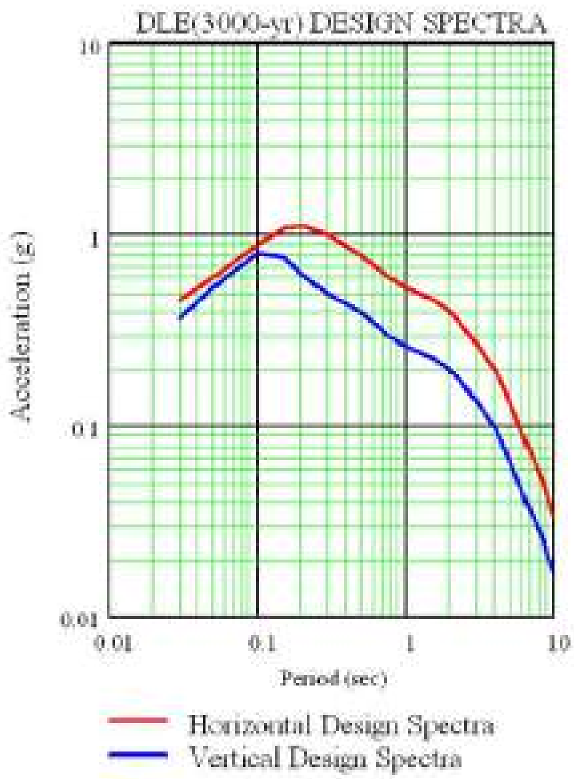


Figure B



APPENDIX 5F

Estimate of Sludge Generated from the WC-PDQ Platform

Estimate of Sludge Generated from the WC-PDQ Platform

The relationship is as follows:

Daily volumetric sludge production =

$$POB \times Sludge \cdot production \cdot for \cdot black \cdot water \Big/ MLSS$$

Maximum persons on board (POB) = 265

Mixed liquor suspended solids concentration (MLSS) = 15,000 g/m^3

Sludge production for black water = 20 to 40 g/head.d

The calculated volumetric sludge productions are given below for range of sludge productions:

	Units	**Highest (offshore)**	**Average (domestic)**	**Least (vendors)**	**Calculation steps**
Mixed liquor suspended solids	g/m^3	15,000	15,000	15,000	Typical value for membrane bioreactor (MBR) plants
Sludge dry solids production	g/head.day	40	30	20	Black water per person load of 40 g BOD removed/head.d x dry solids production for MBR plants (extended aeration) of 0.3 to 1.0 kg dry solids / kg BOD removed (source).
Daily sludge volume	m^3/d	0.7	0.5	0.35	POB x g/head.day / MLSS
Number of days per month	days	30	30	30	Assumed values
Monthly sludge volume	m^3/month	21	15	11	Daily sludge volume x days/month

Source: Construction Industry Research and Information Association Report (CIRIA) Report (2000) The selection of package wastewater treatment plants. CIRIA report FR/IP/33.

APPENDIX 6A

Fauna and flora surveys in the vicinity of the Sangachal Terminal (2006 and 2008)

The Tables below show the fauna and flora species identified in the vicinity of the Sangachal Terminal (2006 and 2008).

Table 1 Terrestrial fauna observed near Sangachal Terminal during 2008

Scientific name	Common name	Azerbaijan Red Book	IUCN Red List	Observed
*Microtus socialis**	Social vole	Not listed	Least concern	Old burrow, New burrow
Mus musculus	Common mouse	Not listed	Not listed	Yes, trapped.
Eremias velox	(lizard)	Not listed	Not listed	Yes
*Lepus europaeus**	European hare, Brown hare, European brown hare	Not listed	Least concern	Scat, new burrows
Testudo graeca	Spur-thighed Tortoise	Listed	Vulnerable	Yes
*Meriones libycus**	Libyan jird	Not listed	Not listed	New burrows
*Vulpes vulpes**	Red Fox, Cross Fox, Silver Fox	Not listed	Least concern	Scat, observed
Ophisops elegans	Snake-eyed lizard	Not listed	Not listed	Yes
*Erinaceus concolor**	Southern white-breasted hedgehog	Not listed	Least concern	Yes
Cyrtopodion caspium	Caspian bent-toed gecko	Not listed	Not listed	Yes
*Allactaga elater**	Small five-toed jerboa	Not listed	Least concern	Old burrows

*Mammalian species

Table 2 Bird species observed in vicinity of Sangachal Terminal during 2008 survey

Species	Common name	Resident	Migratory
Acrocephalus arundinaceus	Great reed warbler	+	
Acanthis cannabina	Linnet		+
Acanthis flavirostris	Twite		+
Accipiter nisus	Eurasian sparrowhawk		+
Acrocephalus schoenobaenus	Sedge warbler		+
Acrocephalus scirpaceus	Reed warbler		+
Alauda arvensis	Skylark		+
Alcedo atthis	Common kingfisher		+
Alectoris chukar	Chukar	+	
Anas crecca	Common teal		+
Anas platyrhynchos	Mallard		+
Anas querquedula	Garganey		+
Anser anser	Graylag goose		+
Anthus pratensis	Meadow pipit		+
Apus apus	Common swift		+
Ardea cinerea	Gray heron	+	
Ardea purpurea	Purple heron		+
Asio flammeus	Short-eared owl		+
Athene noctua	Little owl	+	
Aythya ferina	Common pochard		+
Aythya fuligula	Tufted duck		+

Species	Common name	Resident	Migratory
Botaurus stellarus	Great bittern		+
Burhinus oedicnemus	Stone curlew		+
Buteo rufinus	Long-legged buzzard		+
Calandrella cinerea	Red-capped Lark	+	
Calandrella rufescens	Lesser short-toed Lark	+	
Caprimulgus europaeus	European nightjar		+
Carduelis carduelis	Goldfinch		+
Cercotrichas galactotes	Rufous bush robin		+
Cettia cetti	Cetti's warbler		+
Charadrius alexandrinus	Western snowy plover		+
Charadrius leschenaultii	Greater sand plover		+
Chardrius dubius	Little ringed plover		+
Chloris chloris	Greenfinch		+
Circus aeruginosus	Marsh harrier	+	
Circus cyaneus	Northern Harrier		+
Columba livia	Common Pigeon	+	
Coracias garrulus	European Roller		+
Corvus cornix	Hooded Crow	+	
Corvus corax	Common raven		+
Corvus frugilegus	Rook		+
Coturnix coturnix	Common Quail		+
Cuculus canorus	Common Cuckoo		+
Cygnus cygnus	Whooper Swan		+
Cygnus olor	Mute Swan		+
Delichon urbica	House martin		+
Egretta alba	Great White Egret		+
Emberiza schoeniclus	Reed bunting	+	
Emberizia cia	Rock bunting		+
Erithacus rubecula	European Robin		+
Falco cherrug	Saker Falcon		+
Falco columbarius	Merlin		+
Falco tinnunclus	Common Kestrel	+	
Fringilla coelebs	Chaffinch		+
Fulica atra	Eurasian Coot		+
Galerida cristata	Crested Lark	+	
Himantopus himantopus	Black-winged Stilt		+
Hippolais caligata	Booted Warbler		+
Hippolais languida	Upchers Warbler		+
Hippolais pallida	Olivaceous Warbler		+
Hirundo rustica	Barn Swallow		+
Lanius collurio	Red-backed shrike		+
Lanius minor	Lesser Gray Shrike		+
Lanius senator	Woodchat Shrike		+
Larus cachinnans	Caspian Gull		+
Larus genei	Slender-billed Gull		+

Species	Common name	Resident	Migratory
Larus ichthyaetus	Great Black-headed Gull		+
Larus ridibundus	Black-headed Gull		+
Locustella naevia	Grasshopper Warbler		+
Lusciniola melanopogon	Moustached Warbler		+
Melanocorypha calandra	Calandra Lark	+	
Merops apiaster	European Bee-eater		+
Merops superciliosus	Madagascar Bee-eater		+
Motacilla alba	White Wagtail	+	
Motacilla cinerea	Gray Wagtail		+
Motacilla feldegg	Black-headed Wagtail		+
Motacilla flava	Yellow Wagtail		+
Neophron percnopterus	Egyptian Vulture		+
Netta rufina	Red-crested Pochard		+
Nycticorax nycticorax	Black-crowned Night-Heron		+
Oenanthe deserti	Desert Wheatear		+
Oenanthe finschii	Finsch's Wheatear	+	
Oenanthe isabellina	Isabelline Wheatear		+
Oenanthe pleschanca	Pied Wheatear		+
Panurus biarmicus	Bearded Reedling	+	
Parus major	Great Tit		+
Passer domesticus	House Sparrow	+	
Pastor roseus	Rosy Starling		+
Pelecanus onocrotalus	White Pelican		+
Petronia petronia	Rock Petronia		+
Phalacrocorax carbo	Great Cormorant		+
Phalacrocorax pygmaeus	Pygmy Cormorant		+
Phalaropus lobatus	Red-necked Phalarope		+
Pica pica	European Magpie	+	
Podiceps cristatus	Great Crested Grebe		+
Podiceps nigricollis	Black-necked Grebe		+
Podiceps ruficollis	Little Grebe		+
Prunella modularis	Dunnock		+
Pterocles orientalis	Black-bellied Sandgrouse	+	
Pyrrhocorax pyrrhocorax	Chough		+
Sitta neumayer	Rock nuthatch	+	
Cardelius spinus	Siskin		+
Sterna albifrons	Little Tern		+
Sterna hirundo	Common Tern		+
Streptopelia decaocto	Eurasian Collared Dove	+	
Sturnus vulgaris	European Starling	+	
Sylvia communis	Whitethroat		+
Sylvia atricapilla	Blackcap		+
Sylvia curruca	Lesser Whitethroat		+
Sylvia hortensis	Orphean Warbler		+
Tadorna ferruginea	Ruddy Shelduck	+	

Species	Common name	Resident	Migratory
Tringa totanus	Common Redshank	+	
Troglodytes troglodytes	Wren		+
Turdus merula	Blackbird		+
Upupa epops	Common Hoopoe		+
Vanellus vanellus	Northern Lapwing		+

Table 3 Major perennial plant species and ecosystems identified in surveys 2006-2008.

Scientific name	Life-form	Ecosystem/community types
Alhagi pseudoalhagi	Forb	Semi-desert areas/chal-meadow
Artemisia lerchiana	Semi-shrub	Semi-desert
Bolboschoenus maritimus	Grass	Saline and marshy coastal
Halocnemum strobilaceum	Semi-shrub	Desert
Halostachys caspica	Shrub	Desert and semi-desert
Juncus acutus	Forb	Semi-desert /chal-meadow, wet, saline and sandy areas
Kalidium caspicum	Bush	Saline and marshy coastal
Lycium ruthenicum	Shrub	Desert and semi-desert, saline coastal slopes
Phragmites australis	Grass	Marsh/reedbeds
Poa bulbosa	Grass	Desert and semi-desert
Salsola dendroides	Semi-shrub	Desert and semi-desert
Salsola ericoides	Shrub	Desert
Salsola nodulosa	Shrub	Desert and semi-desert
Suaeda dendroides	Bush	Desert and semi-desert
Suaeda mycrophylla	Bush	Desert and semi-desert
Tamarix ramosissima	Shrub	Desert and semi-desert

APPENDIX 6B

Fish, Seal and Bird Reviews

Appendix 6B
Fish, Seal and Bird Reviews

CONTENTS

1. Fish Fauna Review

In ACG Contract Area, Chirag Oil Project
Author: Professor Mehman M. Akhundov, Doctor of Biology

1.1 Characteristic of Fish Fauna in the Western Part of the South Caspian and ACG Contract Area Waters

The fish fauna of the Caspian numbers in total 123 species (76 species and 47 subspecies) classified to 17 families and 53 genera (Kazancheev, 1981). The surveyed Contract Area is relatively distant from main rivers of the Caspian Sea: Volga and Kura. Due to its geography, stream condition features, bottom configuration as well as shortage and variance of feed organisms, the water area of the Contract Area has never been the permanent habitat or schooling place (Derzhavin, 1956; Ragimov, 1968; Kazancheev, 1981; Belyayeva et al., 1989; Kasimov, 1989; Akhundov, 2000) for fish. In view of the meridian-oriented situation of the Caspian Sea and seasonal dynamics of the seawater temperature, in spring (March to April) and autumn (October to November) the southeastern part of waters of the surveyed Contract Area sides the migration routes of some fish species, chiefly herrings (including anchovy kilka), gray mullets (leaping mullet) and sturgeons.

The Kura area of the western part of the South Caspian adjoining the southern part of surveyed waters of the Contract Area accommodates nearly 80 fish species including marine, fresh-water, migratory and semi-migratory (Akhundov, 2000). The Kura area, Kyzyl-Agach Bay and Lankaran coast play a critical role in the formation of the South Caspian fish fauna, in generation of sturgeon, Caspian trout, and carps stock in particular, and therefore it may be considered to be an area of sensitive fish habitats. As well, herrings and kilkas approach this area at the depth of 10-50 m for spawning. This area is of prime importance in spring, summer and, to a lesser extent, in autumn periods. Muddy-sandy, sandy-silty and silty-shelly soils occur at depths of 10-50 m, which are considered most inhabited with benthic organisms (Kasimov, 1987; Bagirov, 1989). The vast majority of fish inhabit the offshore strip at a depth of up to 50-75 m. Spawners of migratory and semi-migratory fish that are ready for spawning concentrate in the Kura region of the South Caspian; sturgeon fries gather here for fattening in spring as well. Besides, wintering and fattening areas of sturgeons are also located here at sea pasturages at small depths of 10 - 40 m.

Sturgeons in the Contract Area waters are encountered individually as migrating species passing the areas ranging from 50 up to 100 m in depth. In winter, sturgeon populations in the Kura area are fattening along the western coast keeping to the sea shallow depth (10-40 m) pasturages. The fry (up to 85 cm in size) feed within the same sea pasturages along with the adult fish. As compared to common and stellate sturgeons, the beluga feeds over a much more extensive area. The sturgeons in the South Caspian are represented by 5 species and subspecies classified to two genera. Two species are most abundant: Kura (Persian) sturgeon and South-Caspian stellate sturgeon. The beluga is less in numbers; the Russian and barbel sturgeon stocks are comparatively small and insignificant as well. **Carps** rank first in the number of species (42) among the fish fauna of the western part of the South Caspian and comprise fresh-water, migratory and semi-migratory species. The most commercially valuable species are roaches, breams, European carps, and pike perches. River populations of these fish as well as kutum occur in the southwestern part of the South Caspian. For spawning, they enter Kura and desalted coastal areas in vicinity of Kura Bar and Kyzyl-Agach Bay. The western coastal waters of the South Caspian with depths not exceeding 30-40 m, including the pre-estuary area of Kura, constitute foraging sites for migratory fish (asp, shemaya, Caspian vimba and so on). The fry also concentrate here for feeding. **Herrings** in the Caspian are marine forms spending all of their lives in sea. Kilkas are the most abundant fish in the Caspian Sea and represented by 3 species: common, anchovy and big-eyed. In terms of numbers, anchovy and big-eyed kilkas largely keep close (mainly in wintertime) to the studied Contract Area waters. The link between the distribution of herrings and kilkas as their food as well as the distribution of zooplankton that, in its turn, is a food for kilkas is traced during the autumn - winter period. Herrings winter in the South Caspian between Zhiloy Island and Astara, chiefly in vicinity of western coasts and southern slopes of the Absheron Threshold (Kazancheev, 1981). In terms of numbers, herrings are mostly observed in the studied Contract Area waters in winter largely at depths down to 50-100 m. **Gray Mullets** are represented by two species: golden and leaping mullet. Leaping mullets are mostly encountered in the Contract Area during their migrations along the western coasts at depths down to 50 m; however, golden mullets are almost never encountered. **Gobies** are second only to carps by their number of species in the Caspian Sea; they populate in all regions of the sea, predominantly in areas of coastal shallows. Like most other Caspian fish, gobies do not usually leave the boundaries of depths ranging from 50 to75 m.

In different seasons, nearly 20 fish species can be found within a year both in the ACG Contract Area and around the oil platform (Table 1) that either inhabit the coastal waters at depths not exceeding 50-75 m (gobies), or migrate through this area in spring (March to April) and autumn (October to November) seasons, or winter near the western shores and southern slopes of the Absheron Threshold (herrings, anchovy and big-eyed kilkas).

Table 1 Fish Species Composition in the Contract Area Waters

№№	Name of Species
	Acipenseridae family – sturgeons
1	Beluga – Huso huso (Linne)
2	Sturgeon, Russian sturgeon – Acipenser guldenstadti (Brandt)
3	Kura (Persian) sturgeon – Acipenser güldenstädtii persicus natio cyrensis (Belyaeff)
4	Kura barbel sturgeon – Acipenser nudiventris (Derzhav, Borsenko)
5	Kura (South-Caspian) stellate sturgeon – Asipenser stellatus stellatus natio cyrensis (Berg)
	Clupeidae family – Herrings
	Clupeonella genus (Kessler) – Kilka
6	Anchovy kilka – Clupeonella engrauliformis (Borodin)
7	Big-eyed kilka – Clupeonella grimmi (Kessler)
8	Caspian common kilka – Clupeonella delicatula caspia (Stetovidov)
	Alosa Cuvier genus – Herrings
9	Caspian shad – Alosa caspia caspia (Eichwald)
10	Big-eyed shad – Alosa brashnikovi autumnalis (Berg)
11	Volga shad – Alosa kessleri volgensis (Berg)
12	Black-backed shad – Alosa kessleri kessleri (Grimm)
	Cyprinidae family – Carps
13	Kutum – Rutilus frisii kutum (Kamensky)
	Mugilidae family – Gray Mullets
14	Golden mullet – Lisa auratus (Risso)
15	Leaping mullet – Lisa saliens (Risso)
	Gobiidae family – Gobiids
16	Caspian goby – Neogobius caspius (Eichwald)
17	Round goby – Neogobius melanostomus affinis (Eichwald)
18	Caspian syrman goby – Neogobius syrman eurystomus (Kessler)
19	Monkey goby – Neogobius fluviatilis pallasi (Berg)
20	Caspian big-headed goby – Neogobius kessleri gorlap (Iljin)
21	Knipovich long-tailed goby – Knipowitschia longicaudata (Kessler)
22	Grimm big-headed goby – Benthophilus grimmi (Kessler)

1.2 Commercial Catches in Azerbaijan

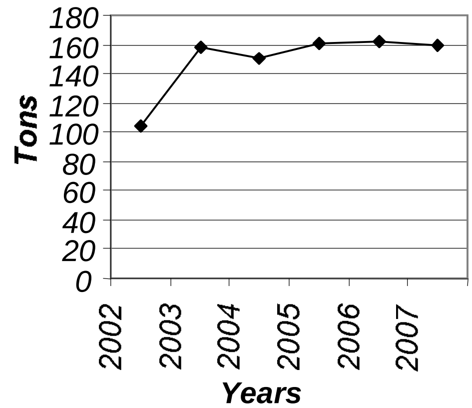
Some 30 fish species and subspecies are of commercial value in the Caspian Sea. Sturgeons (beluga, sturgeon, stellate sturgeon) are the primary object of fishery. The semi-migratory fish, such as roach, Eastern bream, European carp and pike perch, rank next to sturgeons in order of importance. Caspian salmon stocks are formed mainly due to fish-farming, which efficiency has declined many times. Of a large number of species and subspecies of the Caspian, only 4, such as black-backed shad, Brashnikov's shad, Caspian shad and big-eyed shad, are of commercial value. There are only few commercial fish species in the Caspian Sea. Apart from herrings, these include kilkas and gray mullets as well. Judging by the total mass of catch, kilkas today rank first making approximately 75% of the total catch of fish both in the Caspian Sea and coastal river mouths. To date, kilkas are most abundant fish while sturgeons rank second in terms of biomass. The fishery in the Azerbaijan Republic covers the Caspian Sea, the Kura River and inland water bodies. Commercial catches of both the Kura River and the Caspian Sea include over 20 fish species. Eastern bream constitutes the major portion of catches from the Kura River, which value varies between 40 and 50%; pike perch comes second -15-26% and then roach ranks third - 12-17%. Fishing in the Caspian is mainly based on three fish species, of which kutum makes 27 to 60% of catches; second comes the gray mullet with catches increased from 10% (as of 2002) to 37% (2007); the roach making 10-19% of the total catch ranks third. Carps of Cyprinidae family are fished in Azerbaijan in both the Kura River and the Caspian Sea. The catch statistics over 2002-2007 for the Kura River and the Caspian Sea is given in Figure 1.

Sturgeons are mainly fished in the Kura River (Figure 2). They are fished in vicinity of the Kura River mouth and used for fish farming purposes as well. Feeding populations of sturgeons inhabit the western shelf of the Caspian Sea, and commercial stocks are also formed here; sturgeon spawners are in II and II-III phases of maturity and in the state of feed migration. South of the Kura River, sturgeon spawners are in III and III-IV phases of maturity and in the state of spawn migration. Figures of catches of these valuable fish species over 2002-2007 are given below. As is evident from Figure 2, the value of sturgeon catches remains roughly the same in accordance with quota allocated by CITES for each littoral country (Table 2).

Kilka fishing is based today on the coastal form, Clupeonella delicatula, that constitutes 58% of catches; anchovy kilka Clupeonella engrauliformis ranks second - 40%, and 2% fall on big-eyed kilka Clupeonella grimmi. The long-term analysis of commercial Caspian kilka stock dynamics shows that it reached its peak in 1999 and sharply declined in 2001, as such affecting the fishery. The anchovy kilka stock tended to stabilize in 2005, and this trend persisted in 2006-2007 as well. Although the kilka catch in Azerbaijan was 11,000 tons in 2002, it reduced to 2,000 tons in 2007 (Figure 3). The study of kilkas' distribution in the sea showed the increasing role of the western coast of the Middle Caspian in fishing of kilkas. Herrings are fished in the southwestern part of the Caspian from Nord-Ost-Kultuk through to Astara, and the local form of Brashnikov's shad constitutes their major portion where Caspian marine shad Alosa brashnikovi sarensis dominates. Data on herring catches by stationary nets in the coastal area of Sara Island are given in Figure 3. Fishing of gray mullets over 2002-2007 in Azerbaijan showed a growth trend coming up to over 60.0 tons in 2007 (Figure 4). However, gray mullet stocks in the Azerbaijan sector of the Caspian Sea are underexploited.

Figure 1 Fish Catches in the Kura River and the Caspian Sea

Kura



Caspian Sea

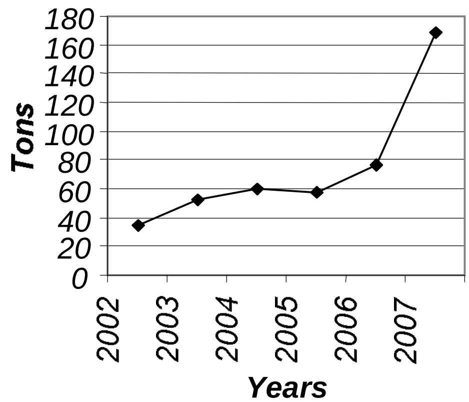


Figure 2 Sturgeon Catches in Azerbaijan

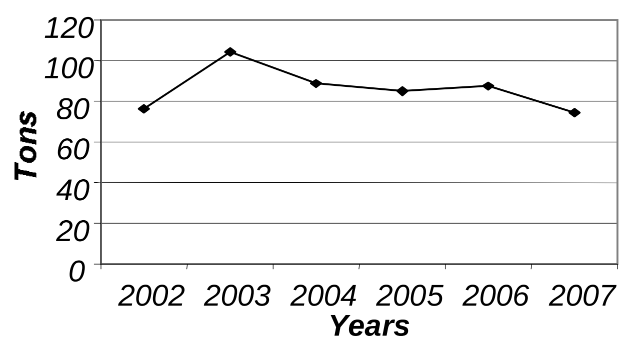
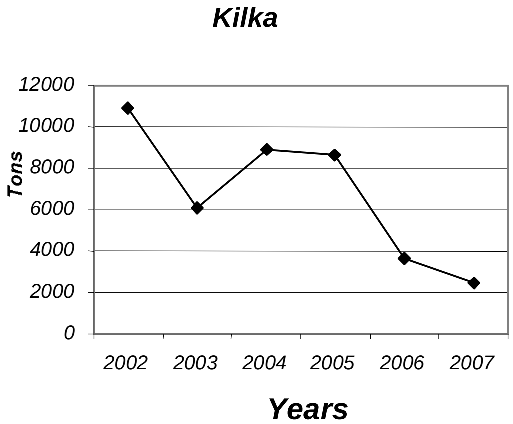


Figure 3 Kilka and Herring Catches in Azerbaijan



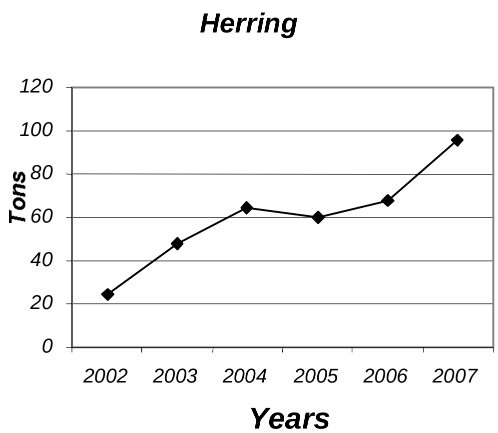


Figure 4 Mullet Catches in Azerbaijan

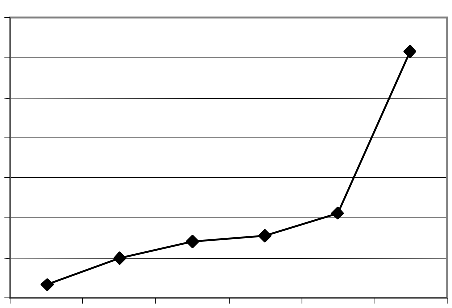


Table 2 Variations of Sturgeon Catches (ton) Over Last Years

Species	2002		2003		2004		2005		2006*		2007	
	Quota	Actual	Quota	Actual	Quota	Actual	Quota	Actual	Quota	Actual	Quota	Actual
Beluga	7.2	5.5	7.2	7.2	7.2	5.7	7.2	4.36	-	0.75	6.0	3.76
Sturgeon	46.86	40.46	46.39	46.3	46.39	46.39	46.39	45.29	-	6.3	46.0	39.8
Stellate sturgeon	38.06	32.97	51.0	50.99	50.41	36.71	46.41	35.09	-	1.68	38.0	30.7
Total:	**92.12**	**78.93**	**104.59**	**104.49**	**104.0**	**88.8**	**100.0**	**84.74**	**-**	**8.73**	**90.0**	**74.26**

Note: * – the catch was used for artificial reproduction and scientific studies only.

1.3 Status of Sturgeon Population in the Azerbaijan Sector of the Caspian Sea

As compared to early 1980s, the annual catch of sturgeons in the Caspian fell 30 times and makes approximately 1,000 ton for all five littoral countries. The sturgeon stock decline in the Caspian Sea started late in 1970s and still goes on. Commercial sturgeon stocks decreased almost 3 times; however, this especially affected the stellate sturgeon, which stocks had become almost 13 times less (Karpyuk, Mazhnik et al., 2006). Last years are featured with the ongoing decline of all species of sturgeons, domination of recruits over remains and high values of unrecorded catches. The quality structure of populations alters; the age range of all sturgeon species as well as the migrating spawners' age reduces; their sizes and the females' portion in breeding populations decrease and the percentage of recurrent spawners are within 15%. However, the species composition of sturgeon populations remains unchanged: sturgeons continue to be most abundant species, followed by stellate sturgeons. As a result of sturgeon populations' reduction in numbers over the entire sea as a whole, no dense populations of them are encountered at the sea pasturages and their distribution throughout the shelf is scattered by nature (Khodorevskaya, 2007). The results of surveys carried out in recent years (Akhundov, 2008; Akhundov et al., 2008) enable to reveal the ongoing changes in distribution, abundance and species ratio of sturgeons at sea pasturages and reflect the general trends specific to the Caspian Sea as a whole at the current stage of the sturgeon fishery.

Based on the results of offshore summer surveys carried out in the Azerbaijan coastal area of the Caspian Sea over 2005-2008, baby fishes dominated (80-83%) in trawl catches. At that, the fish fry in the Middle Caspian dominated noticeably over the adult fish - 89% and 11%, respectively; as well, the quantity of sturgeon fry made 80-82% of the total trawl catch in the South Caspian. The average population mass decrease for sturgeons and stellate sturgeons is observed from 4.6 to 4.0 and from 3.3 to 2.3 kg, respectively. The species composition of sturgeons in research trawl catches was mainly represented by sturgeon and stellate sturgeon, and, to less extent, by beluga and barbel sturgeon. Like in pervious years of observations, sturgeon (59.3-64.0%), stellate sturgeon (34.0-35.6%), barbel sturgeon (1.7-2.2%) and beluga (2.0-3.4%) dominated in catches. In 2005-2008, a regular decrease in relative summer catch values was registered for sturgeons and stellate surgeons as follows: from 0.64 to 0.54 specimen/ trawl and from 0.38 to 0.29 specimen/ trawl, respectively. The beluga and barbell sturgeon abundance was approx. 0.04 and 0.02 specimen/trawl, respectively. The absolute abundance of sturgeons in 2005-2008 over all the studied water area of Azerbaijan shelf of the Middle and South Caspian was estimated in 7.2-7.6 million specimens, including 4.7-5.0 million of sturgeons and 2.2-2.3 million of stellate sturgeons. The sturgeon number decrease in the sea mainly accounts for beluga and stellate sturgeon. In accordance with the change in abundance of sturgeons in 2005-2008, there was observed their stock decline.

Biological data on migration of the sturgeon fry confirm the ongoing decrease in numbers of the fry bred under natural conditions in research catches from the Kura River (Zarbaliyeva et al., 2007). In recent years, the amounts of sturgeons hatched at farms had generally reduced throughout the Caspian Sea (Sudakov, 2007), at Kura hatcheries in particular, from 19.9 million fry specimens in 2004 to 9.7 - in 2007. The results of surveys show that resources of feed organisms in the sea are underused by fish and can sustain a much larger population of sturgeons exceeding by numbers their current population. The current population of sturgeons in the Caspian Sea comprises primarily the fish artificially hatched at farms.

Irrespective of the fact that the portion of artificially hatched fish in catches have already reached 99%, 65% and 45% for beluga, sturgeon and stellate sturgeon, respectively (Khodorevskaya, 2007), today's scales of fish-rearing still neither may compensate the natural reproduction capacities of sturgeons nor diminish the hazard of potential loss of the Caspian sturgeon population's genetic diversity. Average annual figures on sturgeons and individual species of Azerbaijan over the last 5 years (2003-2007) are given in tables 3 and 4:

Table 3 Indicators of Generating the Stock of the Kura Population of Caspian Sturgeons

№	Indicators	Years					
		2003	**2004**	**2005**	**2006**	**2007**	**Average**
1	Freshwater drainage volume, km^3	38.2	35.8	29.4	38.9	33.4	35.1
2	Coefficient of commercial return from natural spawning	0.3	0.3	0.3	0.3	0.3	0.3
3	Hatchery rearing output, million specimen units	12.03	19.92	16.95	16.032	9.68	14.92
4	Sturgeons biomass in fattening areas, thousand tons	31.7	34.75	35.72	40.3	33.7	35.2
5	Annual consumption of feeding-stuffs near the Azerbaijan coast, thousand tons	166.0	184.1	190.3	211.0	145.6	179.4

Table 4 Indicators of Generating the Stock of the Kura Populations of Stellate Sturgeon, Sturgeon and Beluga in the South Caspian

№	Indicators	Species	Years					
			2003	**2004**	**2005**	**2006**	**2007**	**Average**
1	Freshwater drainage volume, km^3	-	38.2	35.8	29.4	38.9	33.4	35.1
2	Coefficient of commercial return from natural spawning	**Stellate sturgeon**	0.3	0.3	0.3	0.3	0.3	0.3
		Sturgeon	0.3	0.3	0.3	0.3	0.3	0.3
		Beluga	-	-	-	-	-	-
3	Hatchery rearing output, million specimen units	**Stellate sturgeon**	3.277	5.968	4.664	3.356	1.74	3.80
		Sturgeon	8.285	12.87	12.287	12.676	7.67	10.76
		Beluga	0.466	0.468	-	-	-	0.19
		Fringe sturgeon	-	0.614	-	-	0.27	0.18
4	Sturgeons biomass in fattening areas, thousand tons	**Stellate sturgeon**	7.4	7.25	7.52	7.7	5.1	7.0
		Sturgeon	19.7	20.7	21.4	22.9	18.88	20.7
		Beluga	4.6	6.8	6.8	9.7	9.7	7.5
5	Annual consumption of feeding-stuffs near the Azerbaijan coast, thousand tons	**Stellate sturgeon**	30.3	29.6	31.8	34.6	21.0	29.5
		Sturgeon	129.6	145.5	151.7	163.5	112.9	140.6
		Beluga	6.1	9.0	6.8	12.9	11.7	9.3

In offshore surveys during the last few years, gastrointestinal contents of the fish taken for a full biologic analysis had been tested. Sturgeons were split to size groups: up to 40 cm, 40-80 cm, and 80-120 cm in length. The qualitative composition of the sturgeon fry with a body length of up to 40 cm included two components: crustaceans and fish food. Out of the total amount of crustaceans, which made only 8.2% of the feed range, 94% fell on Cumaceans.

The food of fish consisted by 10% of gobies that could be identified to species, and 80% of the food constituted digested gobies. The stomach filling index of this group of fish was 68.7‰o., the number of hungry stomachs - 42.8% and the condition factor - 0.68. The fry group with a body length of 40-80 cm consumed fish food only, of which 4/5 was comprised of gobies with kilka added to the ration. The stomach filling index was 103.4‰o., and the number of hungry stomachs was insignificant - 14.2%. The condition factor equaled 0.59. In winter, of the marine nutritive base in the Azerbaijan coastal waters, the marketable population of the sturgeon fry mainly consumed the fish food with predominant gobies, from amongst round gobies and monkey gobies were determined as most abundant and widespread species; one-seventh of the ration were kilkas; of crustaceans, there were registered individual specimens of Cumaceans, mysids, and freshwater shrimps, which constituted 1.64%. The feed range of the stellate sturgeon fry was quite narrow and included one component, clam worms, for the group with a body size of up to 40 cm; the 40-80 cm size fry group consumed the fish food along with clam worms. The stomach filling index of both fish groups exceeded the standard nutrition value for stellate sturgeons -12 ‰o.; at that, the stomach filling index of the fry group with a body length of 40-80 cm exceeded the standard six times. The condition factor of the fish feeding on clam worms was slightly higher - 0.6. Generally, the stellate sturgeon fry population was fattening in wintertime mainly on clam worms (91.3% of food) having optimal stomach filling and fatness indices.

During summer record trawling surveys, fattening of sturgeons taken for the full biologic analysis had been based on a single component - gobies. Digestive tracts of most analyzed specimens of stellate sturgeons appeared empty. The beluga digestive tract analysis showed that it had a narrow nutrient budget, 95.6% of which consisted of gobies and the remaining small portion – of kilka. The feed rate was quite high and the stomach filling index by size groups varied from 42.5 to 52.3, making in average 49.2 ‰o..The condition factor value evidenced of satisfactory fattening conditions; varying by size groups from 0.82 to 0.93 it made 0.91 in average. The analysis of data of recent years on feeding of sturgeons enabled to conclude as follows: younger size groups of both species - sturgeon and stellate sturgeon - are poorer fed in winter. Senior size groups of sturgeons are fed better as their depth ranges are more extensive. The species-specific nutrition was registered: sturgeons fattened on fish food, consuming mainly gobies and big-head gobies and, to less extent, kilkas. In winter fattening, the stellate sturgeon was described as worm-eater as it consumed clam worms, which biomass was notable for enhanced values in benthos. In summer, the feed rate of both sturgeons and beluga fry was quite satisfactory, but digestive tracts of stellate sturgeon mainly proved to be empty.

The trawl surveys in 2002 in the Azerbaijan sector of the Caspian Sea showed the lack of beluga. The beluga fry with a body length of up to 140 cm made 9.6% (5 specimens) of trawl catches (52 specimens) in 2003; 4.0% (2 specimens) of 55 specimens –in 2004; 3.4 % (2 specimens) of 59 specimens - in 2005 and 2.0 % (1 specimen) out of 50 specimens in 2006 while no beluga was observed in trawl catches during 2007 and 2008. In 2002– 2008, the mature beluga constituted 2.0 to 3.8% in onshore net catches. In recent years, the beluga population in the Caspian basin has been reproduced by hatchery rearing. The lack of beluga spawners results in its intermittent reproduction at sturgeon hatcheries of the Kura River. To avoid the loss of the Kura population of beluga, AzerSIFI recommends listing it as a rare and endangered sturgeon species on the Red Book of Azerbaijan.

11 fish hatcheries are currently reproducing fish stocks in Azerbaijan, of which 4 are for sturgeons, 3 - for salmons and 4 - for carps. In 2004, a new sturgeon hatchery with the design output of 15 million juveniles per year was constructed on the state-of-the-art fish-farming technology at the expense of theWorld Bank and commissioned at the Kura River. At present, all four sturgeon hatcheries in Azerbaijan annually reproduce juveniles of Kura sturgeon, stellate sturgeon, barbel sturgeon and beluga and release into the Kura area 14.9 million young fishes per year as the average. Of this amount, the sturgeon and beluga percentage varies by years within 45.2 -79.2% and within 18.0-51.0%, respectively. Totally 1.37 million of beluga fry and 0.88 million of barbell sturgeon fry were released to the Caspian Sea for that period of time.

1.4 Status of Kilka Population in the Azerbaijan Sector of the Caspian Sea

Apart from its commercial value, kilka is the main fodder product for sturgeons, herrings and other predatory fish, as well as for the Caspian seal. The role of invader comb-jelly Mnemiopsis leidyi, which is a plankton-eater, in the Caspian ecosystem comes to overexploitation of fish food reserves as it consumes significant amounts of zooplankton and thus jeopardizes the food consumers. The reduction of stocks as well as the decrease of catches of kilka was recorded with the appearance of M. leidyi in the Caspian Sea. So, the kilka catches throughout the basin have generally fallen from 271 kt in 1999 to 54 kt in 2003 (Sedov et al., 2004), i.e. five-fold. In recent years, the kilka have been observed starting to feed on Acartia. The domination of Acartia (clausi+tonsa) in the current zooplankton structure, instead of Euritemora, Limnocalanus and Calanipede, contributes to change in the biochemical content of food of Caspian kilkas, which applies rather to anchovy and big-eyed kilkas than to common kilka. Proteins prevail in the biochemical composition of Acartia, while Euritemora is noted for the highest fat content (Karpyuk, Katunin et al., 2006). In current conditions, the rise of energy value of small-celled phytoplankton (instead of Rhizosolenia) predetermines the rise of Acartia's energy value as it consumes phytoplankton. This means that in new conditions the anchovy kilka starts consuming more proteins and fewer lipids.

The studies show that the peak development of Mnemiopsis population in the Middle Caspian fell on 2003-2004 and in the South Caspian- on 2004-2005 (Akhundov, Zarbaliyeva, 2006); this is consistent with the information provided by other authors (Karpyuk, katunin et al., 2006). The reduction of comb-jelly Mnemiopsis abundance and biomass is limited by both the trophic factor and the increased competition of anchovy kilkas for food supplies, as their stocks started growing (Karpyuk, Mzhnik et al., 2006). In recent years, certain surveys have been carried out in the Azerbaijan sector of the Caspian Sea on kilkas' distribution and abundance, which showed the presence of their concentrations, though moderate, throughout the entire studied area of the sea. The average catch per cone net in the Middle Caspian was 5.8, and in the South Caspian - 11.3 kg. The anchovy kilka prevailed in catches making 63.4-83.5% (Table 12) of them while the common kilka and the big-eyed kilka constituted 14.6-28.6% and 0.2-2.8%, respectively. The percentage of common kilka in catches has grown significantly (4-5 times) versus previous years; at the same time, the big-eyed kilka has almost disappeared in catches. Major shoals of kilka were recorded in the South Caspian in the area between Oil Rocks and Kornilov-Pavlov Bank. Kilkas highest concentrations were recorded in the coastal area (within 50 m offshore). The mature fish outnumbered in catches. Consequently, the fry numbers in catches were insignificant. The anchovy and common kilkas feeding was studied in their concentration areas near the western coast of both the Middle and South Caspian of the Azerbaijan sector. As the average, 38% of digestive tracts were empty in summer and 26% - winter. The diet of kilkas caught in the summertime at Borisov Bank was characterized by the following parameters: 54.5% of digestive tracts were empty; the food in 33.4% of digestive tracts was represented by single specimens of Cypris larva of Balanus, and only 9.1% of digestive tracts were filled moderately. The condition factor of kilka (as per Clark) had low values. All analyzed specimens of kilka were at the V stage of reproductive maturity and had a high Fulton condition factor.

Surveys conducted during recent years had showed that Acartia dominates in the anchovy and common kilka food at all stations of the South Caspian. In autumn, Cypris larva of Balanus dominated in the food of both species of kilka at Borisov Bank. Apart from Acarttia and Cypris larva of Balanus, cladocerans were also recorded in the food of common kilkas in Shah-Agach area. Thus, Acartia tonsa is ranked first in kilka's food; at that, it constitutes only one-fifth of the food range of common kilkas and a half of ration of anchovy kilkas. After the invasion of Mnemiopsis, the tense food relations remained unchanged, though they were attributed to the impoverishment of food supply of pelagic area of the sea (Zarbaliyeva et al., 2007) and the consumption by kilkas of the same components that had previously constituted secondary food. Fattening rate in the Middle Caspian at the Devechi station was higher than at others while the intensive food consumption by anchovy kilka was recorded at the Shah-Agach station in the South Caspian. The index variation range in summer was quite small: between 1.1 and 18.6 ‰, and between 0.83 and 27.1 ‰ for anchovy and common kilka of the Middle Caspian, respectively. There is no difference between stations in the South Caspian: 1.9 to 5.6 ‰ and 2.3 ‰ for anchovy and common kilkas, respectively. In autumn, stomach filling index variations for kilkas by sea areas and species were even less significant: 0.29-2.2‰, and 0.65 to 4.4‰ for anchovy and common kilka of the Middle Caspian, respectively. In the South Caspian, the stomach filling index varies from station to station ranging from 0.2 to 15.6‰, for anchovy and from 0.9 to 6.3‰. - for common kilka. The provided figures display more than a two-fold decrease over years (Tinenkova, Pochitayeva, 1985; Yelizarenko, 1997; Mammadov, Jalilov, 2003); however, condition factors for the last years are within a long-term tolerance and evidence of favorable fattening conditions in the situation occurred with one of the links in the Caspian Sea food supply chain, the zooplankton, when (Karpyuk, Katunin et al., 2006; Bagirov et al., 2007) the predominance of Acartia tonsa compared with the Caspian species Eurytemora grimmi and Limnocalanus grimaldii had changed the biochemical composition of kilka's food and resulted in increase of individual weight and length of kilka.

Surveys carried out in recent years with respect to the population structure, abundance dynamics and forecasting of the Caspian kilka stock for collection and processing of data on species and sex composition, weight, length and other biologic parameters of anchovy kilka had shown that at the depths of 70-80 m around banks of Borisov and Karagedov and Oil Rocks, most taken kilkas belonged to size groups of 111-115, 116-120 and 121-125 mm; and the 116-120 mm group dominated among them. 99 % of 96-100 mm long anchovy kilkas were females; females made 75 percent in the 101-105 mm size group; 98% of kilkas in the 106-110 mm size group were males; females made 84, 72.5, 50, and 66 percent in 111-115, 116-120, 121-125 and 126-130 mm size groups, respectively. The conducted analyzes showed that there were less males than females in studied mass of fish; they constituted 98% only in 106-110 mm size group and there were equal numbers of males and females in the 121-125 mm size group. Females with high percentage of abundance dominated in other groups. In general, females and males accounted for 75% and 25% of the total analyzed material, respectively. The size of all caught fish exceeded 96-100 mm, i.e. no fish of junior age group were available in catches. The average mass of fish was 7.68 g, which can be assumed a standard figure.

Unlike the spring season, lengths of anchovy kilka caught in summer were less, ranging from76-80 to 101-105 mm size groups. The kilka females of the 86-90 mm size group made 65% and males - 35%. The ratio of females to males in the 91-95, 96-100, and 101-105 mm size groups were 50 to 50, 53 to 47, and 52.4 to 47.6 percent, respectively. Few or no kilka fry specimens are observed in catches. This trend has become especially observable since 2001. The lack of kilka fry in catches shows the low kilka reproduction since 2001 to date. One of the reasons for kilka fry numbers' fall in catches is the invasion of the Caspian Sea by comb jelly Mnemiopsis leidyi, a kilka roe eater, in 1997-1998. Furthermore, the excessive fishing (over fishing) of kilkas also badly affects their reproduction scales. Echometric surveys in winter showed the high abundance of anchovy kilkas in the Middle Caspian, where 50% of the total kilka biomass of the entire sea was recorded in February. The anchovy kilka population comprises eight age groups (0+ to 7+ years). The kilka fishing dynamics in the Caspian Sea within recent years evidences of a sustainable reduction of their commercial stocks, chiefly on account of anchovy kilka (Table 5). Waters of Azerbaijan shelf of both the Middle and South Caspian were surveyed and the survey results showed that catches of herrings, kilka and other species of marine fish varied between 6.2 and 17.5 kg/catch. The maximum kilka concentration was observed athwart Zhdanov Bank.

Table 5 Changes in Sturgeon Catches (kton, %) in Recent Years

Species	2002	2003	2004	2005	2006	2007	2008
Anchovy	9,143.4 (83.5%)	4,882.1 (80.4%)	6,334.26 (71.2%)	7,896.0 (75.2%)	1,965.4 (63.4%)	861.7 (23.5%)	341.0 (34.1%)
Big-eyed	208.0 (1.9%)	30.36 (0.5%)	17.79 (0.2%)	294.0 (2.8%)	12.4 (0.4%)	33.0 (0.9%)	6.0 (0.6%)
Common	1,598.7 (14.6%)	1,159.8 (19.1%)	2,544.38 (28.6%)	2,310.0 (22.0%)	1,122.2 (36.2%)	2,772.2 (75.6%)	653.0 (65.3%)
TOTAL:	**10,950.1**	**6,072.26**	**8,896.43**	**10,500.0**	**3,100.0**	**3,667.0**	**1,000.0**

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2. Information on Caspian Seals

For environmental and social impact assessment (ESIA) in the Azeri, Chirag, Guneshli (ACG) Contract Area where a new platform will be installed and commissioned along with some field pipelines (approximately within 7 km south of the existing DWG platform and within 5 km northwest of Chirag-1 platform). The Contract Area surface is 432 km2. During the pipeline installation, the area will significantly increase.

2.1 Caspian Seals Summary

(a more detailed information of the introduction is given in the AIOC literary review for the Contract Area ESIA (ACG of August 15, 1995))

The Caspian seal is the only marine mammal in the Caspian Sea basin. The seal is endemic to the Caspian basin and extremely vulnerable in this term. We have determined that maximum lifetime of the Caspian seal is 50 years (1976); the females achieve the reproductive maturity when they are 7-8 (the survey of about 10 thousands of pregnant seal females at the Absheron Peninsula coast showed that minimum age of pregnant females was 8. Only in one case we found a pregnant seal female at the age of 7). Menopause of seals starts when they are 30-32 years old. And an embryo has been detected in the uterus of only one individual at the age of 34. The reproductive maturity of seal males comes at the age of 8-9. The sharp increase of sizes and weight of the sexual ossiculum also serves an additional proof of this figure. The physical maturity (completion of synostosis) of a Caspian seal comes at the age of 18-22 and geratic changes (osteochondrosis, osteoporosis, arthroses deformans, teeth roots fragmentation) - at the age of 28 – 32. During their lifetime, the Caspian seals migrate in spring from the North to the South Caspian where they spend summer months, and return back in winter for breeding on the ice. In migration, seals may be observed practically in all parts of the sea. Whelping takes place in winter period, normally from January 25 to February 5; the newborn pup is called “white coat” as it has long white fur and weighs about 5 kg. In two weeks, the long fur starts shedding and is replaced with short grey-blue sivari fur, and this is the tulupki stage of pups. The white fur coat completely disappears within a month and the sivari stage starts, continues up to 6 months to be changed with “stained wool” color (the “stained wool” stage). An ephebic color appears within a year: males’ color as a rule being dark blue with bright spots and females’ of lighter tones. Mating of seals takes place not in the water, but on the ice, immediately after the white coat pups are weaned, i.e. in a month after breeding. Throughout the pups’ feeding, seal males are on the ice waiting for the end of lactating, after which they mate and stay for a while with females on the ice where their spring molting takes place. Females are not concerned about further fate of their pups. After ice melting, the seals start migrating to the south in two directions as follows: the minority moves along the west coast and the majority along the east coast of the Caspian Sea. In the Azerbaijani sector of the Caspian Sea, the seals normally appear at the end of April/ beginning of May. In some years, both breeding and migrations may be shifted for one month subject to weather conditions. Maximum accumulation of seals in the water area of the Absheron Archipelago is observed at the end of May/ beginning of July. Further the seals migrate to the South Caspian and feed in its central part and near the Iranian coast. In June, the seals appear at the territory of Iran. Back migration in autumn commences in October and ends at the end of November/ beginning of December. In 2008, the peak of autumn migration fell on the end of October/ beginning of November. Maximum number of seals fell on November 3. Over thousand of seals were found from helicopters as well as by fishers in the area between Pirallahi and Zhiloy islands i.e. on islands of Malaya Plita, Bolshaya Plita, Podplitochniy and Dardanelles, as well as on capes of Yuzhniy and Urunos of Zhiloy Island. A large migration stream of seals was also observed those days between Zhiloy Island and Oil Rocks.

If at the turn of the 19th century the total number of seals in the Caspian Sea was estimated as 1-2 millions of individuals, as early as the beginning of the 20th century, their population was estimated as approximately one million of individuals. The seals, mainly white coats, were hunted on the ices of the North Caspian throughout 19th and 20th centuries.

In the beginning of the 20th century, up to 100 thousand of seals were killed every year. Later, a quota of 40 thousand animals per year was established, followed by its further reduction to 20 thousand. Currently, the quota for killing of seals is several thousands in all. The planned hunting of seals has significantly decreased in recent years not as a result of quotas reduction, but due to contraction of the seal product market.

Owing to barbaric fishing of seals in 1980-1990s, their numbers reduced to 350 - 400 thousand individuals (Krylov, V.I.) i.e. one seal per square kilometer of the Caspian at the average. The current estimates of seal numbers vary within 110 thousand individuals. This figure is indicated in the report of the Caspian International Seal Survey (CISS) team based on the results of the Caspian seals' census in 2006). The mortality dynamics of seals at the Azerbaijan territory fully confirms this figure.

The Caspian seal is now listed as 'vulnerable' (Endangered) on the IUCN red list. Recently, there had taken place cases of mass mortality of seals that reduced their numbers to a significant extent. Thus, the mass mortality in 2000 resulted in the loss of several dozens of thousands of seals throughout the Caspian Sea (in Azerbaijan, Kazakhstan, Russia and Turkmenistan). 30 thousand of individuals have perished according to our estimates. The number of dead seals washed ashore at the Azerbaijani coast of the Caspian reached 6 thousand of individuals. The scientists noted long ago the accumulation of different parasitic infections, heavy metal ions and organic pesticides (especially DDT and its derivants) in the Caspian basin, but the canine distemper or canine morbilli virus (the term 'rabies virus' is unfitting – a wrong translation) was recognized to be the main agent that caused the seals' mortality in 2000. Almost all seals that were surveyed that time demonstrated a positive reaction to the presence of this morbilli virus. Previous surveys also showed that pollutants might be responsible for seal females' infertility (there is an opinion that infertility can reach 70%). The percentage of seal females failing to participate in breeding still remains very high (up to 80% according to some data).

Apart from hunting and pollution, the Caspian seal is affected by other factors as well. One of the main sources of feeding for seals for a long period of time was kilka (sprat), a small and very abundant fish in the Caspian Sea. In the past decade the stocks of kilka had greatly reduced for a number of reasons including: mass mortality in 2001, increase of catch over 1990-2000 and invasion of the comb jelly Mnemiopsis leidyi.

Factors of disturbance during whelping and feeding of pups are another threat for seals life that has been only recently assessed.

There is a need to take appropriate actions for protection of seals in order to prevent them from becoming extinct. Being the end link in the food chain of the Caspian Sea, the seal plays a key role in its ecosystem. As well, the seal is a remarkable indicator for the health of the Caspian Sea ecosystem.

2.2 Seal Rookeries at the Territory of Azerbaijan

Permanent and seasonal seal rookeries existed since ancient times at the Absheron Peninsula and on islands of Absheron and Baku archipelagoes. In the 1930s, up to 10 thousand seals a year were also hunted (killed) on islands of the Absheron Archipelago and Shahdilli Spit every year. Thus, for example according to N.K. Vereshagin (1938), 14 809 seals were killed in the area of Shahdilli Spit as well as on Zhiloy and Svinoy islands in 1935; 11 321 seals - in 1936; and 7 188 - in 1937. In the same years, from 100 to 200 thousand seals a year were also killed in the North Caspian. And this resulted in a sharp reduction of seal numbers in the Caspian Sea. In the 1970-80s, monitoring surveys of the Caspian seals were conducted by late Professor D.V. Hajiyev; the author of this report had also got involved in these surveys since 1971. Regular trips to Shahdilli Spit during these years allowed to identify that up to two thousand seals were permanently available on the sandbar and an adjacent seal island, which is now drowned, but earlier had been located within one kilometer to the north of the sandbar. In the period of spring and autumn migrations, the seal numbers sharply increase. Some photographs of seal rookeries of those years were also preserved.

In addition, it should be noted that almost all islands of Baku Archipelago, primarily Bulla and Glinyaniy, were the Caspian seal's seasonal haul-out sites where seal numbers reached hundreds, and small groups of seals were observed on these islands even in winter time.

In the 1980-90s, as a result of rising of the Caspian Sea level as well as other reasons (an abundant discharge of a large amount of DDT and other chlororganic compounds by river flow), the numbers of seals on rookeries have sharply reduced and did not exceed thousand individuals. Surveys conducted in 1995-1997 with the assistance of BP, who organised the helicopter flyovers of the Caspian coastland in Azerbaijan including Shahdilli Spit and the islands of Absheron and Baku archipelagoes showed that the numbers of seals on Shahdilli Spit did not exceed 200-300 individuals, whereas about 200 seals resided on islands Malaya Plita, Bolshaya Plita, Podplitochniy and Dardanelles located between Artem (Pirallahi) and Zhiloy islands, and a small group of seals (100-150 individuals) was available on Yuzhnaya Spit of Zhiloy Island. Small groups of seals were regularly observed on Urunos Cape, which had currently turned into an isolated island detached from Zhiloy. Flyovers were primary carried out jointly with a British surveyor, Callan Duck (1996), and then with Susan Wilson (1997) . Apart from flyovers, regular walkovers were carried out for surveying Zhiloy Island and Shahdilli Spit water areas. No special permit was required that time for visiting these territories. Unfortunately, the situation has dramatically changed since that time and now special short-term permits should be obtained from the relevant authorities to conduct monitoring surveys there. Obtaining of permits for access to Zhiloy Island is particularly difficult. All this impedes the detailed and regular walkovers for monitoring. The results of monitoring surveys of those years were reported at the Meeting on the Caspian Sea held in Bordeaux in October 1997 where photos of Azerbaijan seal rookeries were presented, of which one photo demonstrated a poacher hunting seals on Yuzhnaya Spit of Zhiloy Island.

Since 1995 to the present day, no seals are observed on Baku Archipelago islands any more. Only once in 1996, 2 seals were observed from the helicopter at the coastal strip of Glinyany Island.

In summer of 2001, monitoring surveys were conducted together with Susan Wilson and late Iranian surveyor Tormos Asadi (he perished in winter in 2008 in a car accident while surveying the seals at the coast of the Iranian water area of the Caspian); that time the number of seals on Shahdilli Spit achieved 200-300 individuals.

The seal winter haul-out site on Shahdilli Spit was observed last time in in spring (March) 2002. The observation was conducted jointly with British surveyor Susan Wilson and her colleague, a camera operator from UK. In this period, the last haul-out site with approximately 100 individuals had been found and a dead body of a white coat in the stage of 'tulupka' (a pup that started passing the moulting process and most of his white coat fur shed) detected. This fact shows that seal females gave birth at the winter haul-out site on Shahdilli Spit and newborn pups were killed and partially eaten by seagulls. 2 live seals were found last time at the cape tip (which already turned into an isolated island 10 years ago), and it happened in 2005 in winter. Since that time to the present day, neither haul-out sites nor individual seals have been seen on Shahdilli Spit any more. And this is despite the fact that in recent few years monitoring under the Darwin Initiative has been carried out on Shahdilli Spit no less than once or twice per month using motorboats.

As regards the Absheron Archipelago islands, no permanent (day-and-night) rookeries exist any more on them either. On them, only seasonal (migratory) aggregations of large groups of seals comprising up to 1000 individuals continue taking place in the period of spring and autumn migrations. Swimming seals are now rarely observed in the water area of Oil Rocks. One of the main reasons for the rare visits of Oil Rocks by seals, apart from the sharp reduction of their numbers, is also that fact that the oil workers have been prohibited in recent years to fish during their shifts. Earlier, for fishing kilka during night catching, the oil workers have used lighting devices, which attracted seals. In these cases, seals often tore fishing tackles, or tangled themselves in nets, as a result of which the angry oil workers often killed the seals by different means.

Surveys of age and sex composition of seals on haul-out sites found in recent years give evidence of some shifts: if earlier in the 20th century, seal males and juveniles prevailed on haul-out sites in winter, the number of males and females had equalized in recent years and the quantity of juveniles (young-of–the-year's) significantly reduced. The number of old individuals has significantly reduced as well.

At the same time, the similar drastic change has taken place in the Caspian water area of Turkmenistan. According to our colleagues: if in 1980 -1990s as a result of his surveys V. I. Krylov found up to 12 thousand seals on Ogurchinsky Island, then according to P. Yerokhin, the numbers of seals on rookeries does not exceed 2 thousand individuals over the last 4-5 years, i.e. there is a direct evidence of a 6 times reduction of seal numbers at rookeries. The number of newborn pups on this island has also reduced.

A similar trend is observed in Kazakhstan too. As it is only in recent times that our Kazakhstan colleagues have initiated the survey of seals on rookeries, the full scale of reduction in numbers is not clear; and if earlier the numbers of seals on islands and shalygas (sand islands) of Kazakhstan ran into dozens of thousands, now their numbers are significantly less. As regards the Iranian water area of the Caspian, no seal rookeries have ever existed there, but currently, projects on alluviation of artificial islands on which seal rookeries will be arranged in future are being considered.

Unfortunately no information is available in fact regarding rookeries and dynamics in dead seals' numbers in Russian waters of the Caspian Sea. In recent years, Russia has practically isolated hertself from such surveys and refused to cooperate with the Caspian states, although helicopter flyovers carried out in the North Caspian area by Susan Wilson's group showed that groups of breeding seals had actually disappeared from the Russian waters of the Caspian Sea.

2.3 Monitoring of Mortality in the Azerbaijani Sector of the Caspian Sea

Material and Method

A 10 kilometer zone in the main monitoring area 'Buzovni - SDPP (state district power plant) Severnaya' was patrolled once a week as a minimum and all dead seals washed ashore registered. In detection of a dead seal, it was visually examined, photographed and measured to determine: 1. the horizontal length of the dead body from the tip of its nose to the end of tail; 2. the flapper level circumference; 3. the blubber thickness, as well as the sex and approximate age of the individual. The visual examination was followed by body autopsy, and if the body was sufficiently fresh, then tissue samples were taken (adipose tissue, kidneys, skin, gaster with its content etc.); a part of samples was stored in the freezing chamber and another part fixed in formalin. If the body was poorly preserved, then skin samples were taken only. After the visual examination and autopsy, a presumed cause of death was identified. For comparison of washed ashore bodies' dynamics at the coast, less regular (once per month) walkovers were carried out in the coastal zone of beaches of Sumgayit and Nabran in the area of towns of Mukhtadir and Yalama (2-3 times a year). The seals autopsy was carried out and tissue samples taken in these zones as well. These zones monitoring was implemented using a light motor transport. Yeni Zirya Island was also inspected (Wilff).

As in recent yeas Shahdilli Spit had turned into an isolated island, surveys there were carried out using a rubber motorboat. The frequency of surveys was normally 1-2 times per month. Shahdilli Spit was subjected to monitoring by helicopter as well. Apart from surveys at the sandbar tip, the southern and northern coasts of the sandbar were also subjected to a walk around check.

Monitoring by helicopter was mainly conducted in the area from Pirallahi (Artem) Island to Zhiloy Island as well as near islands of Bolshaya Plita, Malaya Plita, Podplitochniy and Dardanelles located between them, sometimes on Lebiazhy Island, and in the water area between Zhiloy Island and Oil Rocks.

The helicopter fixed the seals swimming near aforementioned islands or lying on the shore and separate rocks.

In view of its geographic location, the Absheron Peninsula, and mainly its northern coast, is a unique burial ground of the Caspian seals. This is also contributed to by wind rose and undercurrent directions (for details refer to ACG 1995 Report).

Monitoring of washed ashore bodies of the Caspian seals for more than 35 years (since 1971) on the northern coast of the Caspian Sea allowed to identify their age and sexual composition as well as seasonal population dynamicsdevelop an unorthodox integrated method for determining an individual age, and study geratic changes and the cause of mortality.

Population dynamics' monitoring of recent years (1997-2008) indicated a drastic reduction of seals numbers and recorded extraordinary cases of mass mortality of these animals, which was unusual for the previous years. However, our studies needed a confirmation of surveyors from other littoral states. Therefore we applied to different authorities for arranging an aerial photographic survey of winter rookeries. The aerial survey in the North Caspian carried out by our colleagues from UK and Kazakhstan in 2005 and 2006 under the Darwin Initiative project has fully confirmed at last the results of our survey, i.e. it was proved that in the past decade the numbers of seals in the Caspian Sea reduced from 400 to 111 thousand, or became approximately 4 times less. Such a sharp fall of numbers was acknowledged disastrous and an international recovery programme had been developed to save the Caspian seal from danger of full extinction. So, the Darwin Initiative project is the first such programme.

The mortality dynamics analysis shows not only the sharp reduction in numbers of dead seal bodies washed ashore, but a significant change in dynamics of washing them ashore by months. If in the 20th century maximum washings ashore fell on two peaks: May-June and October-November, then in 2006-2008, the main portion of washings ashore fell on the first (January- February) and last (December) months of the year. And in main peak periods, no washings ashore had practically occurred. The age composition of seals washed ashore had changed as well. In previous years (1971-1990), young-of-the-year males and females of reproductive age constituted the main portion of dead seal bodies washed ashore. Beginning from 1997, the age composition of washed ashore seals was represented by all age groups other than old (40-50 years) individuals.

That fact that the main mass of dead seal bodies are very poorly preserved (even in cold periods of the year) and most of them are heavily macerated and fragmentary becomes regularity as well. Therefore, in actual fact, it is impossible to carry out valid analyses for any of the individuals. This testifies that most of washed ashore animals are presented by seals perished in the Russian water area of the Caspian Sea and driven ashore on the northern coast of Absheron after a long drifting.

As well, the number of individuals whose sex cannot be identified significantly increases.

In addition, though the quantity of seals washed ashore has sharply reduced, the numbers of pregnant cows with embryos not only does not reduce, but have significantly increased.

Although in previous years (1971 - 1999) the number of dead seals on the coast of the Absheron Peninsula yearly varied from 900 to 2500 individuals (1500 individuals per year in average) in previous years (1971 - 1999), this dynamics strongly changed in the 21st century. (Details with respect to seals mortality for these years will be published this year in joint authorship with Susan Wilson; preliminary data and diagrams of washings ashore were reported at the second conference of the ECOTOX project held in Baku in spring 2002)

Table 6 Comparative Analysis of Dynamics of Dead Bodies Washings Ashore on the Northern Coast of the Absheron Peninsula in the 21st Century (100 km zone)

Years	**∑ individuals**	% ♂ of males	**% of females**	Embryos, %
2000	2210	57.5%	42.5%	2.7 %
2001	2140	63.5%	36.5%	0.5%
2002	410	41.5%	58.5%	2.4%
2003	670	31.3%	68.7%	6%
2004	350	42.8 %	57.2%	2.8%
2005	540	51.5 %	48.5%	3.7%
2006	560	32%	68%	8.9%
2007	270	40.7%	59.3%	11.1%
2008	360	38.9%	61.1%	16.6%

2.4 Dynamics of Seal Numbers and Recommendations for Minimization of Potential Damages in Conducting Operations in the Contract Area (Acg)

Information on the Contract Area is received largely from helimen who deliver the shift to remote platforms as well as fishing-boats and vessels delivering the employees and oil workers mainly to/from Oil Rocks and from military men guarding this territory. Information of the appearance of seals within the Contract Area usually coincides with the seals appearance in the water area of Zhiloy Island.

As is seen from the Contract Area's location map and the chart of migration of the main food organisms of the Caspian seal, which are kilkas (ACG Report, 1995), the drilling area reaches the fattening zone of main food organisms of the Caspian seal as well as the zone of seasonal migration streams from north to south and from south to north. If initially the seals distribution in 1998 was one seal per km^2 of the Caspian Sea, the current numbers of individuals versus those in 1980 -1990 have dramatically reduced and now, according to our aggregate assessments, they are 4 times less as a minimum. Therefore, now the total number of seals makes one individual per 4 km^2. It shows that the numbers of seals in the area of works in different seasons also have become 4 times less. So, the operations in the Contract Area do not threaten the rookeries, as no rookeries are there at present.

The main work-related disturbance will fall on May-November when the seals arrive from north for summer fattening and leave the South and Middle Caspian water areas in autumn, mainly in October and November. Seals are mostly vulnerable in the period of spring migration, as these animals are not feeding during winter months in the North Caspian and their blubber layer thickness sharply reduces from 9 to 1 cm for this period. In this case, the seals ability to swim decreases and they cannot stay long in the open water area. For this reason, operations in the Contract Area should be suspended or minimized just in late spring.
It should be also taken into consideration that apart from seals of the Azerbaijani sector of the Caspian Sea, seals from Turkmenistan rookeries and Turkmenistan territorial waters also swim to the Contract Area for fattening.

Major Negative Impacts in the Contract Area Include:

1. Disturbance of seals during fattening, the underyearlings in particular.
These are very timid animals which try to leave the area of their detection as soon as possible.

2. In carrying out drilling, and particularly in lying the pipeline, an abrupt turbidity in the water, which is muddy even without that, occurs, but as the Caspian seal orientates in the water mainly owing to its eyes, it cannot fish in troubled waters.

We are of the opinion that the drastic deterioration of visibility in water during the last few years is the reason why the seal has first left the islands and waters of Baku Archipelago, and then the Shahdilli Spit area. It was difficult to conduct underwater photographic surveys and shooting in Azerbaijani waters of the Caspian Sea in the past as well due to turbid water. The group of oceanologists (Jacques-Ives Coausteau's team) from France learned this at first hand. During few days of their stay in Baku, they had failed to carry out a single underwater survey. I have been engaged in diving and spear hunting for more than 35 years and can definitely state that the abrupt turbidness of the water both in the northern part of the Absheron Peninsula and within the water area around Shahdilli Spit took place particularly in the 21st century. In actual fact, irrespective of fish abundance (mainly gray mullets) I have failed to normally hunt even once in recent years. Usually the maximum sight distance in these areas does not exceed one meter. As regards Zhiloy Island, the water is very clean there practically in any season of the year and the visibility exceeds 10 meters. It becomes obvious why basic masses of seals concentrate in this region. It is beyond doubt that the seals numbers have decreased as a result of reduction of fish resources in these regions as well. So, for example, the resources of sandsmelts in the Shahdilli Spit area sharply decreased, the herrings practically disappeared and the numbers of gobies significantly reduced. In summer 2007, the grey mullet practically disappeared for the first time; although it is true that the numbers of Black sea roaches and copepods have increased in recent years.

Based on the above stated, it is recommended to carry out drilling operations, and pipeline laying in particular, within the period from the end of December to May when no seals are actually available in the Contract Area. In this period, only small groups of seals from Ogurchinsky Island and single individuals may occur in this area that stay in the water area of the South Caspian for winter as well.

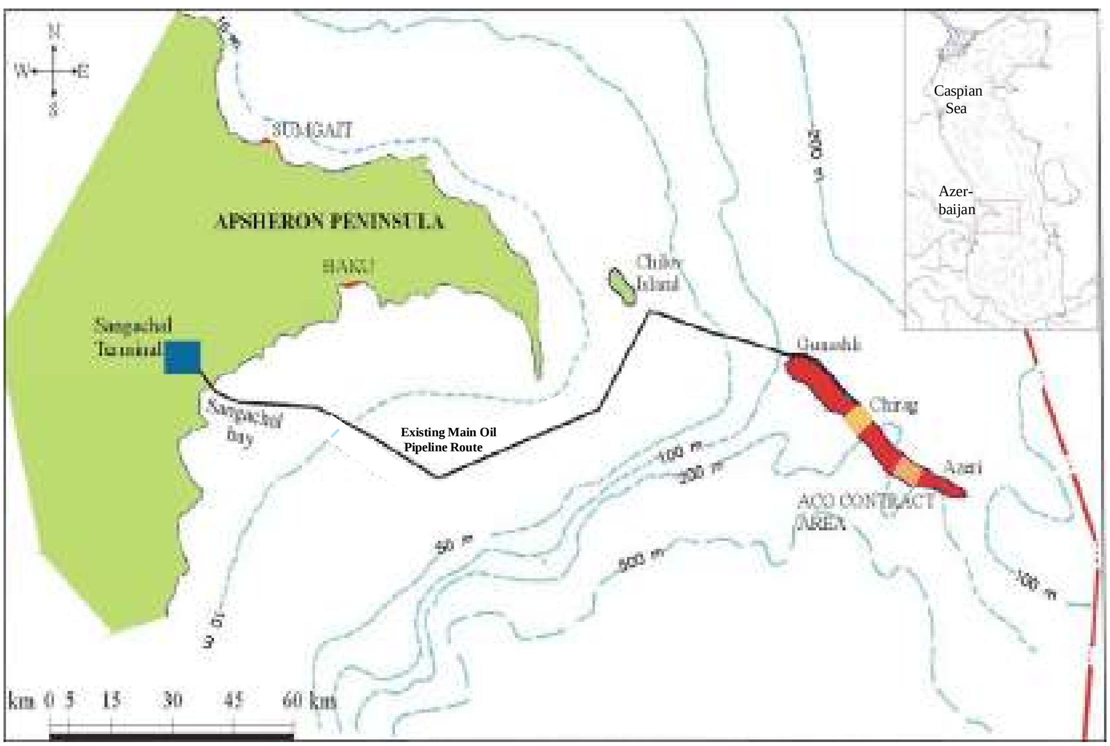
Seals may achieve their maximum numbers in the Contract Area in June and October. In these periods, the numbers of seals may reach few thousands. The rest of the time, they are relatively uniformly distributed in waters of the South and Middle Caspian.

According to our colleagues from Iran, large groups of seals are observed near the Iranian coast from June till September. In this period they are often caught in nets of fishing boats and killed in great numbers. Currently, a center for the protection of seals has been established in Iran and its personnel are raising the local fishermen awareness through workshops to reduce the number of seals killed in nets. Apart from this, they have already been carrying out monitoring of dead seals washed ashore along the Iranian coast for some years; they perform an autopsy on seal carcasses and take samples for identification of the cause of their death. Similar works commenced in Kazakhstan where no specialists on seals have been earlier available at all. Thus, in the near future, as a result of joint efforts of the Caspian states representatives, the scientists will manage to deeply study the causes of seals' death and take reasonable measures for rescue of this unique animal.

The number of vessels in this area should be limited in the period of fattening.

Fishing by oil workers at individual platforms must be controlled as before.

Figure 5 Location of the ACG Contract Area



3. Bird Survey of West Chirag and Adjacent Territories

West Chirag is located 60 km southwest of the Shakhdilli-Pirallahi coastline of the Absheron Peninsula. The Absheron-Pirallahi coastline of the Caspian Sea represents a migration route for waterfowl and coastal birds nesting in European parts of Russia, western Siberia, north-western Kazakhstan and migrating to southern coasts of the Caspian Sea, the Kur-Araz lowland, Turkmenistan, southwest Asia and Africa for wintering. During the migration, a large number of birds stop in this area for rest and feeding. Then, they stay in this area for wintering and nesting in numbers of international significance, while the rest fly on (4, 5, 8, 9, 10).

In addition to its diverse bird fauna, this area also represents importance to the development of oil industry. A large number of birds, including those listed in the Red Book of Azerbaijan and the Red List of Threatened Species of the International Union for the Conservation of Nature (IUCN) (1, 14), can perish as a result of negative impacts of oil production and transportation in this and adjacent areas.

The objective of the survey is to analyse the literature on the number and species of the birds inhabiting the area, which has been published since 2002, and to identify the birds temporarily and permanently inhabiting the West Chirag field and the importance of this area for these species.

3.1 Research Carried Out and its Analysis

The migration (initial, active and in the last days), wintering and reproduction periods of waterfowl and coastal birds differ from each other. However, the birds of Pirallahi-Shahidli area of the Caspian Sea have been studied only in winter (11-12.01.2002; 22-23.01.2004; 15-16.01.2005; 15-26-01.2006), in the first days of spring migration (18.02.2003), during incubation and hatching phases (28.05-4.06.2006) of the reproduction period (3, 11).

3.2 Biotopes, Migration, Species and Numbers of Birds during Wintering and Reproduction

Pirallahı coastline: The habitat of birds mainly stretches from a large shallow coastal area of the sea (4-5 km into the sea) to a narrow (5-20m) humid sandy area. Coastal water in the north and south of the island (southern Absheron bay) is contaminated with oil. Only occasional movement of motor vehicles of oil companies can be observed here. This disturbs the birds and forces them to move to other areas. The south-eastern and western coastline of the island (northern Absheron bay) is not contaminated. On windy days (depending on winddirection), birds shelter either on the western or eastern side of the bay, or near the dam connecting the island with the Absheron Peninsula. Water depth here is 5m in the center, but it sharply decreases towards the coast. Coastal pattern is quite diverse. While the western coastline mainly consists of ravines, the south-eastern part of the island is covered with moist sands. The constant movement of people can observed in the sandy areas. There are underwater and above-water rocks in the central part of the bay. The complex terrain limits the movement of motorboats. The diversity of substrates creates favourable conditions for the development of phyto-benthos and zoo-benthos, which serves as food for the birds. Thirteen species of phyto-benthos and 10 species of zoo-benthos have been recorded in this area. The biomass of *Abra ovata* and *Mytilaster lineatus* bottom fauna is dominant (7). This leads to the accumulation of internationally significant numbers of birds in clean water areas of the island during wintering and migration.

In the beginning of spring migration (18.02.2005), 19 bird species – a total of 7559 birds - dwell in coastal waters of Pirallahi Island, 7397 of them are waterfowl, while 162 are coastal birds. Among the waterfowl only the number of *Podiceps cristatus* and *Aythya ferina* exceeds the 1% limit (12, 13) established for the provision of the RAMSAR status (i.e. of international importance). These species are endangered, i.e. *Cygnus olor* is included in the Red Book of

Azerbaijan, while *Pelecanus crispus* is included both in the Azerbaijan Red Book and the IUCN Red List of Threatened Species.

Shakhdili coastline: The habitat of waterfowl and coastal birds consists in a large shallow coastal area of the sea (4-5 km into the sea), the lagoons in the dry land of the Shakhdili cape, thin reed and tamarisk bushes, narrow (2-10 m) moist sands, Tulen, Gu, Greater Tava, Small Tava and other islands. 783 hectares of the territory is part of the Absheron National Park. There is no oil contamination on the territory of the park. On windy days, birds shelter in Shakhdili lagoons, different parts of the island stretching deep into the sea (10 km, width 600 m) and other islands. The sea is rich in key food source of the waterfowl such as seaweed, phyto-benthos and zoo-benthos. The constant movement of motor vehicles belonging to people catching fish outside protected areas, poachers and oil companies can be observed. This disturbs the birds and forces them to move towards quieter areas of sea which are not as abundant in terms of food. 26 species of birds (a total of –28436 birds) dwell here in the beginning of spring migration (19.02.2005). 28239 of these birds are waterfowl and 197 are coastal birds. The number of waterfowl such as *Podiceps cristatus, Cygnus olor, C.cygnus, C.bewickii, Netta rufina, Aythya ferina* and *A.fuligula* exceeds 1% limit established for the provision of the RAMSAR status in wetland areas and the total number of waterfowl exceeds the 20,000 threshold (12, 13). Some endangered birds dwell here, thus *Phoenicopterus roseus, Cygnus olor, C.bewickii* are listed in the Red Book of Azerbaijan, *Aythya nyroca* in the IUCN Red List of Threatened Species and *Pelecanus crispus* is included both in the Red Book of Azerbaijan and the IUCN Red List of Threatened Species.

3.3 Species and Numbers of Birds during Reproduction Period

Pirallahı coastline: Birds nest on old rigs and some small islands. Only 14 species of waterfowl (*Phalacrocorax carbo*) and 4 species of coastal birds (*Larus cachinnans, Sterna sandivicensus, S.albifrons, S.hirundo*) were registered in this area. A total of 102 birds were registered.

Shakhdili coastline: Birds nest on old rigs, reeds, on Sah, Tulen, Gu and other islands. Only four species of waterfowl *Phalarocorax carbo* (a total of 30), *Tachybabtus ruficollis* (a total of 6), *Tadorna ferruginea* (a total of 2), *Fulica atra* (a total of 15) and 12 species of coastal birds were registered. The most numerically abundant were *Larus cachinnans* (a total of 1760), *Sterna hirundo* (a total of 300) and *S.sandivicensis* (a total of 260). In total, there were 2552 coastal birds (5).

The reproduction period of birds in the Pirallahi and Shakhdili coastline starts at the end of April / beginning of May and continues until mid-July. At the end of July and beginning of August they leave nesting places and disperse across in the territory.

3.4 Species and Number of Wintering Birds

Pirallahı coastline: The absolute majority of wintering birds are waterfowl. The average number of waterfowl in 2002-2006 was 24873, while the number of coastal birds was 181.

In different years different species of birds reached internationally important numbers. For example, the number of *Podiceps cristatus* exceeded 1% limit established for the provision of the RAMSAR status in wetlands in 2002, *Aythya ferina* passed this threshold in 2004, 2005, 2006, while *Aythya fuligula* and *Falica atra* in 2006. The total number of waterfowl exceeded the 20,000 threshold required for the RAMSAR status to wetlands.

Two species of rare and endangered birds were registered. They were *Cygnus olor* listed in the Red Book of Azerbaijan and *Numenius arquata* listed in the IUCN Red List of Threatened Species.

Table 7 Species and Numbers of Birds in the Areas Near West Chirag (Total Number)

Name of species and ecological group	11-12.02. 2002		12-19.02. 2003		22-23.01. 2004		15-16.01. 2005		28.05-04.06. 2005		15-26.01. 2006		1% threshold
	Pirallahi	Shahdili	Pirallahi	Shahdili	Pirallahi	Shahdili	Pirallahi	Shahdili	Pirallahi	Shahdili	Pirallahi	Shahdili	
Waterfowl Total	22442	21733	7397	28239	22138	22005	29027	29063	14	53	25259	12020	
Podiceps ruficollis - little grebe		24	7		11		8	2		6		18	10000
P.nigricollis - black-necked grebe	51	15		14	148	27	119	44			219	44	250
P.auritus – eared grebe					1			1			2	11	150
P.grisegena – red-necked grebe		2			6								150
P.cristatus – great crested grebe	376	9	120	120	61	43	66	27			90	82	100
Pelicanus crispus – Dalmatian pelican			3	2		4							110
Phalacrocorax carbo – Great Cormorant	27	6	19	30	16	4	20	1	14	30	55	250	1000
Ph.pygmaeus – little cormorant	2	15	3	12								44	1000
Cygnus olor – mute swan	95	36	350	3700	1			2				300	2500
C.cygnus- whooper swan	19	2	150	400	18			16			4	16	200
C.bewickii –Bewick's swan				33									5
Tadorna ferruginea – Ruddy Shelduck	1									2			500
Tadorna tadorna – Common Shelduck											1	48	800
Anas acuta – northern pintail												800	7000
A.penelope – Eurasian Wigeon			470	1200		338		25				370	2500
A.crecca – Common Teal	25	20	600			77							15000
Anas platyrhynchos – Mallard	108	1016		2200	365	1479	67	2017				350	8000
A.clupeata – Common shoveller			300	1300		9		42					4000
A.sterepera – Gadwall				1		6							1300
Netta rufina – Red-crested Pochard		1	820	6000	2	13	17	3067			493	1100	2500
Aythya nyroca – Ferruginous Duck				22									1000
A.ferina – Common Pochard	99	3192	375	4500	8910	5360	4632	6660			8088	7000	3500
A.marila – Greater Scaup			180	400								15	1500
A.fuligula – Tufted Duck	1845	4142	2100	8500	1606	10000	883	9645			4965	312	2000
Bucephala clangula – Common Goldeneye	3	1			1	3		5			5	44	250
Mergus albellus – Smew	2	1				4					16	18	300
M.serrator – Red-breasted Merganser	56	1			25	3	33				163		200
Fulica atra – Eurasian Coot	19835	13230	1900	3600	11064	4612	23177	2010		15	11284	1200	20000
Coastal birds Total	412	369	162	197	24	23	180	144	102	2552	108	256	
Botaurus stellaris – Eurasian Bittern		1											
Egretta garzetta– Little Egret	16	18	4	6	8	3					4		580

E.alba - Great Egret		6			2	6					4		1000
Ardea cinerea - Grey Heron	4	6			2	3				4			
A.purpurea – Purple Heron													
Phoenicopterus roseus - Greater Flamingo				6							4		2900
Recurvirostrab avosetta - Pied Avocet				6	13								
Charadrius dubius – Little Ringed Plover													
Ch.hiaticula – Ringed Plover	25				5		15			4			
Ch.alexandrinus – Snowy Plover		1								10			
Ch.beshenaultii – greater sand plover	2												
Pluvialis squatarola – Grey Plover					4	1							
Calidris temminckii - Temminck's Stint	190	60											
C.alpina – Dunlin		1	11	48			75					106	
Gallinago gallinago – American snipe				4		10		3					
Numenius arquata - Eurasian Curlew	1												
Tringa nebularia - Common Greenshank		4										12	
Larus minutus – Little Gull							21	3			4		
L.ridibundus – Black-headed Gull	1						1	3					
L.genei – Slender-billed Gull	6				1					90			
L.canus – Common Gull	1				1		12				11	18	
L.cachinnans – Caspian Gull									20	1760			
L.argentatus – Herring Gull	66	290	141	94	1		56	134			85	104	
Sterna sandvicensis- Sandwich Tern								1	32	260			
S.albifrons – Little Tern									8	80			
Sterna hirundo – Common Tern									42	300			
Ch.leucopterus – White-winged Black Tern										20			
Chlidonias hybrida – Whiskered Tern										10			
Gallinula chloropus – Common Moorhen				12									
Rallus aquaticus – Water Rail				14						10		12	
Porphyrio porphyrio – Purple Swamphen										4			
Total number	22856	22000	7559	28436	22162	22028	29207	23714	116	2605	25267	12276	
Total species	25	26	19	26	24	20	17	20	5	16	21	26	

Shakhdili coastline: As is the case in Pirallahi, the majority of birds in this coastline are waterfowl. The total number of waterfowl in 2002-2006 was 20004, while coastal birds numbered 198. The various species of waterfowl reached a number of international importance in different years (2, 11). For example, the number of *Podiceps cristatus* exceeded 1% limit established for the provision of the RAMSAR status in wetland areas in 2002, *Aythya ferina* passed this threshold in 2004, 2005, 2006, while *Aythya fuligula* and *Falica atra* in 2006. The total number of waterfowl exceeded the 20,000 threshold required for assignment of RAMSAR status to wetland areas

Three species of rare and endangered birds were registered. They were *Cygnus olor* and *Porphyrio porphyrio* listed in the Red Book of Azerbaijan and *Pelecanus crispus* listed both in the Red Book of Azerbaijan and the IUCN Red List of Threatened Species

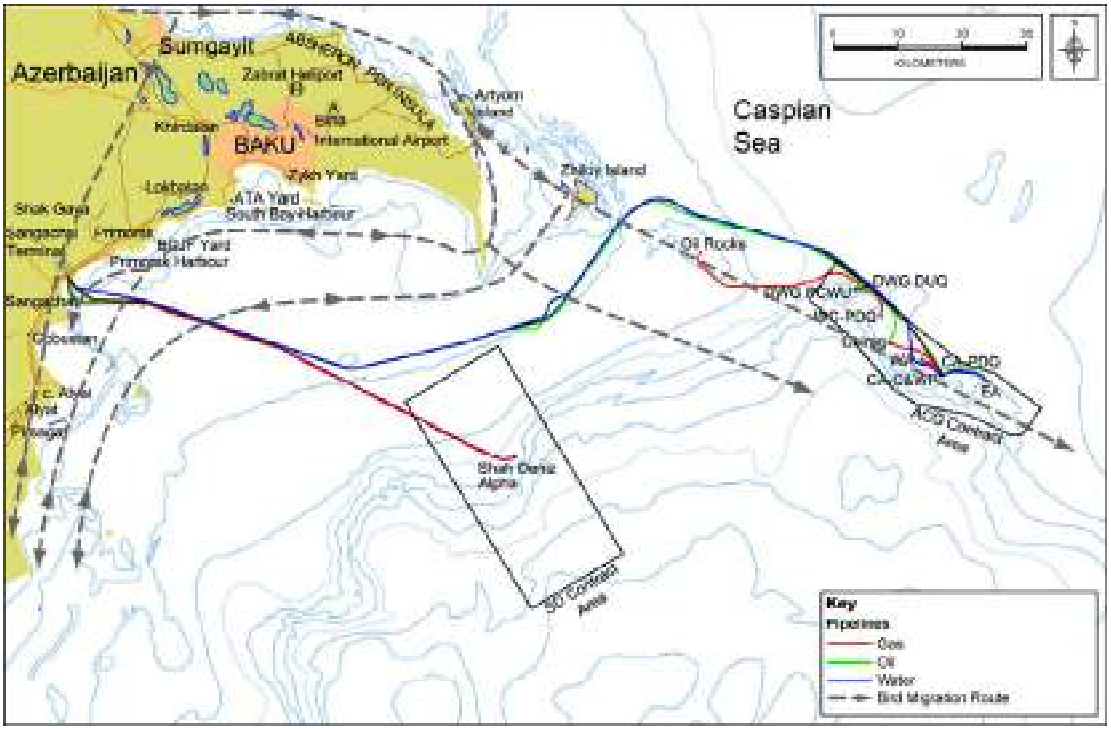
3.5 Migration Period and Direction

The autumn migration of the waterfowl and coastal birds in Absheron mainly starts in the second half of August and continues until mid-December. In case of severe winter conditions in Russia, this migration continues until 10 January. The most active period of migration is November. The spring migration starts in the second half of February and finishes in April with March being the most active period (9, 10). During the autumn migration, 51.43% of birds fly along the Caspian coast to the south, 36.64% fly to the southwest, while 11.93% of the birds fly from the Pirallahi-Shakhdili coastline to the southeast (Figure 6). In spring, 39.76% of the birds fly to the north, 26.32% to the northwest and 25.50% to the northeast (6). BP have observed birds flying through West Chirag towards Turkmenistan during the autumn migration. According to BP employees, at night these birds rest on the surface of the sea around West Chirag platform, while some die after getting caught in the platform. However, there is no accurate data on species or number of the birds in this area.

We can draw the following conclusion from the analysis of the data:

1. No ornithological analysis was carried out in West Chirag.
2. Pirallahi and Shakhdili coastlines adjacent to West Chirag have an international importance as a waterfowl habitat. The total number of waterfowl migrating or wintering in this territory exceeds the 20,000 threshold set for the provision of the RAMSAR status of wetlands and the number of individual species (*Podiceps cristatus, Cygnus olor*, *Netta rufina, Aythya ferina* və *A.fulica*) is above 1% limit for the said status.
3. 59 species of birds of waterfowl and coastal ecological groups inhabit the Pirallahi and Shakhdili coastlines. The following species are observed around West Chirag: *Pahalacrocorax carbo, Ph.pygmaeus, Larus genei, L.cachinnans* (throughout the year), *Pelecanus crispus, Larus minutus, L.canus, L.argentatus* (in winter and during migration), *Sterna hirundo, S.sandivicensis* and *S.albifrons* (during reproduction and migration periods). Moreover, the species of *Anatidae* family (in winter and during migration), the species of *Podicipidae* family, as well as other waterfowl dwelling along the Absheron-Gobustan coastline.
4. In order to provide an objective assessment of the negative impact on birds around West Chirag and adjacent oilfields, birds must be monitored throughout the year (in winter in January, during the active migration period in March, egg-laying and hatching phases of the reproduction period in May-June, the growing and dispersing period of younglings at the beginning of August, and during November migration period).

Figure 6 Migration Movements of Birds



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APPENDIX 9A

Predrill Activities and Events

ACTIVITY/INTERACTIONS					
ID (R=Routine, NR= Non-Routine)	**Activity**	**Scoped In/Out**	**Reference**	**Event**	**Event Category**
Pre	**Predrilling**				
Pre-R1	Tow out and positioning of Mobile Offshore Drilling Unit (MODU)	✓	5.3.2.2	Other discharges to sea	Ballast Water
					Treated Black Water
					Grey Water
					Drainage
				Seabed Disturbance	Seabed Disturbance
				Underwater Noise and Vibration	Underwater Noise and Vibration
				Emissions to atmosphere (non GHG)	MODU Power Generation
					Support Vessels
Pre-R2	Vessel support including standby, supply to MODU and backload to shore	✓	5.3.3 Table 5.9	Other discharges to sea	Ballast Water
					Treated Black Water
					Grey Water
					Drainage
				Underwater Noise and Vibration	Underwater Noise and Vibration
				Emissions to atmosphere (non GHG)	Support Vessels
Pre-R3	Drilling and plugging the Pilot Hole	✓	5.3.2.3	Drilling Discharges to Sea	Drilling Discharges to Sea
Pre-R4	Drilling with water based muds (WBM) (conductor and surface hole sections drilling)	✓	5.3.2.4	Underwater Noise and Vibration	Underwater Noise and Vibration
				Drilling Discharges to Sea	Drilling Discharges to Sea
Pre-NR5	Discharge of residual WBM	✓	5.3.2.4	Drilling Discharges to Sea	Drilling Discharges to Sea
Pre-R6	Drilling with non WBM (lower hole section drilling)	✓	5.3.2.4	Underwater Noise and Vibration	Underwater Noise and Vibration
Pre-R7	Cementing discharges to seabed	✓	5.3.2.5	Cement Discharges to Sea	Cement Discharges to Sea
Pre-NR8	Excess cement discharge to seabed	✓	5.3.2.5	Cement Discharges to Sea	Cement Discharges to Sea
Pre-NR9	Well test flaring	✓	5.3.2.8	Emissions to atmosphere (non GHG)	MODU Well Test Flaring
Pre-R10	MODU power generation	✓	5.3.3 Table 5.9	Emissions to atmosphere (non GHG)	MODU power generation
Pre-R11	MODU seawater lift and cooling discharge	✓	5.3.3 Table 5.9	Water intake/entrainment	Cooling Water Intake and Discharge
				Cooling water discharge to sea	Cooling Water Intake and Discharge
Pre-R12	MODU treated black water / grey water / drainage discharges	✓	5.3.3 Table 5.9	Other discharges to sea	Treated Black Water
					Grey Water
					Drainage
Pre-R13	Crew change operations	×	5.3.3 Table 5.9 and 5.3.4	Emissions to atmosphere (non GHG)	Support Vessels
				Noise	Support Vessels
Pre-R14	MODU removal	✓	5.3.2.2	Other discharges to sea	Ballast Water
					Treated Black Water
					Grey Water
					Drainage
				Seabed Disturbance	Seabed Disturbance
				Emissions to atmosphere (non GHG)	MODU Power Generation
					Support Vessels
Pre-R15	Waste management	×	5.3.4.3	Waste generation	Waste generation

	Event Category	Magnitude Parameters (Event Magnitude)	Ranking (Event Magnitude)	Event Magnitude	Sensitivity Parameters (Receptor Sensitivity)	Human	Seals/Fish		Zooplankton		Phytoplankton		Benthic Invertebrates		Birds		Impact Significance
Pre-drill																	
Emissions to Atmosphere (non GHG)	MODU Power Generation	Scale	1	8	Resilience	1	-	-	-	-	-	-	-	-	1	-	Minor Negative
		Frequency	3														
		Duration	3		Presence	1	-		-		-		-		1		
		Intensity	1														
	Support Vessels	Scale	1	8	Resilience	1	-	-	-	-	-	-	-	-	1	-	Minor Negative
		Frequency	3														
		Duration	3		Presence	1	-		-		-		-		1		
		Intensity	1														
	MODU Well Test Flaring	Scale	1	5	Resilience	1	1										Minor Negative
		Frequency	1														
		Duration	2		Presence	1	1										
		Intensity	1														
Marine Environment	Ballast Water	Scale	1	5	Resilience	-	1										Minor Negative
		Frequency	2														
		Duration	1		Presence	-	1										
		Intensity	1														
	Treated Black Water	Scale	1	8	Resilience	-	1										Minor Negative
		Frequency	3														
		Duration	3		Presence	-	1										
		Intensity	1														
	Grey Water	Scale	1	8	Resilience	-	1										Minor Negative
		Frequency	3														
		Duration	3		Presence	-	1										
		Intensity	1														
	Drainage	Scale	1	8	Resilience	-	1										Minor Negative
		Frequency	3														
		Duration	3		Presence	-	1										
		Intensity	1														
	Underwater Noise and Vibration	Scale	1	8	Resilience	-	1	2	-	-	-	-	-	-	-	-	Minor Negative
		Frequency	3														
		Duration	3		Presence	-	1		-		-		-		-		
		Intensity	1														

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<tr><th rowspan="3"></th><th rowspan="3">Event Category</th><th colspan="3">Event Magnitude</th><th colspan="12">Receptor Sensitivity</th><th rowspan="3">Impact Significance</th></tr>
<tr><th rowspan="2">Magnitude Parameters</th><th rowspan="2">Ranking</th><th rowspan="2">Event Magnitude</th><th rowspan="2">Sensitivity Parameters</th><th rowspan="2">Human</th><th colspan="10">Biological/Ecological</th></tr>
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<tr><td rowspan="16">Marine Environment</td><td rowspan="4">Drilling Discharges to Sea</td><td>Scale</td><td>1</td><td rowspan="4">6</td><td rowspan="2">Resilience</td><td rowspan="2">-</td><td rowspan="2">1</td><td rowspan="4">2</td><td rowspan="2">1</td><td rowspan="4">2</td><td rowspan="2">1</td><td rowspan="4">2</td><td rowspan="2">1</td><td rowspan="4">2</td><td rowspan="2">-</td><td rowspan="4">-</td><td rowspan="4">Minor Negative</td></tr>
<tr><td>Frequency</td><td>2</td></tr>
<tr><td>Duration</td><td>2</td><td rowspan="2">Presence</td><td rowspan="2">-</td><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">-</td></tr>
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<tr><td rowspan="4">Seabed Disturbance</td><td>Scale</td><td>1</td><td rowspan="4">4</td><td rowspan="2">Resilience</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="4">-</td><td rowspan="2">-</td><td rowspan="4">-</td><td rowspan="2">-</td><td rowspan="4">-</td><td rowspan="2">1</td><td rowspan="4">2</td><td rowspan="2">-</td><td rowspan="4">-</td><td rowspan="4">Negligible</td></tr>
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<tr><td>Intensity</td><td>1</td></tr>
<tr><td rowspan="4">Cement Discharges to Sea</td><td>Scale</td><td>1</td><td rowspan="4">6</td><td rowspan="2">Resilience</td><td rowspan="2">-</td><td rowspan="2" colspan="10">1</td><td rowspan="4">Minor Negative</td></tr>
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<tr><td>Duration</td><td>1</td><td rowspan="2">Presence</td><td rowspan="2">-</td><td rowspan="2" colspan="10">1</td></tr>
<tr><td>Intensity</td><td>1</td></tr>
<tr><td rowspan="4">Cooling Water Intake and Discharge</td><td>Scale</td><td>1</td><td rowspan="4">8</td><td rowspan="2">Resilience</td><td rowspan="2">-</td><td rowspan="2" colspan="10">1</td><td rowspan="4">Minor Negative</td></tr>
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<tr><td>Duration</td><td>3</td><td rowspan="2">Presence</td><td rowspan="2"></td><td rowspan="2" colspan="10">1</td></tr>
<tr><td>Intensity</td><td>1</td></tr>
</table>

APPENDIX 10A

Construction, Installation and HUC Activities and Events

ACTIVITY/INTERACTIONS

ID (R=Routine, NR= Non-Routine)	Activity	Scoped In/Out	Reference	Event	Event Category
Con	**Onshore Construction**				
Con-NR1	Potential yard upgrades /expansion	✗	5.4.2	Emissions to atmosphere (non GHG)	Construction Yard Emission Sources
				Onshore Noise	Construction Yard Plant
				Onshore discharges	Non-Hazardous Waste
					Hazardous Waste
				Spills	Spills
Con-R2	STB01, PLBG and DBA upgrade works	✗	5.4.2	Emissions to atmosphere (non GHG)	Construction Yard Emission Sources
				Onshore Noise	Onshore Noise
				Onshore discharges	Non-Hazardous Waste
					Hazardous Waste
				Spills	Spills
Con R3	Use of yard plant (generators and engines) during jacket, topside and drilling module fabrication and topside commissioning	✓	5.4.4 – 5.4.7 & 5.4.9	Emissions to atmosphere (non GHG)	Construction Yard Emission Sources
					Onshore Platform Generator Commissioning
				Onshore noise	Construction Yard Plant
					Onshore Platform Commissioning
Con-R4	Use of yard cooling water system during onshore topside commissioning	✓	5.4.8.1	Cooling water discharges to sea	Construction Yard Cooling Water Discharge
Con-R5	Commissioning of main platform generators and topside utilities	✓	5.4.8	Emissions to atmosphere (non GHG)	Onshore Platform Generator Commissioning
				Onshore noise	Onshore Platform Commissioning
Con-R6	Construction yard utilities (drainage/ sewage)	✗	5.4.10.2	Other Discharges	Treated Black Water
					Drainage
Pip	**Pipeline Installation, Tie in and Commissioning**				
Pip-R1	Vessel operations – pipelay barge, anchor handling vessels and pipe supply barge	✓	5.5.2	Emissions to atmosphere (non GHG)	Jacket and Pipeline Installation Vessels
				Other discharges to sea	Treated Black Water
					Grey Water
					Drainage
				Underwater noise and vibration	Underwater noise and vibration (Vessels)
Pip-R2	Installing new oil pipeline wye and infield pipelines on seabed	✓	5.5.2 & 5.5.4	Seabed disturbance - benthos	Seabed Disturbance
Pip-R3	Installing concrete mats in areas of soft sediment /free spans	✗	5.5.2.	Seabed disturbance - benthos	Seabed Disturbance
Pip-R4	Infield pipeline cleaning, hydrotesting and dewatering	✓	5.5.2, 5.5.5 & 5.5.6	Hydrotest discharges to sea	Pipeline Cleaning and Hydrotest Discharge
				Other discharges to sea	Oil line wye spool water
Ins	**Platform Installation**				
Ins-R1	Jacket installation vessel operations - STB-01, DBA and support vessels	✓	5.6.2	Underwater noise and vibration	Underwater noise and vibration (Vessels)
				Emissions to atmosphere (non GHG)	Jacket and Pipeline Installation Vessels
				Other discharges to sea	Treated Black Water
					Grey Water
					Drainage
Ins-R2	Foundation piling and grouting for jacket	✓	5.6.2	Seabed disturbance - benthos	Seabed Disturbance
				Underwater noise and vibration	Underwater noise and vibration (Piling)
				Cement discharge to sea	Cement Discharges
Ins-R3	Topside installation vessel operations - STB-01 and support vessels	✗	5.6.3	Other discharges to sea	Treated Black Water
					Grey Water
					Drainage
					Ballast Water

ID (R=Routine, NR= Non-Routine)	Activity	Scoped In/Out	Reference	Event	Event Category
HUC	**Platform Hook Up and Commissioning**				
HUC–R1	WC-PDQ platform commissioning	✓	5.6.4	Events associated with platform HUC are included within Chapter 11	-
HUC-R2	Installation of buy back valve system	×	5.6.4	Other discharges to sea	-
HUC-R3	Offshore commissioning of deluge system	×	5.6.4	Other discharges to sea	-
HUC-R4	Offshore commissioning of foam system	×	5.6.4	Other discharges to sea	-
HUC–R5	DWG-PCWU brownfield works – diving support vessels	×	5.6.5	Other discharges to sea	Treated Black Water
					Grey Water
					Drainage
					Ballast Water
Con-R8 Pip-R5 Ins-R4 HUC-R6	Waste Generation	×	5.4.10.3 5.6.7.3	Waste Generation	Waste Generation

	Event Category	Event Magnitude			Receptor Sensitivity								
		Magnitude Parameters	Ranking	Event Magnitude	Sensitivity Parameters	Human	Biological/Ecological					Total	Impact Significance
							Seals/Fish	Zooplankton	Phytoplankton	Benthic Invertebrates	Birds		
Construction, Installation, Hook Up and Commissioning													
Emissions to Atmosphere (non GHG)	Construction Yard Emission Sources	Scale	1	8	Resilience	2	2					3	Moderate Negative
		Frequency	3										
		Duration	3		Presence	1	1						
		Intensity	1										
	Onshore Platform Generator Commissioning	Scale	1	6	Resilience	2	2					3	Moderate Negative
		Frequency	3										
		Duration	1		Presence	1	1						
		Intensity	1										
	Jacket and Pipeline Installation Vessels	Scale	1	8	Resilience	1	1					2	Minor Negative
		Frequency	3										
		Duration	3		Presence	1	1						
		Intensity	1										
Onshore Noise	Construction Yard Plant	Scale	1	8	Resilience	2	2					3	Moderate Negative
		Frequency	3										
		Duration	3		Presence	1	1						
		Intensity	1										
	Onshore Platform Commissioning	Scale	2	7	Resilience	2	2					3	Moderate Negative
		Frequency	3										
		Duration	1		Presence	1	1						
		Intensity	1										
Marine Environment	Construction Yard Cooling Water Discharge	Scale	1	8	Resilience	-	1					2	Minor Negative
		Frequency	3										
		Duration	3		Presence	-	1						
		Intensity	1										
	Treated Black Water	Scale	1	8	Resilience	-	1					2	Minor Negative
		Frequency	3										
		Duration	3		Presence	-	1						
		Intensity	1										
	Grey Water	Scale	1	8	Resilience	-	1					2	Minor Negative
		Frequency	3										
		Duration	3		Presence	-	1						
		Intensity	1										

		Event Magnitude			Receptor Sensitivity													
	Event Category	Magnitude Parameters	Ranking	Event Magnitude	Sensitivity Parameters	Human	Biological/Ecological: Seals/Fish		Zooplankton		Phytoplankton		Benthic Invertebrates		Birds		Total	Impact Significance
Marine Environment	Drainage	Scale	1	8	Resilience	-	1										2	Minor Negative
		Frequency	3															
		Duration	3		Presence	-	1											
		Intensity	1															
	Underwater noise and vibration (Vessels)	Scale	1	8	Resilience	-	1	2	-	-	-	-	-	-	-	-	-	Minor Negative
		Frequency	3															
		Duration	3		Presence	-	1		-		-		-		-			
		Intensity	1															
	Underwater noise and vibration (Piling)	Scale	3	7	Resilience	-	1	2	-	-	-	-	-	-	-	-	-	Minor Negative
		Frequency	2															
		Duration	1		Presence	-	1		-		-		-		-			
		Intensity	1															
	Cement Discharges	Scale	1	4	Resilience	-	-	-	-	-	-	-	1	2	-	-	-	Negligible
		Frequency	1															
		Duration	1		Presence	-	-		-		-		1		-			
		Intensity	1															
	Seabed Disturbance	Scale	1	4	Resilience	-	-	-	-	-	-	-	1	2	-	-	-	Negligible
		Frequency	1															
		Duration	1		Presence	-	-		-		-		1		-			
		Intensity	1															
	Pipeline Cleaning and Hydrotest Discharge	Scale	1	5	Resilience	-	1	2	-	-	-	-	-	-	-	-	-	Minor Negative
		Frequency	2															
		Duration	1		Presence	-	1		-		-		-		-			
		Intensity	1															
	Ballast Water	Scale	1	5	Resilience	-	1										2	Minor Negative
		Frequency	2															
		Duration	1		Presence	-	1											
		Intensity	1															
	Oil line wye spool water	Scale	1	4	Resilience	-	1										2	Negligible
		Frequency	1															
		Duration	1		Presence	-	1											
		Intensity	1															

APPENDIX 10B

Onshore Noise Screening Assessment

Chirag Oil Project

Preliminary Noise Impact Assessment

May 2009
Final Draft

Issue No 1
49316039 /

Project Title:	Chirag Oil Project
Report Title:	Preliminary Noise Impact Assessment
Project No:	49316039
Report Ref:	
Status:	Final Draft
Client Contact Name:	Bill Boulton
Client Company Name:	Azerbaijan International Operating Company
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Issue No: 1	Name	Signature	Date	Position
Prepared by	Michael Craven		21st April 2009	Noise Consultant
Checked by	Peter Ward		22nd April 2009	Principal Consultant
Approved by	Anna Rouse		10th May 2009	Project Manager

Document Revision Record

Issue No	Date	Details of Revisions
1	18th May 2009	Original issue

LIMITATION

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CONTENTS

EXECUTIVE SUMMARY

This report has been prepared by URS Corporation Ltd (URS) on behalf of Azerbaijan International Operating Company (AIOC). The report provides a preliminary assessment of the potential noise impact of onshore construction activities associated with the Chirag Oil Project (COP).

Predictions of the potential noise levels during potential site upgrades, construction activities and commissioning of equipment have been undertaken. The predictions used reasonable worst-case assumptions regarding plant and operating times across the construction period. Predictions of the potential noise impact from the construction sites (during site upgrade, fabrication and commissioning works) at increasing distances from the source were undertaken in accordance with British Standard (BS) 5228 ‘Code of Practice for Noise and Vibration Control on Open Sites’ (2009) and compared to the relevant International Finance Corporation (IFC) Environmental, Health, and Safety General Guidelines (2007) [1].

The assessment assumed plant is well maintained and incorporates relevant acoustic covers and screens as required by industry best practice. The noise screening afforded by the buildings and perimeter fencing around each of the yards was assumed conservatively to be 5 dB(A). No account was taken for current operations at the construction yard(s).

For yard upgrade and construction activities, the modelling demonstrated that at 150 m or more from the noise source the daytime limit of 55 dB would be met and at 450 m from the noise source the night-time limit of 45 dB L_{Aeq} will be met. The commercial limit of 70 dB L_{Aeq} was met at a distance of 30 m from the source. The modelling predicted no exceedances of environmental noise standards at a distance of 450 m or more from noise sources at a construction yard.

For onshore commissioning, the modelling demonstrates that at 180 m or more from the noise source the daytime limit of 55 dB would be met and at 680 m from the noise source the night-time limit of 45 dB L_{Aeq} will be met. The commercial limit of 70 dB L_{Aeq} was found to be met at a distance of 35 m from the source. The modelling predicted no exceedances of environmental noise standards at a distance of 550 m or more from noise sources at the construction yard.

[1] 1 hour L_{Aeq} for 1) Residential; institutional; educational I) Daytime (07:00 – 22:00) – 55dBA ii) Nighttime (22:00 – 07:00) – 45 dBA and 2) Industrial; commercial I) Daytime (07:00 – 22:00) – 55dBA ii) Nighttime (22:00 – 07:00) – 45 dBA

1. INTRODUCTION

This report has been prepared by URS Corporation Ltd (URS) on behalf of Azerbaijan International Operating Company (AIOC). The report provides a preliminary assessment of the potential noise impact of onshore construction activities associated with the Chirag Oil Project (COP).

Predictions of the potential noise impact from the construction sites (during site upgrade, fabrication and commissioning works) at increasing distances from the source were undertaken in accordance with British Standard (BS) 5228 'Code of Practice for Noise and Vibration Control on Open Sites' and compared to the relevant International Finance Corporation (IFC) Environmental, Health, and Safety General Guidelines (2007).

2. PLANNING AND NOISE GUIDANCE

2.1. IFC: Environmental, Health, and Safety General Guidelines

The IFC: Environmental, Health, and Safety General Guidelines (2007) detail environmental noise issues and provide an indication of applicable noise limits at receptors neighbouring a potential construction site/development.

The guidance states that noise impacts should not exceed the levels presented in the table below, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

Table 1 Environmental Noise Level Guidelines

Receptor	One Hour L_{Aeq} (dB(A))	
	Daytime 07:00 - 22:00	Night-time 22:00 - 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

The guidance discusses mitigation measures from potentially noisy activities and provides several measures to attenuate and/or limit the acoustic impact of plant. It also discusses the potential for noise monitoring.

2.2. British Standard 5228 'Code of Practice for noise and vibration control on construction and open sites' – Part 1 (2009)

BS5228 'Code of Practice for noise and vibration control on construction and open sites' – Part 1 (2009) provides an industry-accepted guide for noise and vibration control and includes sound power level (SWL) data, and measured noise data at 10 m for individual plant as well as a calculation method for noise from construction activities. The document also provides practical information on noise reduction measures, and promotes a 'best practicable means' approach to control noise.

The BS5228 Parts 1 and 2 (2009) documents supersede the previous BS5228 Parts 1 to 5 (1997). This revision involves a restructuring of the standard into two parts, an update of legislative requirements and an update of information relating to methods and equipment. The update also incorporates additional equipment sound levels hitherto provided within the document 'DEFRA - Update of Noise Database for Predictions of Noise on Construction Sites' (2006).

3. POTENTIAL SITES

The as yet unselected construction yards where works will potentially take place are:

- Baku Deepwater Jacket Factory (BDJF) Yard;
- Bibi Heybet Yard;
- South Dock Yard; and
- Zykh Yard.

All yards are located in existing industrial areas and are operational construction yards used for previous Azeri-Chirag-Gunashli (ACG) projects. The Bibi Heybat and South Dock Yards are located closest to existing residential receptors; the nearest of which to the operational areas of the yards is approximately 500m. The BDJF yard is located furthest from established residential communities, which are approximately 4 km away.

4. POTENTIAL ONSITE ACITVITIES

4.1. Upgrade Works

The potential construction sites may need to be upgraded prior to the construction of the topside, jacket and drilling facilities. Potential upgrade tasks include the following:

- Extensions of the yard area to allow for equipment storage and fabrication;
- Ground improvement work to increase the weight bearing capacity – e.g. pilling work, back filling and ground compaction; and
- New or refurbishment of the existing site support facilities, sewers, electrical systems, material storage areas and waste handling facilities.

4.2. Construction

Activities associated with the fabrication of the topside, jacket and drilling facilities are likely to include the following:

- Jacket and Piles – The COP jacket and twelve foundation piles will be fabricated within one or more of the proposed yards. This process will involve assembly, inspection, testing, grit blasting and painting.
- Drilling Modules – The Drilling Support Module (DSM) will be constructed over a 16-month period at a selected yard. Testing, pre-commissioning and operator training of the drilling module onshore is expected to take eight months.
- Topside – The COP topside will be constructed within one of the proposed yards. This will involve grit blasting, painting, and using cranes to move relevant equipment and modules. The deck frame and components will be tested with non-destructive techniques.

Activities associated with the commissioning of the main platform power generation system, incorporating the testing of three RB211 (28.5 MW) generators are planned to include the following:

- Each generator running separately and intermittently over a period of a week, for up to 8 hours a day;
- Three tests undertaken using two of the generators run together for an 8 hour period.

Once commissioned, the generators will be run separately and intermittently during further commissioning of:

- The compression system (up to 8 hours per day over a period of up to 4 weeks); and

– Topside utilities (up to 8 hours per day over a period of up to 6 months).

It is expected that the generators will be running at approximately 26% load during the commissioning periods.

The platform pedestal cranes and the emergency generator will also be commissioned onshore. The cranes are expected to be available for approximately 4-6 months.

The majority of fabrication works (welding, shaping and grit blasting) will be undertaken within buildings.

Potential sources of ground vibration include piling. BS5228 Part 2 (2009) advises that vibration due to piling may be significance at distances of 20 m or less from the source. The nearest receptor to the sites is 30 m and is therefore not considered further.

5. PREDICTED NOISE LEVELS

5.1. Methodology

Predictions of the noise associated with the preparation of the sites (upgrade works) and the noise associated with the fabrication and commissioning of the topside, jacket and drilling facilities has been undertaken using the calculation methodology provided in BS5228 (2009). The method is based on the number and types of equipment operating, percentage-on times, their associated sound power levels, the distances to receptors, and ground conditions together with the effects of any screening.

Predictions of the noise associated with the activities detailed above have been undertaken at varying distances from the potential construction sites.

5.2. Assumptions

URS has made the following assumptions in order to undertake predictions of the noise associated with each potential site.

Table 2 Assumptions

Description	Assumption
Upgrade Works	During site upgrade works it is assumed that 2 large excavators, 2 large cranes, 2 rollers, 2 dozers and 2 dump trucks (a total of 10 plant) will be operating at any one time.
Construction Vehicles/Plant Operation	It is assumed that plant equipment including 2 large cranes and 8 large heavy goods vehicles (a total of 10 plant) will be moving on site at any one time This will provide most of the normal noise sources during day to day construction activities on the potential sites.
Commissioning	An assessment of the worst-case noise impact due to the commissioning of the topside utilities has been undertaken. This

Description	Assumption
	assumes that two RB211 (28.5MW) generators are operating simultaneously at any one time. The generators on the topside will incorporate appropriate acoustic covers and silencers and will be housed within a plant room. This is likely to provide an approximate attenuation in noise from commissioning activities of around 15 dB. Other activities, such as the commissioning of the compression systems, will take place during times when a single generator is operating.
Enclosures	A large proportion of fabrication works (e.g. welding, shaping and grit blasting) will be undertaken within buildings. These activities have not been taken into account within the predictions, as they are unlikely to have a significant overall impact on noise levels compared with those works undertaken outside.
Shielding	Hoarding surrounds the site and there are also on-site buildings and warehouses of single and multiple storey height. The hoarding and buildings are likely to provide approximately 5 dB reduction in noise emanating from the potential site.
Ground Conditions	Hard ground conditions have been assumed over all ground on and surrounding the construction site.
Operating Times	It is assumed that all equipment will be operating for 50% of the time unless where specified.

5.3. Equipment and Noise Levels

The following sections detail the assumed noise levels (from BS5228 (2009)) for each stage of the COP onshore construction activities.

5.3.1. Upgrade Works

Table 3 below provides operational details for the assumed plant associated with the upgrade of a potential site.

Table 3 Assumed Upgrade Works/Site Preparation Equipment Details

Equipment	Number	% time on	SPL @ 10m dB(A)	Reference
Tracked Excavator	2	50%	79	C.2-14
Roller	2	50%	73	C.2-38
Dozer	2	50%	81	C.2-12
Dump Truck	2	50%	81	C.2-33

Equipment	Number	% time on	SPL @ 10m dB(A)	Reference
Tower Crane	2	50%	77	C.4-49
Total	**10**		**86**	

5.3.2. Construction

Table 4 below provides operational details for the assumed plant associated with the construction and fabrication of topside, jacket and drilling facilities.

Table 4 Assumed Construction Equipment Details

Equipment	Number	% time on	SPL @ 10m dB(A)	Reference
Road Lorry (full)	8	50%	80	C.6-21
Tower Crane	2	50%	77	C.4-49
Total	**10**		**87**	

Table 5 below provides operational details for the generator proposed to be commissioned on the selected site.

Table 5 Assumed Generator Details

Equipment	Number	% time on	SPL @ 10m dB(A)	Reference
Generator Commissioning	2	100%	93	Estimated noise level from similar equipment
Total	**2**		**98**	

5.4. Assessment

The sections below detail the predicted noise levels associated with the upgrade works and the fabrication/commissioning/construction of the topside, jacket and drilling facilities.

5.4.1. Upgrade Works

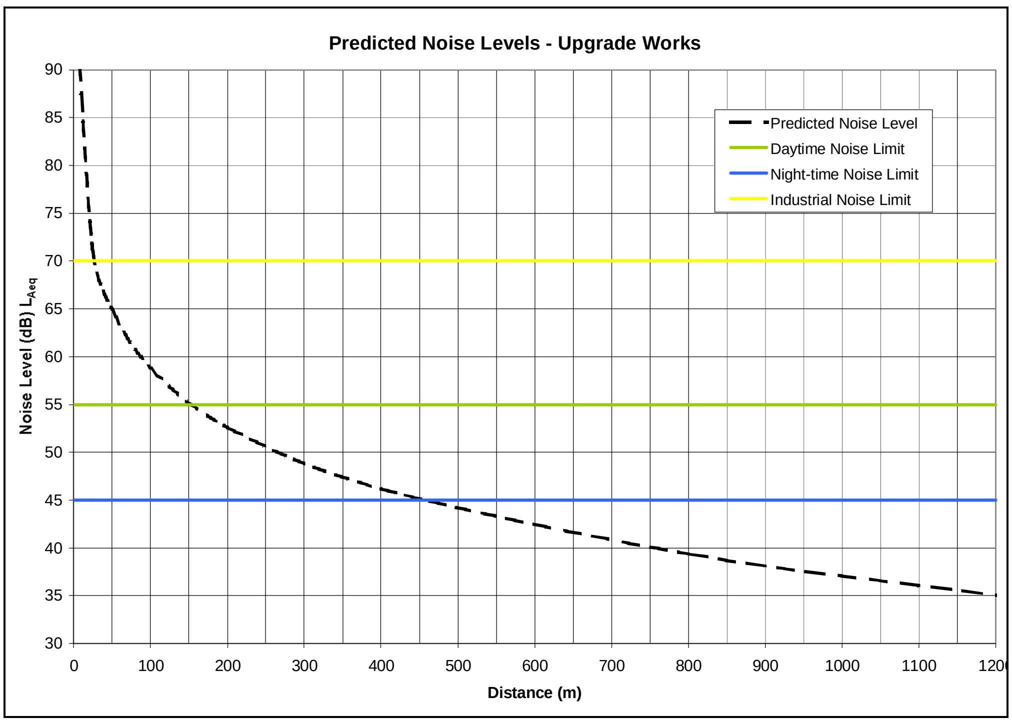
The predicted noise levels associated with the upgrade works are shown within Table 6 and Figure 1 below.

Table 6 Predicted Noise Levels Due to Upgrade Works

Distance (m)	Distance Attenuation (dB)	Screening (dB)	Atmospheric Attenuation (2 dB/km) (dB)	Ground Correction (dB)	Predicted Noise Level dB L_{Aeq}	Daytime Limits dB L_{Aeq}	Daytime Compliance	Night-time Limits dB L_{Aeq}	Night-time Compliance
1	20.0	5	0.0	2	**99.0**	55	44	45	54
25	-8.0	5	0.1	2	**71.0**	55	16	45	26
50	-14.0	5	0.1	2	**65.0**	55	10	45	20
100	-20.0	5	0.2	2	**58.8**	55	4	45	14
200	-26.0	5	0.4	2	**52.6**	55	-2	45	8
400	-32.0	5	0.8	2	**46.2**	55	-9	45	1
800	-38.1	5	1.6	2	**39.4**	55	-16	45	-6
1200	-41.6	5	2.4	2	**35.1**	55	-20	45	-10

*A negative number indicates compliance.

Figure 1 Predicted Noise Levels Due to Upgrade Works



The analysis indicates that predicted noise levels will meet the daytime noise limit at distances greater than approximately 150 m, meet the night-time limit at distances greater than 450 m and meet the industrial noise limit proposed within the World Bank guidelines at distances greater than around 30 m.

It is assumed that the upgrade works will only occur during the day, so predicted night-time noise levels are not relevant.

5.4.2. Construction

The predicted noise levels associated with the fabrication of the topside, jacket and drilling facilities are shown within Table 7 below.

Table 7 Predicted Noise Levels Due to Fabrication

Distance (m)	Distance Attenuation (dB)	Screening (dB)	Atmospheric Attenuation (2 dB/km) (dB)	Ground Correction (dB)	Predicted Noise Level dB L_{Aeq}	Daytime Limits dB L_{Aeq}	Daytime Compliance	Night-time Limits dB L_{Aeq}	Night-time Compliance
1	20.0	5	0.0	2	**99.5**	55	45	45	55
25	-8.0	5	0.1	2	**71.5**	55	17	45	27
50	-14.0	5	0.1	2	**65.5**	55	10	45	20
100	-20.0	5	0.2	2	**59.3**	55	4	45	14
200	-26.0	5	0.4	2	**53.1**	55	-2	45	8
400	-32.0	5	0.8	2	**46.7**	55	-8	45	2
800	-38.1	5	1.6	2	**39.9**	55	-15	45	-5
1200	-41.6	5	2.4	2	**35.5**	55	-19	45	-9

*A negative number indicates compliance.

Noise levels associated with the fabrication works are likely to be similar to that associated with the upgrade works.

The analysis indicates that predicted noise levels will meet the daytime noise limit at distances greater than approximately 150 m, meet the night-time limit at distances greater than 450 m and meet the industrial noise limit proposed within the World Bank guidelines at distances greater than around 30 m.

5.4.3. Commissioning

The predicted noise levels associated with the onshore generator commissioning tests are shown within Table 8 below, these include the activities predicted within Table 8 above.

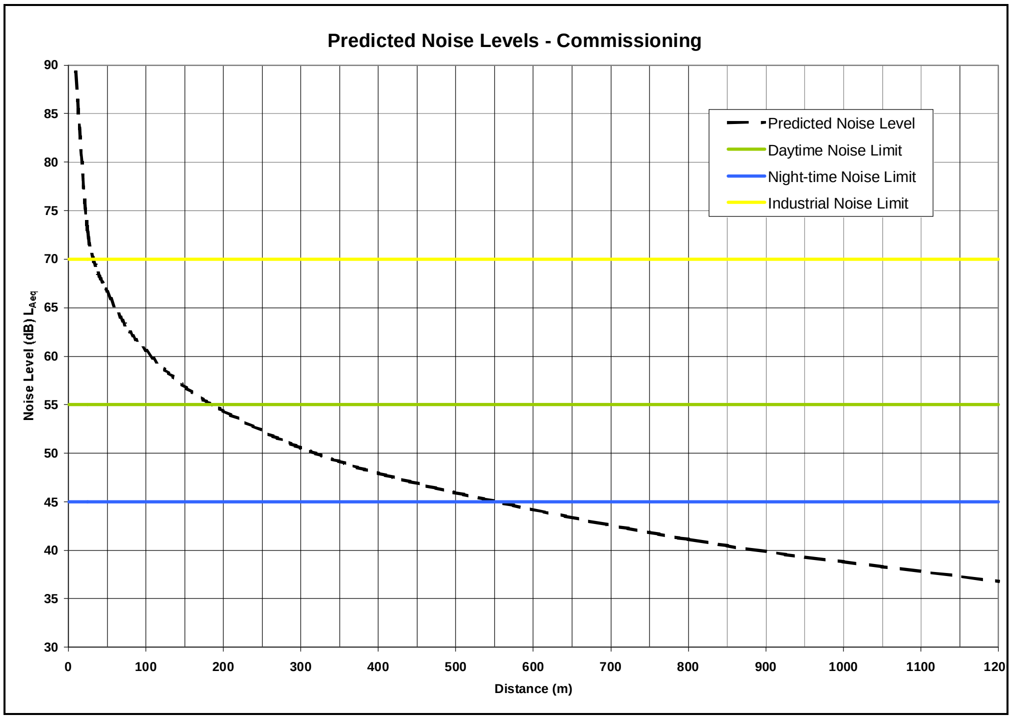
It is assumed that the onshore generator commissioning tests will only occur during the day, so that the predicted night-time noise levels are not relevant.

Table 8 Predicted Noise Levels Due to Commissioning

Distance (m)	Distance Attenuation (dB)	Screening (dB)	Atmospheric Attenuation (2 dB/km) (dB)	Ground Correction (dB)	Predicted Noise Level dB L_{Aeq}	Daytime Limits dB L_{Aeq}	Daytime Compliance	Night-time Limits dB L_{Aeq}	Night-time Compliance
1	20.0	15	0.0	2	**100.8**	55	46	45	56
25	-8.0	15	0.1	2	**72.8**	55	18	45	28
50	-14.0	15	0.1	2	**66.7**	55	12	45	22
100	-20.0	15	0.2	2	**60.6**	55	6	45	16
200	-26.0	15	0.4	2	**54.4**	55	-1	45	9
400	-32.0	15	0.8	2	**47.9**	55	-7	45	3
800	-38.1	15	1.6	2	**41.1**	55	-14	45	-4
1200	-41.6	15	2.4	2	**36.8**	55	-18	45	-8

*A negative number indicates compliance.

Figure 2 Predicted Noise Levels Due to Generator Commissioning



The analysis indicates that predicted noise levels will meet the daytime noise limit at distances greater than approximately 180 m, meet the night-time limit at distances greater than 550 m and meet the industrial noise limit proposed within the World Bank guidelines at distances greater than around 35 m.

The modelling has been undertaken based on the worst case platform generator scenario assuming two of the three generators will be running simultaneously. During periods where only one generator is running, overall noise levels are likely to be around 2 – 3 dB lower than predicted.

6. MITIGATION MEASURES

It is considered that noise is reduced as far as practicable and necessary through the implementation of existing operational control measures including the following:

- Steel works planned to be undertaken in fabrication sheds, where practicable and feasible;
- Grit blasting to be undertaken in sheds or within enclosures;
- Construction contractor to ensure plant/machinery is operated and maintained in accordance with manufacturer's recommendations;

- All platform generators will be operated for minimum duration to complete commissioning;
- Where practicable, equipment powered by mains electricity should be used in preference to equipment powered by internal combustion engine or locally generated electricity; and
- The generators incorporate appropriate noise measures to ensure the health and safety of personnel offshore and are housed in a generator room on the topside.

For all yards except BDJF, additional mitigation will include a noise monitoring programme at the boundary of the selected construction yards and community disturbance management and engagement plans will be implemented and maintained by the construction contractor as a mechamism of communicating with the community.

7. CONCLUSIONS

URS has undertaken a preliminary assessment of the onshore noise impact associated with the potential site upgrade, construction activities and commissioning of the COP project at four potential construction sites (Baku Deepwater Jacket Factory (BDJF) Yard, Bibi Heybet Yard, South Dock Yard and Zykh Yard).

Using reasonable worst case assumptions regarding plant and operating times across the construction period, predictions of potential noise impact from the construction activities at increasing distances from source were undertaken in accordance with BS 5228 (2009) and compared to the relevant IFC Environmental Noise Level Guidelines.

For construction activities, the modelling demonstrates that at 150 m or more from the noise source the Daytime limit of 45 dB would be met and at 450 m from the noise source the Night-time limit of 55 dB L_{Aeq} will be met. The commercial limit of 70 dB L_{Aeq} was found to be met at a distance of 30 m from the source (refer to Figure 1). The modelling predicted no exceedances of environmental noise standards at a distance of 450 m or more from noise sources at the construction yard.

For commissioning activities, the modelling demonstrated that at 180 m or more from the noise source the daytime limit of 55 dB would be met and at 680 m from the noise source the nigh-time limit of 45 dB L_{Aeq} will be met. The industrial/commercial limit of 70 dB L_{Aeq} was found to be met at a distance of 35 m from the source (refer to Figure 2). The modelling predicted no exceedances of environmental noise standards at a distance of 550 m or more from the potential construction sites.

It is considered that noise is reduced as far as practicable and necessary through the implementation o existing operational control measures.

Appendix 10C

Onshore Air Quality Screening Assessment

Onshore Atmospheric Emissions During Construction

Chirag Oil Project

May 2009
Final Draft

Issue No 1
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Issue No: 1	Name	Signature	Date	Position
Prepared by	Matthew Mitchell		22nd April 2009	Air Quality Consultant
Checked by	Neil Titley		22nd April 2009	Principal Air Quality Consultant
Approved by	Anna Rouse		15th May 2009	Project Manager

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CONTENTS

EXECUTIVE SUMMARY

This report has been prepared by URS Corporation Ltd (URS) on behalf of Azerbaijan International Operating Company (AIOC) to predict the potential atmospheric impacts from onshore construction yard operations associated with the Chirag Oil Project (COP).

It is anticipated that the key emissions to air during onshore construction/commissioning activities will be associated with:

- *Short term, peak emissions from power generation associated with onshore commissioning of the topside platform; and*
- *Long term, typical emissions associated with construction/commissioning equipment and vehicles (vehicle exhaust emissions).*

Based on an initial screening exercise, exhaust emissions from power generation and construction plant are unlikely to cause any significant impacts on local air quality, with concentrations easily complying with the relevant ambient air quality limits. Short term, peak emissions are not expected to exceed 25% of the ambient air quality standards, whilst the average impact on ground level concentrations over the period of a year is expected to result in an increase in the order of only 10% (with ambient concentrations predicted to remain at, or below approximately 50% of the limit).

1. INTRODUCTION

This report has been prepared by URS Corporation Ltd (URS) on behalf of Azerbaijan International Operating Company (AIOC) to predict the potential impacts associated with atmospheric emissions from onshore construction yard operations attributed to the Chirag Oil Project (the COP).

It presents the findings of a preliminary screening assessment using ADMS 4.1, based on the most pollutant-emitting phase at the construction yards, that being the construction and commissioning of the Topside platform. A number of possible mitigation measures have also been discussed, where applicable.

It is anticipated that key emissions to air during onshore construction/commissioning activities will be associated with:

- Short term, peak emissions from power generation associated with onshore commissioning of the topside platform; and
- Long term, typical emissions associated with construction/commissioning equipment and vehicles (vehicle exhaust emissions).

2. AIR QUALITY STANDARDS

Table 1 presents the project ambient air quality standards, for the key pollutants of interest: nitrogen dioxide (NO_2), fine particulate matter (PM_{10}), and sulphur dioxide (SO_2). Concentrations are expressed in mass pollutant (micrograms) per cubic metre of air ($\mu g/m^3$).

Table 1: Ambient Air Quality Standards ($\mu g/m^3$)

Pollutant Species	Limit	Averaging Period	International Guideline or Standard (Ref. 1 and 2)	Maximum Number of Exceedances
Nitrogen Dioxide (NO_2)	200 $\mu g/m^3$	1 hour	WHO, EU, WB / IFC	18 per year (EU)
	40 $\mu g/m^3$	1 year	WHO, EU, WB / IFC	Not applicable
Particulate Matter (PM_{10})	50 $\mu g/m^3$	24 hours	WHO, EU, WB / IFC	35 per year (EU)
	20 $\mu g/m^3$	1 year	WHO, WB / IFC	Annual Average
Sulphur Dioxide (SO_2)	500	10 minute	WHO, EU, WB / IFC	Not applicable
	350 $\mu g/m^3$	1 hour	EU	24 per year
	125$\mu g/m^3$	24 hours	EU	3 per year

3. STUDY SPECIES

Oxides of Nitrogen (NOX) predominately comprise nitric oxide (NO) and nitrogen dioxide (NO2). NO is mainly derived from fossil fuel combustion, and although not considered to be harmful to health, once released to the atmosphere it is usually very rapidly oxidised into NO2, which can irritate the lungs and lower resistance to respiratory infections such as influenza.

SO2 is produced during the combustion of fuels with high sulphur content, principally, through coal and heavy oils associated with the energy production and manufacturing processes. It is a respiratory irritant, and even moderate local concentrations may impair lung function in asthmatics. Typical sulphur content in Azerbaijan diesel fuel is considered to be 0.03% as such sulphur emissions are not considered to be high enough to warrant plausible detection levels and have therefore been screened out of further assessment.

Fine particles are composed of a wide range of materials arising from a variety of sources, including combustion (mainly road traffic) and the suspension of soils and dusts from construction work, for example. Particles are measured in a number of different size fractions according to their mean aerodynamic diameter. Most monitoring is currently focussed on PM10, which has an aerodynamic diameter of 10 microns or less. PM10 can be carried deep into the lungs where they can cause inflammation and a worsening of the condition of people with heart and lung disease. Particulate matter from combustion processes is typically. Modelling of particulates was not deemed necessary as concentrations are expected to be very low based on efficient plant operation, regular maintenance and planned use of good quality, diesel. Emissions of PM_{10} are on average 4-10 times lower that that of NO_2, based on this PM_{10} has been screened out of further assessment.

Nuisance dust (particles up to 75 micrometers in diameter) has also been considered in a qualitative context. Dust particles are dispersed by their suspension and entrainment in airflow, with dispersal affected by the size of the particles emitted, wind speeds as well as their shaper and density. Large dust particles (greater than 30 µm) typically deposit within 100 metres (m) of a fugitive dust source. Intermediate particles (10-30 µm) are more likely to travel to up to 200-500 m.

The potential for dust generation associated with yard upgrades have been scoped out of the assessment. The construction yards and roads are hard standing, with little or no earth moving activities anticipated. It is therefore expected that dust emissions will be negligible, particularly given the nature of the dry, dusty surroundings.

4. BASELINE CONDITIONS

Ambient concentrations have been determined using the ‘BP AzSPU Integrated Environmental Monitoring Programme: Annual Summary Report for 2007’, which is summarised in *Chapter 6: Environmental Description* (Ref. 3). The monitoring data suggests that ambient NO_X concentrations range between 5-15 µg/m^3 in the Sangachal area.

The upper end of the monitoring results have been applied to this study, and assuming 100% conversion of NO_X to NO_2, yields existing ambient concentrations for NO_2 of 15 $\mu g/m^3$. This easily complies with the relevant ambient air quality project standards.

5. ASSESSMENT METHODOLOGY

5.1. Overview of the Construction Yards

The, as yet unselected, construction yard(s) where works will potentially take place include;

- The BDJF Yard,
- The Bibi Heybat Yard,
- The South Dock Yard, and
- The Zykh yard.

5.2. Methodology

This section presents the methodology used for the assessment of the potential impacts to air quality associated with the construction yard activities.

A screening assessment of emissions associated with: (i) worst case short term peak emissions from onshore commissioning associated with the main platform generators, and (ii) typical long term emissions from construction/commissioning plant exhaust emissions, has been undertaken using the UK point source dispersion model ADMS (version 4.1).

5.2.1. Generator Emissions

A generic dispersal model was set up based on a worst-case scenario during the construction and commissioning of the Topside platform (i.e. the activity considered to create highest air emissions).

The three platform generators will be utilised during the topside commissioning phase, run separately and intermittently over a 12 week period. In addition, synchronisation tests will be undertaken over a 24 hour period whereby two generators will be run at a load of approx 26% each using 8 tonnes of diesel per hour each.

Table 2 presents the modelled parameters for a single generator, based on measured data from existing plant associated with ACG operations.

Table 2: Model Parameters for each Power Generator

Parameter	Value (per generator)
NO_X emission per generator	10.3 g/s
Anticipated Release Height	22 m
Anticipated Stack Diameter	1.1 m
Anticipated Stack Velocity	62 m/s
Anticipated Release Temperature	719 Deg C
NO_X Concentrations in exhaust flow	660 mg/Nm^3

It has been assumed that 100% of NO_X will convert to NO_2 when calculating long-term averages, and 50% for the 1-hour averaging period (Ref. 4).

5.2.2. Construction Plant Vehicles and Equipment

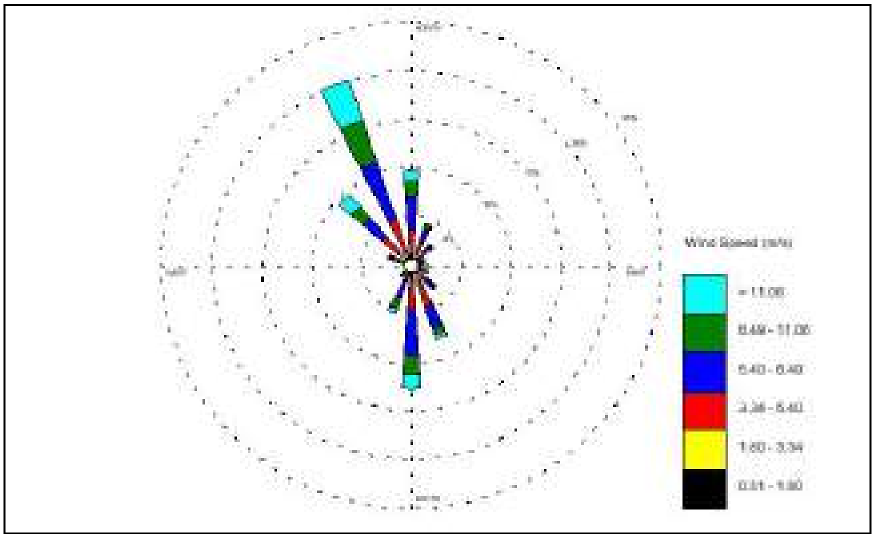
Emissions will also be associated with commissioning/construction plant vehicles on site. In the absence of any project data, it has been assumed that the equivalent of 20 heavy equipment will be operating simultaneously at any one time on site and are evenly distributed across a 9 ha construction yard (approximately 300x300m). This is based on an estimated diesel usage of 8.5 tonnes per month by construction equipment.

Using CORINAIR Inventory, (Ref. 5), an emission rate of 2.25 grams per second (g/s) NO_X was obtained, and subsequently modelled as an area source using ADMS 4.1 as approximately 0.000025 grams per second per square metre (g/s/m^2) of NO_X.

5.3. Meteorological Conditions

Local meteorological conditions strongly influence the dispersion of pollutants. Analysis of the annual wind rose for the Sangachal area demonstrates that the proposed construction sites are subject to predominant northwesterly winds, with secondary southerly/southeasterly winds (Figure 1).

Figure 1: Annual wind rose for the Sangachal area (data from Baku airport, 1999-2001)



The ADMS model was run for a single 1-hour period, based on a wind bearing from 180° (to represent a southerly wind). It was not deemed necessary to analyse the effect of northwesterly winds, which would cause emissions to blow from land to sea (where no sensitive receptors are known to exist).

Model runs were undertaken with varying wind speeds of 1, 5 and 15 meters per second (m/s) to represent low, average and high wind speeds respectively, and with corresponding boundary layer heights at 200 m, 800 m and 800 m. This was assumed to represent stable, moderate, and unstable atmospheric conditions in order to identify the potential impacts associated with a range of meteorological conditions.

6. POTENTIAL IMPACTS

This section presents the findings of the screening assessment emissions.

6.1. Power Generation Emissions

As mentioned above, two reasonable worst-case meteorological conditions have been modelled, as well as a more average scenario, as follows:

- Wind speed of 15 m/s and boundary layer height of 800 m (i.e. unstable conditions); and
- Wind speed of 1 m/s and boundary layer of 200 m (i.e. stable conditions).
- Wind speed conditions of 5 m/s and boundary layer of 800 m, average conditions

All scenarios are modelled for a short term 1 hour concentration for comparison against the short term objective of 200µg/m^3.

Figure 2 presents the model results for the ground level NO_X process contribution under the high wind speed scenario (15 m/s) and unstable meteorological conditions. The maximum ground level process contribution is predicted to be between 30-40 µg/m^3, located approximately 500 m to 1.5 km from the emission source. Assuming that 50% of short term NO_X is converted into NO_2, as discussed above, emissions from the generators are predicted to lead to a maximum increase in 1 hour ground level NO_2 concentration of 15-20 µg/m^3.

Figure 3 presents the model results for the low wind speed scenario (1 m/s) and stable meteorological conditions. The maximum ground level NO_X process contribution in this case is predicted to be 2-3 µg/m^3, located approximately 4-6 km away from the emission source. Again, assuming that 50% of short term NO_X is converted into NO_2, emissions from the generators are predicted to lead to a maximum increase in mean 1 hour level NO_2 concentration of 1-1.5 µg/m^3.

Figure 4 presents the model results for the average wind speed scenario (5 m/s). The maximum ground level NO_X process contribution in this case is predicted to be 20-30 µg/m^3, located approximately 500m to 1.5 km away from the emission source. Again, assuming that 50% of short term NO_X is converted into NO_2, emissions from the generators are predicted to lead to a maximum increase in mean 1 hour level NO_2 concentration of 10-15 µg/m^3.

Figure 2: Ground Level 1-hour NOX Process Contribution in 15 m/s winds

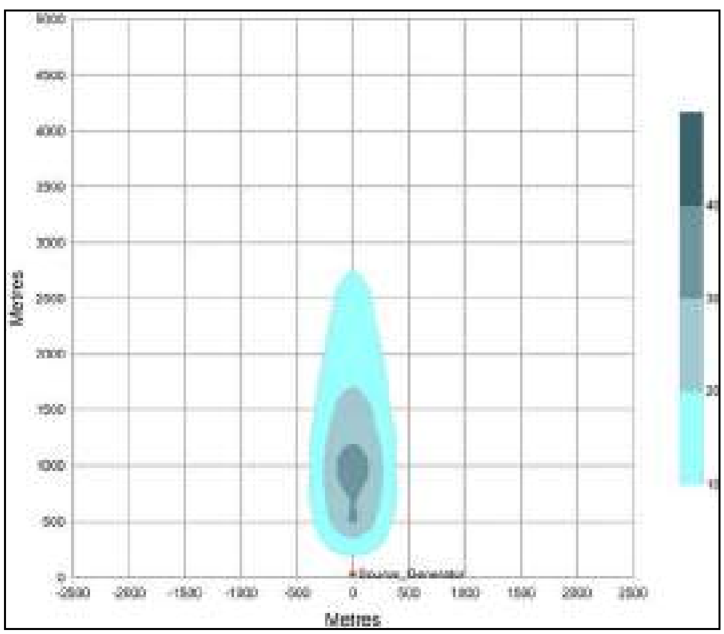


Figure 3: Ground Level 1-hour NO_X process contribution in 1 m/s winds

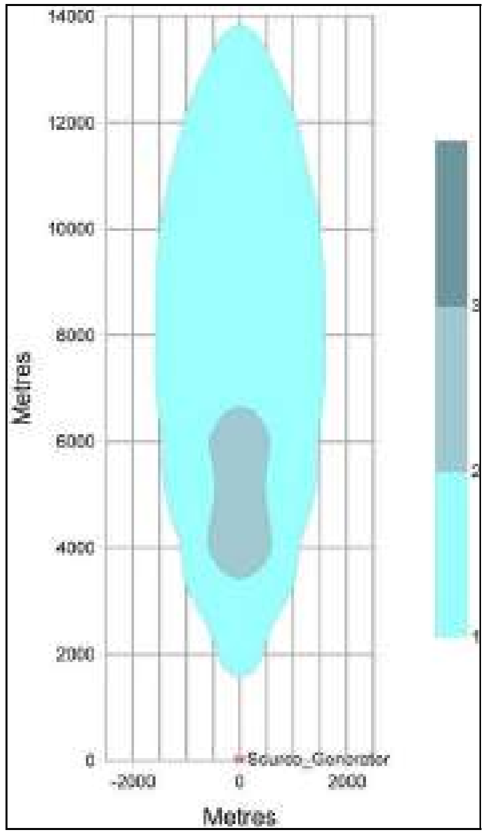
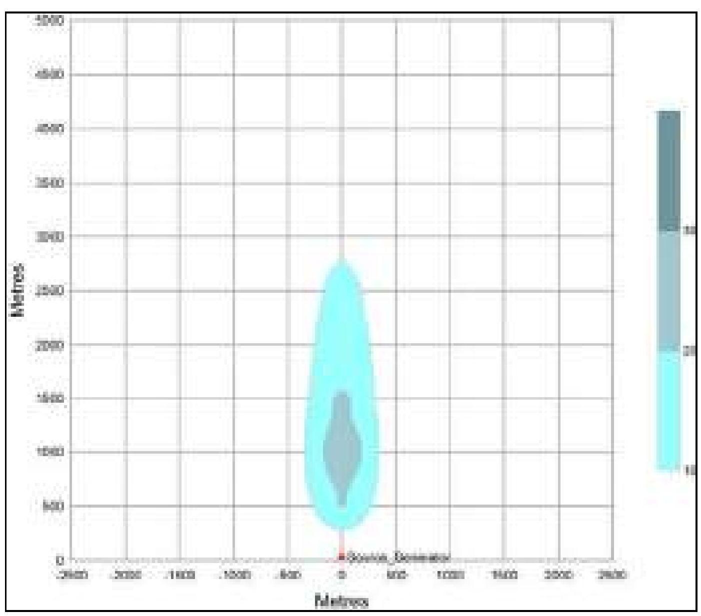


Figure 4: Ground Level 1-hour NO_X process contribution in 5 m/s winds



The worst-case 1-hour NO_2 process contribution (occurring under unstable conditions) is therefore expected to increase background concentrations by 30-40 µg/m^3, from 15 µg/m^3 to 55 µg/m^3, which represents approximately 25% of the short-term ambient NO_2 limit (of 200 µg/m^3).

6.2. Construction Plant Emissions

Construction emissions are predicted to generate a maximum short term ground level NO_X contribution of 6 µg/m^3 extending up to a distance of 200 m away from the emission source, reducing to 3 µg/m^3 at 250 m and returning to background concentrations at over 400 m, under high wind speeds and unstable meteorological conditions (15 m/s) (Figure 5).

Under low wind speed and stable conditions (1 m/s) (Figure 6) there is predicted to be no noticeable increase in NO_X concentrations beyond a distance of 200 m from the centre of the construction site.

Typical wind speeds conditions (5 m/s) (Figure 7) are predicted to result in an increase of NO_X concentrations of approximately 6 µg/m^3 up to 30 m from the centre of the site, reducing to background concentrations at a distance over 200 m.

To convert this average wind speed short term emission input into an annual average (long term) concentration it is assumed that 100% of NO_X is converted to $NO_{2,}$ southern winds occur 50% of the time, and construction activities would only occur for a maximum of 50% of the year. Following this, construction equipment is predicted to lead to a maximum increase in NO_X concentrations of 1.5 µg/m^3, and less than 1 µg/m^3 over 200m away from the site boundary. This leads to a 10% increase in baseline NO_X, from 15 µg/m^3 to 16.5 µg/m^3, still easily complying with the mean annual ambient air limit of 40 µg/m^3.

Figure 5: Ground Level 1-hour NO_X Process Contribution from onsite plant in 15 m/s winds

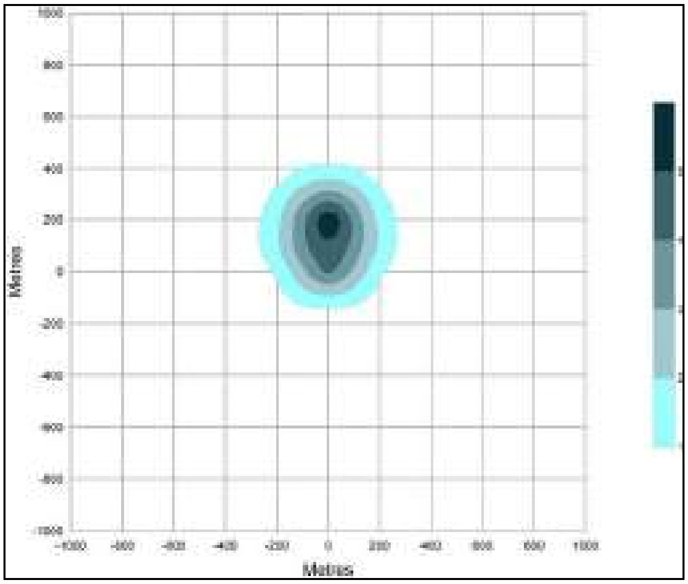


Figure 6: Ground Level 1-hour NO_X Process Contribution from onsite plant in 1 m/s winds

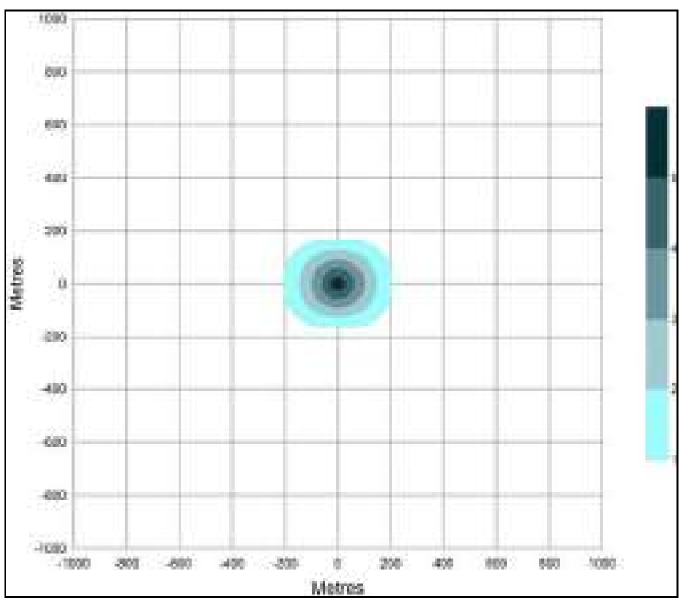
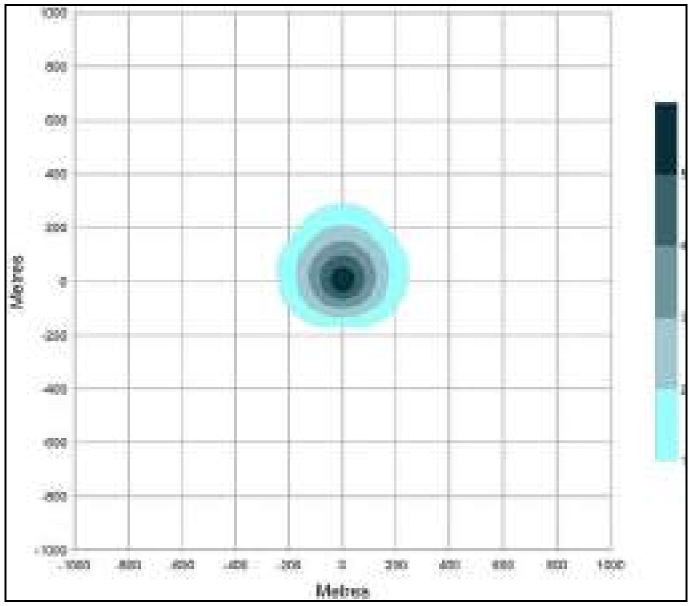


Figure 7: Ground Level short term NO_X Process Contribution from onsite plant considering average winds (5 m/s)



7. CONCLUSIONS

Based on an initial screening exercise, exhaust emissions from power generation during topside commissioning and construction plant emissions are unlikely to cause any significant impacts on local air quality.

Short term, peak emissions are not expected to exceed 25% of the ambient air quality standards, whilst the average impact on ground level concentrations over the period of a year is expected to result in an increase in the order of only 10% (with ambient concentrations predicted to remain at, or below approximately 50% of the limit).

8. MODEL SUITABILITY AND VERIFICATION

ADMS 4 version 4.1, developed by Cambridge Environmental Research Consultants Ltd (CERC) was selected as a viable system for the modelling of generator thermal plumes, because of its superior dispersion model and plume rise methodology. ADMS 4 is a short range dispersal model using two main parameters; boundary layer height and Monin-Obukhov length to describe atmospheric boundary layer and a skewed Gaussian concentration distribution to calculate dispersal under convective conditions. The model is typically applied for distances up to 60km downwind of the source though is useful for up to 100km.

Many regulatory authorities explicitly endorse or accept the use of ADMS4. In the UK the Environment Agency does not formally "approve" any model (the UK Government's open policy). However ADMS 4 is used routinely used in applications to the Environment Agencies in the UK and accepted by them; its development was also supported by the Environment Agencies in UK. The three Environment Agencies: Environment Agency of England and Wales, Scottish Environmental Protection Agency and the Department of the Environment in Northern Ireland, are all users of ADMS 4. ADMS 4 is also used routinely as a key model on behalf of DEFRA the government department for the environment.

ADMS 4 is on the US EPA's Appendix W list of alternative models. ADMS models accepted for all types of environmental impact assessment in China. ADMS models are used by city or regional government and others in France, Italy, the Netherlands, Ireland, the Baltic States, South Africa, Hungary and Thailand and was used by the California Department of Health. The models are also used in Spain, Portugal, Sweden, Cyprus, Austria, United Arab Emirates, Sudan, Saudi Arabia, Tunisia, Slovenia, Poland, New Zealand, Korea, Japan, India, Canada and Australia

9. REFERENCES

Ref. 1. European Commission and the European parliament (1996); The Air Quality Framework Directive (96/62/EC) on ambient air quality assessment and management.

Ref 2. World Health Organization (2005) Air Quality Guidelines.

Ref 3. ESIA COP Chapter 6 Environmental Description.

Ref 4. Environment Agency Air Quality Modelling and Assessment Unit http://www.environment-agency.gov.uk/commondata/acrobat/noxno2conv2005_1233043.pdf.

Ref 5. European Environment Agency (2007); EMEP/CORINAIR Emissions Inventory Guidebook 2007, http://reports.eea.europa.eu/EMEPCORINAIR5/en/B111vs3.1.pdf, table 24.

APPENDIX 10D

Pipeline Hydrotest Discharge Modelling

BMT Fluid Mechanics

Chirag Oil Project Pipeline Hydrotest Water Discharge Modelling

For
BP

Report Title	**Chirag Oil Project Pipeline Hydrotest Water Discharge Modelling**				
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EXECUTIVE SUMMARY

A Computational Fluid Dynamics (CFD) study was carried out by BMT Fluid Mechanics (BMT) to assess the dispersion of hydrotest water discharges from interfield pipelines in the Chirag Oil Project (COP) in Azerbaijan. The study was carried out for BP.

A total of 28 hydrotest water discharge scenarios were considered in the analysis, representing three different release depths:

- from a vessel (at sea surface)
- from a caisson (located at a depth of 50m)
- from the seabed (at a depth of 130m)

A range of port diameters and discharge volumes were assessed for each depth.

Discharges from the vessel and the caisson were directed downwards while releases from seabed were directed upwards.

Two current speeds (i.e. near-stagnant and predominant) were modelled for each depth. Two seawater ambient temperatures (summer and winter conditions) were considered for the discharges from the vessel and from the caisson, while only one seawater temperature (winter condition) was modelled for the discharges from the seabed.

A discharge temperature of 7ºC was assumed for all seabed and caisson discharges, while the vessel discharges were of 25 ºC in summer and 7ºC in winter.

For the vessel discharge scenarios, the maximum distance reached by the discharge plume (for a dilution of 1:3000) occurred for the largest summer near-stagnant current discharge (Scenario 6), where the plume reached a distance of 2,068 m.

For the caisson discharge scenarios, the maximum height reached by the discharge plume (for a dilution of 1:3000) occurred for the summer predominant current discharge (Scenario 20), where the plume reached a depth of -38 m. The maximum distance reached by the discharge plume (for a dilution of 1:3000) occurred for the winter near-stagnant current discharge (Scenario 17), where the plume reached a distance of 5,765 m.

For the seabed discharge scenarios, the maximum height reached by the discharge plume (for a dilution of 1:3000) occurred for the winter near-stagnant current discharge (Scenario 27), where the plume reached a depth of -44 m. The maximum distance reached by the discharge plume (for a dilution of 1:3000) occurred for the winter near-stagnant current discharge (Scenario 27), where the plume reached a distance of 40,462 m. Note that the maximum distance travelled by the plume is not representative of the actual plume length. This is further emphasized for near-stagnant scenarios where the slow current allows the creation of a persistent plume subjected mainly to dispersive effects.

The cases investigated in this analysis involve constant current conditions, which constitute a “worst-case” scenario. The presence of fluctuating directions and speeds of the currents would cause the plumes to dissipate earlier.

Plume persistence for a dilution of 1:3000 was observed to be of a maximum of 60 hours for vessel discharges (Scenario 6), 162 hours for the caisson discharges (Scenario 17), and 1,130 hours (~47 days) for the seabed discharges (Scenario 27).

As with the plume lengths and distances covered, plume persistence is a worst-case scenario, and each discharge has a relevant range of concentrations to consider. In this analysis, and for discharges of more than 1200 m^3 (i.e. Scenarios 21, 22, 27, and 28) only the 300-fold concentration values are relevant. This is due to the fact that Hydrotest water will have degraded considerably for the larger discharges before they take place. Additionally, due to the chemical nature of the Hydrotest Water, it is reasonable to expect that it will have degraded in 7 days.

Chirag Oil Project
Pipeline Hydrotest Water Discharge Modelling

Contents

Chirag Oil Project
Pipeline Hydrotest Water Discharge Modelling

1. Introduction

1.1. General

This report presents results of a Computational Fluid Dynamics (CFD) study carried out by BMT Fluid Mechanics (BMT) to assess the dispersion of hydrotest water discharges from interfield pipelines in the Chirag Oil Project (COP) in Azerbaijan. The scope of work is based on requirement outlined in “Chirag Oil Project: scope of work for dispersion modelling of discharges of hydrotest water from interfield pipelines” issued to BMT by BP on the 2nd of February 2009.

The Chirag Oil Project has prepared a comprehensive schedule of hydrotest water discharges, which will occur during the installation, tie-in and testing of interfield gas, oil, injection water and produced water pipelines. In order to assess the potential environmental impact of these discharges, it is necessary to model the dispersion and fate of the hydrotest water fluids.

1.2. Report Structure

Sections 2 and 3 of this report describe the main objectives of the study and the scope of work agreed to meet those objectives. Results of the hydrotest water dispersion analysis are given in section 4. Details of the modelling and supporting information are given in Appendix A.

1.3. Definitions of Abbreviations and Acronyms

Term / Acronym / Abbreviation	Explanation / Definition
BMT	BMT Fluid Mechanics Limited
CAD	Computer Aided Drawing
cc	Cubic centimetre
CFD	Computational Fluid Dynamics
ppb	Parts Per Billion by volume

2. Objectives

The main objectives of the CFD hydrotest water dispersion analysis were as follows:

- Model dispersion and fate of hydrotest water fluid
- Assess persistence and distance travelled by discharge plume
- Determine concentrations of discharged fluid within plume

3. Scope of Work

3.1. Model Construction

- Construct simplified three-dimensional CFD models of Caspian sea water column for different depths suitable for dispersion modelling

3.2. Dispersion Analysis

- Carry out transient dispersion simulations for a total of 28 hydrotest water discharge scenarios representing three different release depths:
    - from a vessel (at sea surface)
    - from a caisson (located at a depth of 50m)
    - from the seabed (at a depth of 130m)

  A range of port diameters and discharge volumes will be assessed for each depth. Two near-seabed current speeds (i.e. near-stagnant and predominant) will be modelled for each depth. Two seawater temperatures (summer and winter conditions) will be considered for the discharges from the vessel and from the caisson while only one seawater temperature (winter condition) will be modelled for the discharges from the seabed. See Section 4 for further details on discharge scenarios – Total 28 simulations
- Provide horizontal and vertical colour contour plots of hydrotest water concentrations showing the no-effect limit at selected times after discharge
- Provide 3D isosurfaces of hydrotest water concentrations if required
- Determine the toxic plume extent (length, height and width) over time
- Assess the persistence of the toxic plume

3.3. Reporting

- Submit a technical report summarising the main results of the dispersion analysis including method, software and model description, sufficient tabular and illustrative graphical colour images, recommendations and conclusions

4. CFD Analysis

4.1. Introduction

This section presents the results of the hydrotest water dispersion analysis carried out to determine the persistence and distance travelled by the discharge plumes for a range of subsea ambient, current conditions and discharge scenarios.

The CFD model and methodology is described in APPENDIX A.

4.2. Ambient Conditions

Two seasonal options were assessed and compared in the analysis:

- Summer condition: in this case, a vertical seawater temperature profile was obtained from [1]. The thermal profile's prime characteristic is a sudden increase from 9 ºC to 24 ºC in the range of 30 m to 50 m depth. Details of the thermal profile used are shown in Figure 4.1
- Winter condition: in this case, a constant seawater temperature of 7 ºC was obtained from [1] (i.e. no thermocline)

4.3. Current Conditions

For each ambient condition, two current conditions were assessed in the analysis:

- Near-stagnant flow: constant horizontal current flow velocity of 0.01 m/s
- Predominant flow: annual average current data obtained from [2], leading to a uniform constant value of 0.11 m/s

4.4. Chemical Concentration Limits

The hydrotest water discharges will comprise chemically treated Caspian seawater. The chemical dose levels will total less than 500ppm and therefore the discharges were considered to have the same density and physical properties as Caspian seawater. The relevant degree of dilution assessed lies in the range of 1:300 to 1:3000.

4.5. Assessment Scenarios

A total of 28 hydrotest water discharge scenarios were considered in the analysis, representing three different release depths:

- o from a vessel (at sea surface)
- o from a caisson (located at a depth of 50m)
- o from the seabed (at a depth of 130m)

A range of port diameters and discharge volumes were assessed for each depth.

Discharges from the vessel and the caisson were directed downwards while releases from seabed were directed upwards.

Two current speeds (i.e. near-stagnant and predominant) were modelled for each depth. Two seawater ambient temperatures (summer and winter conditions) were considered for the discharges from the vessel and from the caisson, while only one seawater temperature (winter condition) was modelled for the discharges from the seabed.

A discharge temperature of 7ºC was assumed for all seabed and caisson discharges, while the vessel discharges were of 25 ºC in summer and 7ºC in winter.

The hydrotest dispersion scenarios investigated in the analysis are summarised in Table 4.1.

4.6. Results

4.6.1. Discharge Plume Dimensions

Table 4.2 to Table 4.5 presents the discharge plume dimensions measured at relevant degrees of dilution (300-fold, 840-fold, 1380-fold, 1920-fold, 2460-fold, and 3000-fold). The corresponding volume time histories are shown in Figure 4.2.

4.6.2. Discharge Plume Persistence

Table 4.6 presents the persistence time (in hours) of the plumes at each concentration of interest for all scenarios investigated.

4.6.3. Discharge Plume Visualisations

Figure 4.3 depicts the vertical centreline contour plots of the plume concentrations of interest, while Figure 4.4 shows a plan view of the same contours, for each of the scenarios investigated.

5. Conclusions

- For the vessel discharge scenarios, the maximum distance reached by the discharge plume (for a dilution of 1:3000) occurred for the largest summer near-stagnant current discharge (Scenario 6), where the plume reached a distance of 2,068 m.
- For the caisson discharge scenarios, the maximum height reached by the discharge plume (for a dilution of 1:3000) occurred for the summer predominant current discharge (Scenario 20), where the plume reached a depth of -38 m. The maximum distance reached by the discharge plume (for a dilution of 1:3000) occurred for the winter near-stagnant current discharge (Scenario 17), where the plume reached a distance of 5,765 m.
- For the seabed discharge scenarios, the maximum height reached by the discharge plume (for a dilution of 1:3000) occurred for the winter near-stagnant current discharge (Scenario 27), where the plume reached a depth of -44 m. The maximum distance reached by the discharge plume (for a dilution of 1:3000) occurred for the winter near-stagnant current discharge (Scenario 27), where the plume reached a distance of 40,462 m.
- Note that the maximum distance travelled by the plume (as shown in Table 4.4), is not representative of the actual plume length. This is further emphasized for near-stagnant scenarios where the slow current allows the creation of a persistent plume subjected mainly to dispersive effects. Plume sizes (volumes) can be observed on the graphs presented in Figure 4.2, and the maximum width is shown in Table 4.3.
- The cases investigated in this analysis involve constant current conditions, which constitute a “worst-case” scenario. The presence of fluctuating directions and speeds of the currents would cause the plumes to dissipate earlier.
- Plume persistence for a dilution of 1:3000 was observed to be of a maximum of 60 hours for vessel discharges (Scenario 6), 162 hours for the caisson discharges (Scenario 17), and 1,130 hours (~47 days) for the seabed discharges (Scenario 27).
- As with the plume lengths and distances covered, plume persistence is a worst-case scenario, and each discharge has a relevant range of concentrations to consider. In this analysis, and for discharges of more than 1200 m^3 (i.e. Scenarios 21, 22, 27, and 28) only the 300-fold concentration values are relevant. This is due to the fact that Hydrotest water will have degraded considerably for the larger discharges before they take place. Additionally, due to the chemical nature of the Hydrotest Water, it is reasonable to expect that it will have degraded in 7 days.

6. References

[1] ASA, “Hydrodynamic and Dispersion Modelling for the Azeri, Chirag, Gunashi Field Offshore Baku, Azerbaijan”, ASA 01-007, August 2001

[2] Shah Deniz Wind Wave Surge and Current Criteria, v3.1, OceanMetriX Ltd, October 2008

7. Tables

Table 4.1: Summary of discharge scenarios

Scenario	Location	Discharge Depth [m]	Discharge Diameter [m]	Discharge Orientation	Amount of Discharge [m^3]	Discharge Vol. Flow [m^3/s]	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Average Discharge Velocity [m/s]	Current Velocity [m/s]	Ambient condition	Discharge Temperature [ºC]
1	Vessel	0	0.025	Downwards	20	0.01	10.1	2000.0	20.37	0.01	Winter	7
2	Vessel	0	0.025	Downwards	20	0.01	10.1	2000.0	20.37	0.01	Summer	25
3	Vessel	0	0.025	Downwards	20	0.01	10.1	2000.0	20.37	0.11	Winter	7
4	Vessel	0	0.025	Downwards	20	0.01	10.1	2000.0	20.37	0.11	Summer	25
5	Vessel	0	0.025	Downwards	100	0.01	10.1	10000.0	20.37	0.01	Winter	7
6	Vessel	0	0.025	Downwards	100	0.01	10.1	10000.0	20.37	0.01	Summer	25
7	Vessel	0	0.025	Downwards	100	0.01	10.1	10000.0	20.37	0.11	Winter	7
8	Vessel	0	0.025	Downwards	100	0.01	10.1	10000.0	20.37	0.11	Summer	25
9	Caisson	50	0.025	Down	20	0.01	10.1	2000.0	20.37	0.01	Winter	7
10	Caisson	50	0.025	Down	20	0.01	10.1	2000.0	20.37	0.01	Summer	7
11	Caisson	50	0.025	Down	20	0.01	10.1	2000.0	20.37	0.11	Winter	7
12	Caisson	50	0.025	Down	20	0.01	10.1	2000.0	20.37	0.11	Summer	7
13	Caisson	50	0.025	Down	100	0.01	10.1	10000.0	20.37	0.01	Winter	7
14	Caisson	50	0.025	Down	100	0.01	10.1	10000.0	20.37	0.01	Summer	7
15	Caisson	50	0.025	Down	100	0.01	10.1	10000.0	20.37	0.11	Winter	7
16	Caisson	50	0.025	Down	100	0.01	10.1	10000.0	20.37	0.11	Summer	7
17	Caisson	50	0.1	Down	1200	0.06	60.6	20000.0	7.64	0.01	Winter	7
18	Caisson	50	0.1	Down	1200	0.06	60.6	20000.0	7.64	0.01	Summer	7
19	Caisson	50	0.1	Down	1200	0.06	60.6	20000.0	7.64	0.11	Winter	7
20	Caisson	50	0.1	Down	1200	0.06	60.6	20000.0	7.64	0.11	Summer	7
21	Sea Bed	130	0.05	Up	6000	0.18	181.8	33333.3	91.67	0.01	Winter	7
22	Sea Bed	130	0.05	Up	6000	0.18	181.8	33333.3	91.67	0.11	Winter	7
23	Sea Bed	130	0.1	Up	20	0.18	181.8	111.1	22.92	0.01	Winter	7
24	Sea Bed	130	0.1	Up	20	0.18	181.8	111.1	22.92	0.11	Winter	7
25	Sea Bed	130	0.1	Up	1000	0.18	181.8	5555.6	22.92	0.01	Winter	7
26	Sea Bed	130	0.1	Up	1000	0.18	181.8	5555.6	22.92	0.11	Winter	7
27	Sea Bed	130	0.1	Up	7000	0.18	181.8	38888.9	22.92	0.01	Winter	7
28	Sea Bed	130	0.1	Up	7000	0.18	181.8	38888.9	22.92	0.11	Winter	7

* Cases highlighted in red depict the scenarios for which only 300-fold values are relevant

Table 4.2: Summary of plume volume results

Scenario	Location	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Current Velocity [m/s]	Maximum Plume Volume (in m^3)					
					300-fold	840-fold	1380-fold	1920-fold	2460-fold	3000-fold
1	Vessel	10.1	2000.0	0.01	1,718	4,444	6,766	10,101	13,315	15,140
2	Vessel	10.1	2000.0	0.01	1,580	3,528	7,182	10,738	14,024	16,320
3	Vessel	10.1	2000.0	0.11	17	611	1,428	2,699	4,526	7,659
4	Vessel	10.1	2000.0	0.11	14	501	1,486	4,525	9,122	13,517
5	Vessel	10.1	10000.0	0.01	6,045	24,265	38,537	51,797	64,863	85,947
6	Vessel	10.1	10000.0	0.01	2,615	22,038	38,973	50,676	61,077	76,544
7	Vessel	10.1	10000.0	0.11	17	611	1,428	2,699	4,526	7,572
8	Vessel	10.1	10000.0	0.11	14	501	1,486	4,525	9,739	17,868
9	Caisson	10.1	2000.0	0.01	146	2,880	6,261	9,681	12,940	16,524
10	Caisson	10.1	2000.0	0.01	1,838	3,982	6,925	10,066	13,611	16,776
11	Caisson	10.1	2000.0	0.11	18	535	1,298	2,143	4,411	7,560
12	Caisson	10.1	2000.0	0.11	14	594	1,317	2,228	3,353	5,459
13	Caisson	10.1	10000.0	0.01	146	17,855	39,530	57,114	69,498	81,067
14	Caisson	10.1	10000.0	0.01	6,839	22,645	41,082	55,265	66,050	77,727
15	Caisson	10.1	10000.0	0.11	18	535	1,298	2,143	4,411	7,560
16	Caisson	10.1	10000.0	0.11	14	594	1,317	2,228	3,353	5,459
17	Caisson	60.6	20000.0	0.01	118,239	268,982	462,391	624,142	739,740	898,324
18	Caisson	60.6	20000.0	0.01	78,322	209,007	352,882	538,592	739,072	919,127
19	Caisson	60.6	20000.0	0.11	1,504	21,697	65,879	117,010	173,579	257,505
20	Caisson	60.6	20000.0	0.11	1,388	13,859	38,528	57,996	80,579	121,728
21	Sea Bed	181.8	33333.3	0.01	411,274	1,492,247	2,536,004	3,405,165	4,175,435	5,059,772
22	Sea Bed	181.8	33333.3	0.11	6,403	115,177	285,739	601,182	1,144,187	2,099,864
23	Sea Bed	181.8	111.1	0.01	987	2,900	4,300	6,846	8,979	11,371
24	Sea Bed	181.8	111.1	0.11	977	2,863	4,429	6,865	8,781	11,426
25	Sea Bed	181.8	5555.6	0.01	75,926	183,243	312,975	488,438	672,707	861,145
26	Sea Bed	181.8	5555.6	0.11	6,953	92,518	232,432	371,791	566,662	771,375
27	Sea Bed	181.8	38888.9	0.01	593,115	1,526,536	2,957,294	4,228,686	5,289,325	6,203,448
28	Sea Bed	181.8	38888.9	0.11	6,953	92,518	231,901	433,722	898,391	1,634,123

* Cases highlighted in red depict the scenarios for which only 300-fold values are relevant

Table 4.3: Summary of plume width results

Scenario	Location	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Current Velocity [m/s]	Maximum Plume Width (in m)					
					300-fold	840-fold	1380-fold	1920-fold	2460-fold	3000-fold
1	Vessel	10.1	2000.0	0.01	15	20	24	27	30	32
2	Vessel	10.1	2000.0	0.01	12	17	20	25	30	33
3	Vessel	10.1	2000.0	0.11	4	7	10	12	13	13
4	Vessel	10.1	2000.0	0.11	4	7	9	11	15	18
5	Vessel	10.1	10000.0	0.01	16	22	28	35	44	50
6	Vessel	10.1	10000.0	0.01	14	42	56	64	69	73
7	Vessel	10.1	10000.0	0.11	4	7	10	12	13	13
8	Vessel	10.1	10000.0	0.11	4	7	9	11	14	19
9	Caisson	10.1	2000.0	0.01	6	22	26	28	30	31
10	Caisson	10.1	2000.0	0.01	13	18	21	24	26	29
11	Caisson	10.1	2000.0	0.11	4	7	10	12	13	14
12	Caisson	10.1	2000.0	0.11	4	7	11	13	13	14
13	Caisson	10.1	10000.0	0.01	6	28	33	37	40	42
14	Caisson	10.1	10000.0	0.01	15	25	29	31	34	38
15	Caisson	10.1	10000.0	0.11	4	7	10	12	13	14
16	Caisson	10.1	10000.0	0.11	4	7	11	13	13	14
17	Caisson	60.6	20000.0	0.01	39	57	71	82	91	100
18	Caisson	60.6	20000.0	0.01	43	54	66	78	89	98
19	Caisson	60.6	20000.0	0.11	12	19	25	29	32	34
20	Caisson	60.6	20000.0	0.11	10	15	22	26	29	32
21	Sea Bed	181.8	33333.3	0.01	54	110	141	158	172	185
22	Sea Bed	181.8	33333.3	0.11	17	34	46	55	66	77
23	Sea Bed	181.8	111.1	0.01	13	22	26	31	34	36
24	Sea Bed	181.8	111.1	0.11	14	21	29	33	36	39
25	Sea Bed	181.8	5555.6	0.01	57	76	87	97	107	114
26	Sea Bed	181.8	5555.6	0.11	20	31	42	52	60	66
27	Sea Bed	181.8	38888.9	0.01	60	91	126	154	175	192
28	Sea Bed	181.8	38888.9	0.11	19	31	42	52	60	67

* Cases highlighted in red depict the scenarios for which only 300-fold values are relevant

Table 4.4: Summary of maximum distance travelled by plume (measured from discharge location)

Scenario	Location	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Current Velocity [m/s]	Maximum Distance Travelled (in m)					
					300-fold	840-fold	1380-fold	1920-fold	2460-fold	3000-fold
1	Vessel	10.1	2000.0	0.01	107	356	427	519	646	793
2	Vessel	10.1	2000.0	0.01	92	341	475	623	779	940
3	Vessel	10.1	2000.0	0.11	15	58	87	132	201	261
4	Vessel	10.1	2000.0	0.11	15	58	90	211	326	340
5	Vessel	10.1	10000.0	0.01	144	484	1,053	1,600	1,710	1,844
6	Vessel	10.1	10000.0	0.01	102	522	997	1,611	2,085	2,085
7	Vessel	10.1	10000.0	0.11	15	58	87	132	191	266
8	Vessel	10.1	10000.0	0.11	15	58	90	199	307	334
9	Caisson	10.1	2000.0	0.01	5	37	108	221	336	377
10	Caisson	10.1	2000.0	0.01	122	337	393	452	516	580
11	Caisson	10.1	2000.0	0.11	13	51	73	102	142	194
12	Caisson	10.1	2000.0	0.11	13	54	77	110	147	189
13	Caisson	10.1	10000.0	0.01	5	373	583	863	1,184	1,539
14	Caisson	10.1	10000.0	0.01	153	449	664	943	1,269	1,625
15	Caisson	10.1	10000.0	0.11	13	51	73	102	142	194
16	Caisson	10.1	10000.0	0.11	13	54	77	110	147	189
17	Caisson	60.6	20000.0	0.01	1,028	2,326	3,513	4,989	5,426	5,765
18	Caisson	60.6	20000.0	0.01	446	1,072	2,129	3,588	5,171	5,505
19	Caisson	60.6	20000.0	0.11	72	337	459	596	757	991
20	Caisson	60.6	20000.0	0.11	83	299	402	488	587	704
21	Sea Bed	181.8	33333.3	0.01	1,460	5,895	8,730	12,340	19,081	21,552
22	Sea Bed	181.8	33333.3	0.11	133	461	747	1,176	1,716	2,371
23	Sea Bed	181.8	111.1	0.01	67	135	217	298	355	374
24	Sea Bed	181.8	111.1	0.11	65	118	185	245	306	352
25	Sea Bed	181.8	5555.6	0.01	634	1,694	2,980	4,413	5,319	5,658
26	Sea Bed	181.8	5555.6	0.11	128	458	665	932	1,273	1,703
27	Sea Bed	181.8	38888.9	0.01	1,243	6,715	13,034	21,315	28,127	40,462
28	Sea Bed	181.8	38888.9	0.11	128	458	649	914	1,279	1,745

* Cases highlighted in red depict the scenarios for which only 300-fold values are relevant

Table 4.5: Summary of plume height results (Depth from sea surface)

Scenario	Location	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Current Velocity [m/s]	Maximum Plume Height (in m)					
					300-fold	840-fold	1380-fold	1920-fold	2460-fold	3000-fold
1	Vessel	10.1	2000.0	0.01	0	0	0	0	0	0
2	Vessel	10.1	2000.0	0.01	0	0	0	0	0	0
3	Vessel	10.1	2000.0	0.11	0	0	0	0	0	0
4	Vessel	10.1	2000.0	0.11	0	0	0	0	0	0
5	Vessel	10.1	10000.0	0.01	0	0	0	0	0	0
6	Vessel	10.1	10000.0	0.01	0	0	0	0	0	0
7	Vessel	10.1	10000.0	0.11	0	0	0	0	0	0
8	Vessel	10.1	10000.0	0.11	0	0	0	0	0	0
9	Caisson	10.1	2000.0	0.01	-50	-50	-50	-50	-50	-50
10	Caisson	10.1	2000.0	0.01	-50	-50	-50	-50	-50	-50
11	Caisson	10.1	2000.0	0.11	-50	-50	-50	-50	-50	-50
12	Caisson	10.1	2000.0	0.11	-50	-50	-50	-50	-50	-50
13	Caisson	10.1	10000.0	0.01	-50	-50	-50	-50	-50	-50
14	Caisson	10.1	10000.0	0.01	-50	-50	-50	-50	-50	-50
15	Caisson	10.1	10000.0	0.11	-50	-50	-50	-50	-50	-50
16	Caisson	10.1	10000.0	0.11	-50	-50	-50	-50	-50	-49
17	Caisson	60.6	20000.0	0.01	-50	-50	-50	-50	-50	-50
18	Caisson	60.6	20000.0	0.01	-50	-50	-50	-50	-50	-50
19	Caisson	60.6	20000.0	0.11	-50	-50	-50	-50	-50	-50
20	Caisson	60.6	20000.0	0.11	-47	-41	-40	-39	-38	-38
21	Sea Bed	181.8	33333.3	0.01	-82	-80	-80	-79	-78	-78
22	Sea Bed	181.8	33333.3	0.11	-105	-101	-98	-97	-95	-94
23	Sea Bed	181.8	111.1	0.01	-111	-109	-108	-108	-107	-107
24	Sea Bed	181.8	111.1	0.11	-114	-113	-112	-112	-112	-111
25	Sea Bed	181.8	5555.6	0.01	-86	-82	-81	-81	-80	-80
26	Sea Bed	181.8	5555.6	0.11	-107	-104	-104	-103	-103	-102
27	Sea Bed	181.8	38888.9	0.01	-50	-47	-45	-44	-44	-44
28	Sea Bed	181.8	38888.9	0.11	-103	-95	-91	-89	-88	-87

* Cases highlighted in red depict the scenarios for which only 300-fold values are relevant

Table 4.6: Summary of plume persistence results

Scenario	Location	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Current Velocity [m/s]	Plume Persistence (in hours)					
					300-fold	840-fold	1380-fold	1920-fold	2460-fold	3000-fold
1	Vessel	10.1	2000.0	0.01	3	10	12	14	18	22
2	Vessel	10.1	2000.0	0.01	2	10	13	17	22	26
3	Vessel	10.1	2000.0	0.11	1	1	1	1	1	1
4	Vessel	10.1	2000.0	0.11	1	1	1	1	1	1
5	Vessel	10.1	10000.0	0.01	6	14	30	46	49	53
6	Vessel	10.1	10000.0	0.01	4	15	28	45	59	60
7	Vessel	10.1	10000.0	0.11	3	3	3	3	3	3
8	Vessel	10.1	10000.0	0.11	3	3	3	3	3	4
9	Caisson	10.1	2000.0	0.01	1	1	3	6	10	11
10	Caisson	10.1	2000.0	0.01	3	10	11	13	15	16
11	Caisson	10.1	2000.0	0.11	1	1	1	1	1	1
12	Caisson	10.1	2000.0	0.11	1	1	1	1	1	1
13	Caisson	10.1	10000.0	0.01	3	11	18	25	34	44
14	Caisson	10.1	10000.0	0.01	5	14	20	28	37	46
15	Caisson	10.1	10000.0	0.11	3	3	3	3	3	3
16	Caisson	10.1	10000.0	0.11	3	3	3	3	3	3
17	Caisson	60.6	20000.0	0.01	31	66	81	141	153	162
18	Caisson	60.6	20000.0	0.01	15	31	61	102	147	154
19	Caisson	60.6	20000.0	0.11	6	6	6	7	7	8
20	Caisson	60.6	20000.0	0.11	6	6	6	7	7	7
21	Sea Bed	181.8	33333.3	0.01	43	167	247	349	534	601
22	Sea Bed	181.8	33333.3	0.11	10	10	11	12	13	15
23	Sea Bed	181.8	111.1	0.01	2	3	6	8	10	10
24	Sea Bed	181.8	111.1	0.11	0	0	0	1	1	1
25	Sea Bed	181.8	5555.6	0.01	18	48	83	123	148	157
26	Sea Bed	181.8	5555.6	0.11	2	2	3	3	4	5
27	Sea Bed	181.8	38888.9	0.01	39	190	363	594	785	1130
28	Sea Bed	181.8	38888.9	0.11	11	12	12	13	13	14

* Cases highlighted in red depict the scenarios for which only 300-fold values are relevant

8. Figures

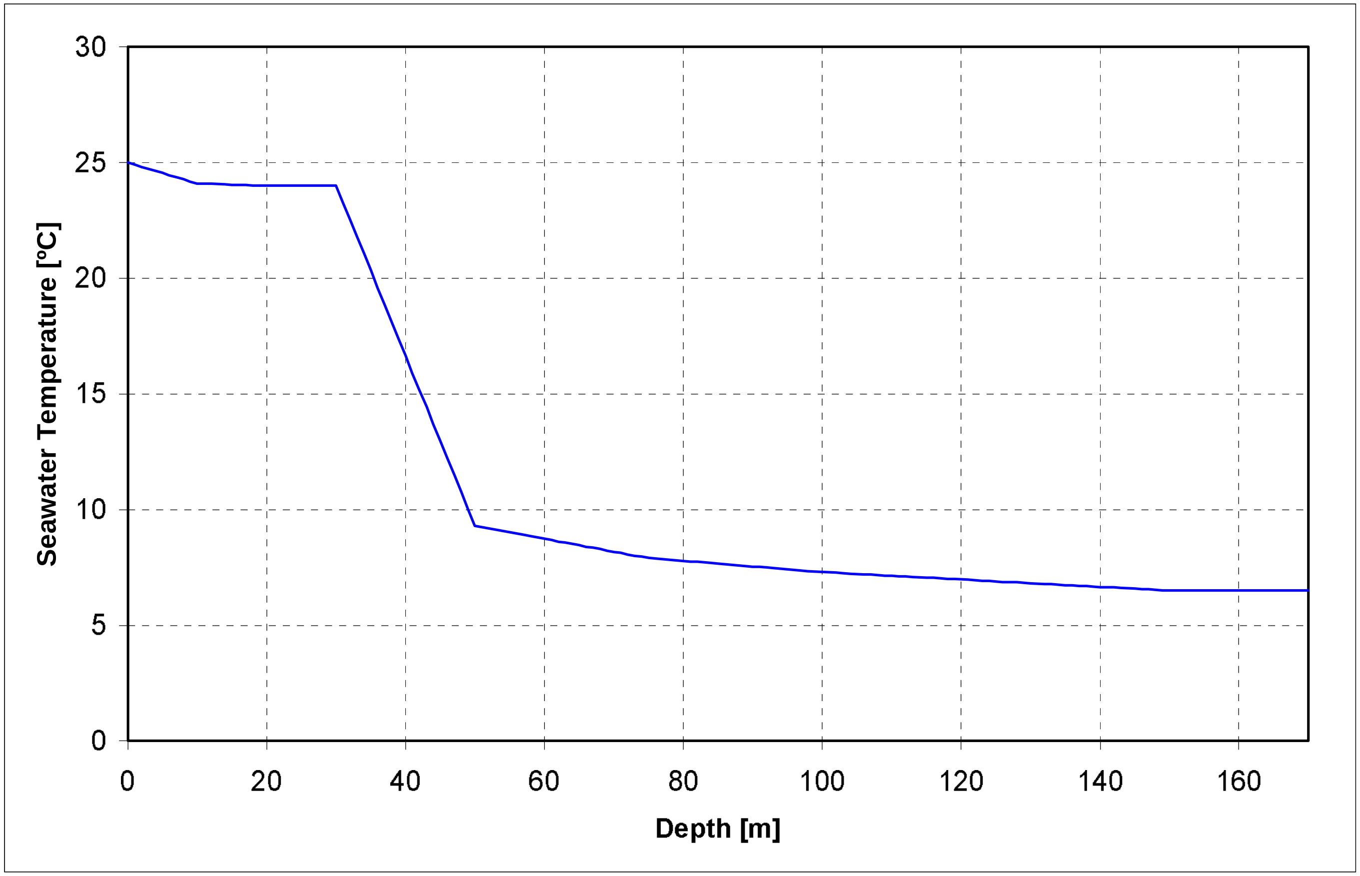
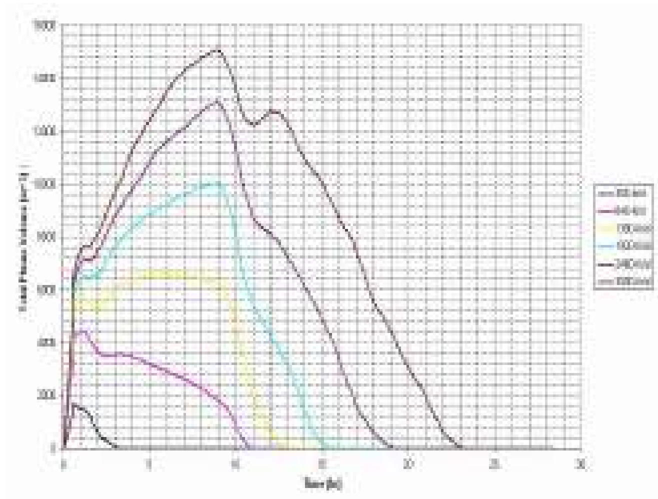
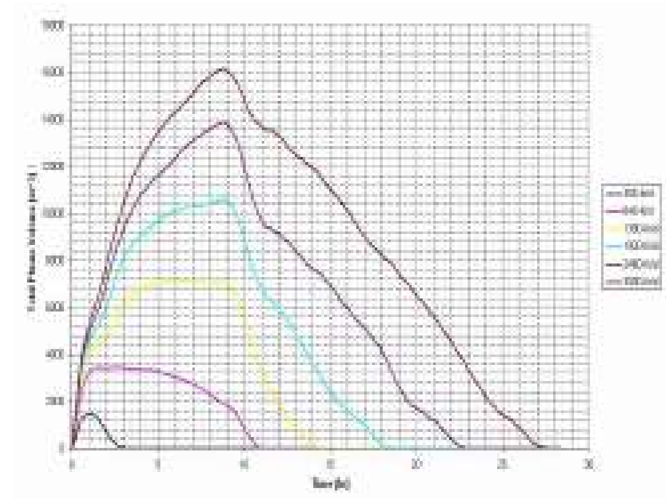


Figure 4.1: Summer seawater temperature variation with depth

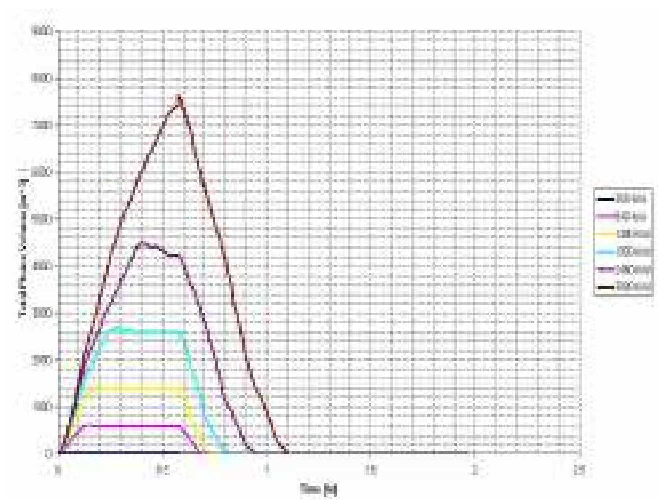
a) Vessel discharge (20 m^3, 0.01 m^3/s), winter near-stagnant current condition (Scenario 1)



b) Vessel discharge (20 m^3, 0.01 m^3/s), summer near-stagnant current condition (Scenario 2)



c) Vessel discharge (20 m^3, 0.01 m^3/s), winter predominant current condition (Scenario 3)



d) Vessel discharge (20 m^3, 0.01 m^3/s), summer predominant current condition (Scenario 4)

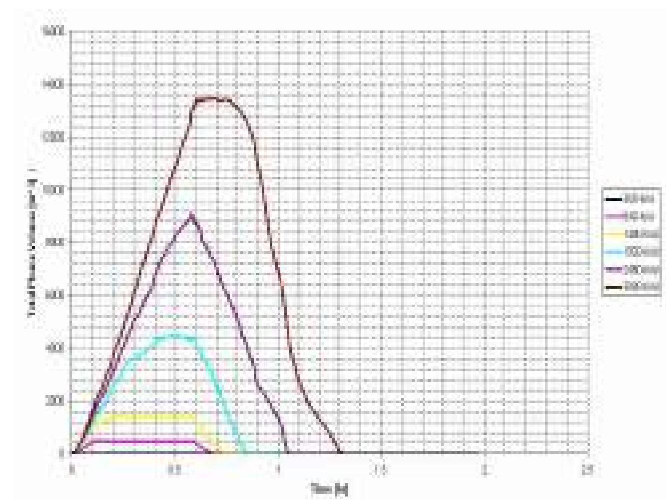
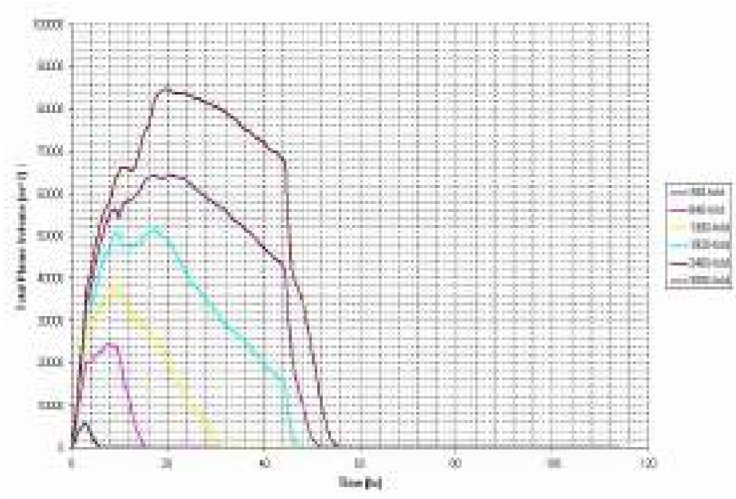
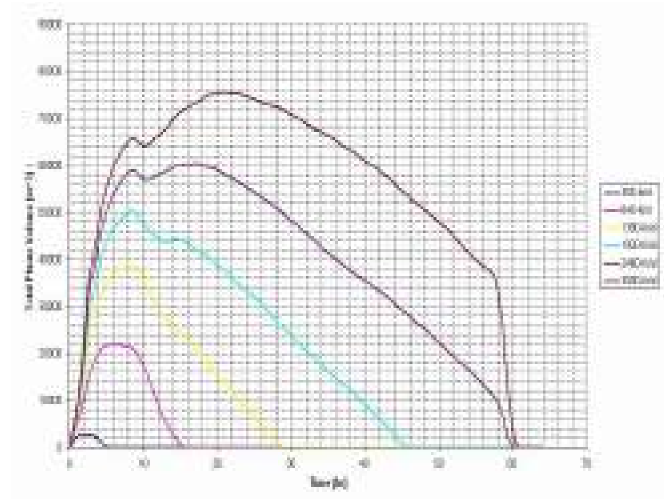


Figure 4.2: Hydrotest discharge plume volume evolution (Scenarios 1 to 4)

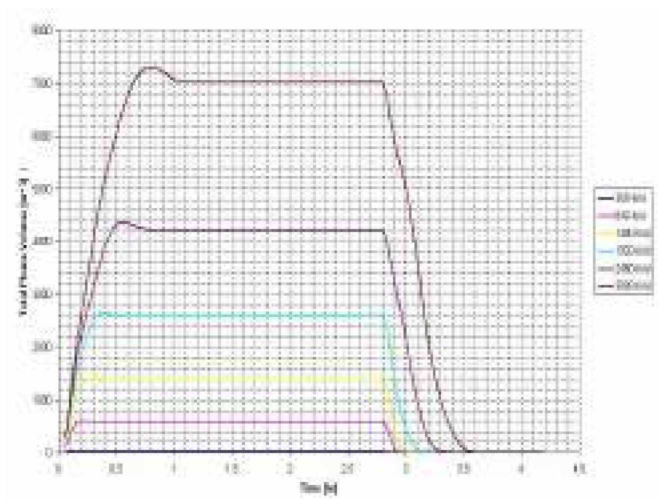
a) Vessel discharge (100 m^3, 0.01 m^3/s), winter near-stagnant current condition (Scenario 5)



b) Vessel discharge (100 m^3, 0.01 m^3/s), summer near-stagnant current condition (Scenario 6)



c) Vessel discharge (100 m^3, 0.01 m^3/s), winter predominant current condition (Scenario 7)



d) Vessel discharge (100 m^3, 0.01 m^3/s), summer predominant current condition (Scenario 8)

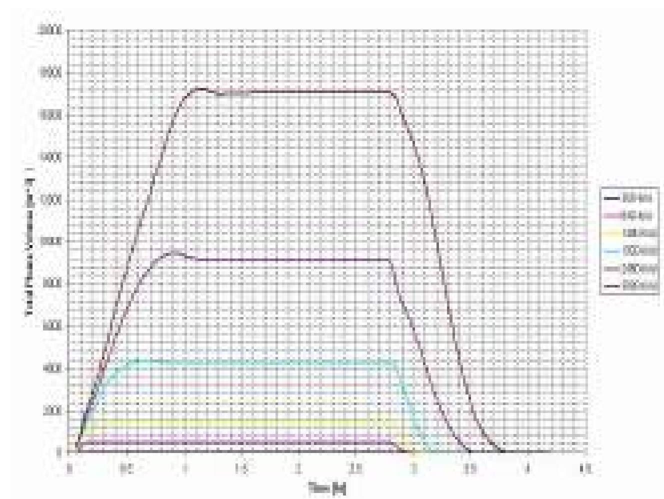
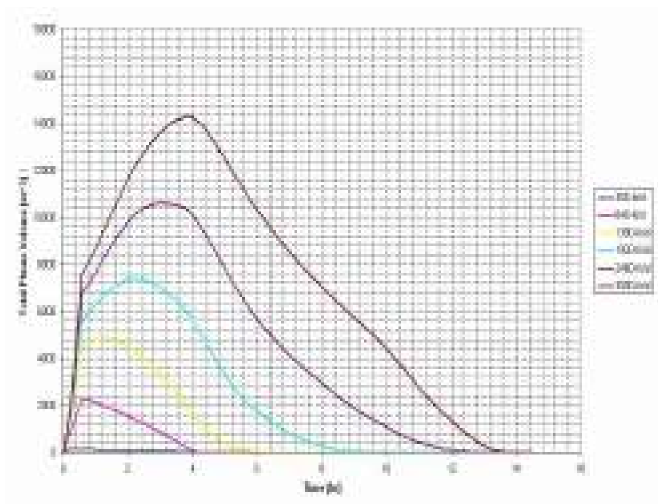
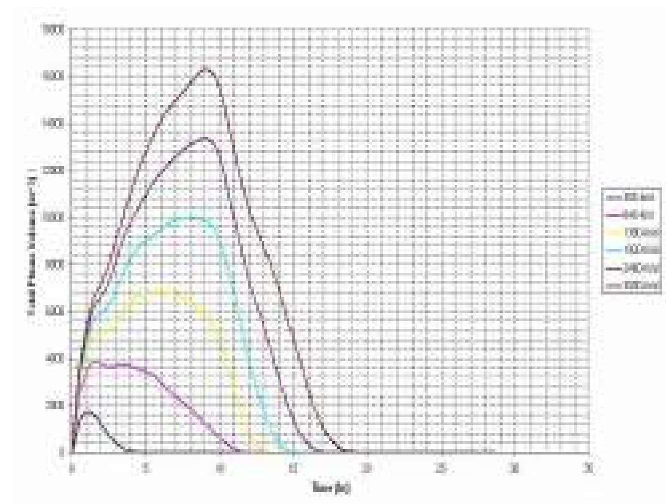


Figure 4.[illegible] : Hydrotest discharge plume volume evolution (Scenarios 5 to 8)

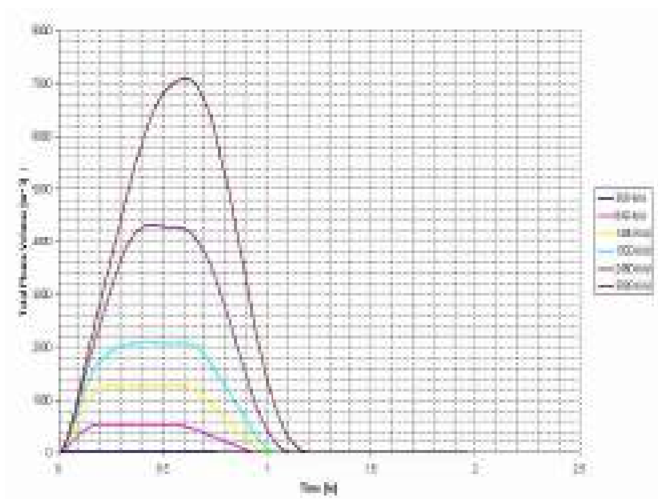
a) Caisson discharge (20 m^3, 0.01 m^3/s), winter near-stagnant current condition (Scenario 9)



b) Caisson discharge (20 m^3, 0.01 m^3/s), summer near-stagnant current condition (Scenario 10)



c) Caisson discharge (20 m^3, 0.01 m^3/s), winter predominant current condition (Scenario 11)



d) Caisson discharge (20 m^3, 0.01 m^3/s), summer predominant current condition (Scenario 12)

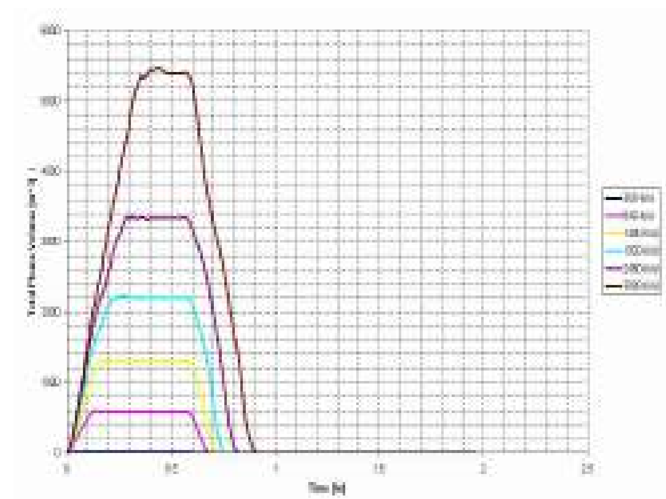
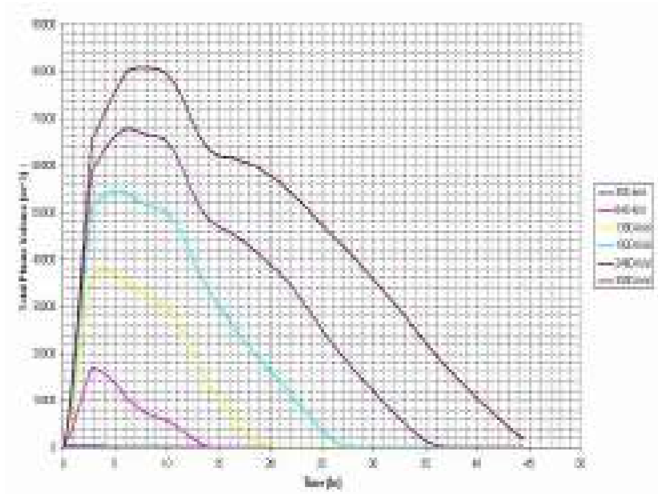
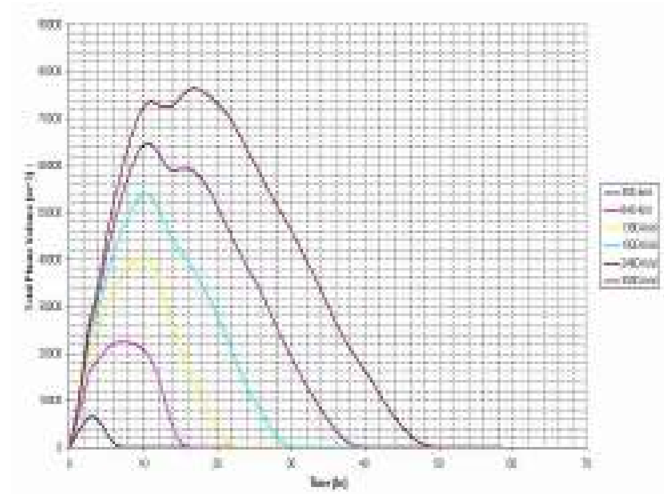


Figure 4.[illegible] : Hydrotest discharge plume volume evolution (Scenarios 9 to 12)

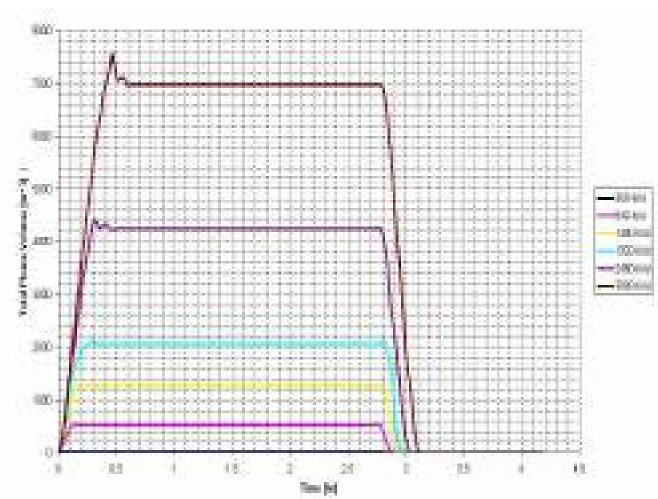
a) Caisson discharge (100 m^3, 0.01 m^3/s), winter near-stagnant current condition (Scenario 13)



b) Caisson discharge (100 m^3, 0.01 m^3/s), summer near-stagnant current condition (Scenario 14)



c) Caisson discharge (100 m^3, 0.01 m^3/s), winter predominant current condition (Scenario 15)



d) Caisson discharge (100 m^3, 0.01 m^3/s), winter predominant current condition (Scenario 16)

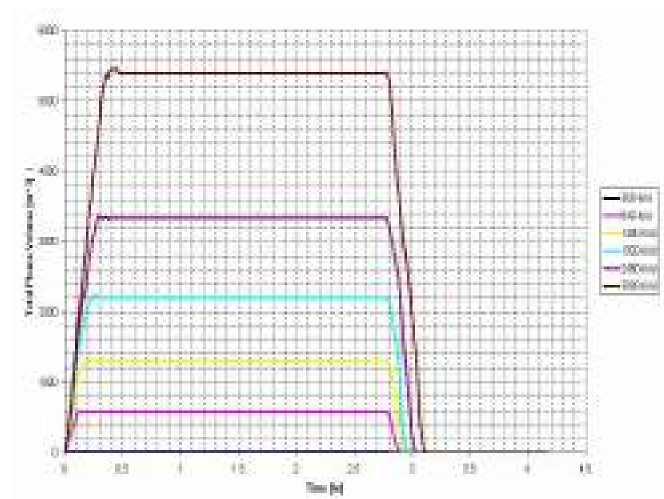
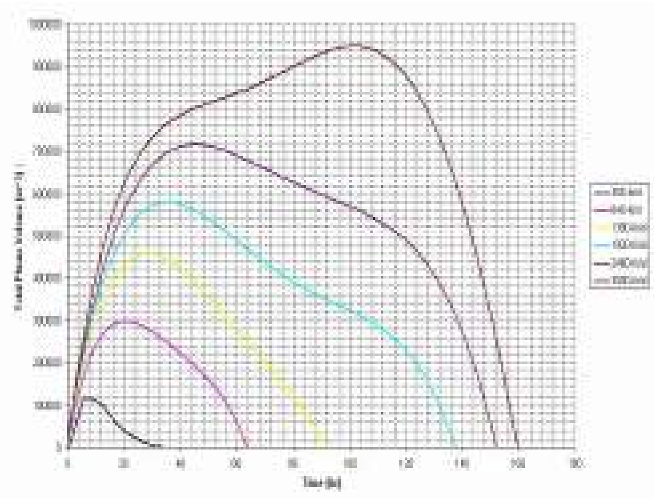
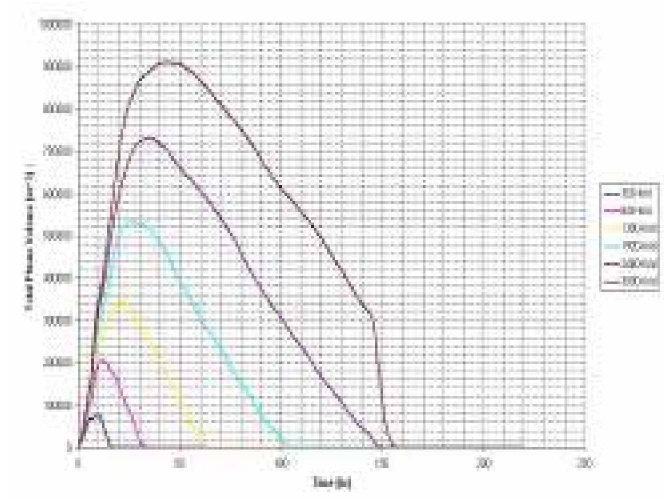


Figure [illegible] : Hydrotest discharge plume volume evolution (Scenarios 13 to 16)

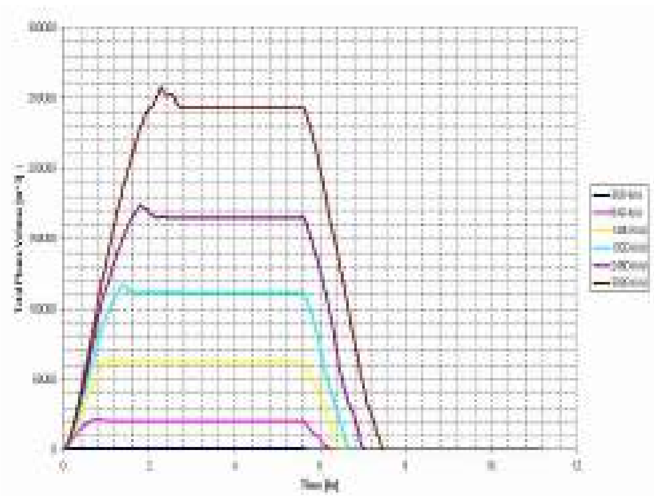
a) Caisson discharge (1200 m³, 0.06 m³/s), winter near-stagnant current condition (Scenario 17)



b) Caisson discharge (1200 m³, 0.06 m³/s), summer near-stagnant current condition (Scenario 18)



c) Caisson discharge (1200 m³, 0.06 m³/s), winter predominant current condition (Scenario 19)



d) Caisson discharge (1200 m³, 0.06 m³/s), summer predominant current condition (Scenario 20)

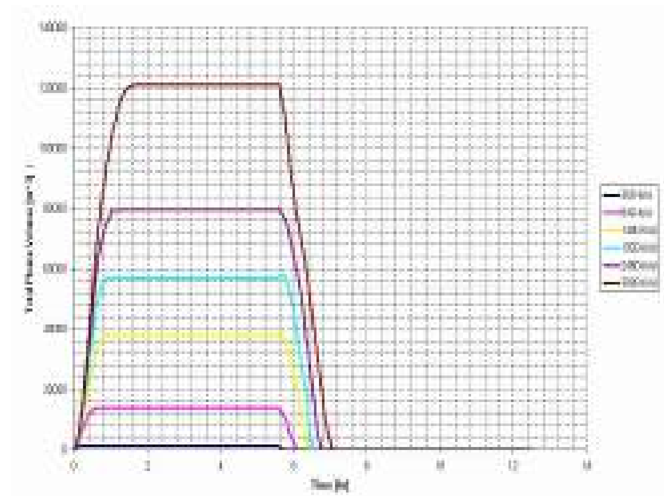
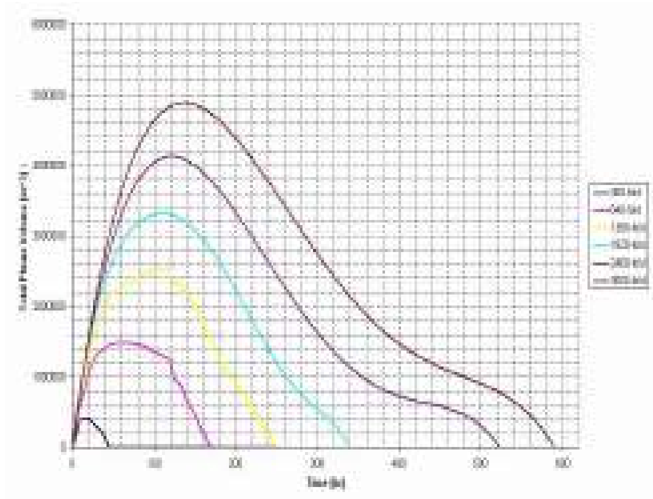
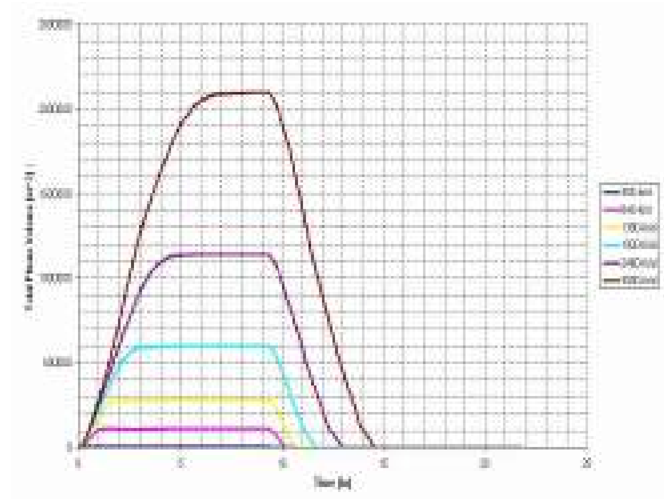


Figure 4.[illegible] : Hydrotest discharge plume volume evolution (Scenarios 17 to 20)

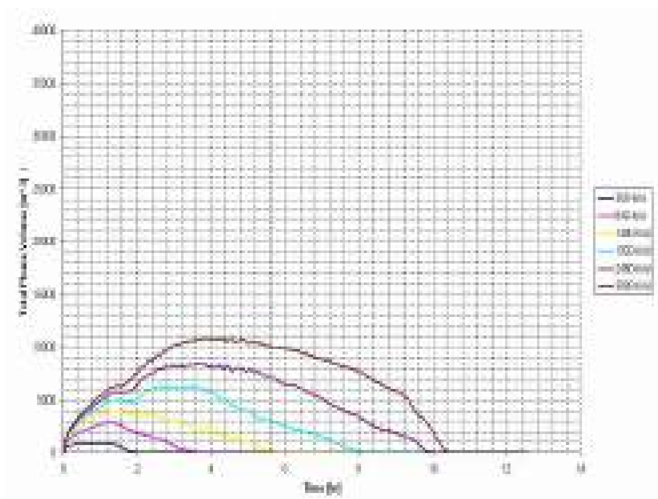
a) Seabed discharge (6000 m^3, 0.18 m^3/s), winter near-stagnant current condition (Scenario 21)



b) Seabed discharge (6000 m^3, 0.18 m^3/s), winter predominant current condition (Scenario 22)



c) Seabed discharge (20 m^3, 0.18 m^3/s), winter near-stagnant current condition (Scenario 23)



d) Seabed discharge (20 m^3, 0.18 m^3/s), winter predominant current condition (Scenario 24)

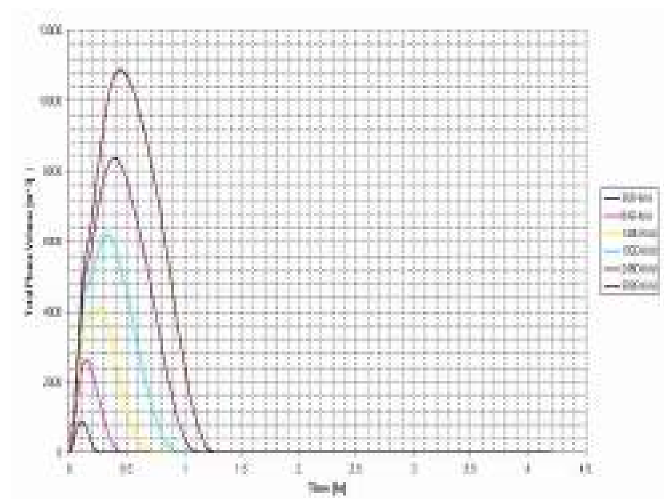
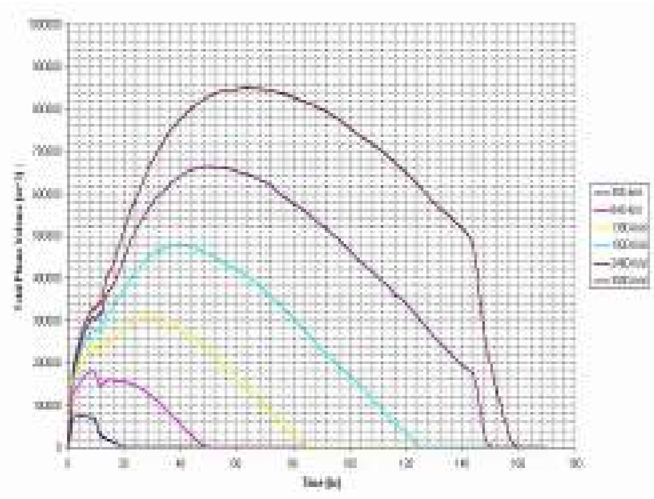
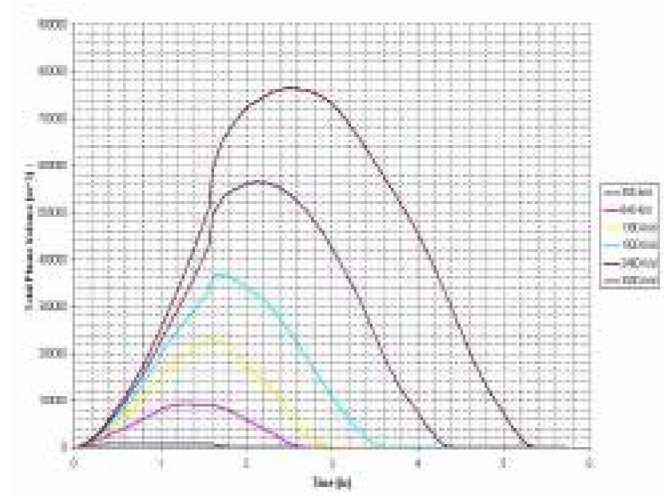


Figure 4.[illegible]: Hydrotest discharge plume volume evolution (Scenarios 21 to 24)

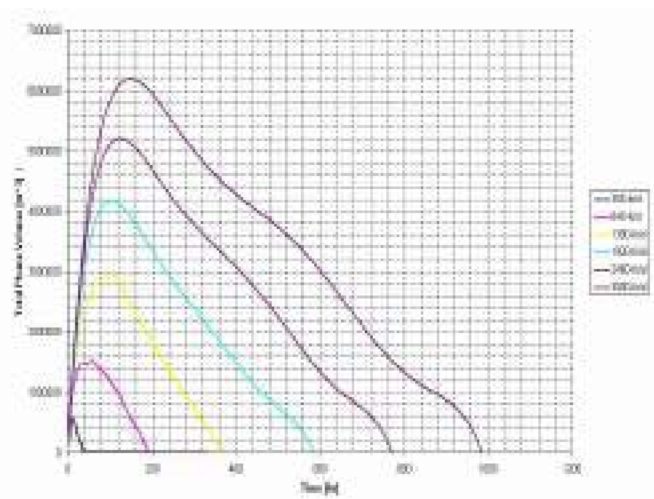
a) Seabed discharge (1000 m^3, 0.18 m^3/s), winter near-stagnant current condition (Scenario 25)



b) Seabed discharge (1000 m^3, 0.18 m^3/s), winter predominant current condition (Scenario 26)



c) Seabed discharge (7000 m^3, 0.18 m^3/s), winter near-stagnant current condition (Scenario 27)



d) Seabed discharge (7000 m^3, 0.18 m^3/s), winter predominant current condition (Scenario 28)

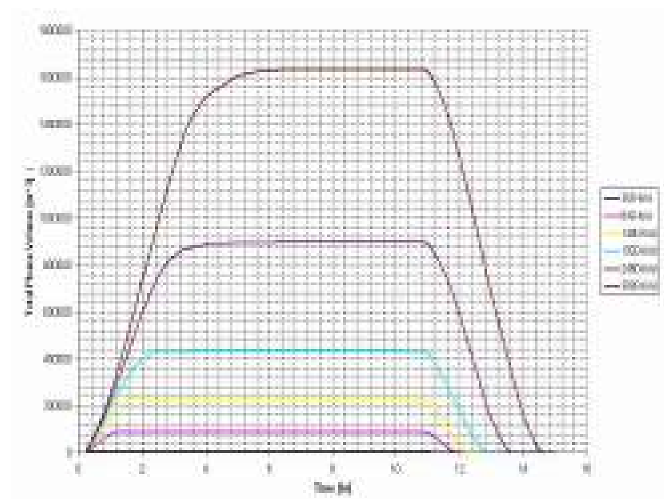


Figure 4.[illegible] : Hydrotest discharge plume volume evolution (Scenarios 24 to 28)

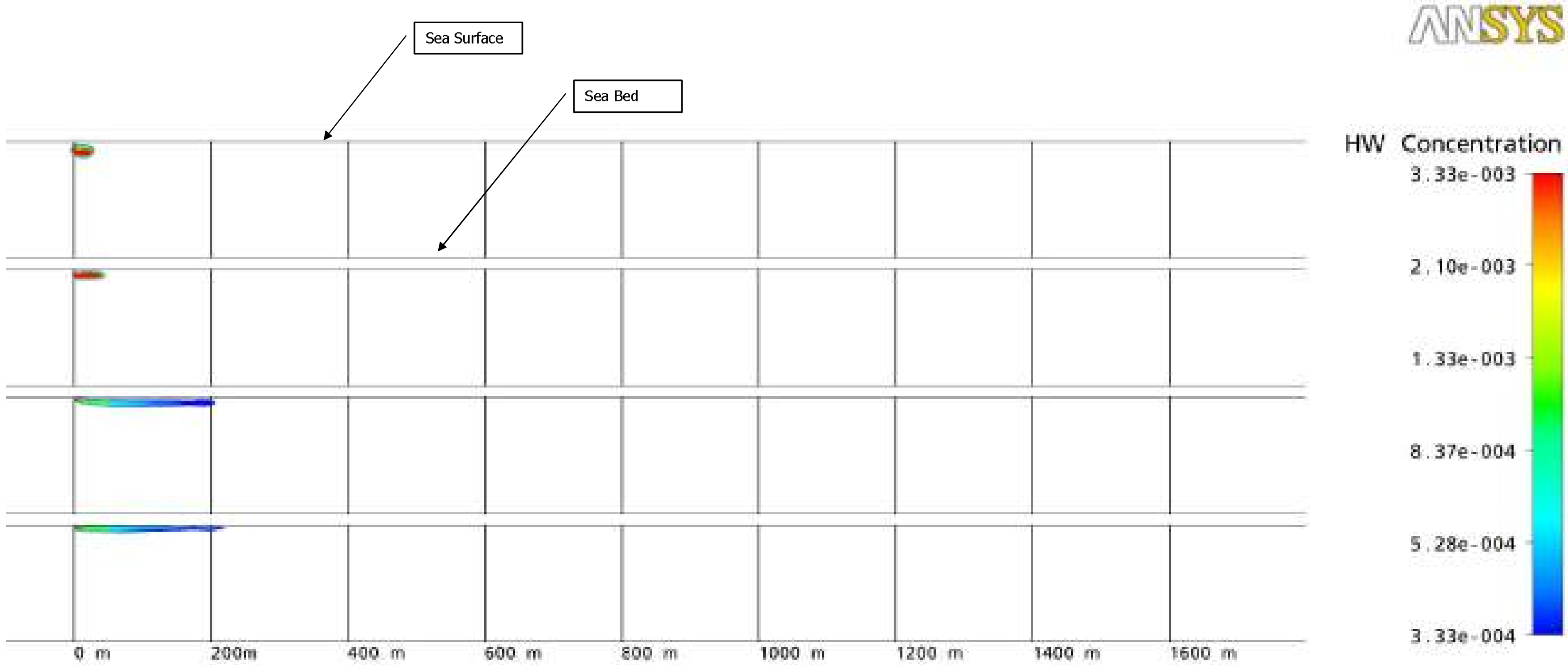


Figure 4.3: Hydrotest plume vertical centreline view at the end of the discharge period. (From top to bottom, Scenarios 1 to 4)

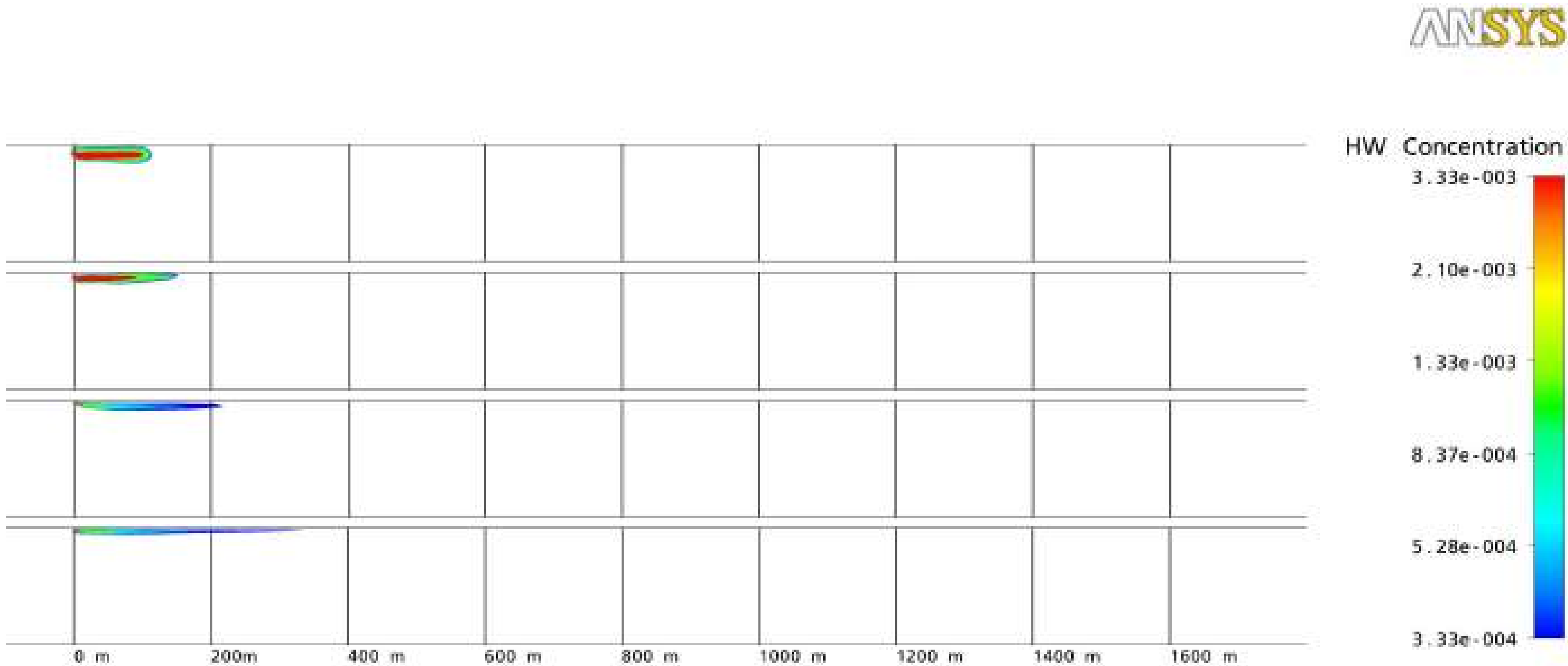


Figure 4.3 Continued: Hydrotest plume vertical centreline view at the end of the discharge period. (From top to bottom, Scenarios 5 to 8)

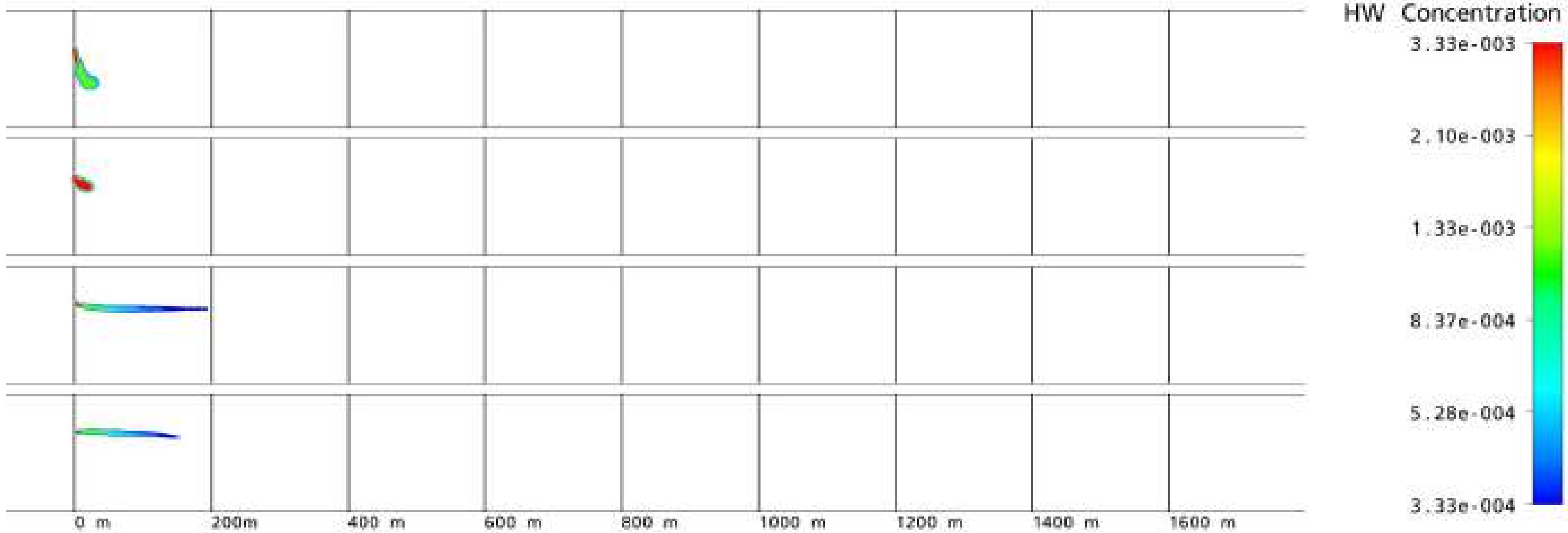


Figure 4.3 Continued: Hydrotest plume vertical centreline view at the end of the discharge period. (From top to bottom, Scenarios 9 to 12)

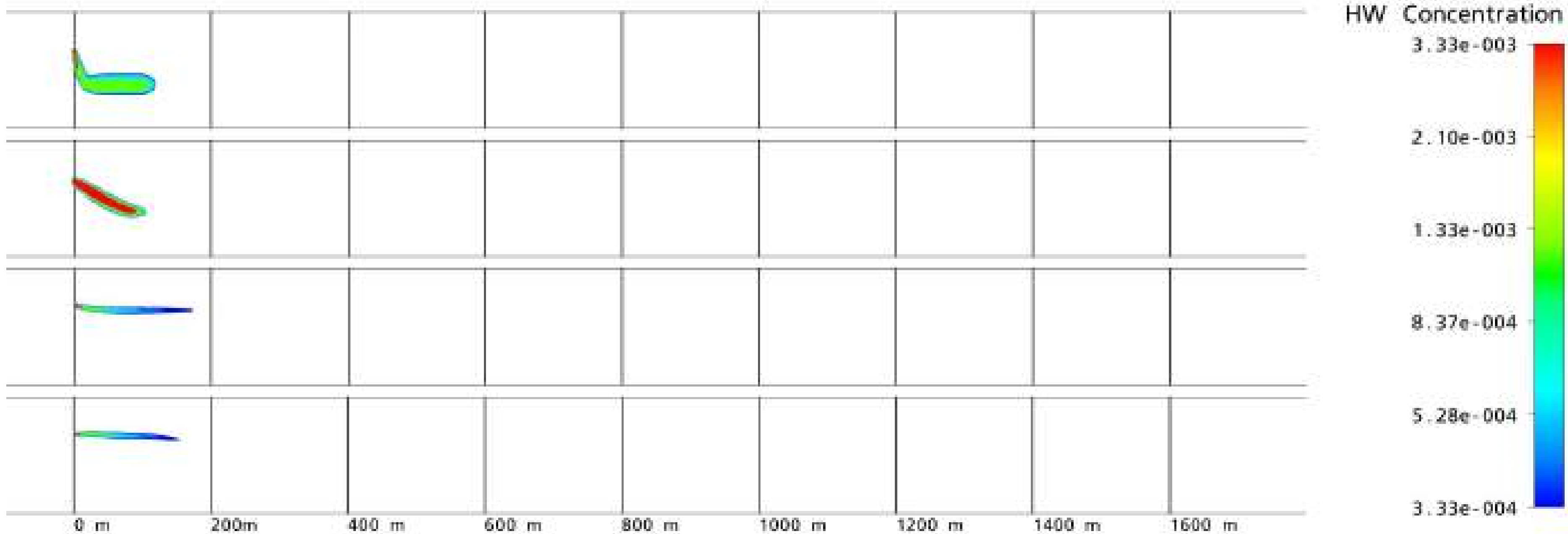


Figure 4.3 Continued: Hydrotest plume vertical centreline view at the end of the discharge. (From top to bottom, Scenarios 13 to 16)

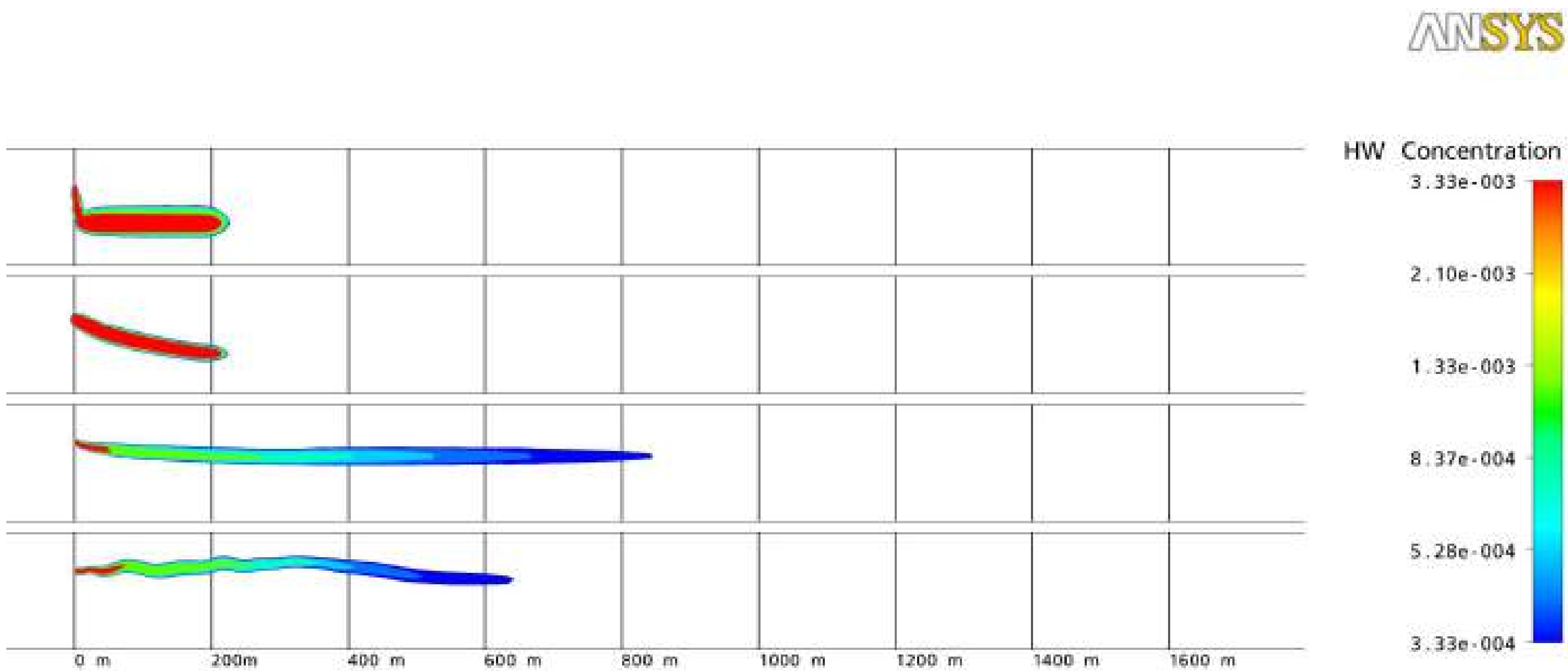


Figure 4.3 Continued: Hydrotest plume vertical centreline view at the end of the discharge. (From top to bottom, Scenarios 17 to 20)

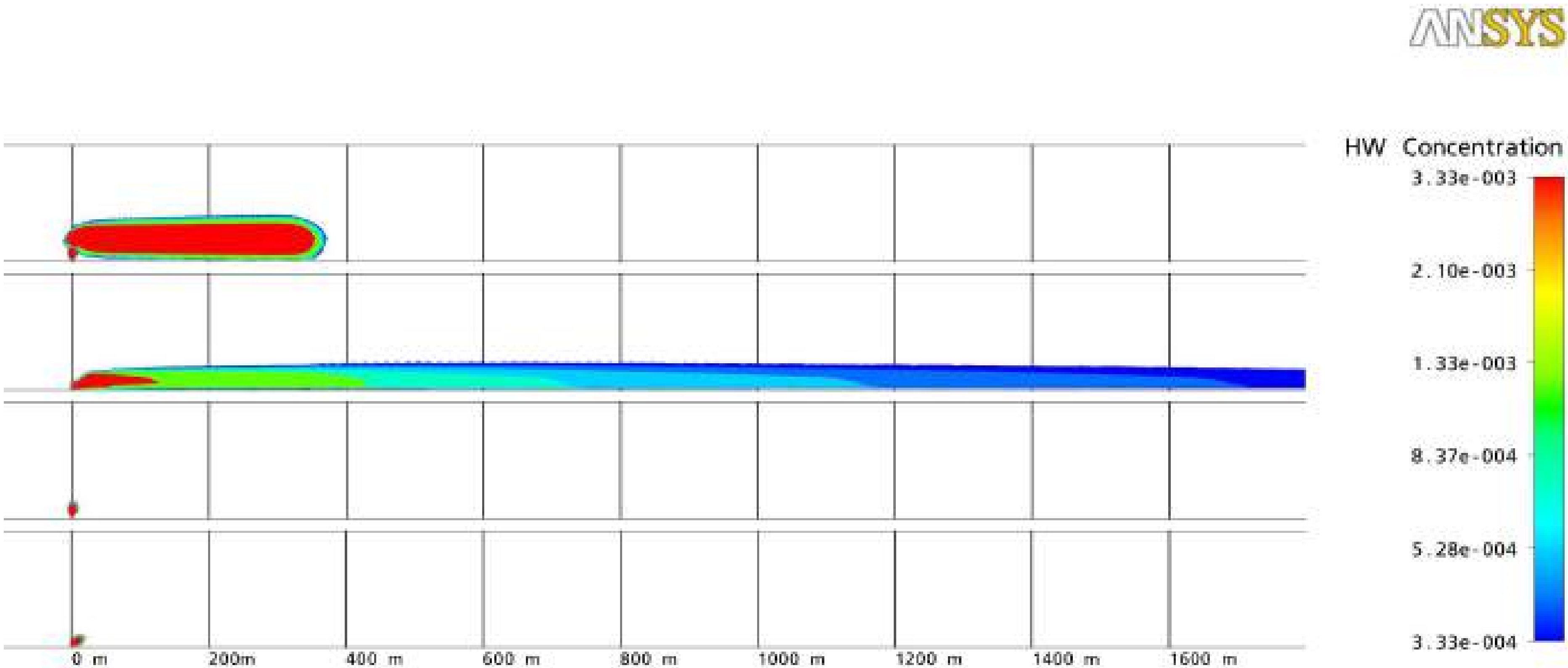


Figure 4.3 Continued: Hydrotest plume vertical centreline view at the end of the discharge. (From top to bottom, Scenarios 21 to 24)

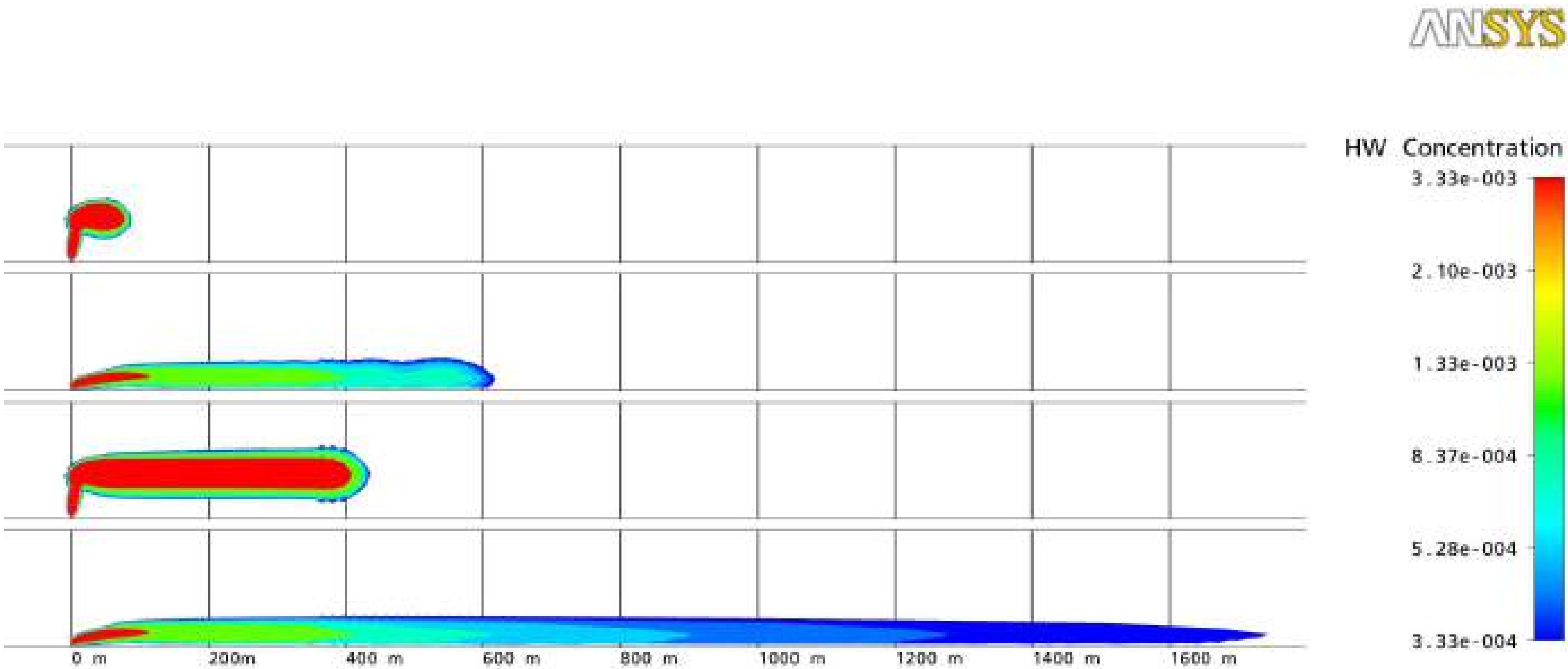


Figure 4.3 Continued: Hydrotest plume vertical centreline view at the end of the discharge. (From top to bottom, Scenarios 25 to 28)

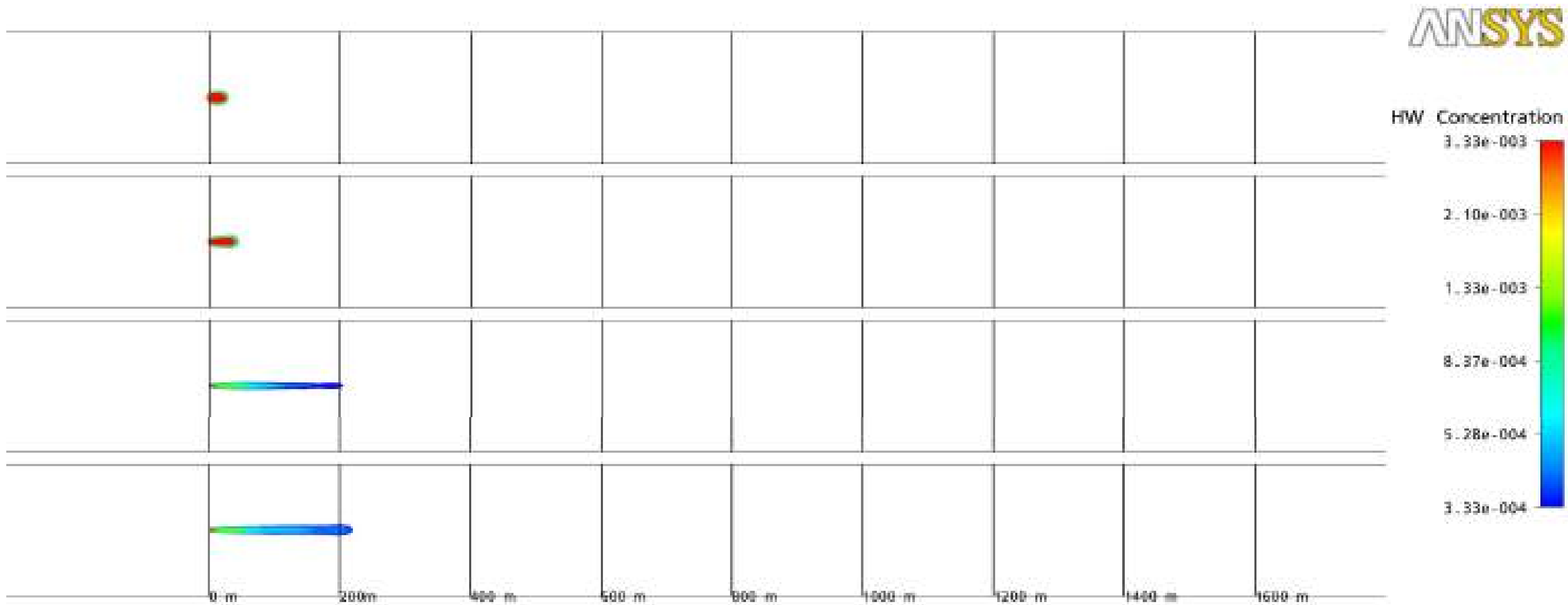


Figure 4.4: Hydrotest plume plan view at the end of the discharge period. (From top to bottom, Scenarios 1 to 4)

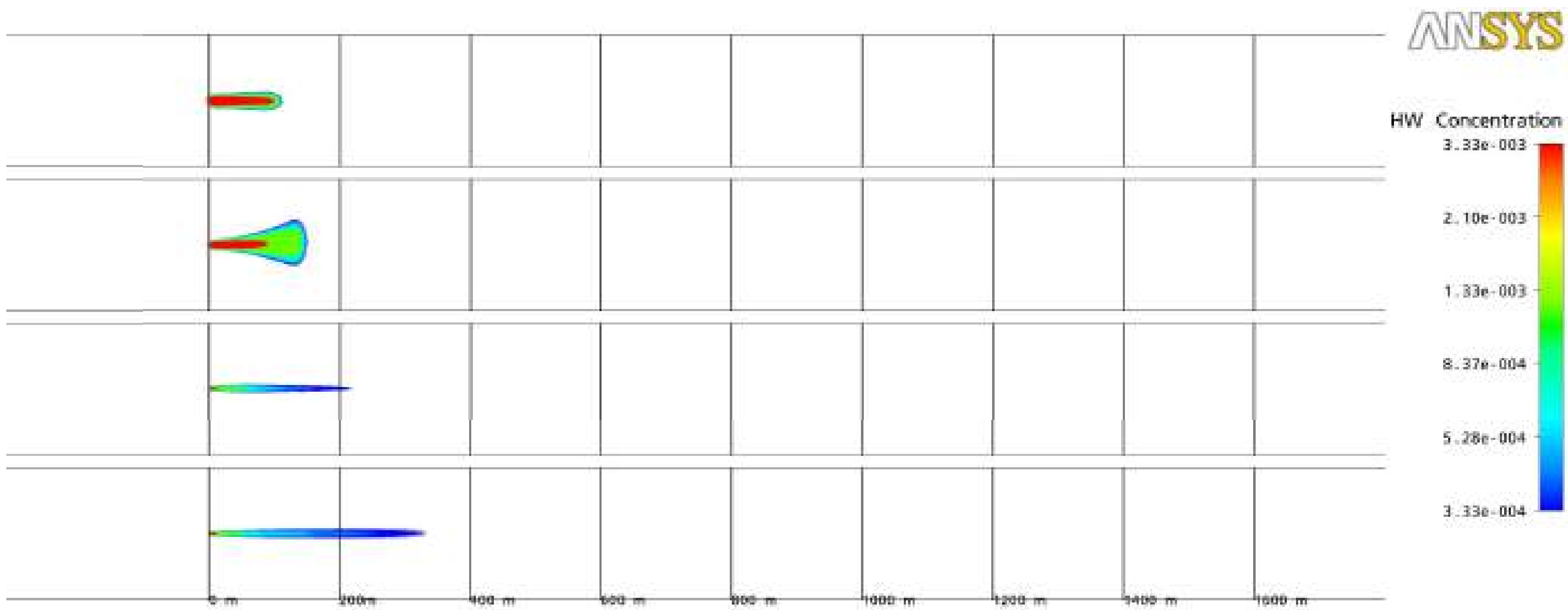


Figure 4.4 Continued: Hydrotest plume plan view at the end of the discharge period. (From top to bottom, Scenarios 5 to 8)

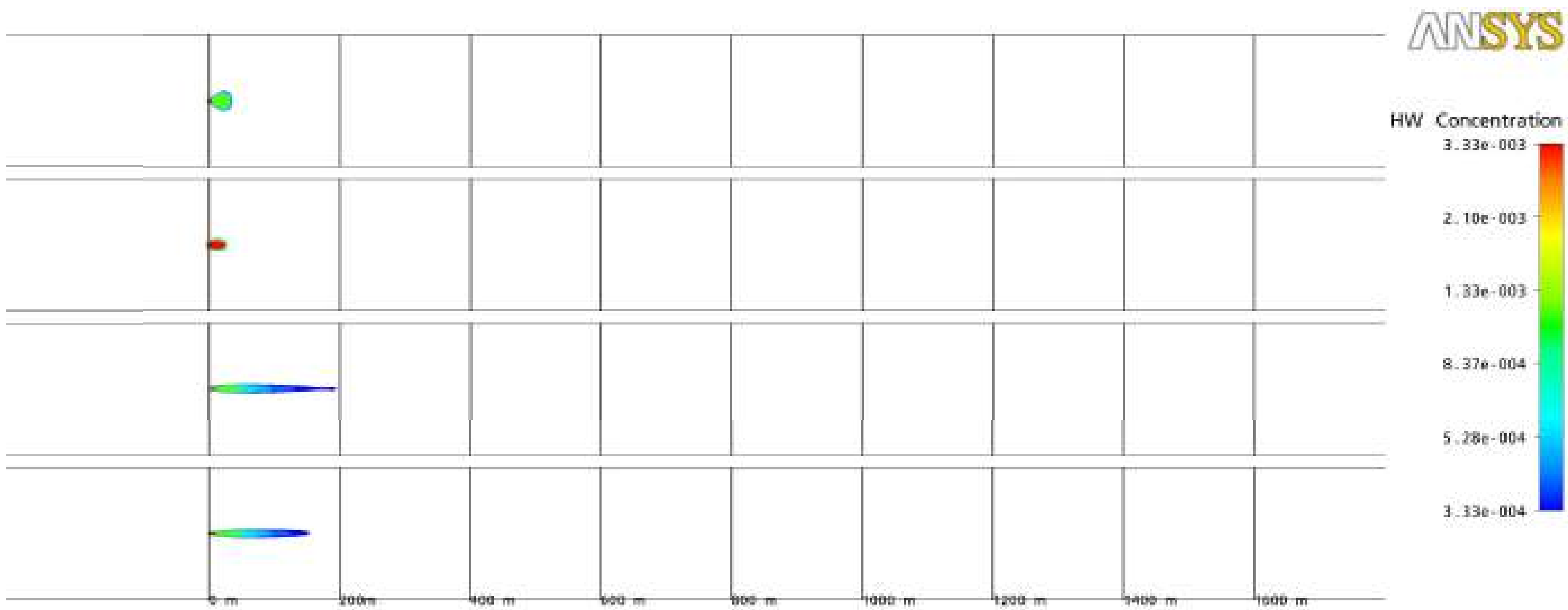


Figure 4.4 Continued: Hydrotest plume plan view at the end of the discharge period. (From top to bottom, Scenarios 9 to 12)

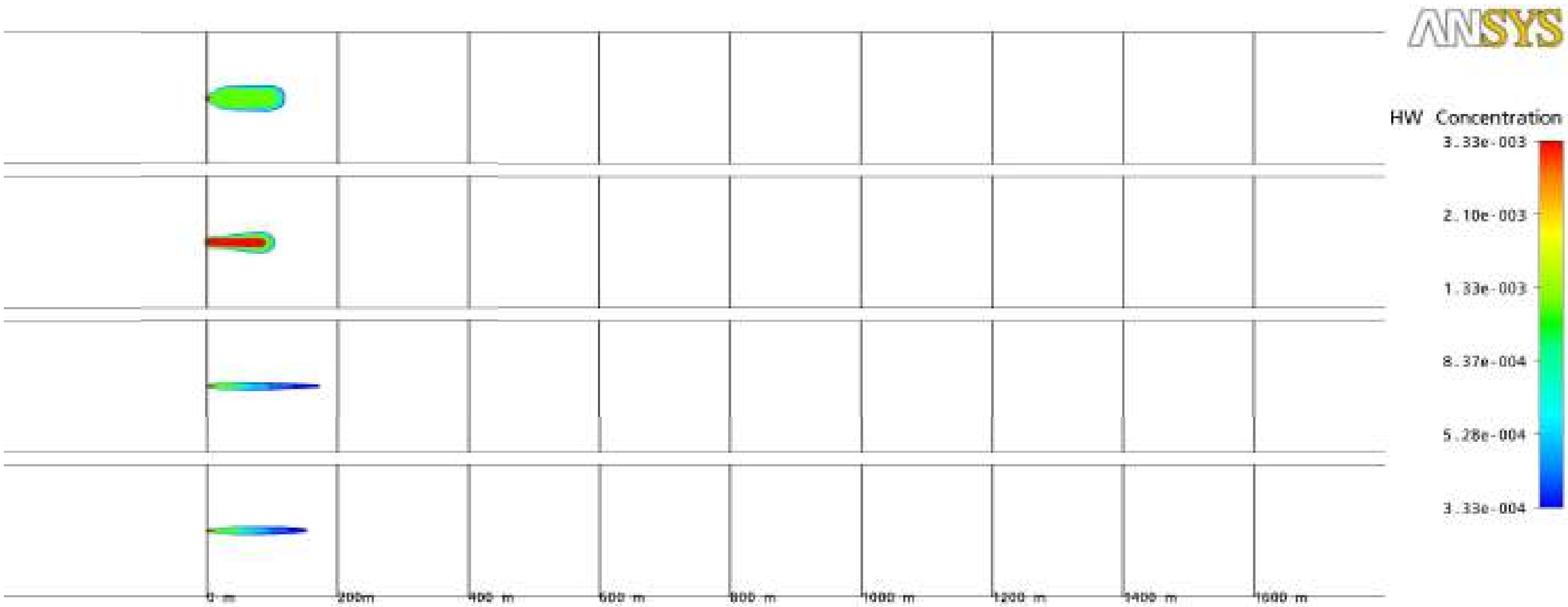


Figure 4.4 Continued: Hydrotest plume plan view at the end of the discharge period. (From top to bottom, Scenarios 13 to 16)

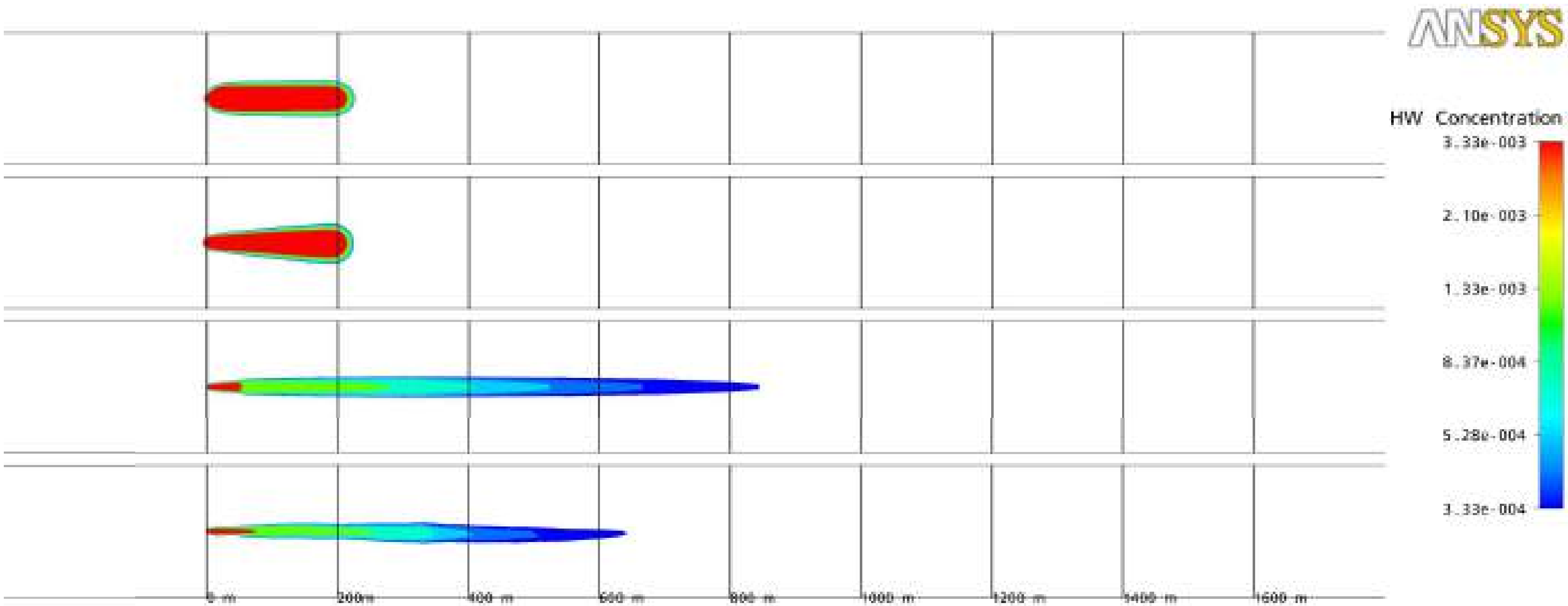


Figure 4.4 Continued: Hydrotest plume plan view at the end of the discharge period. (From top to bottom, Scenarios 17 to 20)

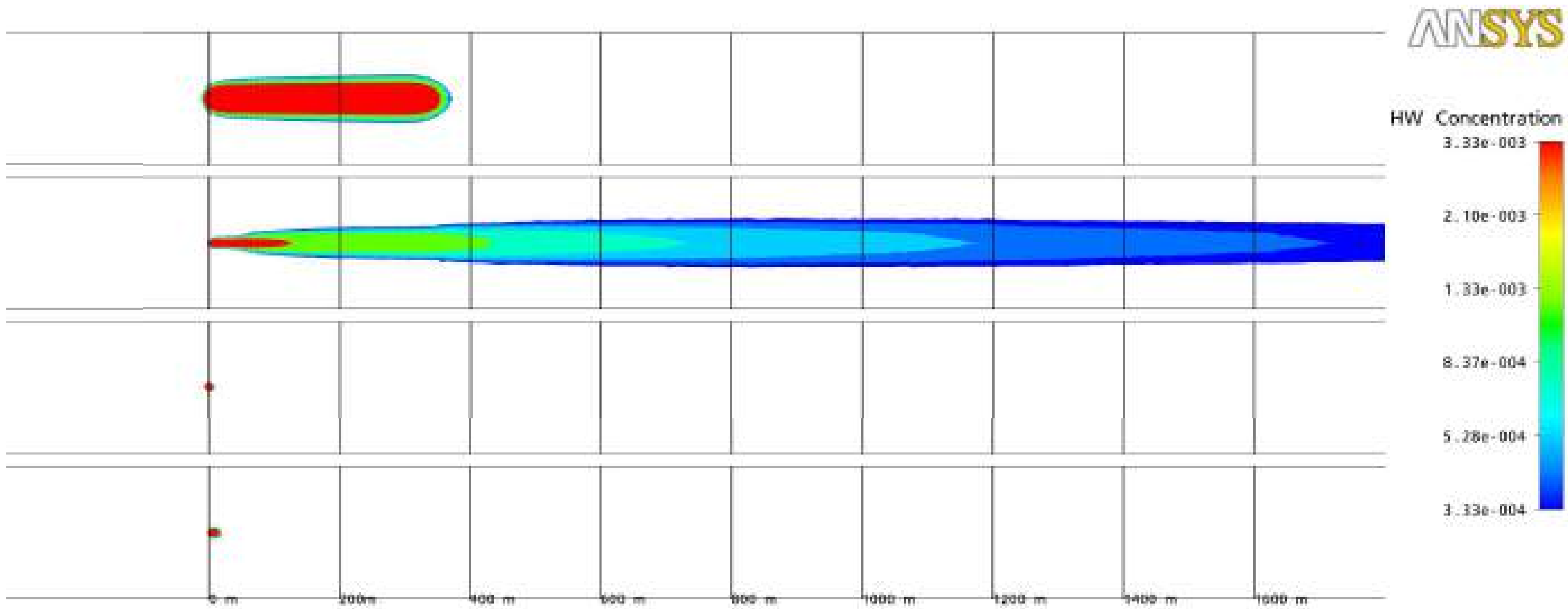


Figure 4.4 Continued: Hydrotest plume plan view at the end of the discharge period. (From top to bottom, Scenarios 21 to 24)

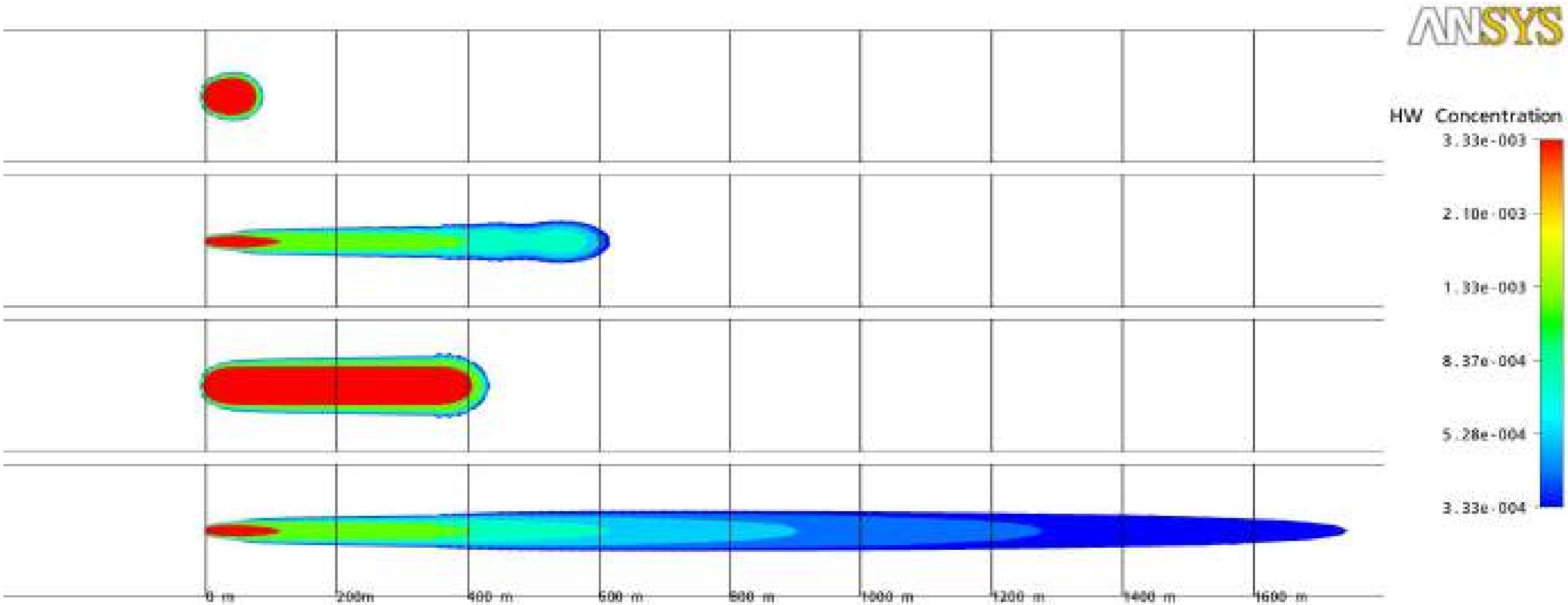


Figure 4.4 Continued: Hydrotest plume plan view at the end of the discharge period. (From top to bottom, Scenarios 24 to 28)

APPENDIX A. CFD MODEL

A.1. Analysis Software

CFX is regarded as a market-leading product that has been thoroughly validated for dispersion problems relevant to the oil and gas industry both by the specialists BMT and by external specialists. Publically available verification studies for a number of different fluids dynamics problems such as movement of solids through liquids and bubble plume behaviour have been undertaken at the University of Melbourne in Australia and the Paul Scherrer Institute in Switzerland[1]. Additional case studies including verification studies are provided here:

http://www.ansys.com/industries/sys-testimonials.asp?ID=10

A.2. Methodology

A.2.1. General

Dispersion of hydrotest water fluid was modelled using discharge parameters supplied by BP, which included total volume and duration of discharges.

The hydrotest schedule involved discharges from a variety of locations and depths. The analysis focused on discharges of $20m^3$ or more and on a subset of representative scenarios for each depth and discharge rate.

Transient dispersion simulations were carried out to determine the extent of the toxic plume for different release depths (i.e. from a vessel, from a caisson at a depth of 50m and from the seabed at a depth of 130m), a range of port diameters and discharge volumes for each depth, different seawater temperatures (summer and winter conditions) and two near-seabed current speeds (i.e. near-stagnant and predominant). For the summer condition, an appropriate thermocline was considered in the analysis while, for the winter condition, a constant temperature profile (7 ºC) was assumed. Discharges from the vessel and the caisson were directed downwards while releases from seabed were directed upwards.

No topography (i.e. flat seabed) was included.

[1] http://www.cfd.com.au/cfd_conf03/papers/123Hol.pdf; http://www.cfd.com.au/cfd_conf97/papers/smi002.pdf; Dispersion of neutrally buoyant solids falling vertically into stationary liquid and horizontal channel flow, K. M. Smith, M. R. Davidson and N. J. Lawson Computers & Fluids Volume 29, Issue 4, 1 May 2000, Pages 369-384; On the modelling of bubble plumes in a liquid pool, B. L. Smith, Applied Mathematical Modelling, Volume 22, Issue 10, October 1998, Pages 773-797

A.3. Fluid Properties

A.3.1. Seawater

Table A.1 presents the properties of seawater used in the analysis.

A.3.2. Hydrotest Water

The hydrotest discharges will comprise chemically treated Caspian seawater. The chemical dose levels will total less than 500ppm and therefore the discharges were considered to have the same density and physical properties as Caspian seawater. The relevant degree of dilution will lie in the range of 1:300 to 1:3000.

A.4. Computational Mesh

The computational mesh was generated in the domain bounded by the seabed and the sea surface. The computational domain extended sufficiently far away in each direction to avoid any boundary influence on the flow solution. The computational mesh used for the simulations comprised approximately 4 million tetrahedral cells. Additional mesh refinement was applied in the proximity regions of the release location.

A.5. Turbulence Model

The K-ε turbulence model was employed in the CFD simulations with standard coefficients.

The K-ε turbulence model is widely used for applications in the offshore industry and is generally suitable for the assessment of dispersion.

A.6. Heat Transfer Model

Heat transfer was modelled in the dispersion simulations. The ambient seawater temperature varied depending on the season condition. Summer and winter thermal conditions were obtained from [1].

A.7. Buoyancy

Buoyancy forces due to changes in fluid density were modelled in the analysis using the Boussinesq approximation.

A.8. Current Velocity Profile

The current velocity profile was simulated as uniform across the water column and consisted of two distinguished cases:

- Predominant current speed = 0.11m/s
- Near-stagnant current speed = 0.01m/s

A.9. Boundary Conditions

A.9.1. Upstream and Downstream Boundaries

Current properties and temperature profile for each scenario (see Section 4.2) were applied at the upstream domain boundary.

A.9.2. Seabed

A no-slip wall boundary condition (u, v, w = 0) was applied at the seabed.

A.9.3. Sea surface

A free-slip wall boundary condition (w = 0) was applied at the sea surface.

Seawater	
Density (kg/m^3)	1,010
Dynamic viscosity (kg/(m.s))	See Figure A.1
Molecular weight (kg/kmole)	18.02
Specific Heat Capacity (J/(kg.K))	4,181.7
Thermal Conductivity (W/(m.K))	0.6069
Thermal Expansivity (K^{-1})	0.000257

Table A.1 – Properties of seawater

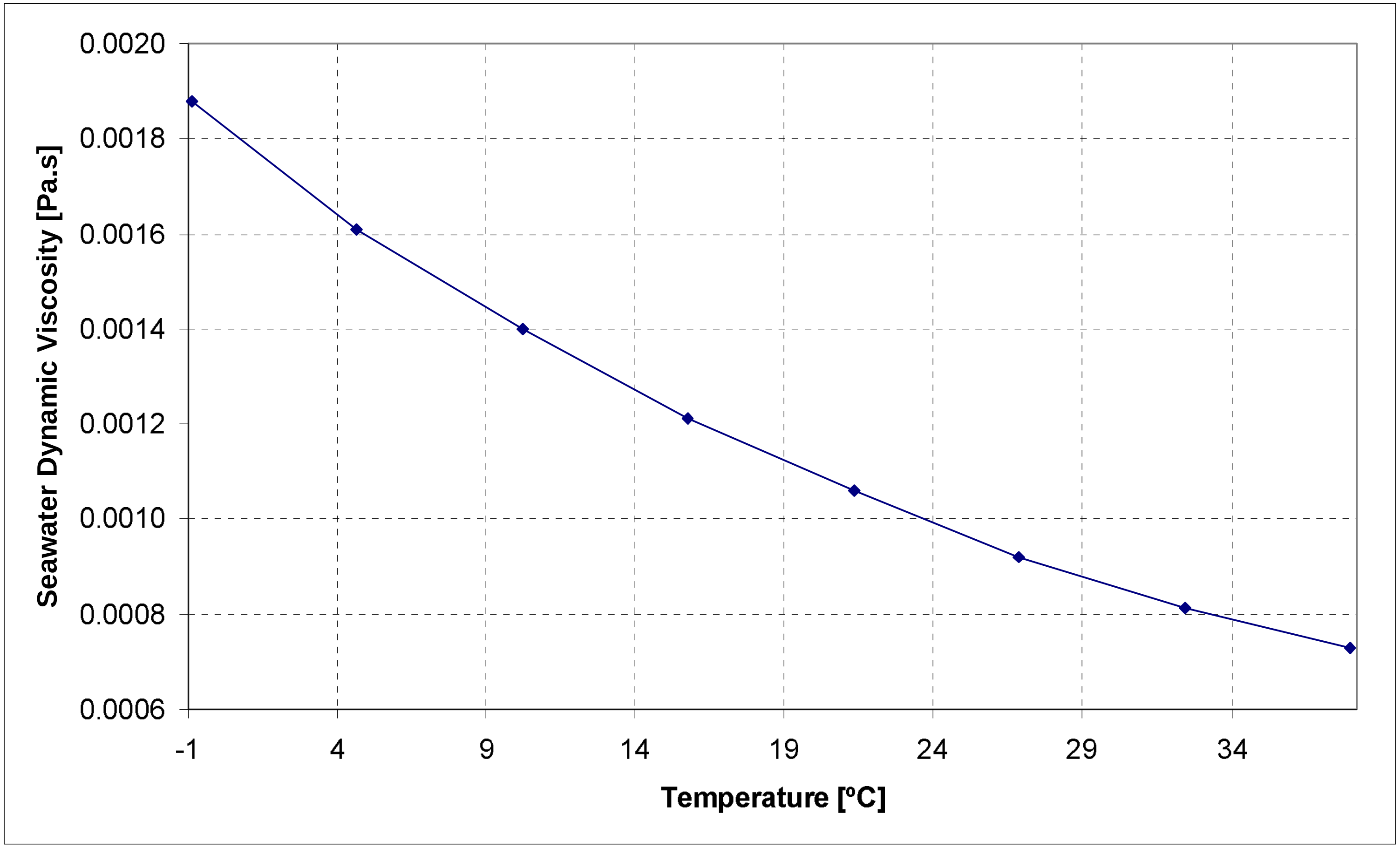


Figure A.1: Seawater viscosity variation with temperature

APPENDIX 11A

Operations Activities and Events

ACTIVITY/INTERACTIONS					
ID (R=Routine, NR= Non-Routine)	**Activity**	**Scoped In/Out**	**Reference**	**Event**	**Event Category**
Ops	**Offshore operations**				
Ops-R1	Pre-drill well tie-in and re-entry	✓	5.7.3	Underwater noise and vibration	Underwater Noise and Vibration (Drilling)
Ops-R2	Driving conductor section and drilling surface hole section with water based muds (WBM)	✓	5.7.4	Drilling discharges to sea	Drilling Discharges
				Underwater noise and vibration	Underwater Noise and Vibration (Drilling)
					Underwater Noise and Vibration (Hammering)
Ops-NR3	Discharge of residual mud	✓	5.7.4	Drilling discharges to sea	Drilling Discharges
Ops-R4	Cement losses	✓	5.7.7.1 and 5.3.2.5	Cement discharges to sea	Cement Discharges
Ops-NR5	Excess cement discharge to sea	✓	5.7.7.1 and 5.3.2.5	Cement discharges to sea	Cement Discharges
Ops-R6	Power generation, cranes, emergency generator testing and pilot flaring	✓	5.8.6.3 and 5.8.6.5	Emissions to atmosphere (non GHG)	Offshore Operations (Routine Operations)
Ops-NR7	Non routine flaring	✓	5.8.6.6	Emissions to atmosphere (non GHG)	Offshore Operations (Non Routine Operations - Flaring)
Ops-NR8	Non routine produced water discharge	✓	5.8.4	Produced water discharges to sea	Produced Water Discharge
Ops-R9	Seawater lift and cooling water discharge	✓	5.8.6.6	Water intake/entrainment	Water Intake/Entrainment and Cooling Water Discharge
				Cooling water discharge to sea	Water Intake/Entrainment and Cooling Water Discharge
Ops-NR10	Fire system tests	×	5.8.6.9	Discharges to sea	Chlorine/copper in discharged water
					Discharge fire fighting foam
Ops-R11	Platform drainage	✓	5.8.6.11	Other discharges to sea	Deck drainage
Ops-R12	Sewage and galley waste discharges	✓	5.8.6.14 and 5.8.6.15	Other discharges to sea	Treated black water
					Grey water
Ops-NR13	Pipeline operations and maintenance – pigging of oil and gas lines	×	5.9.4	Pigging discharge to sea	Pigging Discharge
Ops-R14	Maintenance of produced water and injection water pipelines (pigging)	✓	5.8.7	Pigging discharge to sea	Pigging Discharge
Ops-R15	Supply vessel operations	✓	5.8.8	Emissions to atmosphere (non GHG)	Supply Vessels
				Underwater noise and vibration	Underwater Noise & Vibration (Vessels)
				Other discharges to sea	Treated black water
					Grey water
					Deck drainage
					Ballast Water
Ops-R16	Crew change operations	×	5.8.8	Emissions to atmosphere (non GHG)	Support Vessels
				Noise	Support Vessels
Ops-R17	Physical presence of WC-PDQ platform	×	5.8	Visual Intrusion	Visual Intrusion
				Light Pollution	Light Pollution
				Physical presence	Physical presence
Ops-R18	Waste generation	×	5.8.9	Waste generation	Waste generation
Ter	**Onshore Operations**				
Ter-R1	Use of existing processing and storage facilities	✓	5.9.4	Emissions to atmosphere (non GHG)	Onshore Operations (Routine Operations)
Ter-NR2	Non-routine flaring associated with COP	✓	5.9.4	Emissions to atmosphere (non GHG)	Onshore Operations (Non Routine Operations – Flaring)
Ter-R3	Waste generation	×	5.9.4	Waste generation	Waste generation
Ter-R4	Onshore discharges	×	5.9.4	Onshore discharges	Onshore discharges

	Event Category	Event Magnitude: Magnitude Parameters	Event Magnitude: Ranking	Event Magnitude: Event Magnitude	Receptor Sensivity: Sensitivity Parameters	Human	Biological/Ecological: Seals/Fish		Zooplankton		Phytoplankton		Benthic Invertebrates		Birds		Total	Impact Significance
Offshore and Onshore Operations																		
Emissions to Atmosphere (non GHG)	Offshore Operations (Routine Operations)	Scale	1	8	Resilience	1	1										2	Minor Negative
		Frequency	3															
		Duration	3		Presence	1	1											
		Intensity	1															
	Offshore Operations (Non Routine Operations - Flaring)	Scale	1	6	Resilience	1	1										2	Minor Negative
		Frequency	3															
		Duration	1		Presence	1	1											
		Intensity	1															
	Support Vessels	Scale	1	6	Resilience	1	1										2	Minor Negative
		Frequency	3															
		Duration	1		Presence	1	1											
		Intensity	1															
	Onshore Operations (Routine Operations)	Scale	1	8	Resilience	4	-	-	-	-	-	-	-	-	1	2		Moderate Negative (Humans) Minor Negative (Biological/Ecological)
		Frequency	3															
		Duration	3		Presence		-		-		-		-		1			
		Intensity	1															
	Onshore Operations (Non-routine Operations: Flaring)	Scale	1	6	Resilience	4	-	-	-	-	-	-	-	-	1	2		Moderate Negative (Humans) Minor Negative (Biological/Ecological)
		Frequency	3															
		Duration	1		Presence		-		-		-		-		1			
		Intensity	1															
Marine Environment	Underwater Noise and Vibration (Drilling)	Scale	1	8	Resilience	-	2	4	-	-	-	-	-	-	-	-		Moderate Negative
		Frequency	3															
		Duration	3		Presence	-	2		-		-		-		-			
		Intensity	1															
	Underwater Noise and Vibration (Hammering)	Scale	3	8	Resilience	-	2	4	-	-	-	-	-	-	-	-		Moderate Negative
		Frequency	2															
		Duration	2		Presence	-	2		-		-		-		-			
		Intensity	1															

Event Category	Magnitude Parameters	Ranking	Event Magnitude	Sensitivity Parameters	Human	Seals/Fish	Seals/Fish	Zooplankton	Zooplankton	Phytoplankton	Phytoplankton	Benthic Invertebrates	Benthic Invertebrates	Birds	Birds	Total	Impact Significance
Underwater Noise & Vibration (Vessels)	Scale	1	8	Resilience	-	2	4	-	-	-	-	-	-	-	-		Moderate Negative
	Frequency	3															
	Duration	3		Presence	-	2		-		-		-		-			
	Intensity	1															
Cement Discharges	Scale	1	6	Resilience	-	-	-	-	-	-	-	1	2	-	-		Minor Negative
	Frequency	3															
	Duration	1		Presence	-	-		-		-		1		-			
	Intensity	1															
Drilling Discharges	Scale	1	6	Resilience	-	1	2	1	2	1	2	1	2	-	-		Minor Negative
	Frequency	2															
	Duration	2		Presence	-	1		1		1		1		-			
	Intensity	1															
Produced Water Discharge	Scale	1	8	Resilience	-	1										2	Minor Negative
	Frequency	3															
	Duration	2		Presence	-	1											
	Intensity	2															
Water Intake/Entrainment and Cooling Water Discharge	Scale	1	8	Resilience	-	1										2	Minor Negative
	Frequency	3															
	Duration	3		Presence	-	1											
	Intensity	1															
Deck drainage	Scale	1	8	Resilience	-	1										2	Minor Negative
	Frequency	3															
	Duration	3		Presence	-	1											
	Intensity	1															
Treated black water	Scale	1	8	Resilience	-	1										2	Minor Negative
	Frequency	3															
	Duration	3		Presence	-	1											
	Intensity	1															

Event Category	Event Magnitude			Receptor Sensitivity								Total	Impact Significance
	Magnitude Parameters	Ranking	Event Magnitude	Sensitivity Parameters	Human	Biological/Ecological							
						Seals/Fish	Zooplankton	Phytoplankton	Benthic Invertebrates	Birds			
Grey water	Scale	1	8	Resilience	-	1						2	Minor Negative
	Frequency	3											
	Duration	3		Presence	-	1							
	Intensity	1											
Pigging discharge	Scale	1	7	Resilience	-	1						2	Minor Negative
	Frequency	3											
	Duration	1		Presence	-	1							
	Intensity	2											
Ballast Water	Scale	1	5	Resilience	-	1						2	Minor Negative
	Frequency	2											
	Duration	1		Presence	-	1							
	Intensity	1											

APPENDIX 11B

Offshore Air Dispersion Modelling

AZERBAIJAN INTERNATIONAL OPERATING COMPANY (AIOC)

CHIRAG OIL PROJECT

WEST CHIRAG OFFSHORE PLATFORM

AIR DISPERSION MODELLING FOR WEST CHIRAG OFFSHORE PLATFORM

December 2009

9740-COP-RC-X-00001

Revision: 3

REV	DATE	DESCRIPTION	PREPARED	CHECKED	APPROVED	QA
0	18/03/2009	Final Report	J Rumble	S Wilford	P Russell	E Bridge
1	08/04/2009	Final Report	J Rumble	S Wilford	P Russell	E Bridge
2	16/06/2009	Final Report	J Rumble	S Wilford	P Russell	E Bridge
3	23/12/2009	Final Report	P Russell	E Cielslak	P Russell	K Denton

Granherne Ltd

Hill Park South, Springfield Drive, Leatherhead, Surrey, KT22 7LH

www.granherne.com | Tel: +44 1372 380000 | Fax: +44 1372 388888

CONTENTS

ABBREVIATIONS

ACG	Azeri-Chirag-Gunashli Oil Field
ACGIH	American Conference of Governmental Industrial Hygienists
ADMS	Atmospheric Dispersion Modelling System
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AIOC	Azerbaijan International Operating Company
CA	Central Azeri Platform
CASMOS	Caspian Met Ocean Study
CERC	Cambridge Environmental Research Consultants
COP	Chirag Oil Project
DUQ	Drilling, Utilities and Quarters Platform
DWG	Deep Water Gunashli
EA	East Azeri
ESIA	Environmental and Social Impact Assessment
EU	European Union
F_b	Heat Release
F_m	Momentum Flux
ISCST	Industrial Source Complex Short Term
MODU	Mobile Offshore Drilling Unit
NO_x	Nitrogen Oxides
NRPB	National Radiological Protection Board
OCD	Offshore and Coastal Dispersion Model
PCWU	Production, Compression, Water Injection and Utilities Platform
RR	Rolls-Royce
SD	Shah-Deniz
UKOOA	United Kingdom Offshore Operators Association
VOC	Volatile Organic Compound
WA	West Azeri Platform
WC-PDQ	West Chirag Drilling Production Quarters

1.0 EXECUTIVE SUMMARY

The AIOC Chirag Oil Project (COP) development in the Central Caspian Sea, to the East of Baku, is to include a new West Chirag Production Drilling Quarters (WC-PDQ) platform. It will comprise of drilling, gas and oil processing and export facilities, along with utilities and accommodation. The emission sources on the platform will comprise of 3 gas turbines (for power generation), a safety flare system and a number of minor diesel engines for emergency or support functions.

AIOC commissioned this study to understand the impact of emissions from WC-PDQ and the surrounding installations on the WC-PDQ workers and on the air quality of onshore, coastal locations.

In the comparison of emission quantities, air quality and occupational exposure limits, it was apparent that nitrogen dioxide (NO_2) was the most significant emission from the platform in terms of possible impacts (Section 3).

The platform is located in an area with a number of other facilities. In order to examine the exposure of workers on the proposed new platform to air pollution, this study began by modelling emissions from existing platforms in the Central Caspian Sea. Workers on the new platform must not be exposed to concentrations exceeding occupational exposure levels and the modelling predicted that concentrations will be well below exposure levels at the proposed platform location. The limit for occupational exposure is 3760 $\mu g/m^3$ ACGIH[5], calculated for a twelve hour shift, which can be compared with the predicted peak concentrations which rarely exceed 30 $\mu g/m^3$ offshore in the vicinity of the platforms.

For the study, recent offshore meteorological measurements have been used, recorded on platforms within the ACG complex and supplied by AIOC. These provide for more accurate predictions of air quality through the use of dispersion modelling.

Onshore air quality standards are based upon a mixed population, in terms of ages and health, and therefore it is generally accepted that onshore standards do not apply offshore, where only those of working age and fitness are present for extended periods.

The emissions from both existing and proposed platforms were modelled to determine the future contribution of emissions to the air quality at Azerbaijan coastal locations, in particular Baku and Sangachal. Account was taken of the background concentrations found in the region. The results showed that the contribution to the long-term average NO_x concentration at Baku was less than 1 $\mu g/m^3$, and the peak would rarely exceed 2 $\mu g/m^3$ above background. This is a relatively insignificant contribution. However, concentrations over 10 $\mu g/m^3$ will occasionally occur on the peninsula to the east of Baku. For comparison, the EU standard is 200 $\mu g/m^3$.

The fact that contribution to onshore air quality levels is small is partly due to the prevailing wind direction which limits the proportion of emissions which blow directly towards the shore and partly due to the distance from the shore to the offshore platforms. For example, the WC-PDQ location is over 100 km to the east of Baku.

The development of WC-PDQ is not at risk from exposure to pollution offshore. Equally, the additional emissions from the new platform will not pose a risk of significant additional deterioration of air quality, either offshore or onshore.

2.0 INTRODUCTION

Granherne Ltd was commissioned by AIOC to carry out an air dispersion modelling study of the effects of emissions on offshore personnel onboard WC-PDQ. The study investigated the contribution of emissions originating from platforms on populated areas of Azerbaijan. The findings on this report will form part of the Chirag Oil Project Environmental and Social Impact Assessment (ESIA).

2.1 Scope

An air quality dispersion study was required in order to identify any potential health impact on the population of WC-PDQ. This involved comparing findings against the occupational standards for average exposure time of personnel working offshore.

The modelling was also used to identify whether any emissions from the ACG complex of platforms reach landfall either in Azerbaijan or other countries such that they impact on the ambient air quality of any receiving regions. Again, these findings were compared to existing ambient air quality standards.

Modelling also took into account the cumulative impact of other platforms within the ACG and Shah Deniz contract areas also flaring/ operating concurrently.

Modelling scenarios included:

- Normal operations with only purge and pilot flaring to include all platforms except SD2;
- Normal operations with flaring options likely from one platform due to gas export problems; and
- Full emergency flaring, from one platform.

2.2 Propose

The study has three main aims:

- Ensure that workers on the proposed WC-PDQ would not be exposed to pollutants exceeding occupational exposure limits;
- Evaluate the contribution of emissions from WC-PDQ on local and regional air quality; and
- Determine the impact of emissions from existing and the proposed WC-PDQ onshore.

2.3 Methodology

For this study the ADMS-4.1 atmospheric dispersion model was used to predict the impact on air quality from offshore platforms (See Section 4). An initial assessment determined that NO_x emissions from power generation turbines and engines were the most significant sources of emission in terms of health and environmental impact.

The dispersion modelling involved the consideration of:

- Source emissions and characteristics;
- Evaluation of meteorological conditions and preparation of model input files;
- Model selection, set-up and modelling runs;
- Provision of contour maps of the air pollution levels; and
- Evaluation of impact and of significance.

3.0 EMISSIONS AND AIR QUALITY STANDARDS

The preliminary screening identified that nitrogen oxides (NO_x) are the key pollutant of interest. These are comprised of NO and NO_2 but NO_2 is the more toxic. Whilst emissions of carbon monoxide occur, exposure limits and air quality standards are far higher than for NO_2. As CO is not emitted in significantly larger quantities than NO_2, the latter emissions would be the first emission to exceed any limit.

NO converts to NO_2 over time in the atmosphere, primarily due to the mixing of the emitted plume with the ozone (O_3) present in the background air, its reaction being $NO + O_3 = NO_2 + O_2$.

The negative health effects of NO_2 overexposure can range from chest pain and shortness of breath in the short term, to the gradual development of emphysema, lung oedema or other chronic respiratory disorders following sustained periods of exposure.

The environmental impacts of NO_2 include contributions to acid rain, visibility impairment and eutrophication. However, due to the large distances involved,the small number of sources present on the offshore platforms and low amounts of NO_2 emitted, these effects will be negligible and the primary focus of this study will be on the effects on human health on the offshore platforms as well as on populated regions on the coastline.

For the prediction of short-term peak concentrations, expressed in terms of the 99.97% percentile, it was assumed that 50% of the NO_X emitted was present in the form of NO_2, reflecting the fact that less mixing occurs for peak concentrations to exist. For long-term average concentrations, it was assumed that 100% of the NO_x was present as NO_2.

Azerbaijan standards are evolving and the EU air quality standards, including Directive (99/30/EC), are considered as providing suitable guidance. EU standards were used in the assessment of air quality at the Sangachal Terminal by AIOC. These standards are applicable onshore and may also be used to evaluate impact when the offshore emissions reach the shore.

Offshore, where only workers are generally present for extended periods, with members of the public having only transitory presence, onshore standards are not relevant. However, occupational exposure standards must be met. The American Conference of Governmental Industrial Hygienists (ACGIH) provides occupational exposure limits for NO_2 and these, together with the EU air quality standards, are given in Table 3.1. The ACGIH limit is also used by the International Occupational Safety and Health Information Centre, but the limits are under review in Europe and in the USA and it is expected that future occupational health limits for NO_2 may be lowered.

Table 3.1
Exposure and Air Quality Standards

POLLUTANT	OBJECTIVE		MEASURED AS
	Concentration		
	µg/m³	ppb	
EU limits Nitrogen Dioxide (NO_2)	200	105	1 hour mean not to be exceeded more than 18 times a year
	40	21	Annual mean
ACGIH 8 hour	5,640	3,000	Time weighted average exposure 8 hour
ACGIH 12 hour	3,760	2,000	The 8 hour value calculated for a 12 hr shift

Offshore workers will spend at least half their day in the accommodation unit and offices on the platform. Their exposure to air pollutants, ignoring indoor air quality, is based on their shift, hence it is the occupational exposure standards that are of most relevance to them.

4.0 DISPERSION MODEL DESCRIPTION

A range of models is available for dispersion modelling but their use offshore generally requires the re-setting of dispersion parameters and use of suitable meteorological data. Commonly available models include Offshore and Coastal Dispersion model (OCD), National Radiological Protection Board (NRPB-91), Industrial Source Complex Short Term (ISCST), American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) and Atmospheric Dispersion Modelling System (ADMS). ADMS-4.1 incorporates a superior basis for dispersion modelling, based on the Monin-Obhukov length parameter, rather than the Pasquill stability classes/Gaussian profiles used in early models, which include OCD, NRPB-91 and ISCST. The systems in practice give similar results for stable and neutral atmospheric stability conditions, but, under unstable conditions, the predictions of models incorporating the Monin-Obhukov length are regarded as superior.

The ADMS-4.1 model incorporates an integrated plume rise module, rather than the simple empirical formula used in ISCST and the basic AERMOD model. The empirical approach is known to give poor predictions of emissions from small stacks or high-momentum releases as the equations were established primarily from the observations of large power station plumes. A version of the NRPB-91 model is available, called RAMPART; this incorporates the integrated plume rise approach but lacks a Monin-Obhukov based dispersion model.

ADMS-4.1 also introduces a marine boundary layer option which is specifically designed to model offshore sites, such as WC-PDQ. The ability to model the changing offshore marine boundary layer provides a more realistic representation of the metrological conditions, such as lapse rates, encountered offshore.

ADMS-4.1 was selected because of its superior dispersion model and plume rise methodology and integrated offshore marine boundary layer facility. The developers of this model, Cambridge Environmental Research Consultants (CERC), were consulted about the use of the model offshore and the setting up of dispersion parameters.

5.0 EMISSION PARAMETERS

Offshore turbine configuration and loading parameters were based on the available operational data, with emissions calculated accordingly.

The ACG and Shah Deniz platforms have a number of diesel engines which are available for emergency service or periodic use. These include stand-by generators, crane engines and fire pump engines. These diesel-fuelled, emergency-only units are routinely test-run for short periods. Their contribution to emissions is regarded as insignificant and they have not been considered further in this study.

The turbine locations were determined according to the central jacket grid co-ordinates as specified in the supplied structural drawings for the ACG and Shah Deniz 1 platforms.

Most turbines are RB-211 units, manufactured by Rolls-Royce [2]. The emission parameters such as load and exhaust temperature were obtained. In addition, the CA platform has a Solar Mars turbine; on Chirag-1, two Solar Taurus, two ABB-Alstrom Tornadoes and one Solar Saturn turbines are installed.

Electrical power on Shah Deniz 1 is delivered via four dual-fuel reciprocating engines, Bergen B type units, also manufactured by Rolls-Royce. Emissions were determined from rating and manufacturer's data.

5.1 Emission Source Data Summary

- Most gas turbines on the ACG platforms are RB-211 units and emission calculations have been based on the most common model, with data test sheets provided by RR and ACG.
- Solar and ABB-Alstrom Tornadoes turbines are also installed and monitoring data and manufacturer's data sheets were used to derive emissions and stack parameters.
- Dimensions for the reciprocating dual-fuel engine stacks present on Shah Deniz 1 were based upon manufacturer's data.
- Flare heights and widths were derived using the supplied piping diagrams taking into account the height of the base platform above sea level.
- Turbine and engine configuration and loading parameters were based upon supplied operational data.
- Based on the operational data provided, turbines operating as reserve were identified and excluded as they are used only as replacements when other turbines are off-line; hence, there is no change to overall emission rates.
- Turbine load information was provided and used to determine emissions: Loads vary from 50-100% and, at lower loads, for a given turbine, emissions are also reduced. Where turbine model emission-load profiles are available, these were used.

5.2 Model Source Inputs

In Table 5.1 the turbine and engine source data is given. This includes stack height, diameter, grid location and the operational loadings of the machines. Where no turbine or engine load data was available, it was conservatively assumed these units operated at 100% load. The data for flares is given in Table 5.2.

Table 5.1
Turbine and Engine Sources

Source Name	Height (m)	X Location (m)	Y Location (m)	Diameter (m)	Assumed Load (%)	Fuel Combustion Rate (Nm^3/s)
CA-PDQ-GT1	67	79,532	16,888	2.4	70	1.4
CA-PDQ-GT2	67	79,537	16,893	2.4	70	1.4
CA-CWP-GT1	67	79,393	16,850	2.4	100	2.0
CA-CWP-GT2	67	79,398	16,855	2.4	100	2.0
CA-CWP-GT3	67	79,403	16,860	2.4	100	2.0
CA-CWP-GT4	67	79,408	16,865	2.4	100	2.0
CA-CWP-GT5	67	79,413	16,870	2.4	100	2.0
CA-CWP-GT6	67	79,418	16,875	2.4	100	2.0
CA-CWP-GT7	67	79,423	16,880	2.4	100	2.0
CA-CWP-GT8	67	79,428	16,885	2.4	100	2.0
CA-CWP-GT9	67	79,433	16,890	2.4	100	2.0
CA-CWP-Mars	67	79,433	16,895	2.0	100	0.8
WA-GT1	67	75,669	19,505	2.4	70	1.4
EA-GT1	67	88,167	15,576	2.4	70	1.4
DWG-DUQ-GT1	67	63,741	32,323	2.4	100	2.0
DWG-PCWU-GT1	67	63,604	32,282	2.4	100	2.0
DWG-PCWU-GT2	67	63,609	32,287	2.4	100	2.0
DWG-PCWU-GT3	67	63,614	32,292	2.4	100	2.0
WCHIRAG-GT1	67	68,408	27,490	2.4	50	1.0
WCHIRAG-GT2	67	68,413	27,495	2.4	50	1.0
WCHIRAG-GT3	67	68,418	27,500	2.4	50	1.0
CHIRAG1-Taurus1	67	69,832	22,661	1.0	100	0.4
CHIRAG1-Taurus2	67	69,837	22,666	1.0	100	0.4
CHIRAG1-Tornado1	67	69,837	22,666	1.5	100	0.5
CHIRAG1-Tornado2	67	69,837	22,666	1.5	100	0.5
CHIRAG1-Saturn1	67	69,837	22,666	0.742	100	0.1

Source Name	Height (m)	X Location (m)	Y Location (m)	Diameter (m)	Assumed Load (%)	Fuel Combustion Rate (Nm^3/s)
SD1-GRE1	57	2000	2000	1	100	0.5
SD1-GRE2	57	2005	2005	1	100	0.5
SD1-GRE3	57	2010	2010	1	100	0.5

Table 5.2
Flare Sources

Source Name	Height (m)	X Location (m)	Y Location (m)	Diameter (m)
CA-CWP-FLARE	124.9	79,408	16,865	0.6
WA-FLARE	124.9	75,684	19,520	0.4
EA-FLARE	124.9	88,182	15,591	0.4
DWG-PCWU-FLARE	165.5	63,619	32,297	0.6
WCHIRAG-FLARE	124.9	68,423	27,505	0.4
CHIRAG1-FLARE	180.0	69,847	22,676	0.4

The emission rates for the sources modelled are given in Tables 5.3 and 5.4.

Table 5.3
RB211 Turbine Emission Rates

Load Percentage	NO_2 Release Rate (g/s)	Efflux Velocity (m/s)
100	13.73	44.99
70	6.28	29.60
50	3.08	20.30

Source: RR RB211 Model 6562 data sheet [2]

Table 5.4
Flare Emission Rates

Release Type	NO_2 Release Rate (g/s)	Fm (m^4/s^2)	Fb (Mw)
Pilot & Purge(All)	0.03	1	1
Operational (DWG-PCWU)	76.00	17,314	1,751
Emergency (DWG-PCWU)	284.00	100,000	10,000
Operational (WC-PDQ)	75.00	38,424	1,739
Emergency (WC-PDQ)	284.00	73,272	2,401

Source: UKOOA emission factors for flares[6]

6.0 MODELLED DOMAIN/RECEPTORS

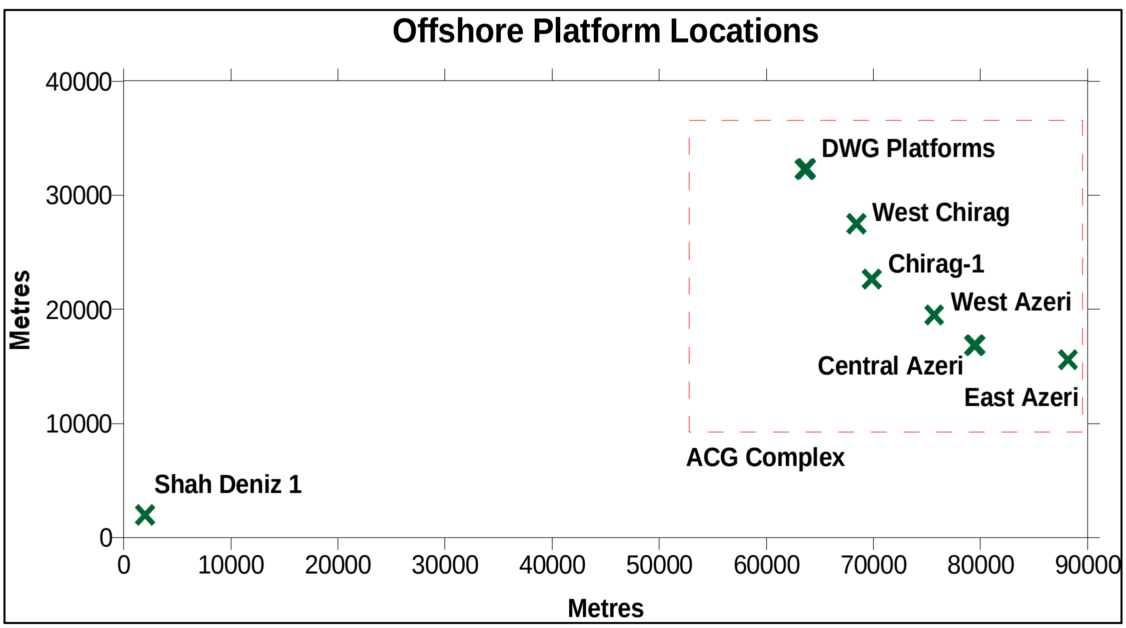
6.1 Offshore Domain (All Platform Emission Sources)

The offshore modelling domain consisted of the existing ACG contract area (6 platforms), Chirag-1 and Shah Deniz 1 which were enclosed within a 90km x 60km modelling area beginning 2km south and west of Shah Deniz 1. The grid origin was offset from Shah Deniz 1 to account for any possible NO_2 dispersion to the south and west of the platform itself. A grid of 81 by 81 points was used, providing an average resolution of 0.8km. A representation of this domain is shown in Figure 6.1.

6.2 Onshore and Offshore Combined Domain

In addition to the offshore sources, a second separate offshore domain was designated to take into account NO_2 concentrations onshore, including the populated regions of Baku and Sangachal Town. This offshore domain grid is a superset of the extended west to include all of the offshore platforms, including WC-PDQ, and the populated region between Baku and Sangachal.

Figure 6.1
Offshore Domain Grid Representation



6.3 Offshore Domain (WC-PDQ Sources Only)

To assess the impact of WC-PDQ emissions upon the existing ACG platforms, a separate suite of scenarios was run with emission sources present on WC-PDQ only. The modelling area was changed to 28km x 28km with the grid size remaining at 81 by 81 points providing a resolution of approximately 0.12km.

6.4 Central Caspian Regional Domain

To illustrate the overall impact of emissions in the Central Caspian region, the modelling area was increased significantly to 550km x 550km covering a substantial section of the Central Caspian Sea and surrounding land borders of Russia, Iran, Turkmenistan and Kazakhstan. The grid size was increased to 101, the maximum permitted in ADMS providing a resolution of approximately 5.45km. A separate suite of scenarios were run to assess the impact of existing platforms, proposed WC-PDQ sources in isolation and well tests preceding the construction of WC-PDQ on the Dada Gorgud Mobile Offshore Drilling Unit (MODU). Note that the prediction of concentrations beyond 60km from source should be view as indicative only due to model limitations.

6.5 Sensitive Receptors

Platforms located within the ACG contract area currently number six, with the addition of Chirag-1. The nearest platform to the proposed location of WC-PDQ is Chirag-1, located 5.03km away. As all of the ACG complex platforms are manned installations, NO_2 concentrations have been predicted over the area occupied by the platforms.

The potential impact on onshore air quality was also assessed. Two receptors were modelled, Baku and Sangachal, with Baku being the main population centre in the region and Sangachal being the town which is close to the AIOC oil and gas reception terminal.

The concentrations predicted at the designated locations are presented in Table 6.1.

Table 6.1
Sensitive Receptors

Receptor	Distance From WC-PDQ (km)	Direction
Central Azeri-PDQ	15.37	South East
Central Azeri-CWP	15.29	South East
West Azeri	10.79	South East
East Azeri	23.07	North South East
Deep Water Gunashli-PDQ	6.72	North West
Deep Water Gunashli-PCWU	6.79	North West
Chirag-1	5.03	South South East
Baku	118.09	West
Sangachal	147.20	West South West

Note: Baku and Sangachal Town distances are approximate as grid references were converted from latitude and longitude and into Pulkovo 1942 co-ordinates to maintain compatibility with offshore co-ordinate system

7.0 METEOROLOGY/SURFACE CHARACTERISTICS

The meteorological data used in the dispersion modelling were compiled and produced as part of scope, based on the available offshore measurements.

An annual hourly dataset was created using existing measured platform data and data derived from a CASpian Met Ocean Study (CASMOS2) output [3]. The data was formatted to meet the requirements of the Marine boundary layer scheme of ADMS4 [4]. These parameters included year, Julian day, hour, air temperature, sea temperature, wind speed and wind direction. Sea surface temperature was extracted from the CASMOS2 report and air temperature and wind speed and direction were averaged from CHIRAG-1 and Central Azeri measurements. The surface roughness for calculations was set to 0.001, the ADMS default for the sea.

ADMS determines the offshore lapse rates and turbulence which have a significant impact on plume rise and atmospheric dispersion.

Short-term concentrations for the emergency shutdown flaring scenario utilised a screening metrological dataset used in similar studies, which represents a comprehensive collection of possible stability classes and wind speeds. This enables the determination of the maximum concentrations.

8.0 SCENARIOS MODELLED

Three basic scenarios were evaluated, as given below. A number of variations were also modelled to help distinguish impacts, including SD operating independantly of ACG, WC-PDQ only, MODU operations only and SD running on diesel rather than fuel gas.

Scenario 1 – Normal Operation

The normal operation of the offshore platforms involves power generation etc using turbines, and in the case of SD1, gas engines. Flares operate in pilot and purge mode, the minimum necessary to maintain their safe operation.

Scenario 2 – Operational Flaring

During periods of restricted gas export capability, a platform may temporarily flare gas. This is generally due to the need for unplanned maintenance and such flaring is reduced to the lowest practicable level. Rarely would more than one platform be flaring. Any processing platform could need to flare and DWG and the proposed new platform, WC-PDQ, have been modelled.

DWG-PCWU was selected as it is normally upwind of WC-PDQ and is comparatively near. Its selection was to fulfil the objective of evaluating the exposure of workers on the new platform to air pollutants. Flaring from WC-PDQ was also modelled as part of the Environmental and Social Impact Assessment (ESIA) of the proposed facility.

Scenario 3 – Emergency Shut-Down (Depressurisation)

Should there be an incident or alarm on the platform, an emergency depressurisation may be necessary. The platform is isolated from production and export pipelines and the process inventory on the platform is directed to flare. This involves an initial high rate of release which reduces exponentially as the pressure declines. The complete depressurisation of a platform is rapid, with most of the inventory assumed to have been flared within one hour.

As for operational flare modelling, DWG-PCWU and WC-PDQ were selected.

Scenario 4 –WC-PDQ Only

In order to quantify the contribution of the proposed platforms on air quality in the area, the emissions from WC-PDQ were modelled independently of other sources. Normal operations, emergency and restricted gas export scenarios were modelled.

Scenario 5- MODU (Dada Gorgud) Normal Operations

Prior to the installation of WC-PDQ emissions from the drilling rig on location were modelled, along with the emissions from other platforms in the area. The MODU emission consisted of those from the power generators.

Scenario 6- MODU (Dada Gorgud) Well Testing

As above but with well testing in progress. It was assumed that an EverGreen Burner[7] will be used.

Grid size

Each scenario described above was modelled on various grid sizes. A finer grid included the concession zone, including all offshore platforms and giving good resolution. A medium sized grid was used to include Baku and Sangachal, the main onshore receptors in the area. A regional grid was used which encompassed the Central Caspian Area which includes adjacent states.

In addition, a separate grid size was used to show in detail the near-source concentrations from the operation of WC-PDQ alone.

9.0 ASSESSMENT OF IMPACT

9.1 Background Concentrations

The predicted concentrations resulting from platform emissions are added to the prevailing background concentrations when determining impact. There is limited information on air quality offshore, but measurements taken along the coastline at Sangachal were available. Sample points which where not strongly affected by local sources were taken to be indicative of the background concentrations, giving a value of 5.0 $\mu g/m^3$, a value typical of unpolluted, rural areas.

9.2 Discrete Receptor Concentrations

The ADMS model allows discrete receptor locations to be assessed, in addition to modelling on a grid. Platforms offshore were included along with the capital Baku and Sangachal Town. In tables 9.1 to 9.5, the results for all platforms operating are given. In tables 9.6 to 9.8, the results are given for the contribution of WC-PDQ only, as part of the Environmental and Social Impact Assessment requirements.

Onshore locations are compared with the EU air quality standards, with the concentrations based on the contribution from offshore sources and background levels. No account is taken of onshore sources, which will result in far higher levels of pollution locally. Two values are given, the annual average and the peak hourly concentrations, expressed as the highest 18 values, the equivalent of the 99.79th percentile.

Offshore, occupational exposure levels are applicable and these generally relate to an 8 or 12 hour shift.

Table 9.1

All Platforms, Normal Operations: Predicted NO_2 (µg/m³) Concentrations

Receptor	Annual	99.79th%
EU Air Quality Standards	***40***	**200**
Baku	5.2	7.1
Sangachal	5.1	6.8
ACGIH Occupational Standards	***NA***	***12-hr Exposure-3,760***
CA-CWP	5.1	7.0
CA-PDQ	5.1	7.0
Chirag-1	5.5	14.6
DWG-DUQ	5.4	12.6
DWG-PCWU	5.4	12.9
East Azeri	5.2	13.0
Shah Deniz 1	5.1	6.6
West Azeri	5.8	30.8
WC-PDQ	5.5	13.8

Table 9.2

WC-PDQ Operational Flaring (Restricted Gas Export) and

All Other Platforms Normal Operations: Predicted NO_2 (µg/m³) Concentrations

Receptor	Annual	99.79th%
EU Air Quality Standards	***40***	**200**
Baku	5.2	7.1
Sangachal	5.1	6.8
ACGIH Occupational Standards	***NA***	***12-hr Exposure-3,760***
CA-CWP	5.1	7.2
CA-PDQ	5.1	7.1
Chirag-1	5.5	14.6
DWG-DUQ	5.4	12.6
DWG-PCWU	5.4	12.9
East Azeri	5.2	13.0
Shah Deniz 1	5.1	6.6
West Azeri	5.8	30.8
WC-PDQ	5.5	13.8

Table 9.3
DWG-PCWU Operational Flaring (Restricted Gas Export) and
All Other Platforms Normal Operations: Predicted NO_2 (µg/m³) Concentrations

Receptor	Annual	99.79th%
EU Air Quality Standards	***40***	**200**
Baku	5.2	7.1
Sangachal	5.1	6.8
ACGIH Occupational Standards	***NA***	***12-hr Exposure-3,760***
CA-CWP	5.1	7.5
CA-PDQ	5.1	7.4
Chirag-1	5.5	14.6
DWG-DUQ	5.4	12.6
DWG-PCWU	5.4	12.9
East Azeri	5.2	13.0
Shah Deniz 1	5.1	6.7
West Azeri	5.8	30.8
WC-PDQ	5.5	14.0

Table 9.4
WC-PDQ Emergency Flaring and
All Other Platforms Normal Operations: Predicted NO_2 (µg/m³) Concentrations

Receptor	Annual	99.79th%
EU Air Quality Standards	***40***	***200***
Baku	5.2	7.1
Sangachal	5.1	6.8
ACGIH Occupational Standards	***NA***	***12-hr Exposure-3,760***
CA-CWP	5.1	7.1
CA-PDQ	5.1	7.1
Chirag-1	5.5	14.6
DWG-DUQ	5.4	12.7
DWG-PCWU	5.4	12.9
East Azeri	5.2	13.0
Shah Deniz 1	5.1	6.6
West Azeri	5.8	30.8
WC-PDQ	5.5	13.8

Table 9.5
DWG-PCWU Emergency Flaring and
All Other Platforms Normal Operations: Predicted NO_2 (µg/m^3) Concentrations

Receptor	Annual	99.79th%
EU Air Quality Standards	*40*	*200*
Baku	5.2	7.1
Sangachal	5.1	6.8
ACGIH Occupational Standards	*NA*	*12-hr Exposure-3,760*
CA-CWP	5.1	7.1
CA-PDQ	5.1	7.1
Chirag-1	5.5	14.6
DWG-DUQ	5.4	12.7
DWG-PCWU	5.4	12.9
East Azeri	5.2	13.0
Shah Deniz 1	5.1	6.6
West Azeri	5.8	30.8
WC-PDQ	5.5	13.8

The tables above are all remarkably similar with either operational or emergency flaring having little obvious impact on average or peak concentrations. However, it is commonly found that flares have substantial plume rise due to their high momentum and buoyancy, such that by the time mixing down to ground or sea level occurs, the pollutants are well dispersed and concentrations comparatively low.

Table 9.6
WC-PDQ Normal Operations Only,
No Other Platforms in Operation: Predicted NO_2 Concentrations

Receptor	Annual	99.79th%
EU Air Quality Standards	*40*	*200*
Baku	5.2	7.1
Sangachal	5.1	6.8
ACGIH Occupational Standards	*NA*	*12-hr Exposure-3,760*
CA-CWP	5.1	5.5
CA-PDQ	5.1	5.4
Chirag-1	5.2	7.1
DWG-DUQ	5.2	6.6
DWG-PCWU	5.2	6.6
East Azeri	5.1	5.3
West Azeri	5.1	5.8
WC-PDQ	5.1	5.1

Table 9.7
WC-PDQ Operational Flaring (Restricted Gas Export) Only,
No Other Platforms in Operation: Predicted NO_2 Concentrations

Receptor	Annual	99.79th%
EU Air Quality Standards	*40*	*200*
Baku	5.2	7.1
Sangachal	5.1	6.8
ACGIH Occupational Standards	*NA*	*12-hr Exposure-3,760*
CA-CWP	5.1	5.6
CA-PDQ	5.1	5.6
Chirag-1	5.2	7.5
DWG-DUQ	5.2	7.9
DWG-PCWU	5.2	8.0
East Azeri	5.1	5.3
West Azeri	5.1	5.9
WC-PDQ	5.1	5.1

Table 9.8

WC-PDQ Only: Predicted NO_2 Concentrations - Emergency Flaring

Receptor	Annual	99.79th%
EU Air Quality Standards	*40*	*200*
Baku	5.2	7.1
Sangachal	5.1	6.8
ACGIH Occupational Standards	*NA*	*12-hr Exposure-3,760*
CA-CWP	5.1	5.5
CA-PDQ	5.1	5.5
Chirag-1	5.2	7.0
DWG-DUQ	5.2	8.7
DWG-PCWU	5.2	9.0
East Azeri	5.1	5.4
West Azeri	5.1	5.7
WC-PDQ	5.1	5.1

WC-PDQ alone makes a very small difference to the air quality, even with respect of other platforms located nearby. .

9.3 Offshore Gridded Receptors-Fine Grid

In this section contour plots of the 99.79th percentile and annual average NO_2 concentrations for the defined scenarios are given. The plots within Section 9.3 show DWG and Central Azeri complexes as single points, representing bridge-linked platforms.

Figure 9.1a
All Platforms Normal Operations: NO_2 P99.79th Percentile Concentrations

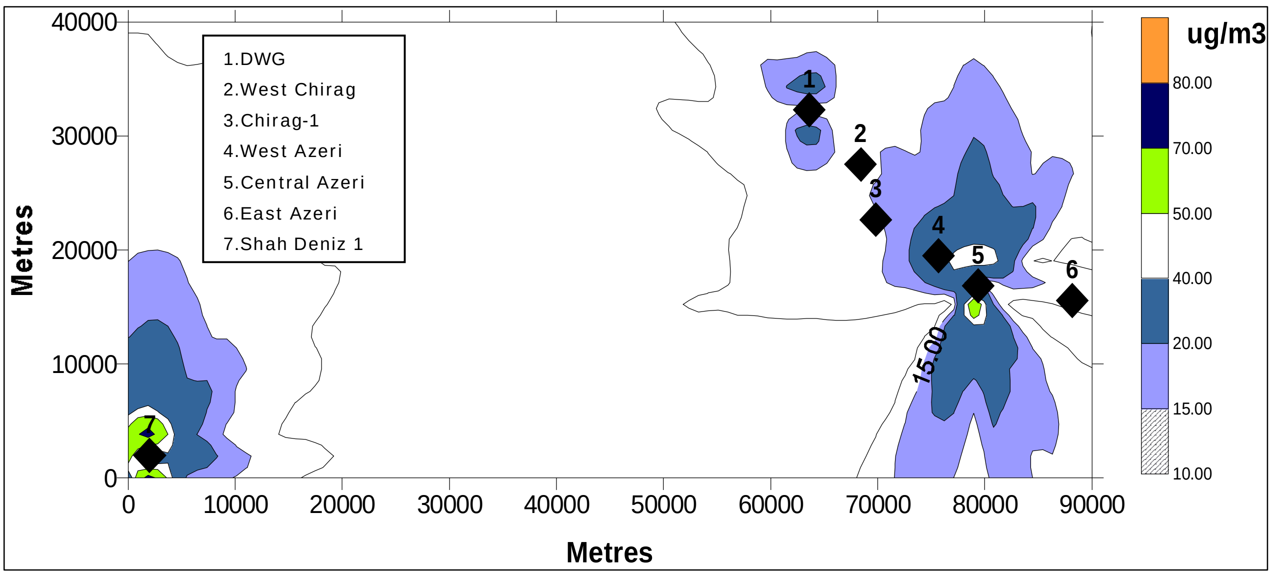


Figure 9.1b
All Platforms Normal Operations: NO_2 Annual Average Concentrations

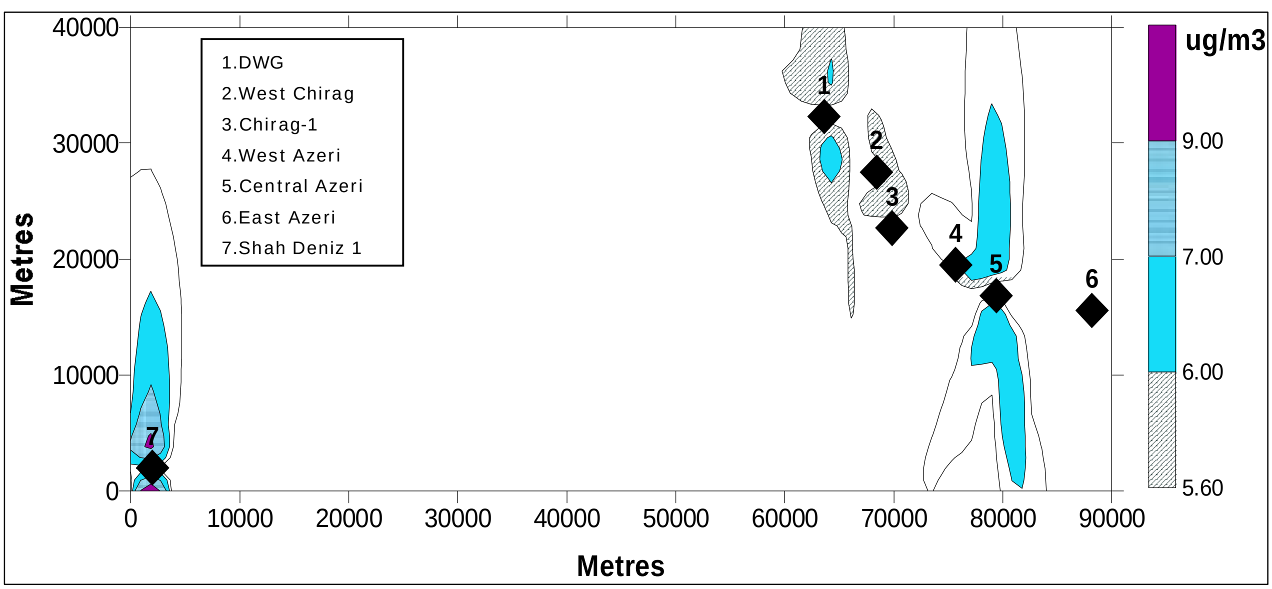


Figure 9.2a

WC-PDQ Operational Flaring (Restricted Gas Export) and

All Other Platforms Normal Operations: NO_2 P99.79th Percentile Concentrations

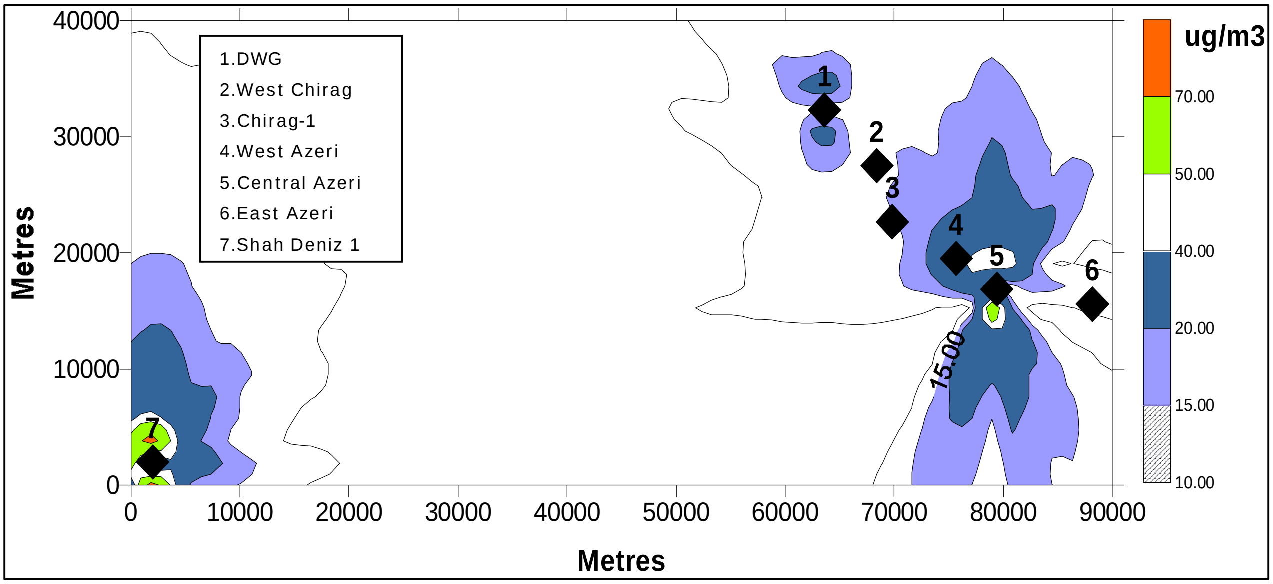


Figure 9.2b

WC-PDQ Operational Flaring (Restricted Gas Export) and

All Other Platforms Normal Operations: NO_2 Annual Average Concentrations

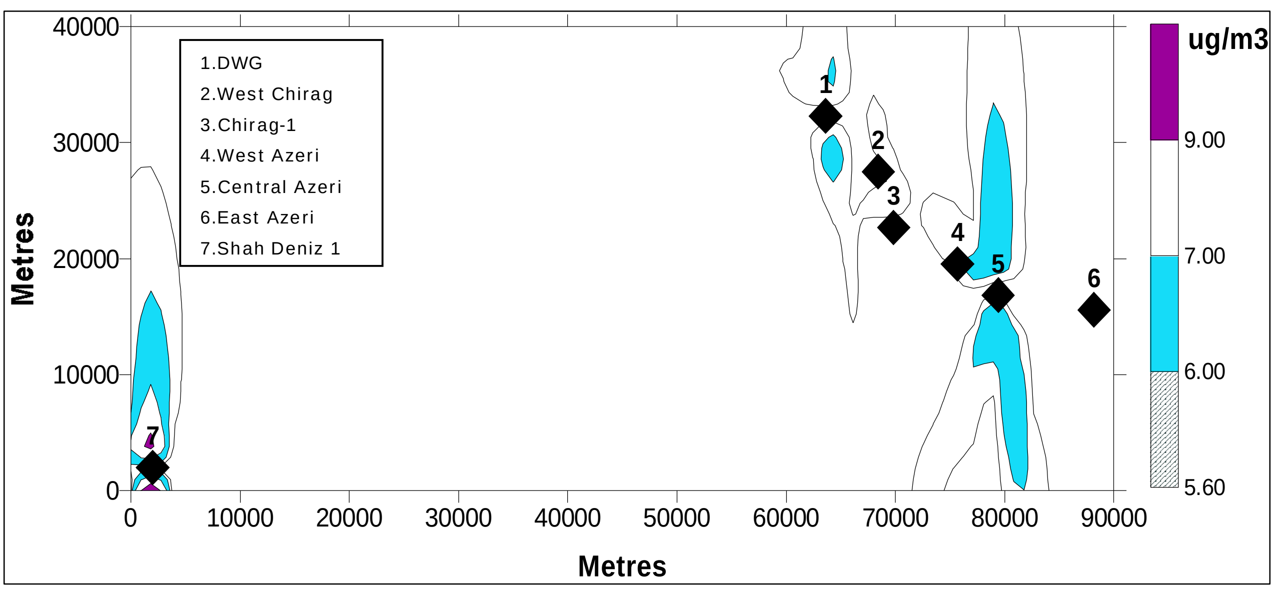


Figure 9.3a

DWG-PCWU Operational Flaring (Restricted Gas Export) and

All Other Platforms Normal Operations: NO_2 P99.79th Percentile Concentrations

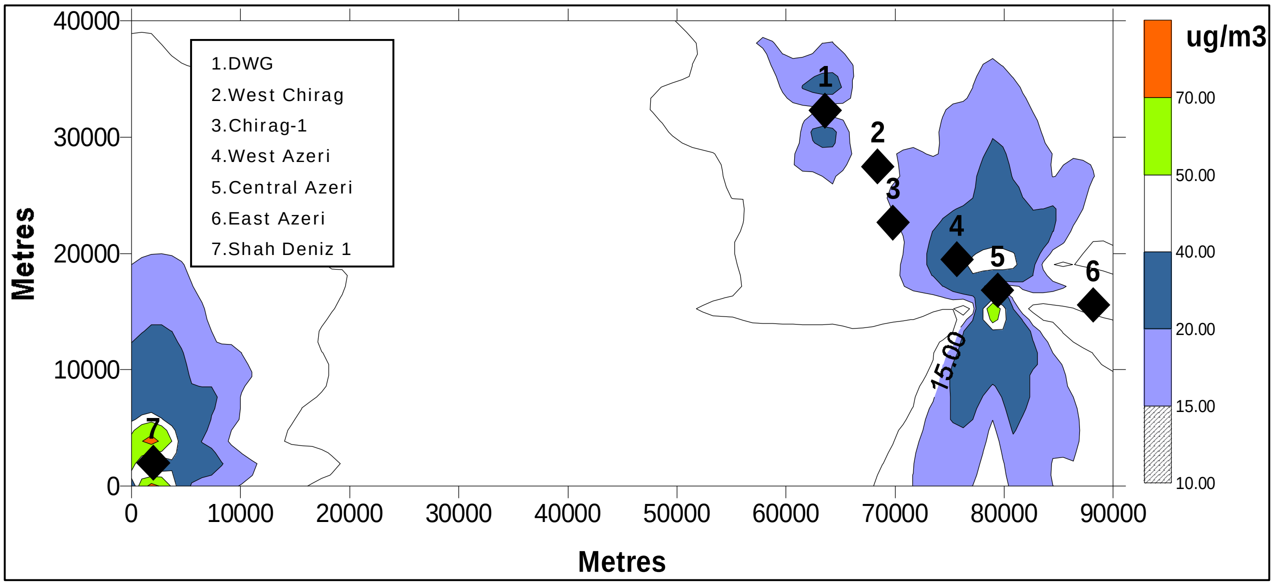


Figure 9.3b

DWG-PCWU Operational Flaring (Restricted Gas Export) and

All Other Platforms Normal Operations: NO_2 Annual Average Concentrations

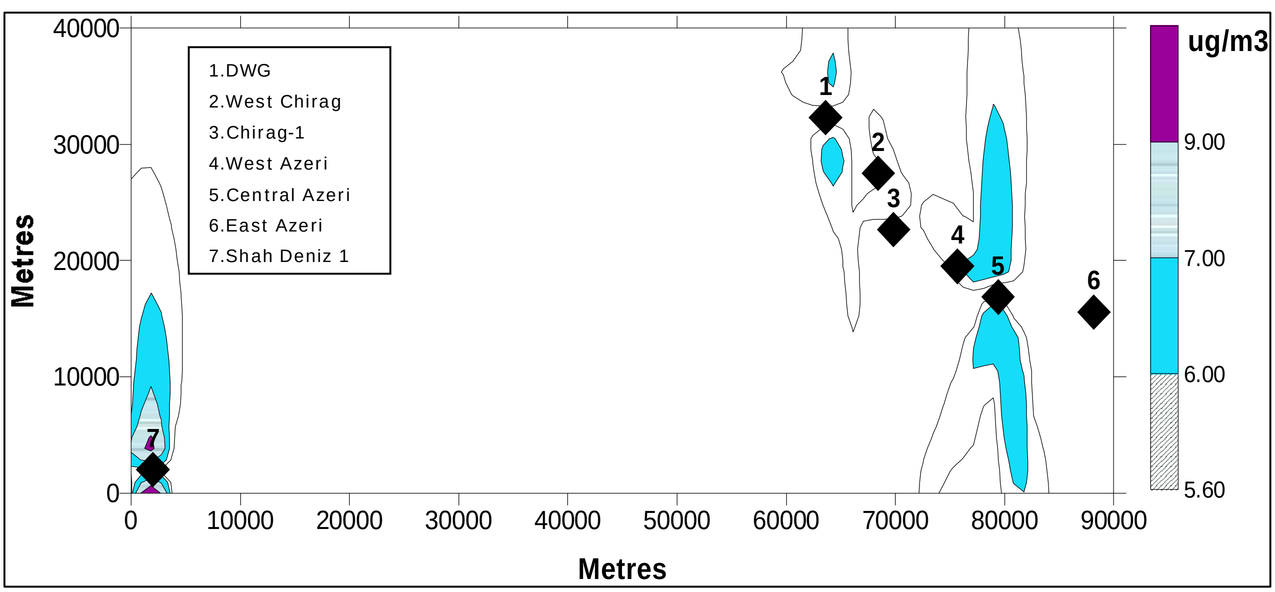


Figure 9.4a
WC-PDQ ESD Flaring and
All Other Platforms Normal Operations: NO_2 P99.79th Percentile Concentrations

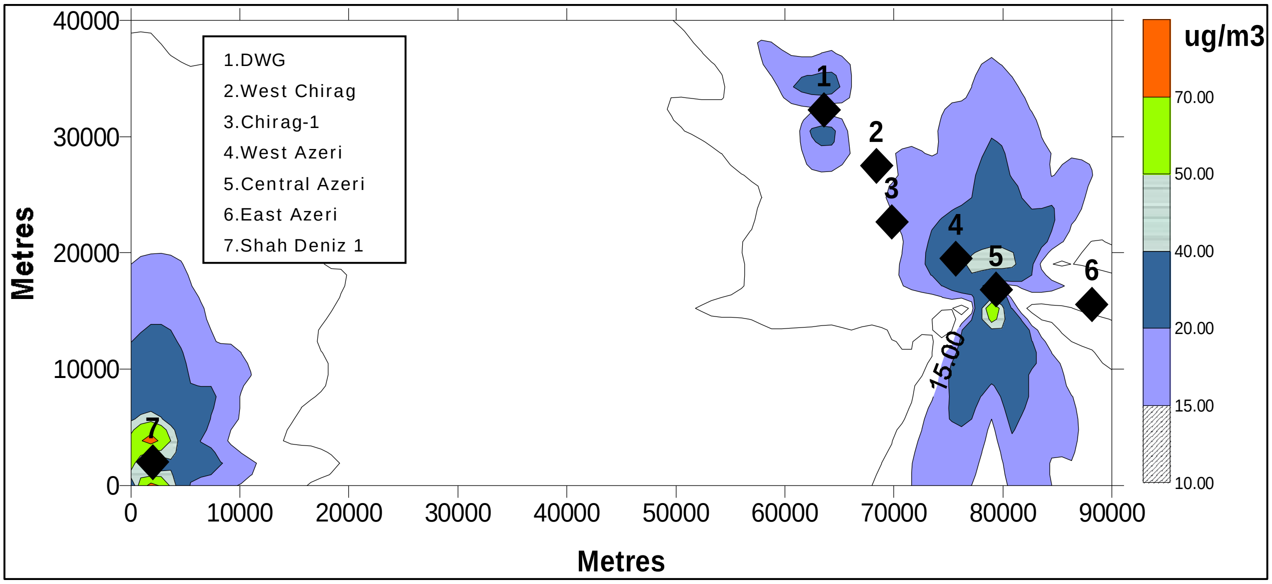


Figure 9.4b
WC-PDQ ESD Flaring and
All Other Platforms Normal Operations: NO_2 Annual Average Concentrations

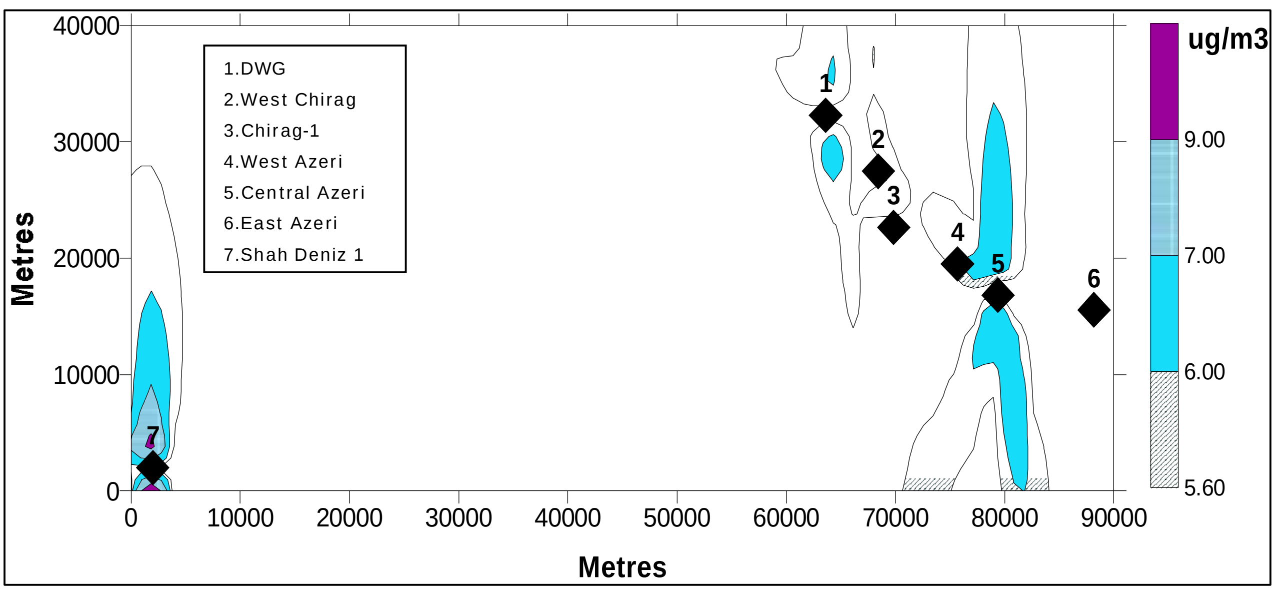


Figure 9.5a
DWG-PCWU ESD Flaring and
All Other Platforms Normal Operations: NO_2 P99.79th Percentile Concentrations

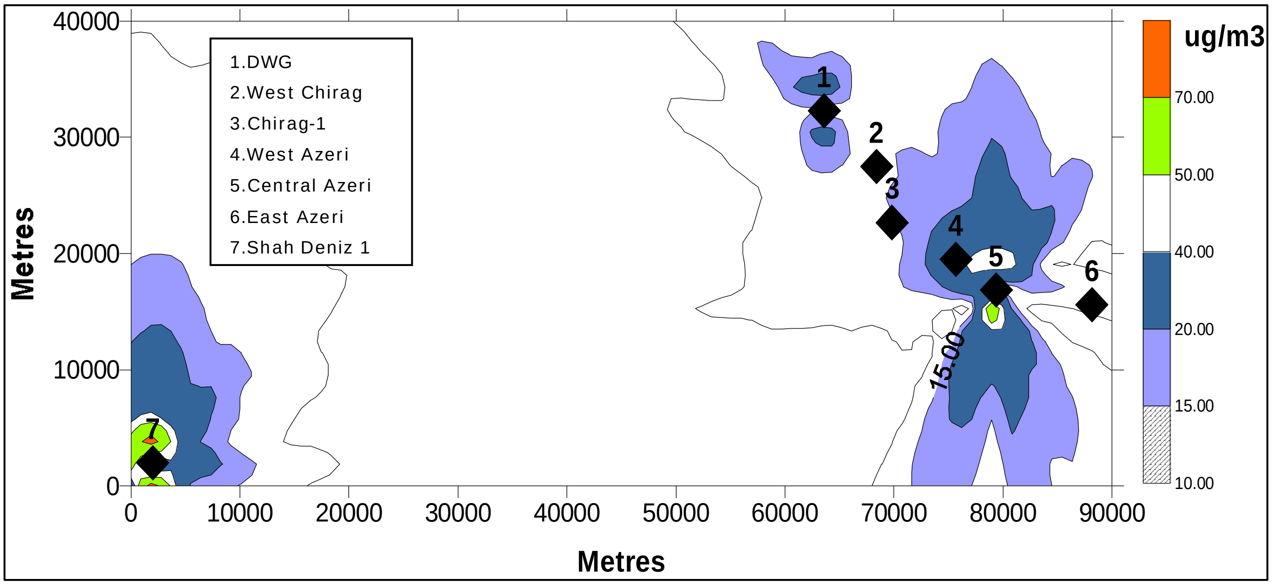
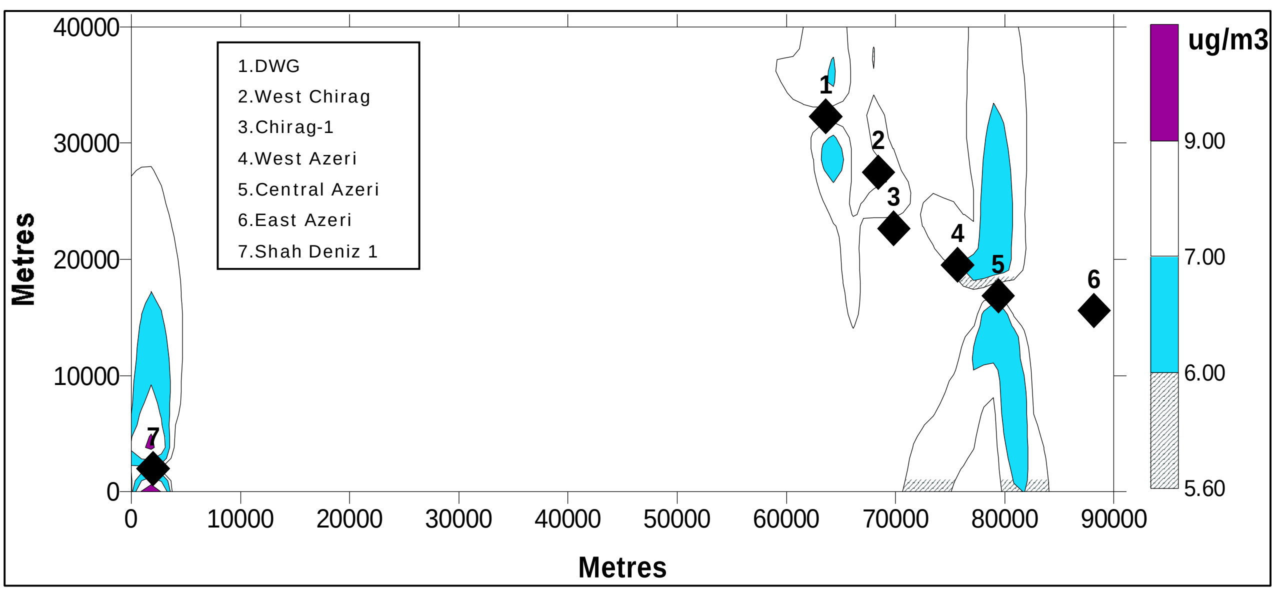


Figure 9.5b
DWG-PCWU ESD Flaring and
All Other Platforms Normal Operations: NO_2 Annual Average Concentrations



The plots of NO_2 concentration offshore show the effects of the north-south prevailing wind directions, with the highest concentrations aligned with the wind direction. The areas of higher concentrations, for example above 50 µg/m³ (short–term), are quite limited. Long-term concentrations are only marginally above background at most locations. Flaring, operational or ESD, makes little contribution to pollution levels.

9.4 Medium Grid Including Nearest Onshore Receptors

Using a large grid enables onshore receptors to be included. The results are given as contour plots for 99.79th percentile and annual average concentrations in the tables below.

Figure 9.6a
Normal Operations All Platforms: NO_2 P99.79th Percentile Concentrations

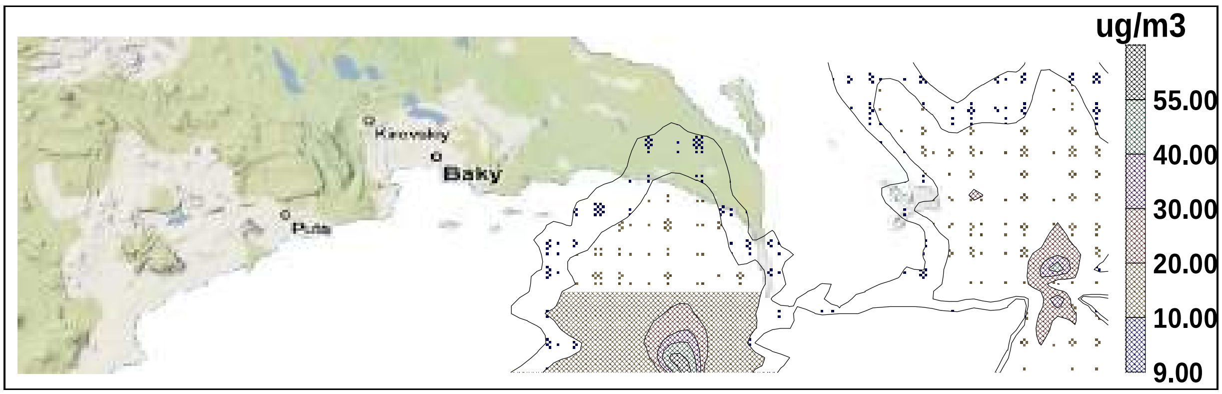


Figure 9.6b
Normal Operations All Platforms: NO_2 Annual Average Concentrations

Figure 9.7a
WC-PDQ Operational Flaring (Restricted Gas Export) and
All Other Platforms Normal Operations: NO_2 P99.79th Percentile Concentrations

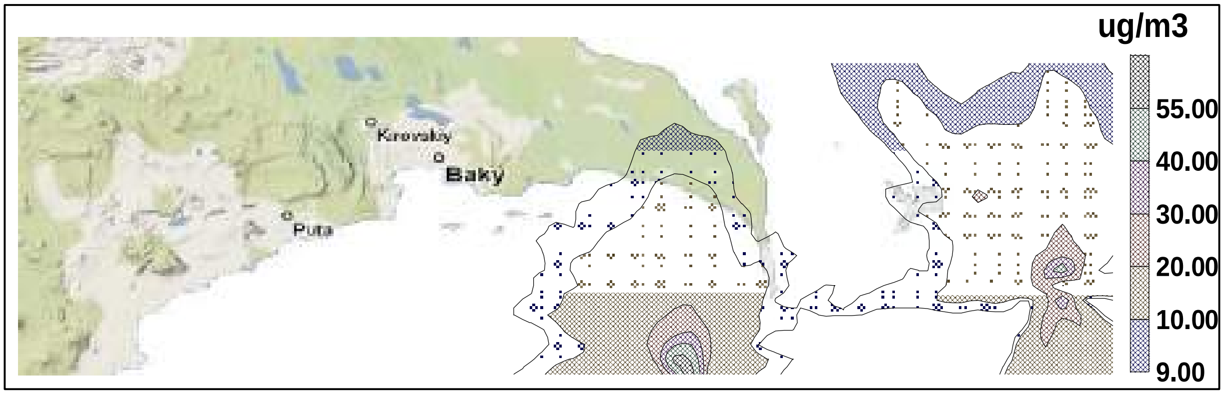


Figure 9.7b
WC-PDQ Operational Flaring (Restricted Gas Export) and
All Other Platforms Normal Operations: NO_2 Annual Average Concentrations

Figure 9.8a
DWG-PCWU Operational Flaring (Restricted Gas Export) and
All Other Platforms Normal Operations: NO_2 P99.79th Percentile Concentrations

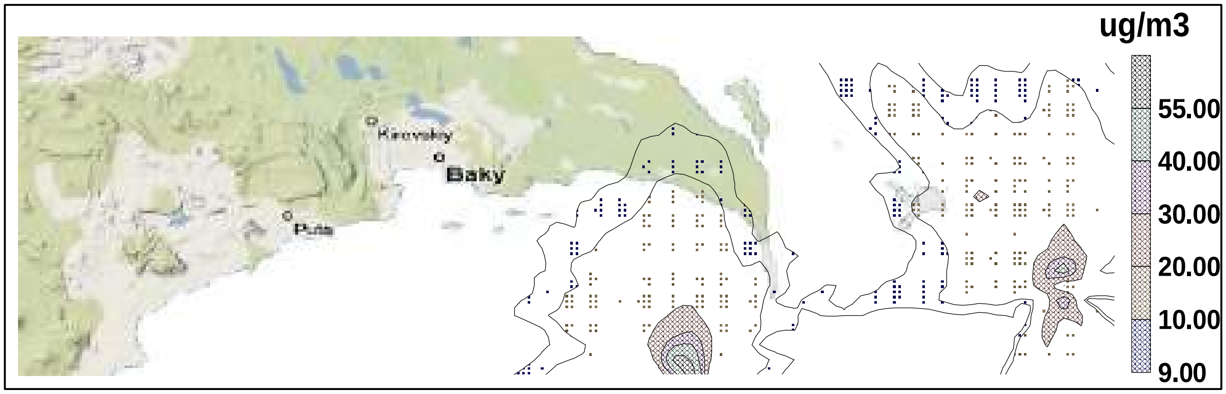
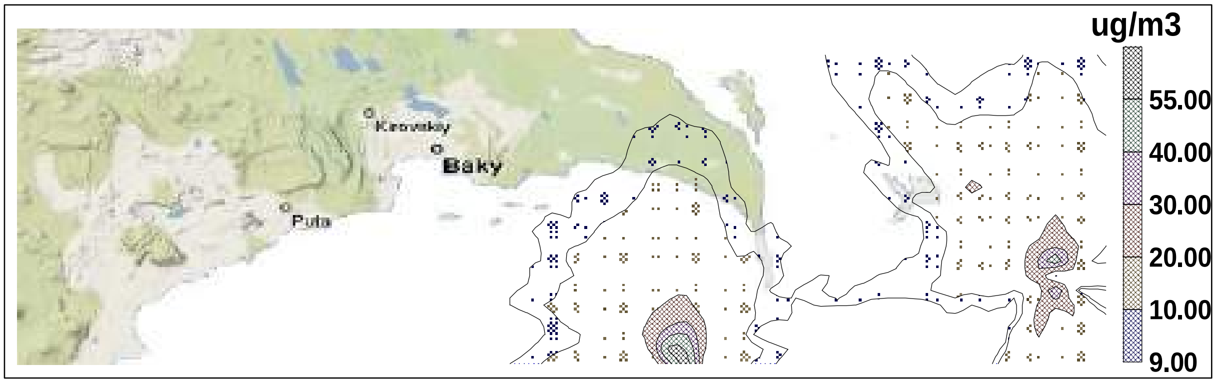


Figure 9.8b
DWG-PCWU Operational Flaring (Restricted Gas Export) and
All Other Platforms Normal Operations: NO_2 Annual Average Concentrations

Figure 9.9
WC-PDQ ESD Flaring and
All Other Platforms Normal Operations: NO_2 P99.79th Percentile Concentrations



9.5 WC-PDQ Only Impact

In this section, only WC-PDQ is assumed to be operating in order to allow the contribution of its emissions to air quality levels. The grid size is reduced to enable near-source concentrations to be show in detail.

Figure 9.10
WC-PDQ Only, Normal Operations: NO_2 P99.79th Percentile Concentrations

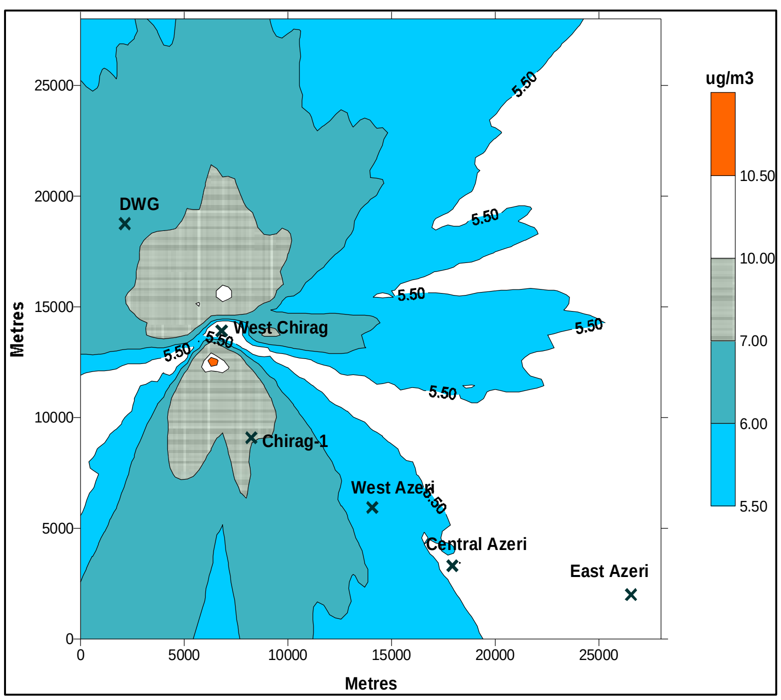


Figure 9.11

WC-PDQ Only, Normal Operations: NO_2 Annual Average Concentrations

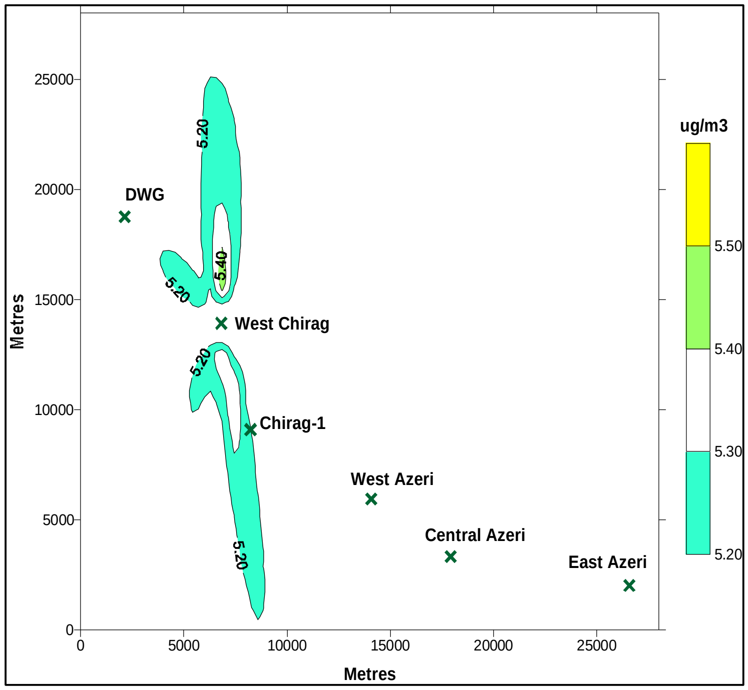


Figure 9.12

WC-PDQ Only, Operational Flaring (Restricted Gas Export): NO_2 P99.79th Percentile Concentrations

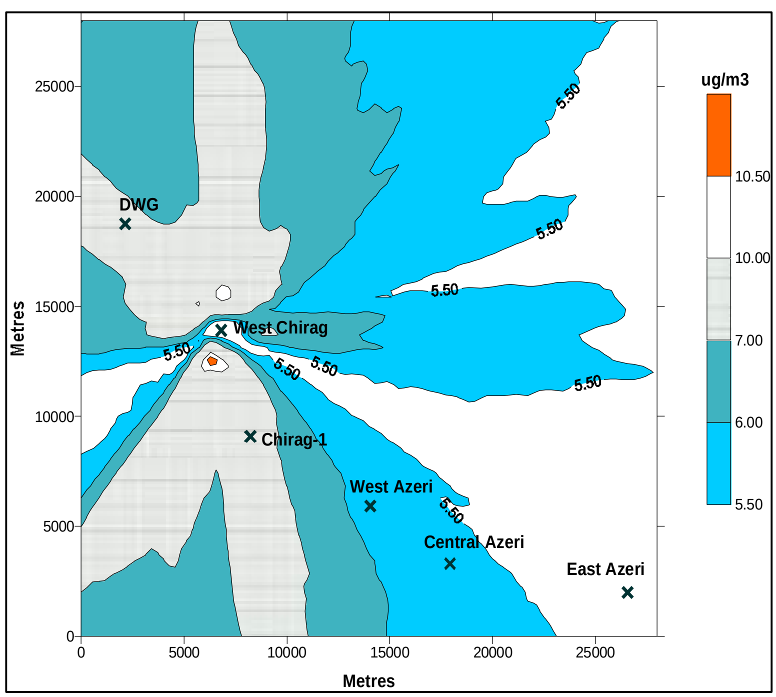


Figure 9.13
WC-PDQ Only, Operational Flaring (Restricted Gas Export): NO_2 Annual Average Concentrations

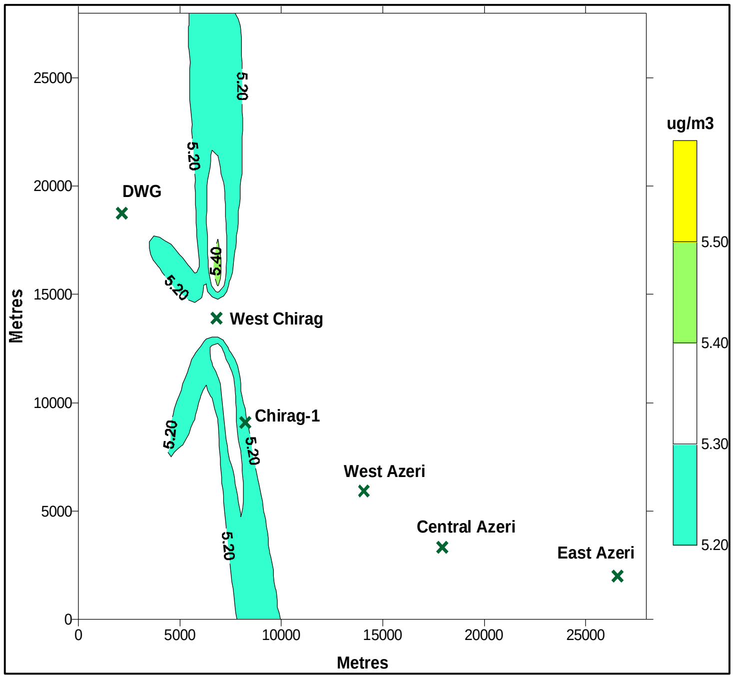


Figure 9.14
WC-PDQ Only, ESD Flaring: NO_2 P99.79th Percentile Concentrations

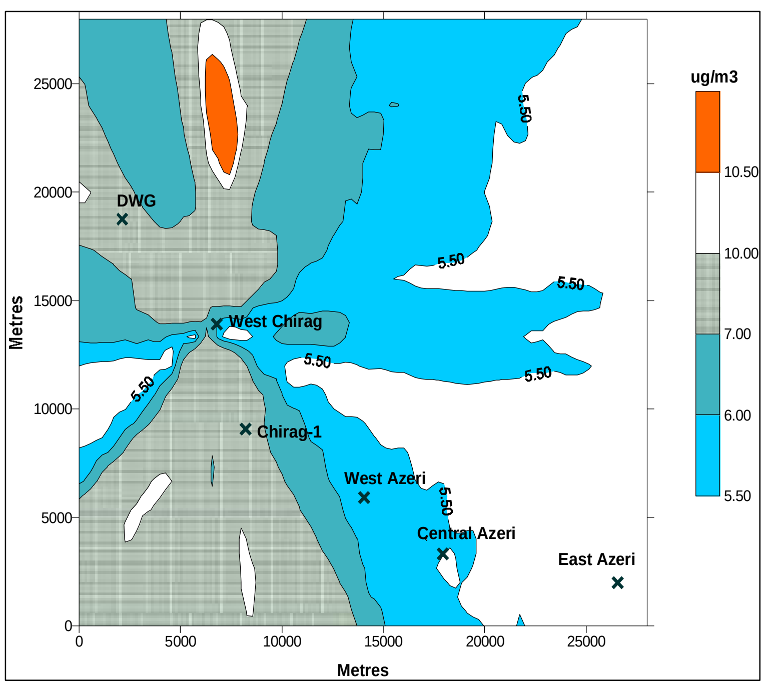
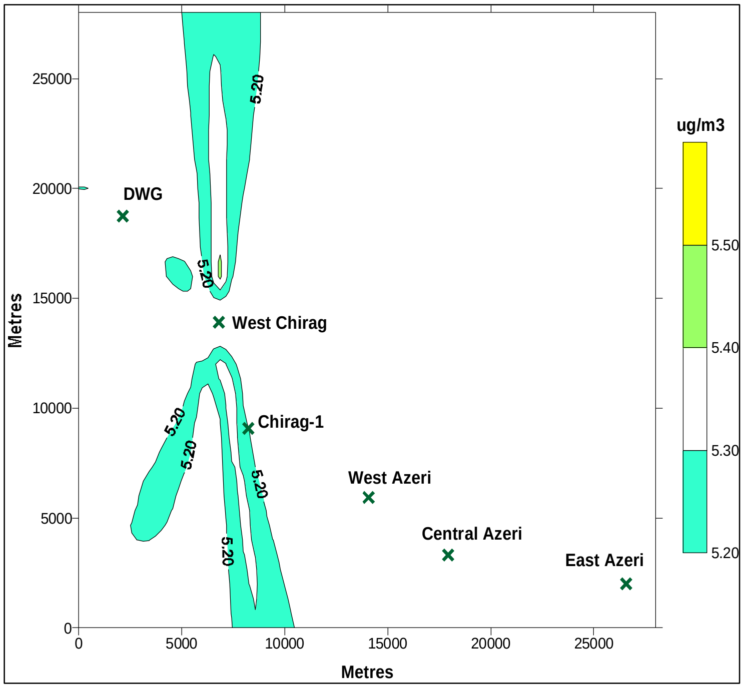


Figure 9.15
WC-PDQ Only, ESD Flaring: NO_2 Annual Average Concentrations



The figures show that, during normal operations, the maximum concentrations are found under 3km from the platform. When flaring, in particular during the ESD flaring, the maximum is found between 5-15km from the platform. This is due to the greater effective height of the flare plume resulting in a longer period for mixing down to sea level to occur. The maximum concentration remains well below occupational exposure limits.

9.6 Central Caspian Region

An area of 550km x 550km was modelled in order to show adjacent states. The results are presented in Appendix II in Figures AII.1a – AII.5b. The contours serve to illustrate the shape of the concentration distrubutions but the pollution levels are well below those considered significant as all points in the grid. It should be bourne in mind that the total emissions from the concession area are below many individual industrial plants or cities, and that emissions sources are comparatively high which aids dispersion, reducing the concentrations at the ground.

9.7 Dada Gorgud MODU modelling

The Dada Gorgud MODU was modelled druing drilling and well testing. The NO_2 release rate from the well test was found to be less than operational or emergency flaring from a production platform. The results show that the MODU has no significant impact on adjacent offshore receptors or onshore areas. Smoke , a common problem with well tests, should be effectively controlled by the use of the EverGreen Burner.

10.0 CONCLUSIONS

The offshore air quality in the region has been determined on the basis of the emissions from the platforms in the Central Caspian using dispersion modelling. Meteorological data files, suitable for input into dispersion modelling, have been prepared for this study. They have been based upon measurements made offshore of the platforms.

The focus has included both the exposure of workers on the new WC-PDQ platform to air pollutants and of the contribution of the platform itself to air pollution levels in the region. Both offshore and onshore air quality impacts have been assessed.

Occupational exposure limits apply offshore and the prediction concentrations are low compared with the occupational limits. Indeed, the air quality offshore would be regarded as good even when compared with onshore standards. The concentrations of NO_2 are well below the EU standards of 40µg/m^3 annual average and 200 µg/m^3 99.79th percentile.

The findings show that, for receptors within the region, including marine traffic around the offshore platforms and onshore receptors along the coastline, including Baku and Sangachal, NO_2 concentrations resulting from platform emission are low. Emissions from the Dada Gorgud MODU during both normal operations and well testing are low with no significant impacts to receptors within the Central Caspian.

In conclusion, the proposed WC-PDQ platform workforce is not at risk from air pollution nor does the addition of the new platform and associated drilling activities cause levels in the region to rise significantly. There is a small contribution from offshore to onshore, but it is well below a level that could be considered significant.

11.0 REFERENCES

1 EU First Daughter Directive (99/30/EC),1999

2 Rolls-Royce," Combustion Gas Turbine Performance Curves (Purchase Order No. BPAC-ACGX-PMME01A)", 2005

3 Caspian Sea "Ocean Meteorological And Oceanographic Study 2",Oceanweather Inc, 2005

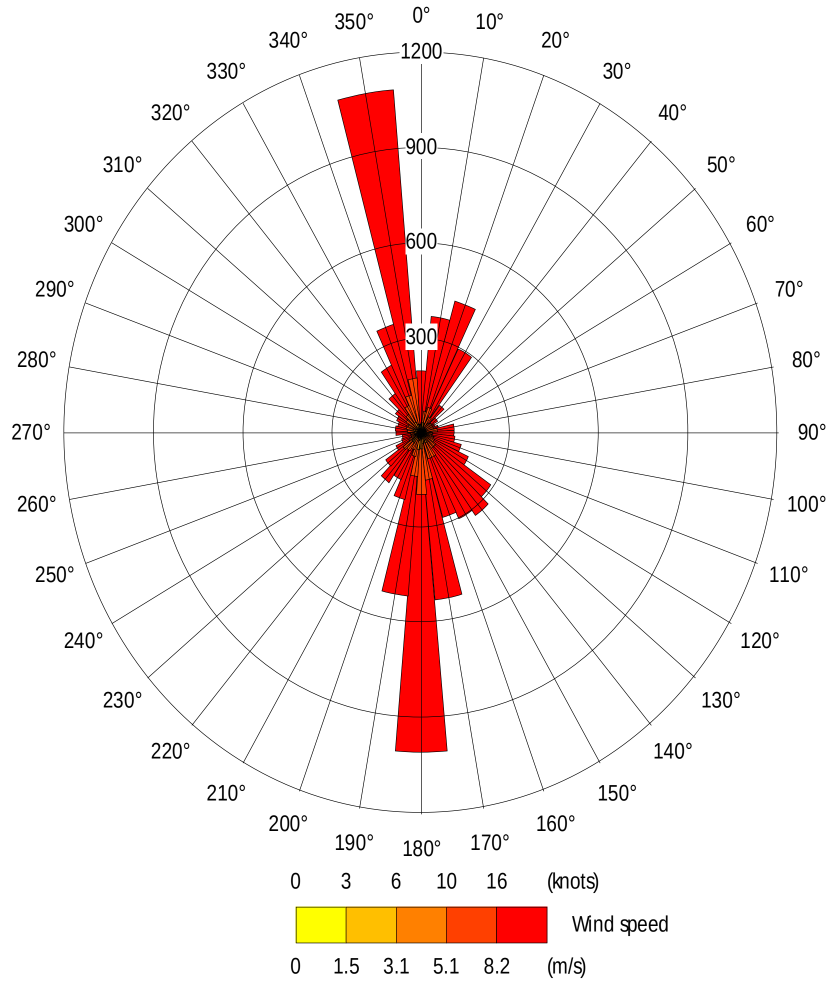
4 Cambridge Environmental Research Consultants,"ADMS4 User Guide", June 2007

5 American Conference of Governmental Industrial Hygienists, 2008

6 UK Offshore Operators Association ,"UKOOA emission factors for flares",2005

7 Schlumberger, "EverGreen Burner",2006

APPENDIX I
WINDROSE



APPENDIX II
CENTRAL CASPIAN REGIONAL IMPACT

AII 1.1 All Platforms, Central Caspian Regional Impact

Figure AII.1a
All Platforms Normal Operations: NO_2 P99.79th Percentile Concentrations

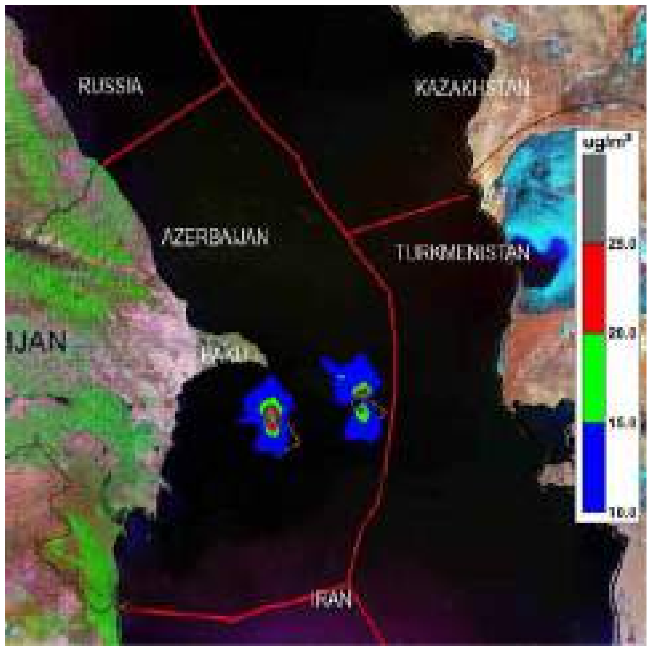


Figure AII.1b
All Platforms Normal Operations: NO_2 Annual Average Concentrations

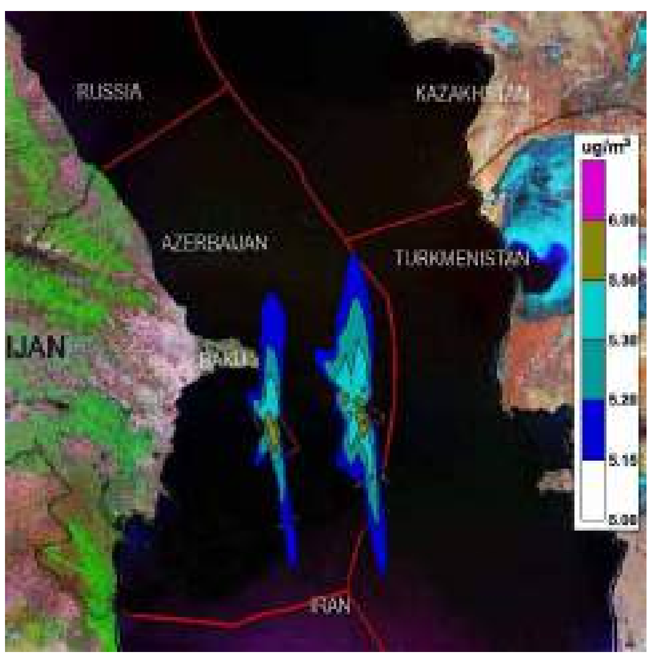


Figure AII.2a

WC-PDQ Emergency Depressurisation and All Other Platforms Normal Operations: NO_2 P99.79th Percentile Concentrations

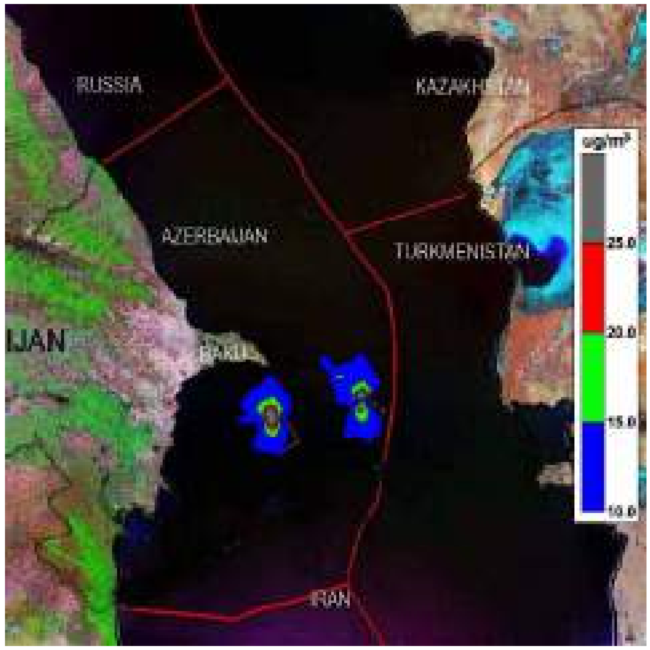
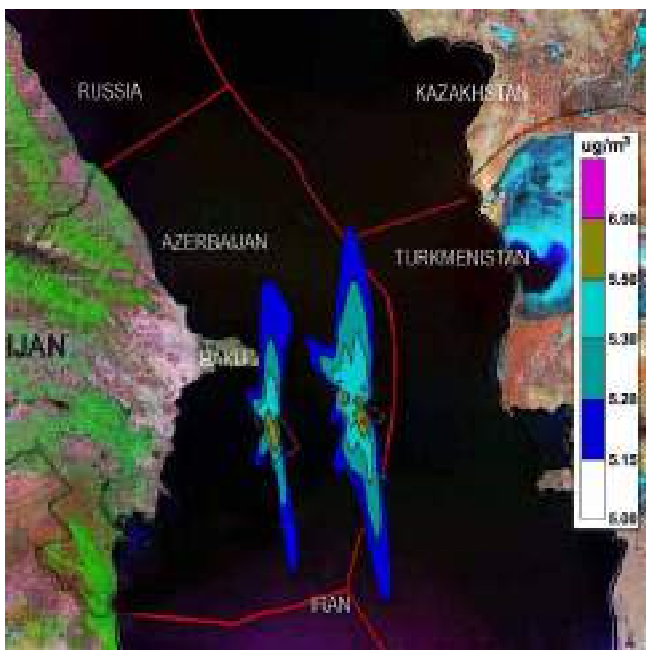


Figure AII.2b

WC-PDQ Emergency Depressurisation and All Other Platforms Normal Operations: NO_2 Annual Average Concentrations



AII 1.2 WC-PDQ Only, Central Caspian Regional Impact

Figure AII.3a
WC-PDQ Only, Normal Operations: NO_2 P99.79th Percentile Concentrations

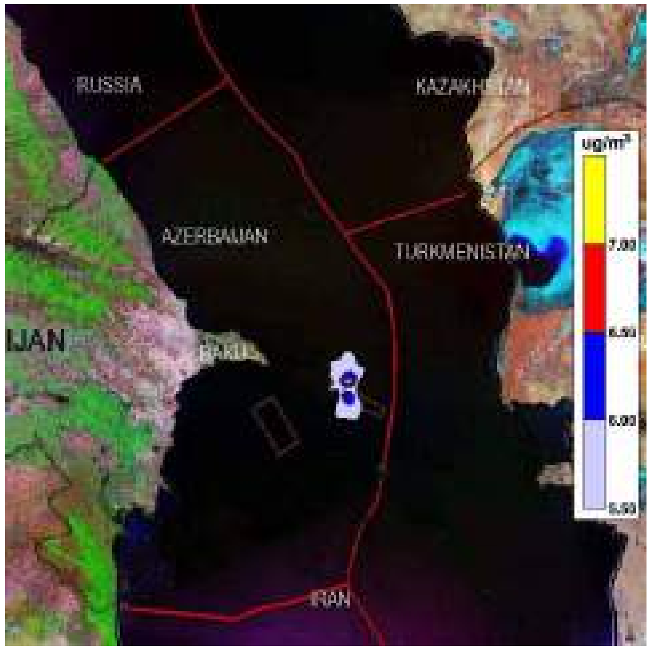


Figure AII.3b
WC-PDQ Only, Normal Operations: NO_2 Annual Average Concentrations

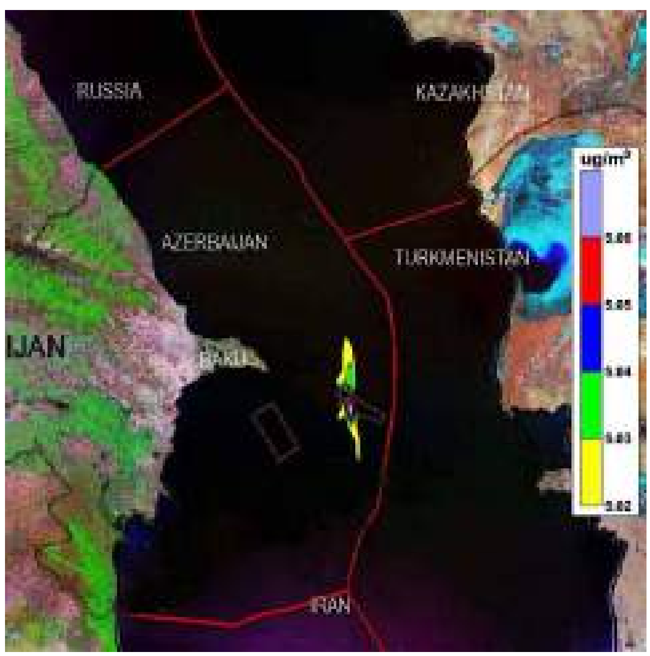


Figure AII.4a

WC-PDQ Only, Operational Flaring (Restricted Gas Export): NO_2 P99.79th Percentile Concentrations

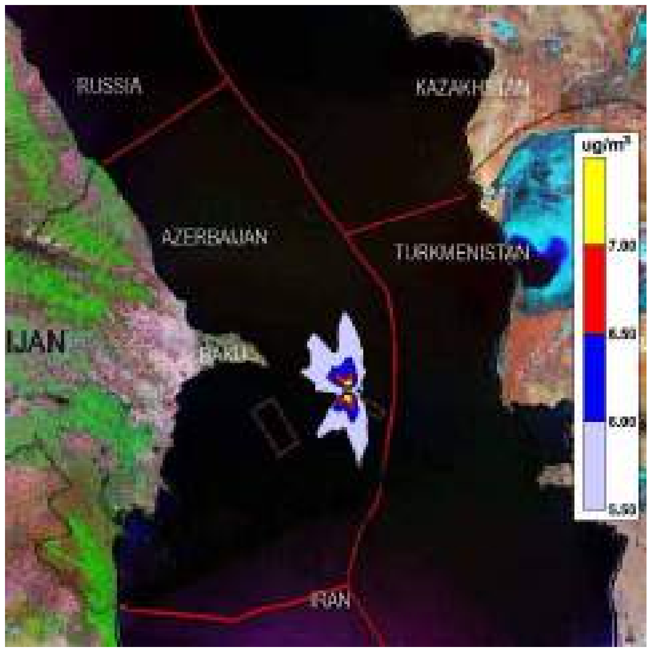


Figure AII.4b

WC-PDQ Only, Operational Flaring (Restricted Gas Export): NO_2 Annual Average Concentrations

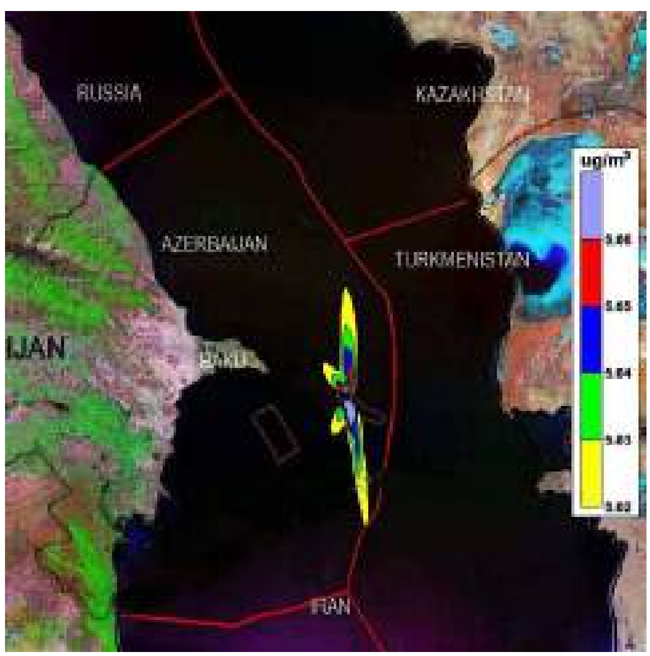


Figure AII.5a

WC-PDQ Only, Emergency Depressurisation: NO_2 P99.79th Percentile Concentrations

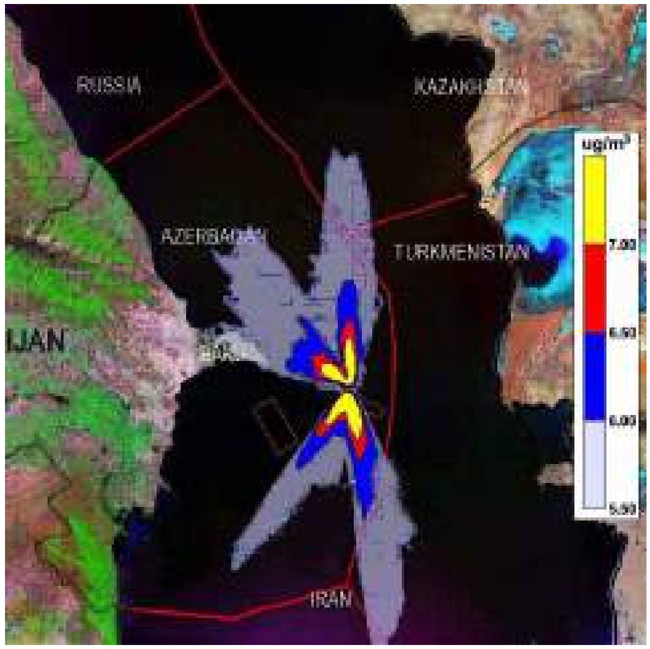
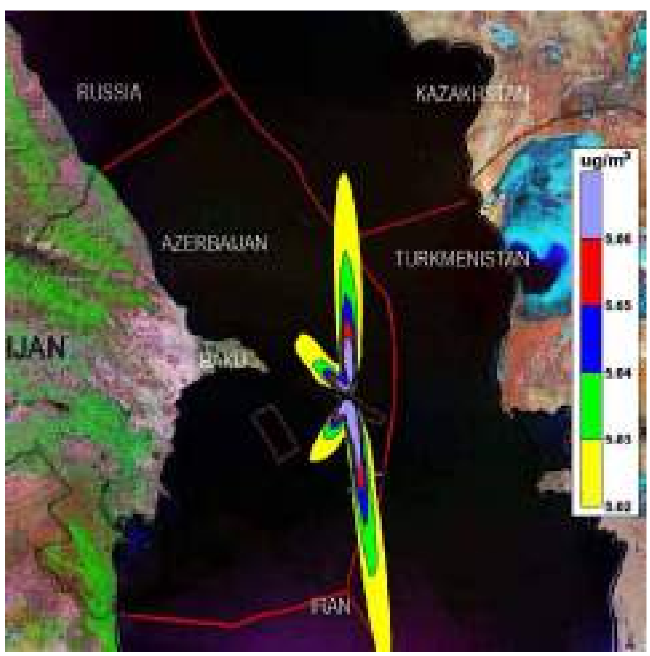


Figure AII.5b

WC-PDQ Only, Emergency Depressurisation: NO_2 Annual Average Concentrations



AII 1.3 Dada Gorgud MODU and All Other Platforms, Central Caspian Regional Impact

Figure AII.6a

Dada Gorgud MODU Power Generation and Normal Operations on All Other Platforms: P99.79th

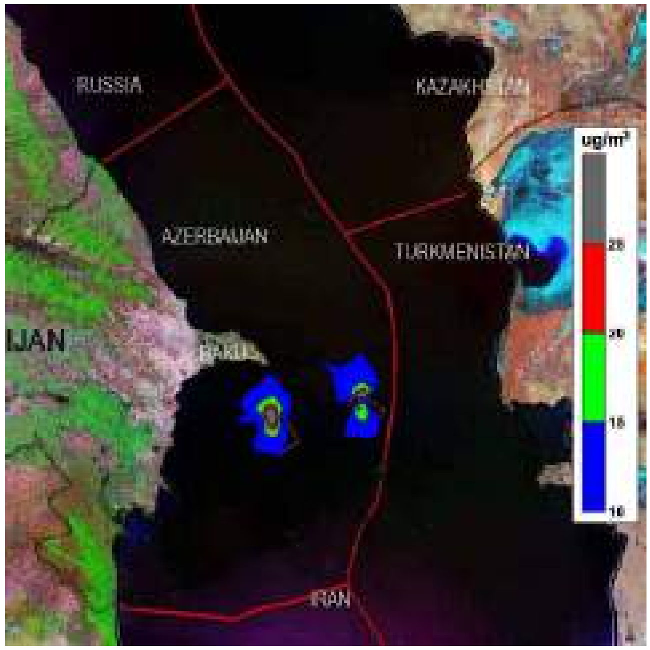


Figure AII.6b

Dada Gorgud MODU Power Generation and Normal Operations on All Other Platforms: NO_2 Annual Average Concentrations

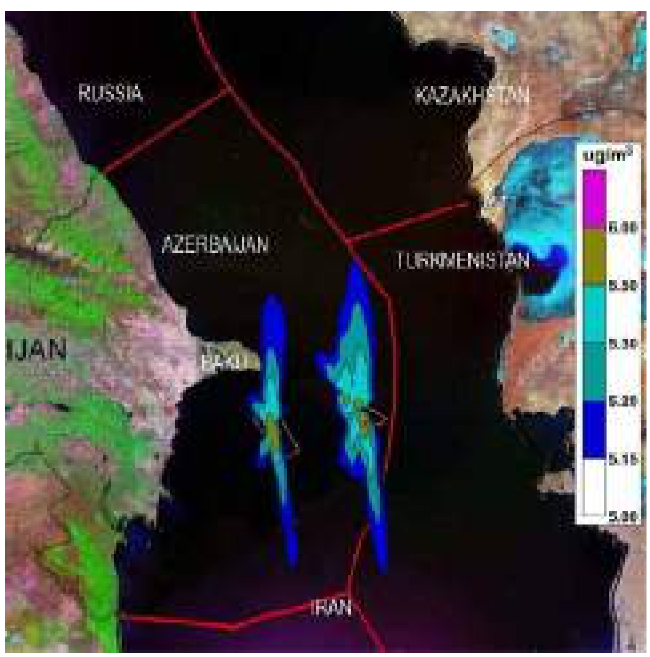


Figure AII.7a
Dada Gorgud MODU, Well Test Flaring and Normal Operations on All Other Platforms: NO_2 P99.79th Percentile Concentrations

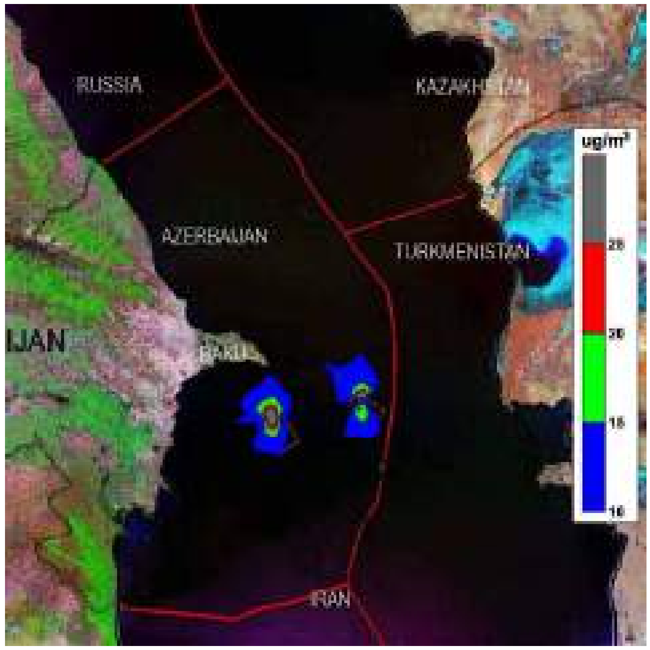


Figure AII.7b
Dada Gorgud MODU, Well Test Flaring and Normal Operations on All Other Platforms: NO_2 Annual Average Concentrations

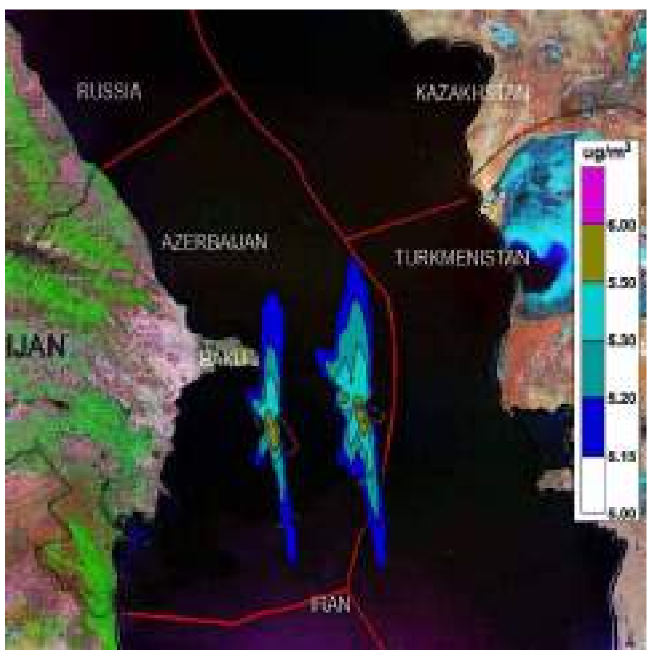


Figure AII.8a

Shah Deniz Diesel Power Generation and Normal Operations on All Other Platforms: NO_2 P99.79th Percentile Concentrations

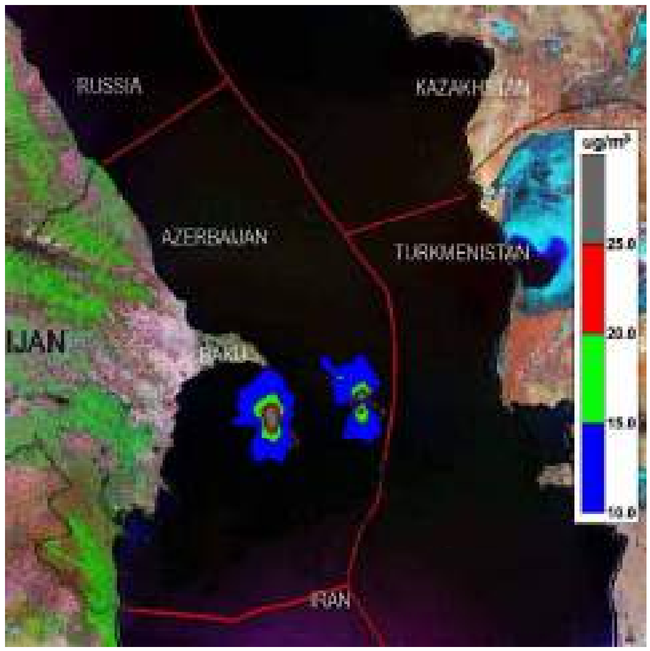
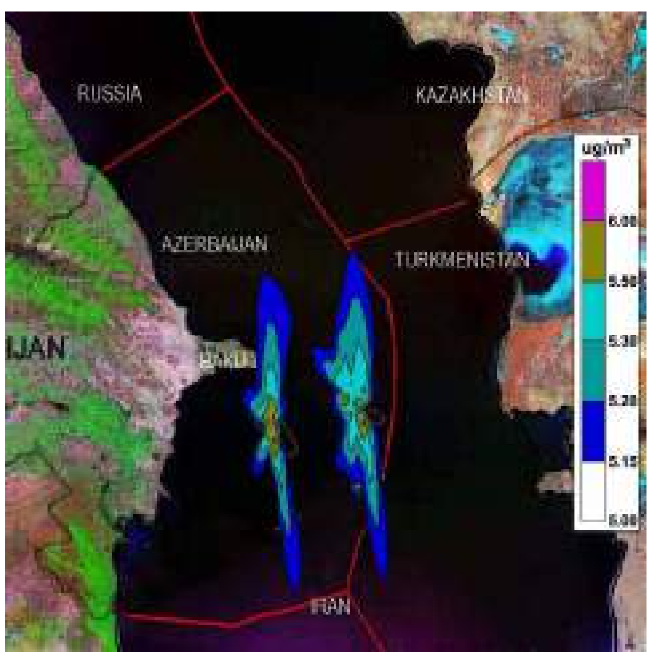


Figure AII.8b

Shah Deniz Diesel Power Generation and Normal Operations on All Other Platforms: NO_2 Annual Average Concentrations



AII 1.4 ACG Contract Area Only, Caspian Regional Impact

Figure AII.9a

ACG Contract Area Platforms Only, Normal Operations on All Platforms: NO_2 P99.79th

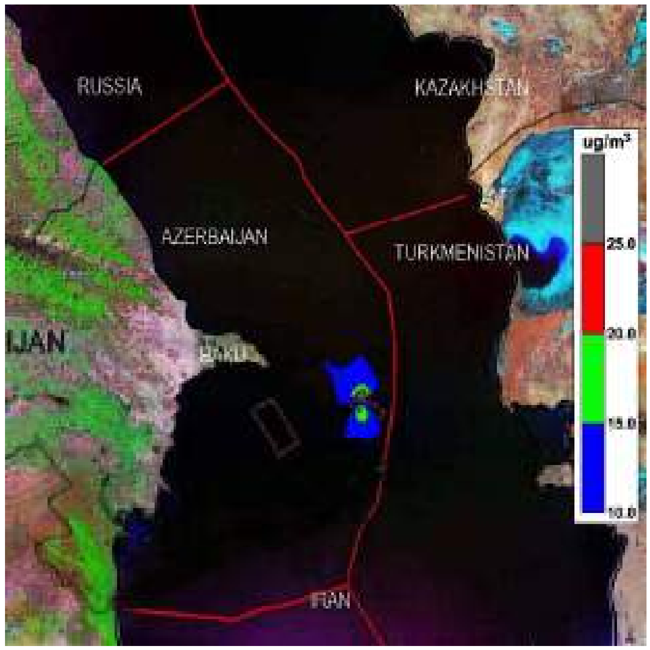


Figure AII.9b

ACG Contract Area Platforms Only, Normal Operations on All Platforms: NO_2 Annual Average Concentrations

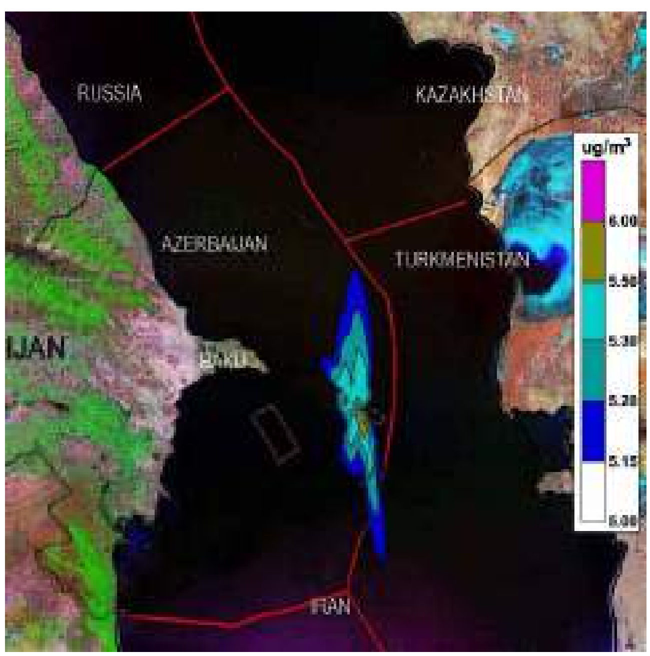


Figure AII.10a

ACG Contract Area Platforms Only, WC-PDQ Operational Flaring (Restricted Gas Export) and Normal Operations on All Other ACG Platforms: NO_2 P99.79th Percentile Concentrations

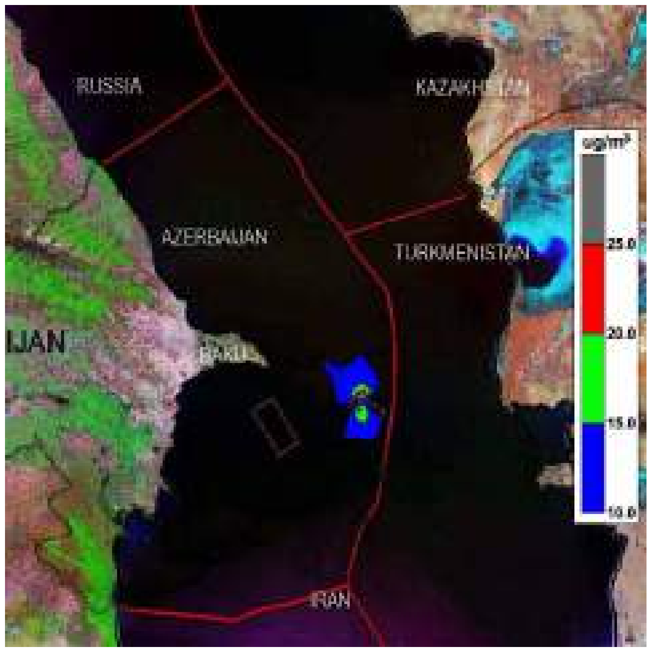


Figure AII.10b

ACG Contract Area Platforms Only, WC-PDQ Operational Flaring (Restricted Gas Export) and Normal Operations on All Other ACG Platforms : NO_2 Annual Average Concentrations

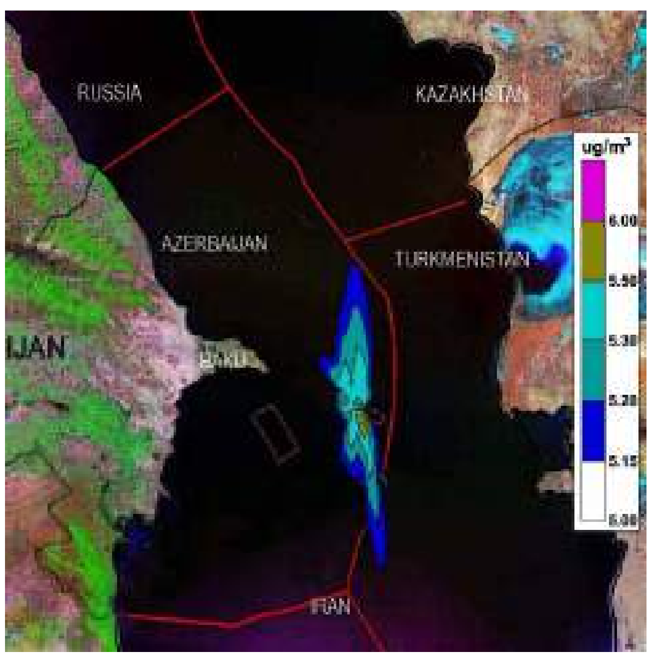


Figure AII.11a
ACG Contract Area Platforms Only, WC-PDQ Emergency Depressurisation and Normal Operations on All Other ACG Platforms: NO_2 P99.79th Percentile Concentrations

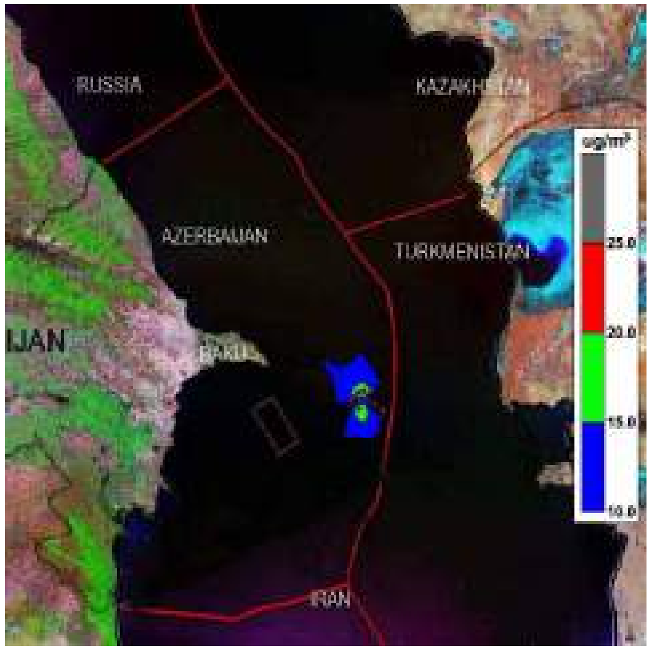
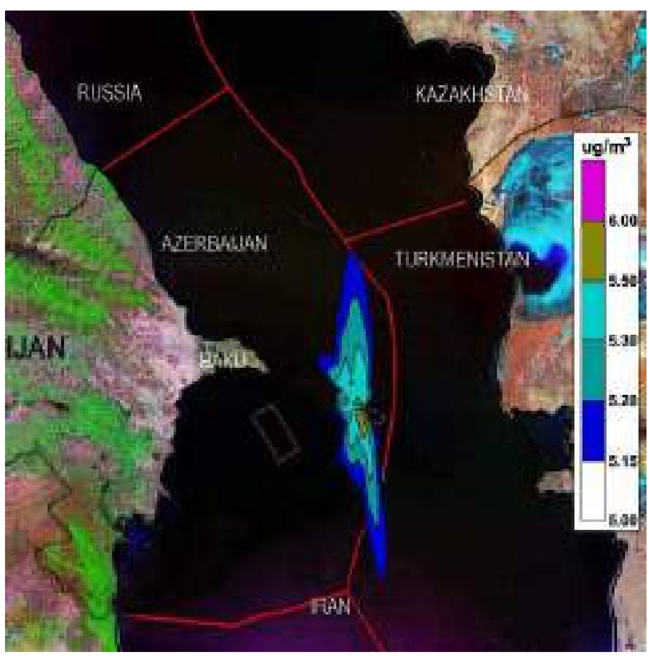


Figure AII.11b
ACG Contract Area Platforms Only, WC-PDQ Emergency Depressurisation and Normal Operations on All Other ACG Platforms: NO_2 Annual Average Concentrations



AII 1.5 Shah Deniz Contract Area, Central Caspian Regional Impact

Figure AII.12a
Shah Deniz Contract Area Platform Only, Normal Operations: NO_2 P99.79th Percentile

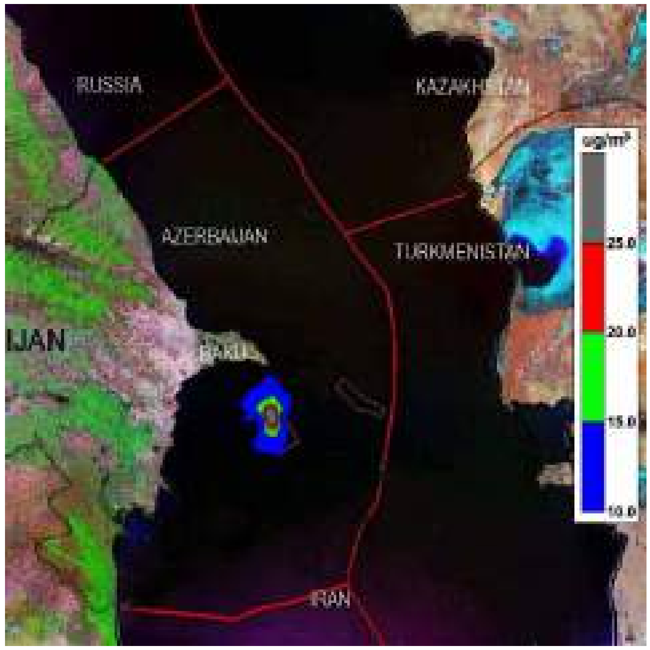


Table AII.12b
Shah Deniz Contract Area Platform Only, Normal Operations: NO_2 Annual Average Concentrations

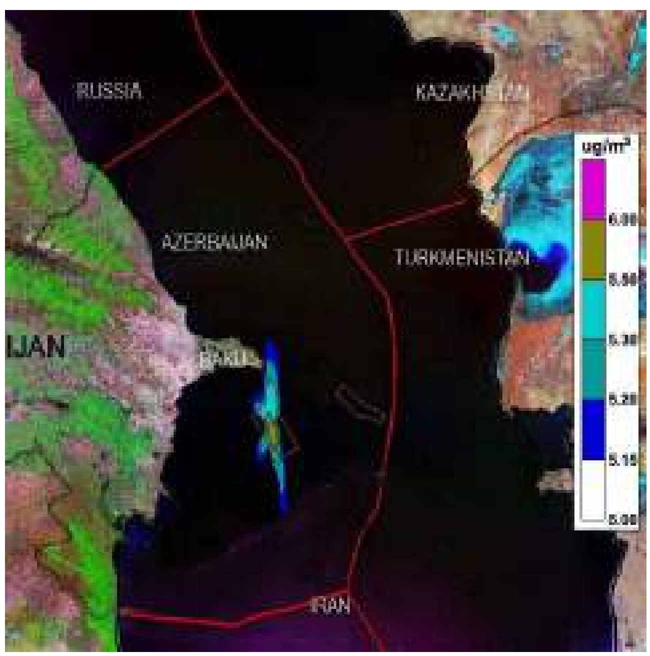


Figure AII.13a
Dada Gorgud MODU Only, Normal Power Generation: NO_2 P99.79th Percentile Concentrations

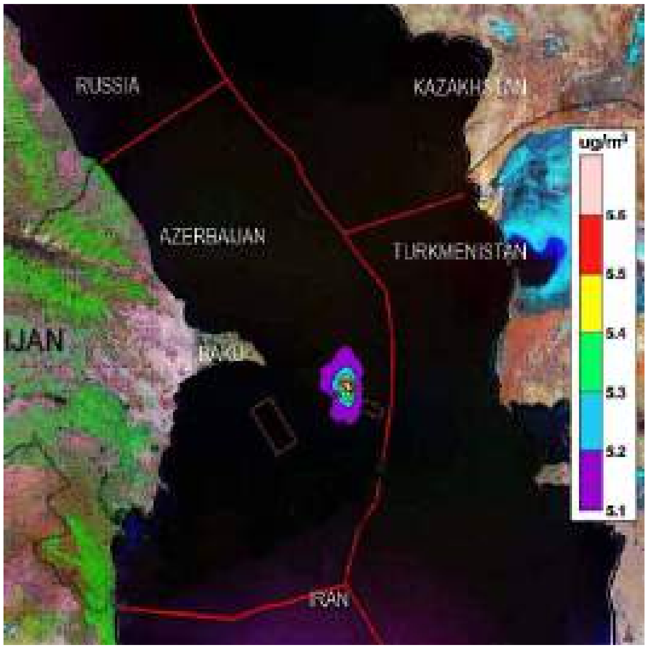


Figure AII.13b
Dada Gorgud MODU Only, Normal Power Generation: NO_2 Annual Average Concentrations

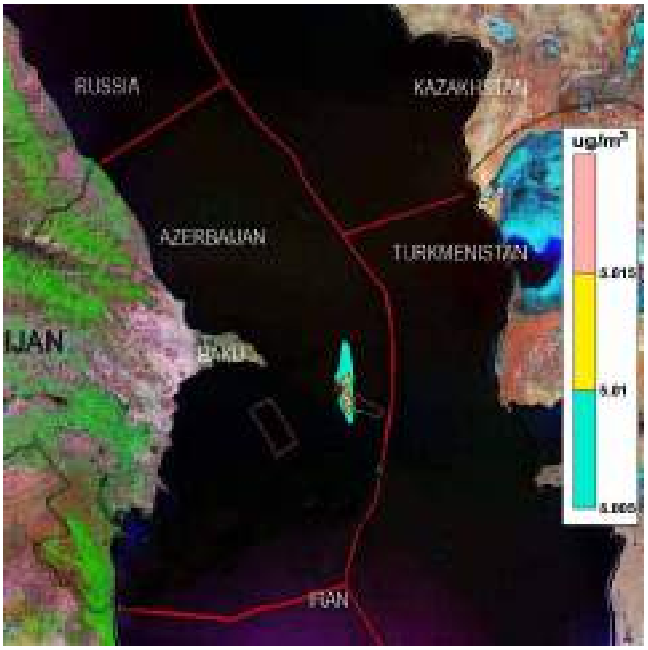


Figure AII.14a
Dada Gorgud MODU Only, Well Test and Power Generation: NO_2 P99.79th Percentile

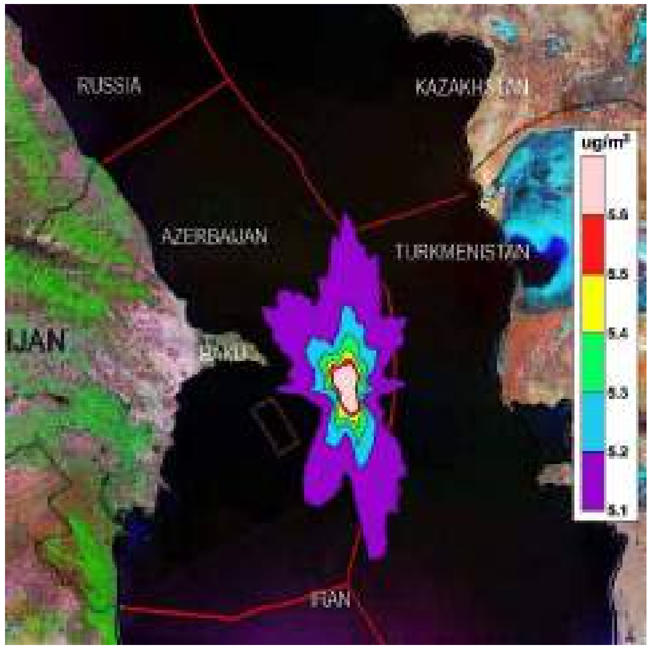


Figure AII.14b
Dada Gorgud MODU Only, Well Test and Power Generation: NO_2 Annual Average Concentrations

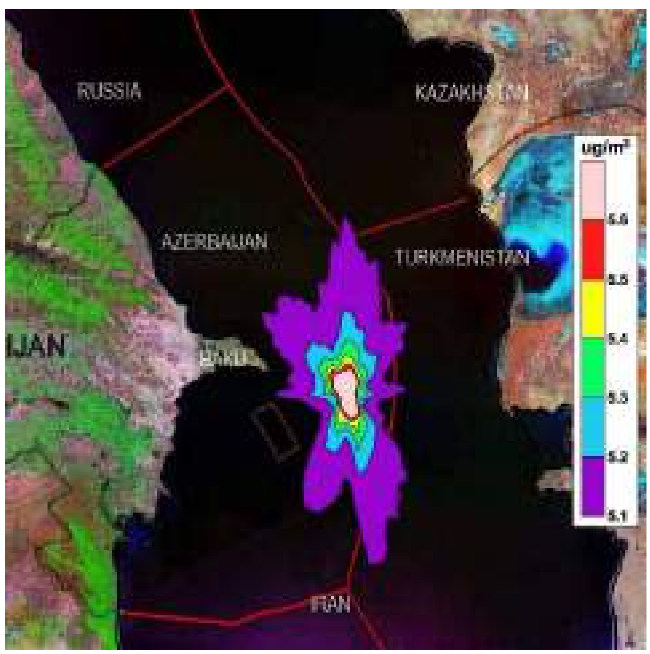


Figure AII.15a

Dada Gorgud MODU Well Test Flare Only: NO_2 P99.79th Percentile Concentrations

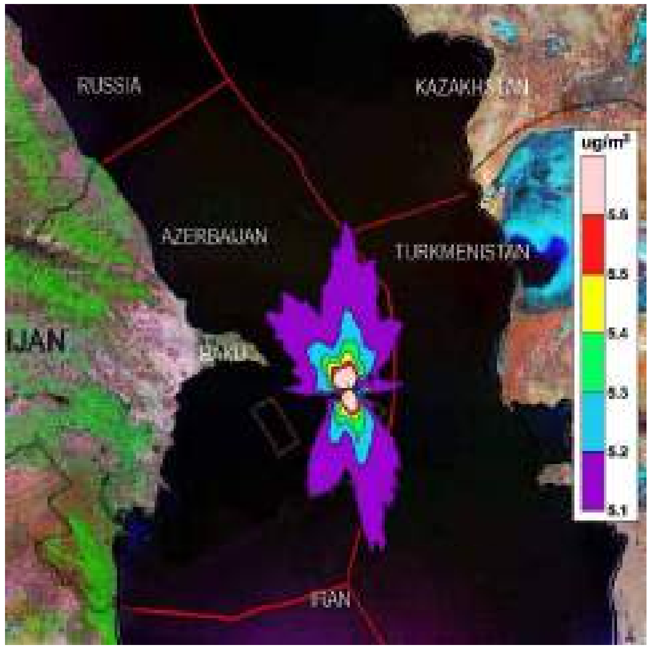
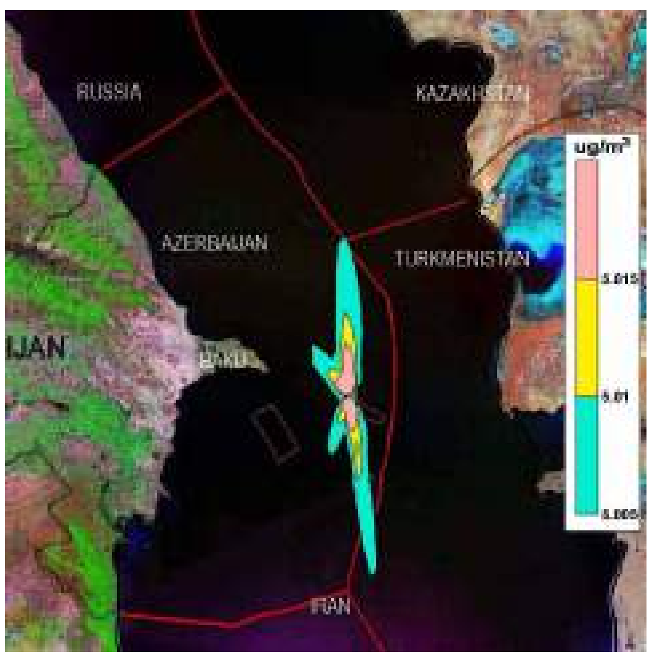


Figure AII.15b

Dada Gorgud MODU Well Test Flare Only: NO_2 Annual Average Concentrations



AZERBAIJAN INTERNATIONAL OPERATING COMPANY (AIOC)

CHIRAG OIL PROJECT

WEST CHIRAG OFFSHORE PLATFORM

APPENDIX 11B

UPDATE 1: AIR DISPERSION MODELLING FOR WEST CHIRAG OFFSHORE PLATFORM

December 2009

1.0 INTRODUCTION

Following consultation for the COP ESIA a number of amendments and updates have been made to the offshore dispersion modelling assessment as requested by the ESIA reviewers. These comprise:

- Modelling and assessment of emissions of SO_2, CO and PM_{10} from the offshore facilities.
- Comparison between predicted NO_2 concentrations against the traditional (ex Soviet) air quality limits for Azerbaijan; and
- Additional details regarding model verification.

2.0 MODELLING AND ASSESSMENT OF SULPHUR DIOXIDE, CARBON MONOXIDE AND PARTICULATES

This report has recently been updated to include emissions of sulphur dioxide, carbon monoxide and particulates. The gas turbines on the platform are RB-211 units and emission calculations have been based on the data test sheets provided by RR and data from ACG on fuel gas composition.

2.1 Emission parameters

Offshore turbine configuration and loading parameters were based on the available operational data, with emissions calculated accordingly. Flare emissions where calculated based on the values given by UKOOA and, for particulate emissions, by CONCAWE. The date on emissions is given in Tables 1 and 2.

Table 1 RB211 Turbine Emission Rates – other emissions ($S0_2$, CO, PM10)

Load Percentage	Release Rate (g/s)	Efflux Velocity (m/s)
SO_2 50%	1.27	20.30
CO 50%	1.46	20.30
PM10 50%	0.13	20.30

Source: RR RB211 Model 6562 data sheet [1]

Table 2 Flare Emissions Rates – other emissions ($S0_2$, CO, PM10)

Release Type	Release Rate (g/s)	Fm (m^4/s^2)	Fb (Mw)
Pilot & Purge(All) NO_2 *(a)*	0.03	1	1
Pilot & Purge(All) SO_2 *(b)*	0.04	1	1
Pilot & Purge(All) CO *(a)*	0.20	1	1
Pilot & Purge(All) PM10 *(c)*	1.07	1	1
Emergency (WC-PDQ) SO_2 *(b)*	109.70	73,272	2,401
Emergency (WC-PDQ) CO *(a)*	567.16	73,272	2,401
Emergency (WC-PDQ) PM10 *(c)*	3115.57	73,272	2,401

Source: (a) UKOOA emission factors for flares[2] (b) Calculated from gas composition (c) CONCAWE factor[3]

Note WC-PDQ emissions amended to reflect updated ESD rate.

2.2 Modelling domain / receptors

The Central Caspian region was modelled using a grid with the dimensions of 550km x 550km, covering a substantial section of the Central Caspian Sea and surrounding land borders of Russia, Iran, Turkmenistan and Kazakhstan. The number of grid lines used was 101, the maximum permitted in ADMS, providing a resolution of approximately 5.45km.

Further details of the grids used and sensitive receptors in the area are given in the original report ‘Air Dispersion Modelling for West Chirag Offshore Platform’ report (June 2009) Section 6.0 [4].

2.3 Meteorology / Surface Characteristics

The meteorological data set used and the surface characteristic have been kept common to those used in the original study, reference should be made to ‘Air Dispersion Modelling for West Chirag Offshore Platform’ report (June 2009) Section 7.0 for further information.

2.4 Background Concentrations

The predicted concentrations resulting from platform emissions are added to the prevailing background concentrations when determining impact. There is limited information on air quality offshore, but measurements taken along the coastline at Sangachal were available [5]. Sample points which where not strongly affected by local sources were taken to be indicative of the background concentrations, values typical of unpolluted, rural areas. These are given below:

- SO_2 8.5 µg/m^3; and
- CO 2000.0 µg/m^3.

The background concentrations of PM10 where taken from a study on the air quality of Baku [6].

- PM10 38 µg/m^3.

2.5 Scenarios Modelled

Scenario 4 focuses exclusively on WC-PDQ emissions. This is in order to quantify the contribution of the proposed development on air quality in the area. The emissions from WC-PDQ were modelled independently of other sources. Normal operations, emergency and restricted gas export scenarios were modelled. For further details of the other scenarios modelled please refer to ‘Air Dispersion Modelling for West Chirag Offshore Platform’ report (June 2009) Section 8.0.

2.6 Assessment of Impact

2.6.1 WC PDQ: Discrete Receptor Concentrations – Sulphur Dioxide, Carbon Monoxide, Particulate Matter

The original study focused on nitrogen dioxide as the prime pollutant of interest. In this updated report sulphur dioxide, carbon monoxide, particulate matter are also assessed and all are evaluated with respect to EU air quality standards and the traditional Azeri air quality concentration limits (as requested by the ESIA reviewers).

The WC PDQ platform is modelled in normal operational mode and when under going emergency flaring.

1. WC PDQ Normal Operations

In Table 3 the results are given of dispersion modelling for SO_2, CO and PM10 for WC PDQ alone, operating normally.

Table 3 WC-PDQ Normal Operations Only, No Other Platforms in Operation

SO_2	24hr Peak (ug/m^3)		24hr Peak P99.18 (ug/m^3)		1 hour P99.73	
Receptor	Modelled SO_2 Concentration	SO_2 Air Quality Standard Traditional Azeri Limits	Modelled SO_2 Concentration	EU Air Quality Standard	Modelled SO_2 Concentration	EU Air Quality Standard
Baku	8.506	*50*	8.50	*125*	8.53	*350*
Sangachal	8.506	*50*	8.50	*125*	8.52	*350*

CO	24hr Peak (ug/m^3)			1hr Peak (ug/m^3)	
Receptor	Modelled CO Concentration	CO Air Quality Standard as Traditional Azeri Limits	EU Air Quality Standard	Modelled CO Concentration	CO Air Quality Standard Traditional Azeri Limits
Baku	2000.01	3000	10,000	2000.09	5000
Sangachal	2000.01	3000	10,000	2000.09	5000

PM_{10}	24hr Peak (ug/m^3)		24hr Peak P98.08 (ug/m^3)		1hr Peak (ug/m^3)	
	Modelled PM10 Concentration	PM10 Air Quality Standard Traditional Azeri Limits	Modelled PM10 Concentration	EU Air Quality Standard	Modelled PM10 Concentration	PM10 Air Quality Standard Traditional Azeri Limits
Baku	38.02	100	38.002	50	38.04	300
Sangachal	38.02	100	38.002	50	38.03	300

Table 3 shows that the increase in the concentrations of pollutant species associated with emissions from the WC-PDQ platform during normal operations will not result in any exceedances of the traditional Azeri limits.

The incremental contribution of the platform emissions to onshore air pollution is of low significance.

2. WC PDQ ESD Flaring Operations

WC PDQ has been modelled under emergency flaring conditions; the results for SO_2, CO and PM_{10} are given in Table 4.

Table 4 WC-PDQ ESD Flaring Only, No Other Platforms in Operation

SO_2	24hr Peak (ug/m^3)		24hr Peak P99.18 (ug/m^3)		1 hour P99.73	
Receptor	Modelled SO_2 Concentration	SO_2 Air Quality Standard Traditional Azeri Limits	Modelled SO_2 Concentration	EU Air Quality Standard	Modelled SO_2 Concentration	EU Air Quality Standard
Baku	8.56	*50*	8.60	*125*	8.53	*350*
Sangachal	8.534	*50*	8.53	*125*	8.51	*350*

CO	24hr Peak (ug/m^3)			1hr Peak (ug/m^3)	
Receptor	Modelled CO Concentration	CO Air Quality Standard Traditional Azeri Limits	EU Air Quality Standard	Modelled CO Concentration	CO Air Quality Standard Traditional Azeri Limits
Baku	2000.3	3000	10,000	2002.34	5000
Sangachal	2000.17	3000	10,000	2001.70	5000

PM_{10}	24hr Peak (ug/m^3)		24hr Peak P98.08 (ug/m^3)		1hr Peak (ug/m^3)	
	Modelled PM10 Concentration	PM10 Air Quality Standard Traditional Azeri Limits	Modelled PM10 Concentration	EU Air Quality Standard	Modelled PM10 Concentration	PM10 Air Quality Standard Traditional Azeri Limits
Baku	39.64	100	38.39	50	50.77	300
Sangachal	38.93	100	38.07	50	47.27	300

Table 4 shows that the increase in the concentrations of pollutant species associated with emissions from the WC-PDQ platform during emergency flaring conditions will not result in any exceedances of the traditional Azeri limits.

The incremental contribution of the platform emissions to onshore air pollution is of low significance.

Contour plots showing the predicted dispersion for each pollutant are provided within Appendix I.

3.0 COMPARISON BETWEEN PREDICTED NO_2 CONCENTRATIONS AGAINST EU AND TRADITIONAL AZERI LIMITS.

The results given in Tables 5 and 6 show that the standards recommended will not be exceeded, including traditional Azeri standards and EU standards.

Table 5
WC-PDQ Normal Operations Only,
No Other Platforms in Operation: Predicted NO_2 Concentrations

Receptor		
EU Air Quality Standards	Annual	99.79th%
"	*40*	*200*
Baku	5.10	5.18
Sangachal	5.10	5.16
Traditional Azeri Air Quality Standards	24hr	8hr
"	40	85
Baku	5.11	5.14
Sangachal	5.11	5.13
ACGIH Occupational Standards	*NA*	*12-hr Exposure-3,760*
CA-CWP	5.1	5.5
CA-PDQ	5.1	5.4
Chirag-1	5.2	7.1
DWG-DUQ	5.2	6.6
DWG-PCWU	5.2	6.6
East Azeri	5.1	5.3
West Azeri	5.1	5.8
WC-PDQ	5.1	5.1

Table 6
WC-PDQ Operational Flaring (Restricted Gas Export) Only,
No Other Platforms in Operation: Predicted NO_2 Concentrations

Receptor		
EU Air Quality Standards	Annual	99.79th%
"	*40*	*200*
Baku	5.1	5.21
Sangachal	5.1	5.19
Traditional Azeri Air Quality Standards	24hr	8hr
"	40	85
Baku	5.11	5.14
Sangachal	5.11	5.13

Receptor		
ACGIH Occupational Standards	***NA***	***12-hr Exposure-3,760***
CA-CWP	5.1	5.5
CA-PDQ	5.1	5.5
Chirag-1	5.2	7.0
DWG-DUQ	5.2	8.7
DWG-PCWU	5.2	9.0
East Azeri	5.1	5.4
West Azeri	5.1	5.7
WC-PDQ	5.1	5.1

In Appendix I contour plots are given of the NO_2 concentrations predicted.

4.0 ADDITIONAL DETAILS REGARDING MODEL VERIFICATION

ADMS-4.1 was selected because of its superior dispersion model and plume rise methodology and integrated offshore marine boundary layer facility. The developers of this model, Cambridge Environmental Research Consultants (CERC), were consulted about the use of the model offshore and the setting up of dispersion parameters.

Many regulatory authorities explicitly endorse or accept the use of ADMS4. In the UK the Environment Agency does not formally “approve” any model (the UK Government's open policy). However ADMS is used routinely used in applications to the Environment Agencies in the UK and accepted by them; its development was also supported by the Environment Agencies in UK. The three Environment Agencies: Environment Agency of England and Wales, Scottish Environmental Protection Agency and the Department of the Environment in Northern Ireland, are all users of ADMS. ADMS is also used routinely as a key model on behalf of DEFRA the government department for the environment.

ADMS is on the US EPA’s Appendix W list of alternative models. ADMS models accepted for all types of environmental impact assessment in China. ADMS models are used by city or regional government and others in France, Italy, the Netherlands, Ireland, the Baltic States, South Africa, Hungary and Thailand and was used by the California Department of Health. The models are also used in Spain, Portugal, Sweden, Cyprus, Austria, United Arab Emirates, Sudan, Saudi Arabia, Tunisia, Slovenia, Poland, New Zealand, Korea, Japan, India, Canada and Australia.

An extensive library of ADMS validation reports is available at: http://www.cerc.co.uk/software/publications.htm

5.0 References

1 Rolls-Royce,” Combustion Gas Turbine Performance Curves (Purchase Order No. BPAC-ACGX-PMME01A)”, 2005

2 UK Offshore Operators Association ,“UKOOA emission factors for flares”, 2005

3 Concawe, 2006. Air pollutant emission estimation methods for EPER and PRTR reporting by refineries (revised), Prepared by the CONCAWE Air Quality Management Group’s Special Task Force on Emission Reporting Methodologies (STF-64), P. Goodsell (Technical Coordinator), Report no. 9/05R, Brussels, April 2006

4 Granherne Air Dispersion Modelling for West Chirag Offshore Platform’ report 9740-COP-RC-X-00001, June 2009

5 Sangachal Ambient Air Quality Monitoring Programme 2007. First round (September). AmC report 7716-R1, 2007

6 Air Quality Monitoring in the Central Caucasus, Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP), no. 21295, 2000

Appendix I

WC-PDQ Only – Emissions Contour Plots

Figure A1.1a
WC-PDQ Only, Normal Operations: NO_2 P99.79th Percentile Concentrations

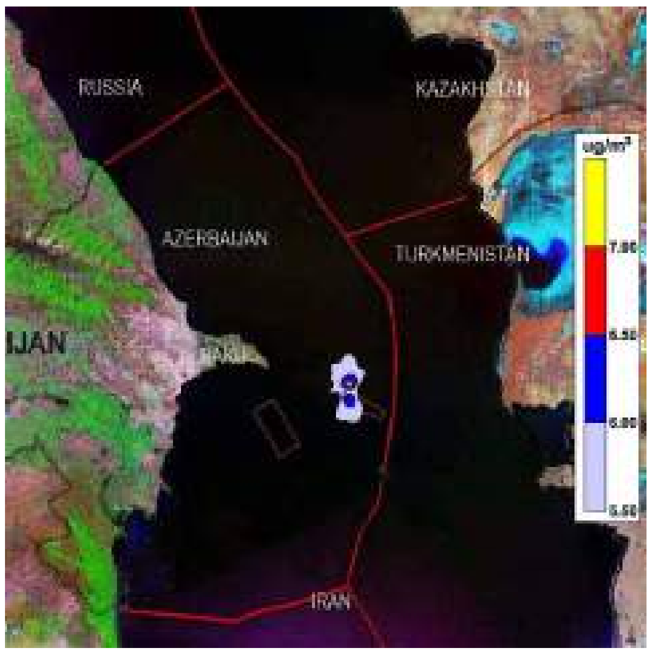


Figure A1.1b

WC-PDQ Only, Normal Operations: NO_2 Annual Average Concentrations

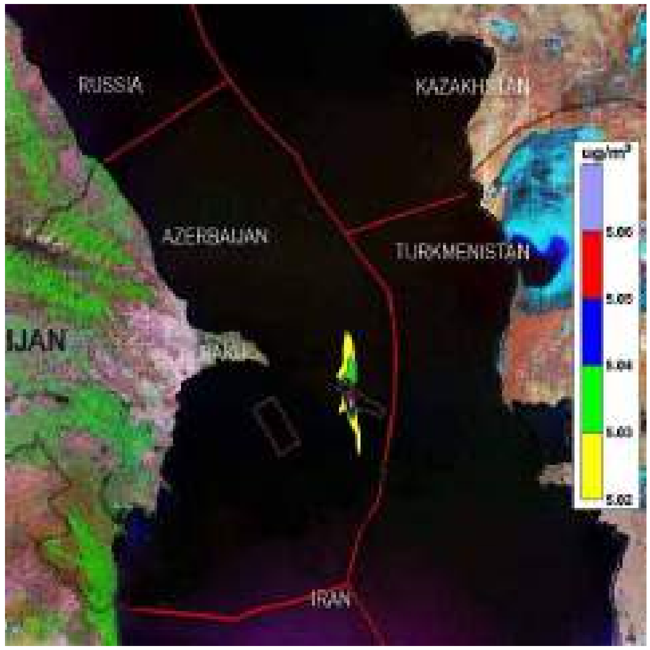


Figure A1.1c

WC-PDQ Only, Normal Operations: SO_2 24hr Peak Concentrations

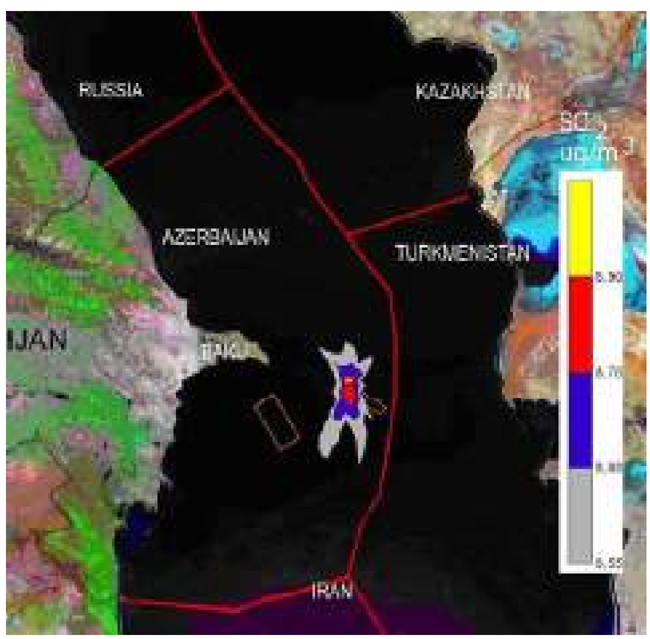


Figure A1.1d

WC-PDQ Only, Normal Operations: CO 1hr Peak Concentrations

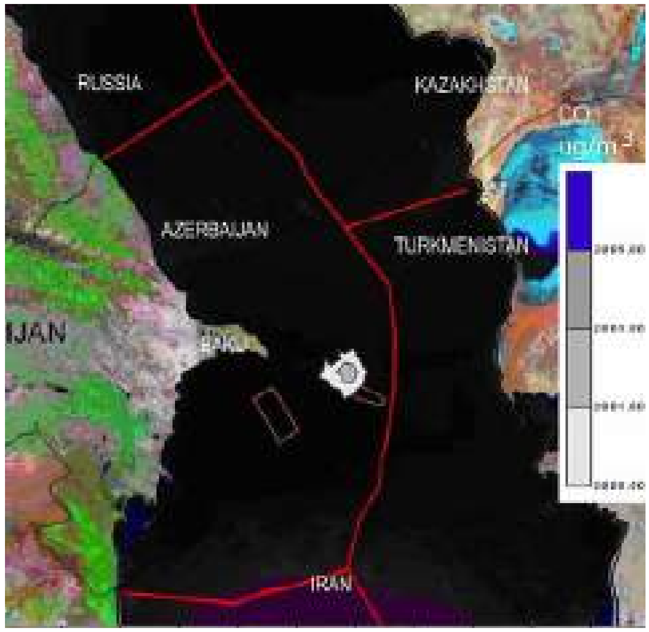


Figure A1.1e

WC-PDQ Only, Normal Operations: PM10 1hr Peak Concentrations

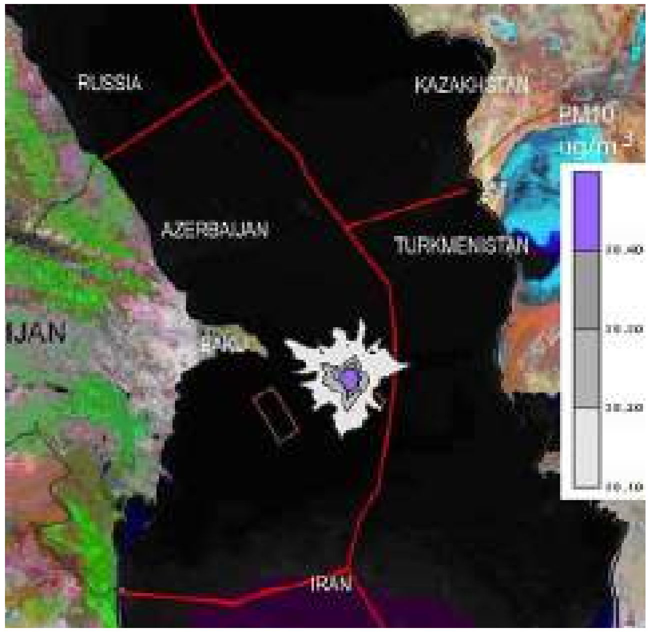


Figure A1.2a

WC-PDQ Only, Emergency Depressurisation: NO_2 P99.79[th] Percentile Concentrations

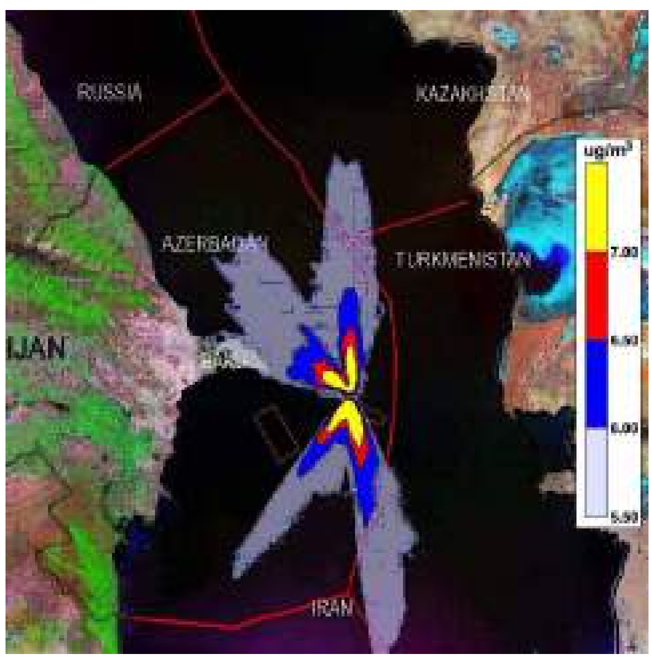


Figure A1.2b

WC-PDQ Only, Emergency Depressurisation: NO_2 Annual Average Concentrations

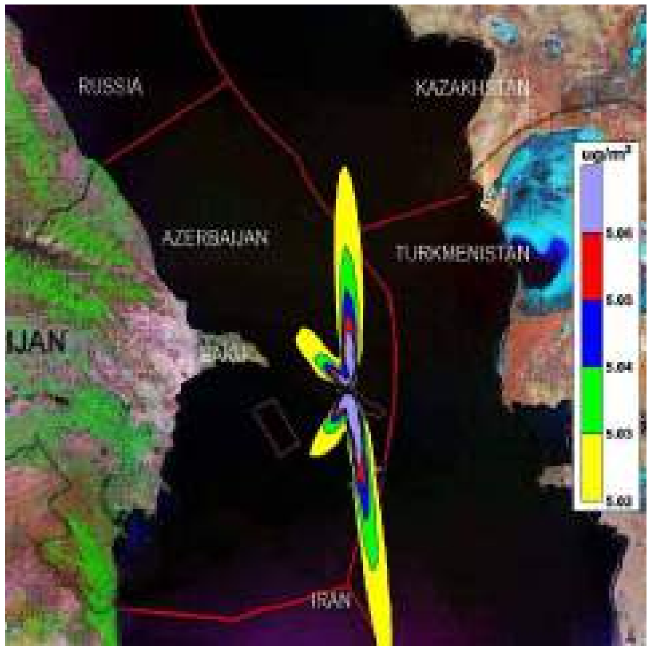


Figure A1.2c

WC-PDQ Only, Emergency Depressurisation: SO_2 24hr Peak Concentrations

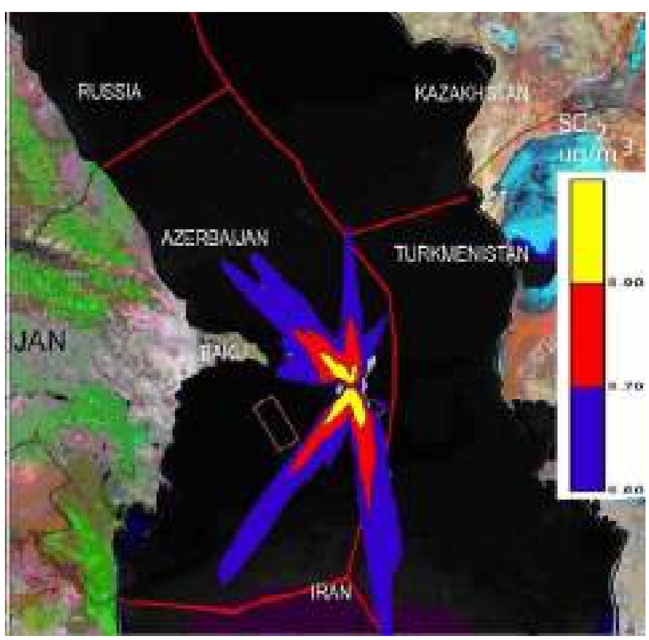


Figure A1.2d
WC-PDQ Only, Emergency Depressurisation: CO 1hr Peak Concentrations

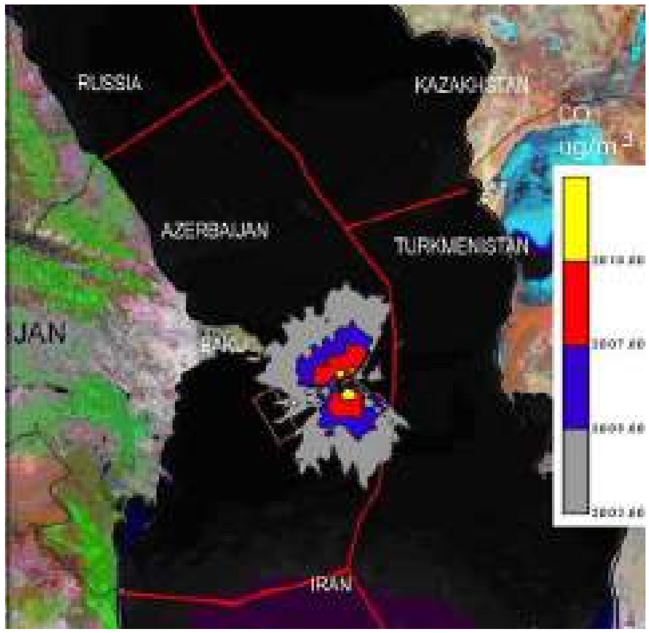
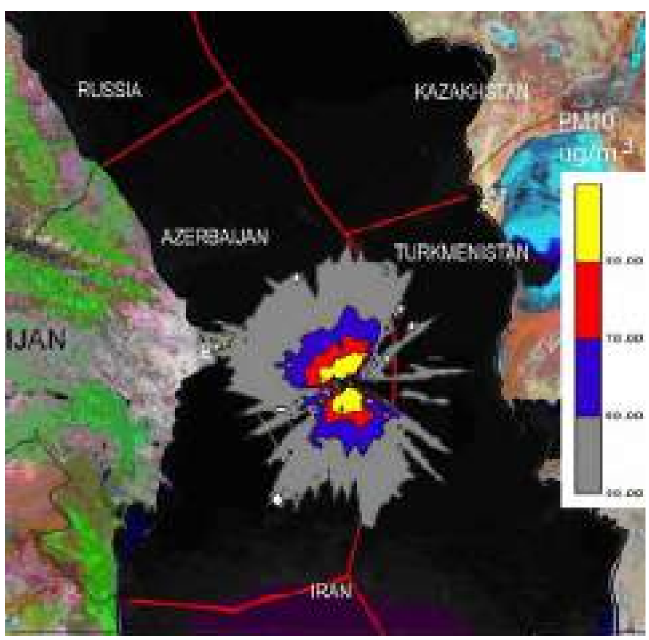


Figure A1.2e
WC-PDQ Only, Emergency Depressurisation: PM10 1hr Peak Concentrations



APPENDIX 11C

Underwater Noise Modelling

Acoustic Impact of Drilling and Vessel Noise: Chirag Oil Project

March 2009
Final

Issue No 2
49316039

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Issue No: 2	**Name**	**Signature**	**Date**	**Position**
Prepared by	Peter Ward		02/03/2009	Principal Acoustic Consultant
Checked and Approved by	Graham Cowling		05/03/2009	Principal Acoustic Consultant

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1	25/11/2008	Original issue
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CONTENTS

EXECUTIVE SUMMARY

Underwater noise will result principally from driving the foundation piles during installation, drilling and vessel movements during construction and offshore operations and have the potential to impact biological/ecological receptors (specifically seals and fish) in the marine environment. An analysis of the propagation of underwater noise during the construction, installation and HUC phase and offshore operations phase was undertaken in order to estimate distances at which various acoustic impacts on marine species may occur. The effect of exposure to high intensity sound on marine life has been discussed. It is noted that, although a number of species are known to inhabit the ACG Contract Area, they are not necessarily the same species of animals for which hearing sensitivity data exists. The use of generic hearing curves has been used to determine the hearing sensitivity of pinnipeds and fish with and without swim bladders. It has been assumed that these groupings cover all species of marine life in the study area that may be impacted by underwater noise. It was found that fatality, physical injury and permanent or temporary deafness do not occur following exposure to vessel noise, drilling noise or piling noise. Behavioural changes were assessed using a probabilistic impact criterion. Four levels were considered whereby an impact was represented by a sound level above the hearing threshold of a given species. Total avoidance was represented by a level of 100 dBht; this means that all of the individuals in a group will show significant changes in their current behaviour. Strong avoidance, represented by a level of 90 dBht indicates that most of the individuals in a group will show significant changes in their current behaviour while mild avoidance and a low likelihood of disturbance are represented by the 75 dBht and 50 dBht thresholds respectively.

It was found that the potential for complete and strong avoidance reactions in individuals of fish or pinnipeds following exposure to vessel noise and drilling noise was deemed extremely unlikely. Mild avoidance reactions may be experienced by a number of individuals in a group of fish with swimbladders (being the most sensitive of the groups of species considered in this report) at distances up to 15 m while a low likelihood of disturbance may arise at a distance up to 980 m from the site. All other species would experience similar behavioural impacts at much reduced distances. By contrast, piling noise has the potential to give rise to a complete avoidance reaction up to 294 m from the piling site, with strong and mild avoidance reactions being seen up to distances of 1.9 km and 15 km respectively. A low likelihood of disturbance following exposure to piling noise exists up to 49 km away from the piling site.

Due to the lack of available data on underwater background noise levels in the Caspian Sea, estimates of the likely noise levels were made by comparisons with data from a similar, shallow water site - the North Sea.

1. INTRODUCTION

This report has been prepared by URS for AIOC to address potential underwater noise impacts on the marine life associated with the offshore activities of the Chirag Oil Project (COP), located off the coast of Azerbaijan in the Caspian Sea.

The COP offshore facilities include a single fixed production drilling and quarters platform (denoted WC-PDQ) located between the existing Chirag-1 and DWG platforms in the Chirag Deep Water Guneshli (CDWG) area of the Azeri Chirag Guneshli (ACG) Contract Area. The platform will be partially integrated via infield pipelines with the nearby DWG-PCWU platform for produced water disposal and provision of injection water. In-field marine pipelines will also be installed to tie-in the WC-PDQ platform to the existing Phase 2 30" oil pipeline and the 28" gas pipeline to transport hydrocarbons to the onshore Sangachal Terminal.

Following a review of the key project activities the following were identified as potential sources of underwater noise with the potential to impact upon the local marine fauna:

- Vessels - to install elements of the COP offshore facilities and to supply materials to and provide support for installation, commissioning and operational offshore activities;
- Piling equipment – to secure the drilling template and main jacket piles to the sea floor; and
- Drilling – including drilling from the mobile drilling rig and from the installed platform.

This study provides a high level review of the local marine wildlife and includes information relating to their conservation status and their susceptibility to sound. This is followed by an assessment of the significance of the noise impact generated by vessels, drilling and piling operations on the fauna and based on the modelling of the underwater noise field. This modelling considers the acoustic impact on pinnipeds and fish both with and without swim bladders. It is assumed that these groupings cover all species of marine life that could be present within the ACG Contract Area.

2. SENSITIVE MARINE FAUNA IN THE CASPIAN SEA

2.1. Introduction

Previous studies have identified a number of species of fish, birds and mammals as being extant in the ACG Contract Area of the Caspian Sea[1]. This section provides an overview of the susceptibility of the species to underwater sound and also notes their conservation status according to the Red List of the International Union for Conservation of Nature (IUCN)[2].

2.2. Fish

Table 2.1 lists the species of fish found in the ACG Contract Area. It is noted that most of the fish species possess a swim-bladder. The significance of this in relation to potential acoustic impacts is discussed below.

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 the fish 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 don't possess such an organ. Subsequently, there is the potential for such species of fish to be more susceptible to acoustic impacts than fish with no swim-bladder.

It will be seen from Table 2-1 that there are a number of species of fish that have swim-bladders and are therefore susceptible to acoustic impacts are also classed as "Endangered" or "Near Threatened". Such fish include all the sturgeon species, the Caspian salmon and the Caspian lamprey.

Table 2-1: Fish species found in the ACG contract area

Fish	Swim Bladder?	Conservation Status
Migratory Species		
Sturgeon Fish (*Acipenseridae)*		
Belgua (*Huso huso*)	Large swim bladder characteristic of family	IUCN Endangered. It is a protected species listed in appendix III of the Bern Convention and its trade is restricted under CITES appendix II.
Russian (*Acipenser gueldenstaedtii*)		IUCN Endangered
Persian (*A. gueldenstaedtii persicus*)		IUCN Endangered

[1] COP Environmental Chapter.

[2] The IUCN Red List of Threatened Species™ 2008, http://www.iucn.org/about/work/programmes/species/red_list/index.cfm. Accessed November 2008.

Fish	Swim Bladder?	Conservation Status
Barbel (*A. nudiventris*)		IUCN Endangered
Stellate/starred (*A. stellatus*)		IUCN Endangered
Kilka (*Clupeonella*)		
Big-eye kilka (*Clupeonella grimmi*)	swim bladder	IUCN low vulnerability.
Anchovy kilka (*C. engrauliformis*)		IUCN low vulnerability. Such species suffered from the accidental introduction of a comb jelly sp.
Caspian common kilka *Clupeonella delicatula caspia*		IUCN low vulnerability.
Caspian salmon (*Salmo trutta caspius*)***		IUCN Endangered
Caspian lamprey (*Caspiomyzon wagneri*)***		IUCN Near Threatened
Shad (*Alosa Cuvier*)		
Caspian shad (*Alosa caspia*)	swim bladder	IUCN least concern.
Big-eyed shad (*A. saposhnikovi*)		IUCN least concern.
Blackback shad (*A. kessleri*)		IUCN least concern.
Volga shad (*A. volgensis*)		IUCN least concern.
Carp (Cyprinidae)		
Kutum (*Rutilus frisii kutum*)	swim bladder	IUCN least concern.
Mullet (*Mugilidae*)		
Leaping mullet (*Liza saliens*)	swim bladder	IUCN least concern
Golden mullet (*L. aurata*)	swim bladder	IUCN least concern
Goby (Gobiidae)		
Caspian goby *Neogobius caspius*	Sometimes lacking swim bladder depending on species.	ICUN Least Concern
Round goby *Neogobius melanostomus affinis*		ICUN Least Concern
Caspian syrman goby *Neogobius syrman eurystomus*		ICUN Least Concern
Monkey goby *Neogobius fluviatilis pallasi*		ICUN Least Concern
Caspian big-headed goby *Neogobius kessleri gorlap*		ICUN Least Concern
Knipovich long-tailed goby *Knipowitschia longicaudata*		ICUN Least Concern
Grimm big-headed goby *Benthophilus grimmi*		ICUN Least Concern
Resident Species		
Sandsmelt (*Atherina mochon pontica*)	swim bladder	Not evaluated
Pipefish (*Syngnathus nigrolineatus*)	swim bladder	IUCN least concern.

2.3. Birds

A number of species of sea birds found in the ACG Contract Area have been identified earlier[1] and these are listed in Table 2-2. These four species have been highlighted as being the most numerically abundant in published data for the Absheron Peninsula (Gambarov et al., 1958; Gambarov, 1968; Mustafaev et al. 1968) and the Shakhdilli-Pirallahi area (Sultanov and Kerimov, 1998, 1999).

Sea birds spend short periods of time under water during hunting and feeding activities. During this activity, the birds may be susceptible to impacts from underwater sound. It is noted that the IUCN conservation status for all the birds listed is “Least Concern”.

Table 2-2: Seabird species found in the ACG contract area

BIRDS	Conservation Status
Great cormorant (*Phalacrocorax carbo*)	IUCN Least Concern
Herring gull (*Larus argentatus*)	IUCN Least Concern
Common tern (*Sterna hirundo*)	IUCN Least Concern
Sandwich tern (*Sterna sandvicensis*)	IUCN Least Concern

2.4. Sea mammals

Table 2-3 records that only one species of sea mammal is found in the ACG Contract Area and this is the Caspian Seal.

The ACG Environmental Assessment Phase 3[1] notes that the Absheron and Baku Archipelago, Shakdilli Spit, and Ogurchinsk Island (Turkmenistan) are used as year-round haul-out sites (Gadjiev and Aybatov 1998). Helicopter surveys of the coast and islands of the Absheron Peninsula identified year-round haul-out sites on Shakdilli spit, Zilhoy Island, and other nearby islands. A total of 2000 seals were recorded within these sites during the winter period between 1996 and 1997 (ibid). 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 400000 to 111000[3,4]

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. Equally, when on land, they may be liable to impacts arising through the emission of sound in-air such as low-flying planes and helicopters.

Any impacts arising on Caspian seals should be considered in the context of their conservation status. This has recently been changed from “Vulnerable” to “Endangered”.

[3] Krylov, 1990

[4] Report of the Caspian International Seal Survey (CISS) team based on the results of the Caspian seals’ census in 2006

Table 2-3: Marine mammal species found in the ACG contract area

Mammals	
Caspian seal (*Phoca caspica*)	IUCN Endangered

2.5. Conclusion

It has been found that a number of species of marine fauna that inhabit the ACG Contract Area are sensitive to sound emitted either underwater or in-air. It is further noted that many of these species are also classed as "Endangered". For such vulnerable animals, it is important to provide a rigorous methodology for quantifying the potential risk that the animals face following exposure to sound. This is addressed in the next section.

3. ACOUSTIC IMPACTS AND THRESHOLDS

3.1. Introduction

Over the past 20 years or so, it has become increasingly apparent that noise from human activities in and around underwater environments may have an impact on the marine life in the area. As a result, interest in the hearing of a number of species particularly of seal and fish, has increased and this has begun to lead to a greater understanding of how marine life may be impacted by underwater sound.

The degree to which a given species might be affected by underwater sound emissions depends on a number of factors, these being the sensitivity of the species or individual to the sound, the level of sound on the receptor, its frequency content and the duration of the sound.

As an aid to quantifying the impact of sound on a receptor, thresholds of hearing have been established for a number of species of cetacean, pinniped, sirenia and fish. The following sections describe a number of impacts on marine life. Evidence is provided that has been obtained in support of these impacts. From the data collected, a number of acoustic impact criteria have been developed and these are summarized below.

3.2. Lethality and physical injury

High levels of underwater sound can be lethal to marine life. Yelverton *et al*[5] carried out a number of studies on various species of fish and terrestrial mammals and demonstrated that mortality rates were related to body mass of the subject and the magnitude of the impulsive wave. The work indicates that there are levels below which a sound would cease to be lethal to a creature of a certain weight. It is shown that the upper limit for No-Injury ranges from 26 Pa s for rats (0.2 kg) to 210 Pa s for sheep (45 kg). While these impulse levels may not cause swim bladder rupture or kidney and liver damage that may be seen after lethal doses of sound, there still may be considerable tissue damage to susceptible organs such as the lungs, gastro-intestinal tract or eyes. Any mortality or direct physical injury from the noise and vibration generated by a particular sound source is associated with very high peak pressure or impulse levels. Typically, these effects would be associated with blasting operations or in the immediate vicinity of an impact piling operation where the pile is being driven into the seabed, and is therefore in direct contact with water allowing efficient sound radiation. It has been observed that at high exposure levels, such as those typical of underwater explosive operations or offshore impact piling (pile driving) operations, fatality may occur in species of fish and marine mammal where the incident peak to peak sound level exceeds 240 dB re. 1 µPa. The likelihood of fatality increases with level above 240 dB re. 1 µPa, and as the time period of the exposure increases. Similarly, physical injury has been seen to occur where peak

[5] Yelverton, J. T., Richmond, D. R., Hicks, W., Saunders, K., and Fletcher, E. R. (1975). "The Relationship Between Fish Size and Their Response to Underwater Blast." Report DNA 3677T, Director, Defense Nuclear Agency, Washington, DC.

to peak levels exceed 220 dB re. 1μPa (Rawlins[6], Hill[7], Goertner[8], Richardson *et al*[9]., Cudahy and Parvin[10], Hastings and Popper[11].

The US National Marine Fisheries Services (NMFS) propose a non-injury limit for pinnipeds of 190 dB re. 1μPa[12]. The

3.3. Auditory damage

At lower sound pressure levels, permanent and temporary hearing loss may occur when marine animals are constrained within a high level sound environment for prolonged periods. Permanent hearing loss results from the death of the sensory hair cells of the inner ear. This gives rise to a permanent increase in threshold sensitivity over the affected frequencies and is known as Permanent Threshold Shift (PTS). Temporary hearing loss is an injury that is recoverable over a period of time ranging from minutes to days or even weeks and this is known as Temporary Threshold Shift (TTS). Threshold levels for each of these impacts are related to the sound level experienced by a receptor, its frequency and the duration to which the animal is exposed. The technique forms the basis of the QinetiQ impact model[13] where the frequency of the sound source is compared with the frequency range over which a given receptor has the ability to hear and from this, ranges at which PTS and TTS occur may be estimated. Studies indicate that PTS and TTS in all species is found to occur at sound pressure levels of 95 dB and 75 dB respectively above the hearing threshold for all species of fish, cetaceans and pinnipeds with an additional factor which takes into account the duration of the sound to which the receptor is exposed. PTS is normally considered over a time period of 30 minutes and TTS, in this instance, is calculated over eight hours duration.

3.4. Audiogram data

Richardson *et al.*[9] summarises the hearing sensitivity of a number of marine species and these are shown in Figure 3-1. Although at first glance, the data seems extensive, in

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[6] Rawlins J S P. (1974) Physical and patho-physiological effects of blast. Joint Royal Navy Scientific service. Volume 29, No. 3, pp124 – 129.

[7] Hill, S.H. (1978). A guide to the effects of underwater shock waves in arctic marine mammals and fish. Pacific Mar. Sci. Rep.78-26. Inst. Ocean Sciences, Patricia Bay, Sidney, B.C. 50 pp

[8] Goertner J F. (1982) Prediction of underwater explosion safe ranges for sea mammals. NSWC/WOL TR-82-188. Naval surface Weapons Centre, White Oak Laboratory, Silver Spring, MD, USA, NTIS AD-A139823.

[9] Richardson, W.J., Green Jr, C.R., Malme, C.I. & Thomson, D.H. (1995). Marine Mammals and Noise. Academic Press, New York.

[10] Cudahy, E., and S. Parvin. (2001). The effects of underwater blast on divers. Naval Submarine Medical Research Laboratory Report 1218, Groton, CT 06349 62 p.

[11] Hastings M C, and Popper A N., (2005), Effects of sound on fish, Subconsultants to Jones & Stokes Under California Department of Transportation Contract No. 43A0139, Task Order 1.

[12] This was based on findings at the High-Energy Seismic Workshop held at Pepperdine University in 1997 as updated by the NMFS' Acoustics Workshop held in Silver Spring, MD in 1999.

[13] QinetiQ (2003), Sonar 2087 and the Environment, Defence Procurement Agency, Ministry of Defence, 2nd Edition, November 2003. Available at http://www.oceannet.org/medag/reports/IACMST_reports/underwater_noise/S2087%20NGO%20document%20issue%202%20Adobe.pdf

totality, it actually amounts to only a relatively few species of marine life. Included on the figure are the hearing sensitivities for species of fish, pinnipeds, odontocetes and sirenia.

The overall frequency range is as low as 10 Hz for various species of fish and as high as 190 kHz for some pinnipeds. It will be seen that the hearing threshold generally falls as frequency increases up to around 20 kHz then it starts to rise again. The figure includes the ambient noise level measured at sea for a calm sea and it will be seen that this generally defines the lower limit of hearing for any species in the sea.

The hearing data shows that families of similar species are also grouped together: all fish hear over a similar frequency range, as do all pinnipeds. However, within each grouping, there is a considerable degree of variation.

Fish can be divided into two groups related to their hearing threshold. One group has a hearing threshold around 70-80 dB while another group appears less sensitive having a hearing threshold between 90 and 100 dB. The first group consists of fish with swim-bladders. This feature enhances their hearing sensitivity; such species include goldfish (*Carassius auratus*) and members of the herring family (spp *Clupeidae*). The second group do not have swim bladders and representative members of this group are the dab (*Limanda limanda*) and other flatfish of the *Pleuronectiforms* family. Fish generally become insensitive to sound above 1 kHz although herring are able to detect sounds as high as 40 kHz.

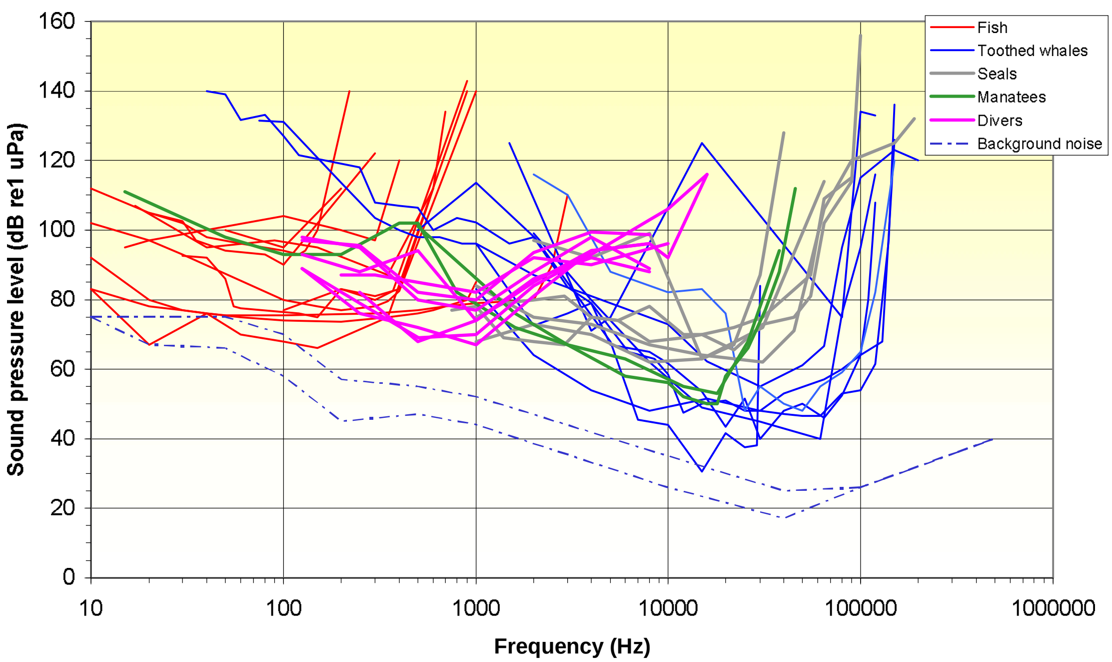

Figure 3-1: Underwater hearing thresholds for fish, humans and marine mammals

The figure shows that pinnipeds are sensitive to sound between 1 kHz and 190 kHz with a minimum sensitivity of 63 dB over the frequency range 8-30 kHz. The species that have been tested consist of the harbour seal (*Phoca vitulina*), grey seal (*Halichoerus grypus*), ringed seal (*Pusa hispida*), Hawaiian monk seal (*Monachus schauinslandi*), elephant seal of the genus *Mirounga* and fur seal of the family *Otariidae*.

It must be stated that the audiograms given in Figure 3-1 are rarely based on more than one individual of a given species. Hence it is not known whether the hearing ability demonstrated by the hearing curve is truly representative of the species as a whole. Even when more than one member of a species is tested, the results often show a considerable variation between test subjects. In addition, the hearing sensitivity of a number of species remains unknown; particularly, and of relevance to this study, the Caspian Seal.

In addition, the hearing sensitivity of a number of species, in particular and of relevance to this study namely the Caspian Seal and the beluga, do not exist. These species may be the subject of hearing threshold tests in the future. Currently, the hearing sensitivities for these animals are unknown.

To address the lack of hearing data for species of interest, Harland proposed the use of generic audiograms[14]. It is suggested that when faced with the relatively wide frequency range of a number of species within a given family coupled with the uncertainty of not knowing precisely which species are in a given locality at any specific time, the use of generic audiograms for a small number of key species is a good approach. Harland recommends a possible audiogram set consisting of mysticete, odontocetes, pinniped, swim bladder fish and non-swim bladder fish. Similarly, where a species is known to exist in a given area but its hearing sensitivity is unknown, it is estimated that a proxy species may be used in its place. For example, Section 3 above identified a number of species of *Gobiidae* found around the Chirag field but for which, audiograms do not exist. It is proposed to use the audiogram for a dab to represent all fish that do not have a swim bladder. Similarly, a herring may be used as a proxy species for all fish that are relatively sensitive to underwater noise.

Audiograms for all generic and proxy species relevant to this study are given in Figure 3-2 below:

[14] Harland E. J., "Measuring Underwater Noise: Perils And Pitfalls", *Proceedings of the Institute of Acoustics*, Vol 30, Pt 5, 2008.

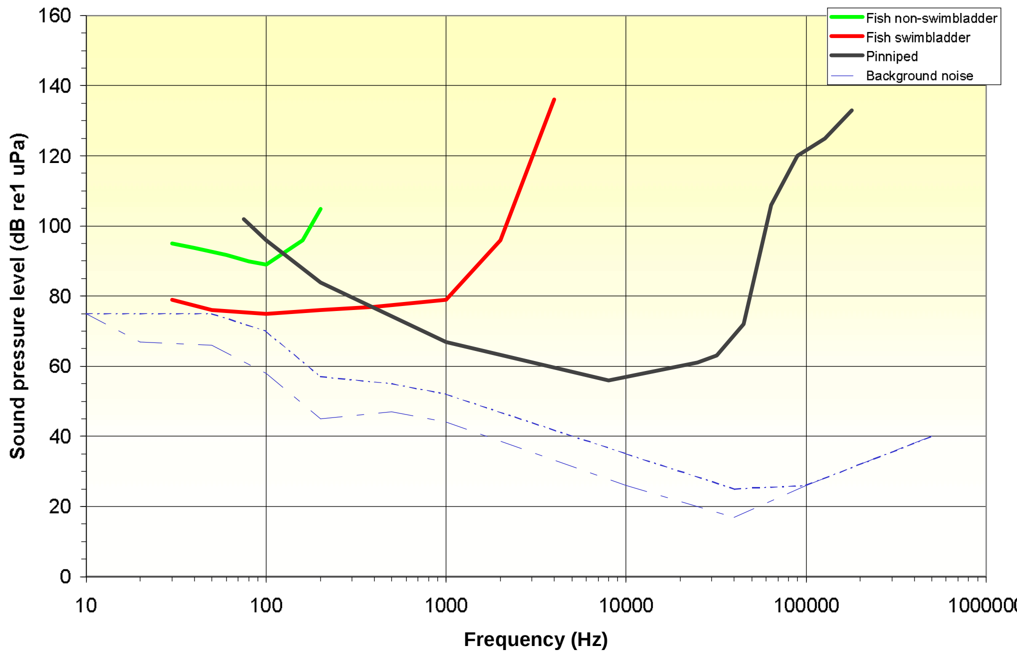

Figure 3-2: Audiograms for generic and proxy species

3.5. Behavioural response

At still lower sound pressure levels, it has been observed that fish and marine mammals may exhibit changes in their normal behaviour. These changes range from a startle reaction to the sound, a cessation of their current activities (e.g. feeding, nursing, breeding) or the animals may leave the area for a period of time.

A number of researchers (Terhune *et al.*[15], Fjälling *et al.*[16], Yurk and Trites[17]) have noted levels of sound necessary to deter harbour seals (*Phoca vitulina*) and grey seals (*Haliochoerus grypus*) from predation on fish stocks. Acoustic harassment devices (AHDs) with source levels of between 191 to 195 dB re 1 µPa @ 1 metre were used to determine the response of marine animals to these devices. Behavioural avoidance responses were observed out to ranges of between 100 m and 2.9 km from the sound source. While monitoring common dolphin (*Delphinus delphis*) before, during and after a seismic survey in the Irish Sea, Goold[18] (1996) observed an avoidance reaction in the area, from 1 to 2 km from the survey vessel.

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[15] Terhune, J.M., Hoover, C.L. & Jacobs, S.R. (2002). Potential detection and deterrence ranges by harbour seals of underwater acoustic harassment devices (AHD) in the Bay of Fundy, Canada. Journal of the World Aquaculture Society 33:176–183.

[16] Fjälling. A, Wahlberg, M, & Westerberg, H. (2005). Acoustic Harassment Devices (AHD) for salmon trapnets in the Baltic Sea. National Board of Fisheries, Institute of Coastal Research, SE-178 93. Drottningholm, Sweden.

[17] Yurk, H. & A.W. Trites. (2000). Experimental attempts to reduce predation by harbour seals (Phoca vitulina) on outmigrating juvenile salmonids. Transactions of the American Fisheries Society, 129, 1360-1366.

[18] Goold, J.C. (1996). Acoustic assessment of populations of common dolphin Delphinus delphis in conjunction with seismic surveying. Journal of the Marine Biology Association. 76, 811-820.

Analysis of behavioural responses coupled with measurements of sound levels at receptor locations has led to the development of impact criteria for assessing the significance of behavioural impacts[19]. The level by which the impact is measured is may be thought of as a dB scale where the species' hearing threshold is used as the reference unit and is analogous to the dB(A) scale used for rating the behavioural effects of sound on humans. It is noted that the response from a species tends to be probabilistic in nature, e.g. for a given sound pressure level on a receptor, one individual from a species may react whereas another individual may not. Four impact levels are commonly used:

- a level of 100 dB_{ht}(species) corresponds to nearly 100% avoidance by most individuals;

- a level of 90 dB_{ht}(species) and above which will cause a significant avoidance reaction by most individuals;

- a level of 75 dB_{ht}(species) and above which will cause a milder avoidance response occurs in a majority of individuals;

- a level of 50 dB_{ht}(*species*) will give rise to a low likelihood of disturbance.

A level of 0 dB_{ht}(*species*) represents a sound that is at the hearing threshold for that species and is therefore at a level at which sound has the potential to be heard by that species. At this, and lower perceived sound levels no response occurs as the receptor cannot hear the sound.

Using the thresholds above, ranges from the sound source may be determined at which each of the impact criteria are met.

3.6. Range to masking

The maximum range over which an underwater noise is detectable by a marine animal is the range from the source to the point at which the noise falls below the 0 dBht threshold level. Beyond this range, the noise from the activity is masked. Masking also occurs when a communication signal from an animal is lost in the background noise and thus becomes inaudible to its intended recipient. Beyond the range for the 0 dBht impact discussed above, the animal will not be aware of the noise and is not likely to respond to it as a result. The ability of an animal to hear the signal is said to be threshold-limited. It is quite possible though, that the ability of an animal to hear down to 0 dBht may be compromised by the relatively high levels of background noise. In this instance, the noise would be lost in the background noise at a distance which is less than the range corresponding to the 0 dBht threshold. In this instance, the ability of an animal to hear is said to be noise-limited.

The approach that has been undertaken in this study is to determine the range at which the 0 dBht impact criterion is met and compare this with the maximum range at which the

[19] Nedwell J R (2005) 'A metric for estimating the behavioural effects of noise on marine mammal species'. Subacoustech Report Reference: 59R0303, Presented at the National Physics Laboratory Seminar on Underwater Acoustics, Teddington, UK, October 2005.

vessel noise and drilling noise falls into the background level. The likely range at which the sound becomes inaudible to the target species is the smaller of the two ranges.

3.7. Summary of impact thresholds

3.7.1. Fatality and physical injury

Lethal effect – where peak-to-peak levels exceed 240 dB re. 1 µPa,

Physical injury – where peak-to-peak levels exceed 220 dB re. 1µPa

NMFS No Injury (pinniped) 190 dB re.1µ Pa

3.7.2. Audiological injury

PTS – 95 dB above hearing threshold + exposure duration factor

TTS – 75 dB above hearing threshold + exposure duration factor

3.7.3. Behavioural

100 dB_{ht}(*species*) – nearly 100% avoidance by most individuals.

90 dB_{ht}(*species*) – Strong avoidance reaction by most individuals.

75 dB_{ht}(*species*) - Mild avoidance reaction occurs in a majority of individuals.

50 dB_{ht}(*species*) – Low likelihood of disturbance.

0 dB_{ht}(*species*) – limit of audibility.

4. SOURCES OF NOISE: VESSEL, DRILLING AND PILING

4.1. Introduction

Man-made noise in the marine environment has the potential to affect marine life. Of most importance and relevance to this study are vessel noise, drilling noise and piling noise. Noise from any of these activities may contribute to the total noise in any given area.

4.2. Vessel noise

A number of vessels will be used to support the Chirag field activities and details of these are summarised in Table 4-1 below[20]. Specific noise signatures for these vessels are not known. To assist in the subsequent analysis of hearing impacts on marine fauna, indicative noise data from representative vessels will be used instead.

Table 4-1: Summary details of vessels used in COP project

Vessel	Type	LOA	Gross tonnage
STB-1	Transport and launch barge	190 m	18850 tonne
DBA	Heavy lift crane vessel	127 m	12179 tonne
PLBG	Pipelay barge – non self propelled	120 m	17129 tonne
DSV	Dive support vessel	90 m	5181 tonne
Jura / Islay	Additional support vessels	84 m	2181 tonne

Noise from vessels is a major contributor to the overall noise in a given sea area due principally to the large numbers of ships present, their wide distribution and their mobility. Sound levels and frequency characteristics are related approximately to ship size and speed however, even amongst vessels of similar classes, there is considerable variation.

Vessel noise is a combination of narrowband sounds at specific frequencies and broadband sounds with energy spread over a range of frequencies. The narrowband sound or tonals arise from the propeller blade rate, engine cylinder firing and crankshaft rotation. Typical frequencies for these components lie in the range 10 - 100 Hz. Broadband noise can be attributed to propeller cavitation and flow noise and may extend up to 100 kHz peaking in the range 50-150 Hz (Ross 1987).

[20] COP Infrastructure and Logistics Chapter

A review of shipping noise for small vessels was carried out by Richardson *et al*[9]. In this context, small vessels include small tugs, crewboats and other vessels with outboard motors. The findings are summarised in Table 4-2 below.

Table 4-2: Source levels of underwater noise for small vessels.

Sources	Freq (Hz)		dB re 1μPa at 1 m	
Small ship 55 m-85m long		Broadband	180	Broadband noise levels lie in range 170-180 dB re 1μPa
MS Sparton 25m long	37	tonal	166	Tug pulling empty barge
Arctic Fox	1000	1/3 octave	170	Tug pulling loaded barge
Arctic Fox	1000	1/3 octave	164	Tug pulling empty barge
Arctic Fox	5000	1/3 octave	161	Tug pulling loaded barge
Arctic Fox	5000	1/3 octave	145	Tug pulling empty barge
Twin diesel 34m long	630	1/3 octave	159	
Trawlers	100	1/3 octave	158	Same level 100, 125, 160, 200, 250 Hz
Imperial Adgo 16m	90	tonal	156	Crewboat, 2nd harmonic of prop blade rate
Outboard drive	630	1/3 octave	156	Same level 400, 500, 630, 800 Hz
MV Sequel	250-1000		151	Fishing boat 7 kt
Zodiac	6300	1/3 oct	152	Outboard engine

It must be noted that the actual broadband source levels may be somewhat greater than those indicated in the table because the data above does not span all the frequencies over which vessel noise is generated.

The table includes data on noise levels measured over a number of specific 1/3 octaves as well as data measured broadband. Strictly, this makes comparison between various of the data above somewhat difficult. The table indicates that broadband source levels lie in the range 170-180 dB re 1 μPa at 1 m. It will also be seen that tonal noise levels can vary between 145 dB re 1 μPa at 1 m and 170 dB re 1 μPa at 1 m and that the noise levels are dependent on vessel size and engine loading. The table shows 1/3 octave band levels for a number of tonals for tugs pulling both empty barges and loaded barges. Clearly, the noise levels are greater when the engine is loaded in this way. The mean noise level for a tug pulling an empty barge is given as 158 dB re 1 μPa at 1 m, increasing to 163 dB re 1 μPa at 1 m when the tug pulls a loaded barge.

Frequency spectra for a number of classes of vessels have been transcribed from Richardson *et al.*[9]. Figure 4-1 shows 1/3 octave band levels for a 34 m diesel boat, a trawler, a supertanker and a tug/barge. The measurements were made over a frequency range of 10 Hz to 10 kHz. It will be seen that for a given 1/3 octave band, there is a spread of source levels for each vessel of typically 30-40 dB once again, indicating the considerable variability in vessel noise with ship size. The frequencies at which peak levels arise, increase as vessel size decreases and it will be seen that for the supertanker the peak level is at 16 Hz while for the tug and 34 m diesel-engined vessel, the peak levels are found around 500-600 Hz. Generally, therefore, it might be expected that the vessel noise impacts more on fish with their relative sensitivity to low frequency sound, than on the pinnipeds whose hearing is most sensitive at frequencies from 2 to 20 kHz.

Figure 4-1 indicates that there is no high-frequency noise data at frequencies above 10 kHz. This is a major shortfall in the published data particularly with regards to assessing the noise impact on seal species that are known to be responsive to sound at such frequencies. To address this issue for this study, the noise levels for each vessel have been extrapolated to 100 kHz. Until such time that measured noise levels become available at these elevated frequencies, the uncertainty in these projected figures is unquantifiable.

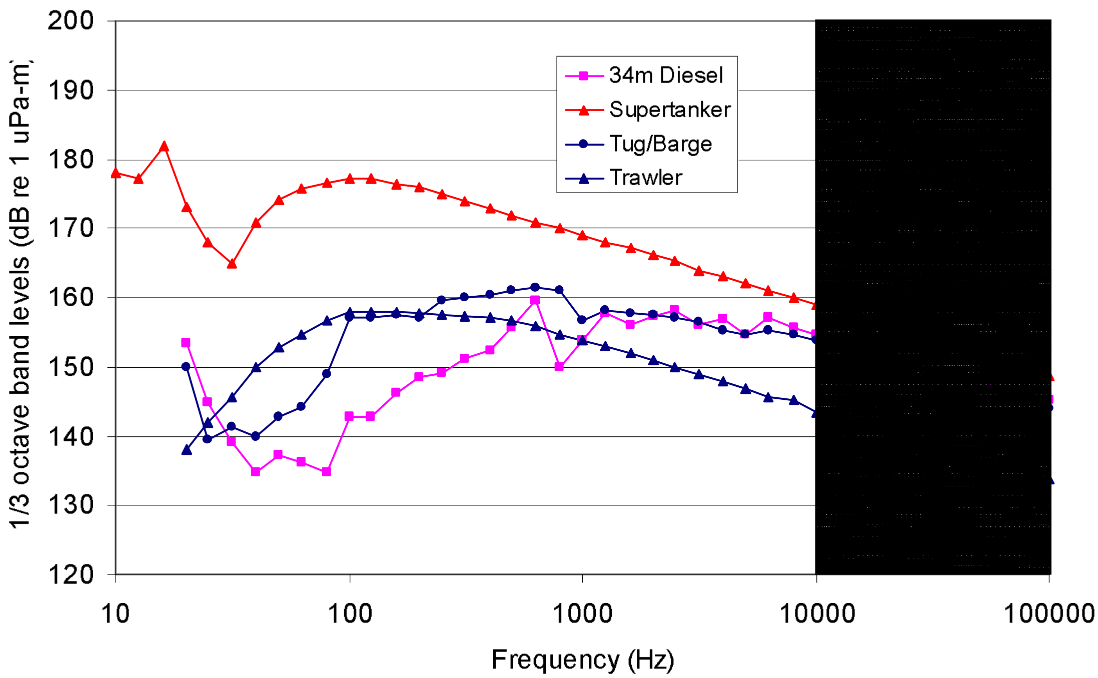

Figure 4-1: Estimated 1/3 octave band source levels of underwater noise for various classes of vessel

From the frequency spectra given in Figure 4-1, broadband source levels are estimated for each of the vessels considered and these are listed in Table 4-3.

Table 4-3: Estimated broadband source levels for various classes of vessel

Vessel type	Broadband Source Sound Pressure Level (dB re 1 μPa at 1 m)
Trawler	169
34 m diesel	168
Supertanker	189
Tug/barge	172

On the basis of the information contained in Table 4-3, it is proposed to use a value of 189 dB re 1 μPa at 1 m to represent the source level of a single vessel used in the COP activities.

4.3. Drilling noise

Noise is generated during drilling through the action of the drill bit on the surrounding rocks. The level of noise created is dependent therefore on the degree to which the seabed rock is consolidated; a soft clay will produce lower levels of sound compared to that generated by a granite layer.

Sound generated at the drill head is likely to be transmitted into the water via two paths. The first is where the noise is transmitted into the surrounding seabed layers before becoming refracted into the water column while the second is where vibrations travel up the drill shaft and then be transmitted into the water.

McCauley *et al.*[21] provide examples of noise levels recorded from an oil drilling rig in the Timor Sea. During drilling, the highest noise levels measured were around 115-117 dB re 1μPa at distances of 405 m and 125 m from the rig. This indicates a broadband source level of around 170 dB re 1 μPa. An analysis of the drill noise showed that dominant tones were produced in the 31 Hz and 62 Hz 1/3 octave bands.

4.4. Piling noise

Underwater piling is carried out in order to provide secure foundations for the drilling templates and the jacket. Depending on the installation design, a large single pile or several smaller piles may be hammered into the seabed. Piling techniques tend to be either impact piling using a large impulsive hammer or vibro-piling where smaller amplitude vibrations are used to push the pile into the seabed. Previous studies[1] indicate

[21] McCauley R., Radiated Underwater Noise Measured From The Drilling Rig *Ocean General*, Rig Tenders *Pacific Ariki* And *Pacific Frontier*, Fishing Vessel *Reef Venture* And Natural Sources In The Timor Sea, Northern Australia. Prepared for: Shell Australia, Shell House Melbourne, July 1998.

that impact piling will be used in the Chirag oilfield. However, precise noise spectra and levels associated with each piling operation are unknown. As a result, this section looks at noise levels associated with a range of piling operations so as to provide indicative noise levels for the specific COP piling operations.

For impulse piling, the force required to hammer the piles into the seabed and hence the noise level generated, depends on two factors:

1. The diameter of the pile and

2. The nature of the seabed sediment.

A review of underwater piling in Canada[22] shows that source levels vary from 206 dB re 1 μPa @ 1 m, peak overpressure using an 8" (203 mm) cedar pile to 223 dB re 1 μPa, peak overpressure at an unspecified range for a 36" (914 mm) closed end steel pile.

Richardson *et al.*[9] states that impulsive hammering sounds may be as high as 131-135 dB re 1 μPa at a range of 1 km from the source and that the transient signals had strongest components at frequencies of 30-40 Hz and ~100 Hz. By propagating back to the source using spherical spreading, this suggests that source levels could be of the order of 195 dB re 1 μPa at 1 m. Strictly, spherical spreading is only applicable in deep water; Richardson *et al.*[9] makes no comment on water depth and fails to provide any information that would allow for the determination of an appropriate propagation law.

The Pile Installation Demonstration Project[23] gave sound pressure levels of 185-196 dB rms and 197-207 linear-peak re 1 μPa at a distance of 109 m from the source and in a water depth of 1-6 m. Source levels were estimated at 225-236 dB rms and 237-247 dB linear-peak re 1 μPa. It is assumed that the source levels quoted here are measured across a frequency band of 20-20000 Hz. In addition, measurements indicate that the peak of the acoustic energy was found to be around 130-150 Hz and for these frequencies, spectrum levels are estimated to be around 202 dB re 1 μPa/Hz.

A review of a number of papers commissioned by Washington State Department of Transportation[24] on underwater piling noise indicated that for a 30″ diameter pile (comparable to the size of the pin piles used to support the template), noise source levels will be around 210 dB_{peak} re 1 μPa at 1 m (195 dB_{rms} re 1 μPa at 1 m). For a 96″ diameter pile (forming the temporary foundation support for the WC-PDQ jacket), noise source levels are expected to be around 220 dB_{peak} re 1 μPa at 1 m (205 dB_{rms} re 1 μPa at 1 m).

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[22] Vagle, S., "On the Impact of Underwater Pile-Driving Noise on Marine Life", Ocean Science Productivity Division, Institute of Ocean Sciences, DFO/Pacific, 2003.

[23] Final Environmental Impact Statement/Statutory Exemption Volume I: Pile Installation Demonstration Project (PIDP) for the Oakland Bay Bridge East Span Seismic Safety Project, May 2001, at http://www.dot.ca.gov.

[24] http://www.wsdot.wa.gov/Environment/Air/PileDrivingReports.htm accessed December 3, 2008

4.5. Background noise

Background noise levels in shallow water are very variable being dependent on shipping activity and marine industrial activity as well as wind speed and rainfall[25]. Typically, at frequencies around 100 Hz, background noise levels are around 70-80 dB re 1 μPa per Hz. For a 1/3 octave band centred on 100 Hz, this gives background levels in the range 85-95 dB re 1 μPa.

No data of underwater background noise in the Caspian Sea have been found. However, comparisons may be made with other shallow water sites in which similar shipping, drilling and piling activity takes place. The North Sea contains a number of oil platforms that are being both developed and commissioned or else are in full operation. Measurements of background noise in the coastal fringe of the North Sea by Nedwell *et al*[26], indicated a background noise level range of 100-135 dB re 1μPa with a modal value of 120 dB re 1 μPa. It is suggested that a value of 120 dB re 1 μPa be taken for the background noise levels in the Caspian Sea. It must be emphasised that the North Sea data is the best estimate available but nevertheless may not be wholly representative of noise levels in the Caspian Sea.

4.6. Summary of underwater noise sources

Although there is extensive literature on shipping noise in general, specific details of noise levels for principal vessels that are expected to be used in the COP programme are not available. Based on reviews of vessel noise data, it is recommended that the maximum broadband source level for vessels be given as 190 dB re 1 μPa at 1 m.

Very little information on drilling noise is available. From the literature review undertaken, an indicative broadband source level of 170 dB re 1 μPa is used for the subsequent noise analysis.

Piling noise is approximately proportional to pile size. The literature review indicates that for a 36″ pile which corresponds to the pile used to support the jacket, noise levels will be around 210 dB re 1 μPa at 1 m while for the 96″ pile used to provide foundation support for the jacket, noise levels will be around 220 dB re 1 μPa at 1 m.

No data are available on underwater background noise levels for the Caspian Sea. Similar noisy, shallow water sites give values of 120 dB re 1 μPa and this is taken as an indicative level at the Chirag field.

[25] Urick R J., Ambient Noise in the Sea, 1984

[26] Nedwell J R, Parvin S J, Edwards B, Workman R, Brooker A G, Kynoch J E, Measurement and interpretation of underwater noise during construction and operation of offshore windfarms in UK waters, COWRIE NOISE-03-2003, 2007

5. MODELLING OF THE ACOUSTIC NOISE CAUSED BY SHIPPING AND DRILLING

5.1. Description of the model and limitations

Numerous computer models are available to predict acoustic propagation in the marine environment. Each model has its own strengths and weaknesses in terms of input requirements and calculation methods, but all include some form of description of various environmental parameters, such as the water column sound speed profile (SSP) and sediment acoustic properties.

Reviews of a number of acoustic propagation models are given by Buckingham[27], Jensen *et al.*[28] and Etter[29]. A number of these have been coded up and are included in the Acoustics Toolbox[30]. The models are based on ray-trace, normal mode, parabolic equation and fast field techniques. The model of relevance to the analysis undertaken for this report is RAM. RAM is based on the parabolic equation and carries out 2-D analysis for a given sound speed profile in an ocean waveguide overlying a range-dependent, absorbent seabed sediment.

The codes on which RAM is based have been used world-wide since the 1990's and many peer-reviewed publications have been produced based on the program including work by Zingarelli and King[31], Milou *et al.*[32] and Fabre and Dennis[33].

The quality of the output data is highly dependent on obtaining site-specific oceanographic and geo-acoustic data. The sources of data used as inputs to the propagation modelling process are discussed below.

5.2. Oceanographic data

The acoustic model requires sound speed profiles as one of the sets of input data. Archived oceanographic data for the Caspian Sea is however, very scarce. Sound speed profiles were constructed using temperature data[34] and salinity data[35] together with the Chen-Millero[36] relationship and these are shown in Figure 5-1.

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[27] Buckingham M.J., "Ocean-acoustic propagation models". Journal d'Acoustique: 223-287 June 1992

[28] Finn Jensen, William Kuperman, Michael Porter, and Hernik Schmidt, Computational Ocean Acoustics, Springer-Verlag (2000)

[29] Etter Paul C., Underwater Acoustic Modeling and Simulation , 3rd edition, Spon Press, New York, 2003, ISBN 0-419-26220-2

[30] http://oalib.hlsresearch.com/Modes/AcousticsToolbox/

[31] Zingarelli R.A. and King D.B., "RAM to Navy Standard Parabolic Equation: Transition from Research to Fleet Acoustic Model", NRL, 2003. Downloaded from http://www.nrl.navy.mil/content.php?P=03REVIEW212

[32] de Milou Marta E, Salvadores Silvia R., Blanc Silvia, "Using updated parabolic equations codes to examine acoustic transmission losses measurements over the Argentinean continental slope", Gayana (Concepción) v.68 n.2 supl.TIIProc Concepción 2004, downloaded from http://www.scielo.cl/scielo.php?pid=S0717-65382004000300013&script=sci_arttext

[33] Fabre, J.P.; Dennis, S.M., "Characterization of the Variability of the Ocean Acoustic Environment", OCEANS 2007, Volume , Issue , Sept. 29 2007-Oct. 4 2007 Page(s):1 - 3

[34] Ambient Temperatures Design Basis - TN-FFD-PE-082, 2008

The figure shows that during the winter months the sound speed is strongly upwardly refracting over the top 20 m and less so down to a depth of 100 m. Below this depth, there is a shallow sound channel at a depth of 150 m. The nature of the profile is such that for shallow sound sources such as a vessel, the sound tends to become trapped in a surface channel and subsequently may propagate to considerable distances. Sound from deeper sources tends to become trapped near to the seabed and hence may undergo greater attenuation during reflection and refraction at the water-sediment interface. By contrast, the summer profile shows a shallow surface channel at a depth of 10 m and this has been generated through the heating of the surface layers. Below about 50 m, the seasonal heating has little effect as water temperatures remain little changed over the course of the year. Consequently, the sound speed falls down to a depth of 150 m where a shallow sound channel is produced. In such a profile, the sound from a shallow source again tends to become trapped in a surface duct while that from a deep source tends to propagate at depths close to the seabed bed.

5.3. Seabed data

The bathymetry of the seabed in the vicinity of the Chirag oilfield was constructed using data extracted from a chart of the area[37]. This is shown in Figure 5-2. It shows that the site of interest to this study is located in a water depth of around 170-180 m. Beyond a range of 17 km, the water depth rapidly decreases to remain in the range 10-20 m until the coastline is reached some 85 km distant.

The nature of the seabed is reported in a number of documents provided by the client[38],[39],[40]. They indicate that the seabed is predominantly very soft clay. It is assumed that the clay is very thick (500 m) and hence the nature of the basement is unimportant. Hamilton[41,42,43] provides advice on seabed sediment parameters and from this, the sound speed and attenuation data was obtained. This is summarised in Table 5-1. It is noted that the classic 3-layer acoustic model as represented in both BELLHOP and RAM, assume a basement that is semi-infinite in thickness.

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35 HYCOM Caspian Sea Modeling. Part I: An Overview of the Model and Coastal Upwelling By Birol Kara, Alan Wallcraft And Joe Metzger Naval Research Laboratory, Stennis Space Center, USA, and Murat Gunduz, Institute of Marine Sciences, Erdemli, Icel, Turkey.

36 C-T. Chen and F. J. Millero, 1977, Speed of Sound in Seawater at High Pressures. J. Acoust Soc Am, 32(10), p 1357

37 Chart downloaded from http://www.caspianenvironment.org. Accessed December 12, 2008.

38 Fugro-Geoteam Pipeline Route Survey Report, Report No. M1380 dated 20.03.00

39 Fugro Geotechnical Interpretative Report, Pipeline Route Survey, Report No. N-3652/02

40 Fugro Geotechnical Parameters West Chirag ACG Phase 3, Caspian Sea, Azerbaijan, Report No. N-4253/05, 26 Sep. 2003.

41 E.L. Hamilton: Sediment Sound Velocity Measurements made In Situ from Bathyscaph TRIESTE, Journal of Geophysical Research 68 (1963) pp. 5991-5998.

42 E.L. Hamilton: Sound velocity and related properties of marine sediments, North Pacific, Journal of Geophysical Research 75 (1970) pp. 4423-4446.

43 E.L. Hamilton: Compressional-wave attenuation in marine sediments, Geophysics 37 (1972) pp. 620-646.

Table 5-1: Seabed sediment properties

Layer	Compressional wave velocity Vp m/s	Density kg/m^3	Attenuation dB/m/kHz	Thickness m
Terrigenous mud	1451	1652	0.468	250
Metamorphic basement	5548	2745	0.094	not applicable

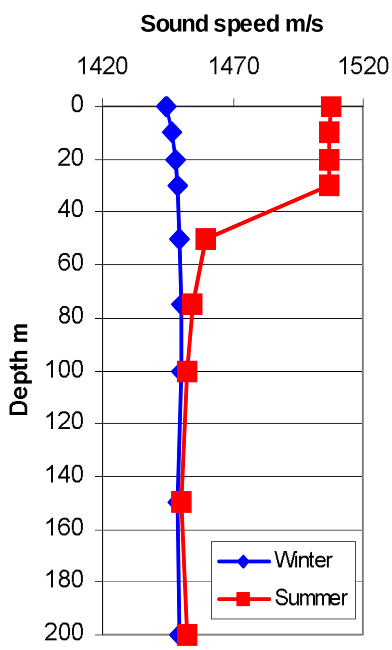

Figure 5-1: Seasonal sound speed profiles

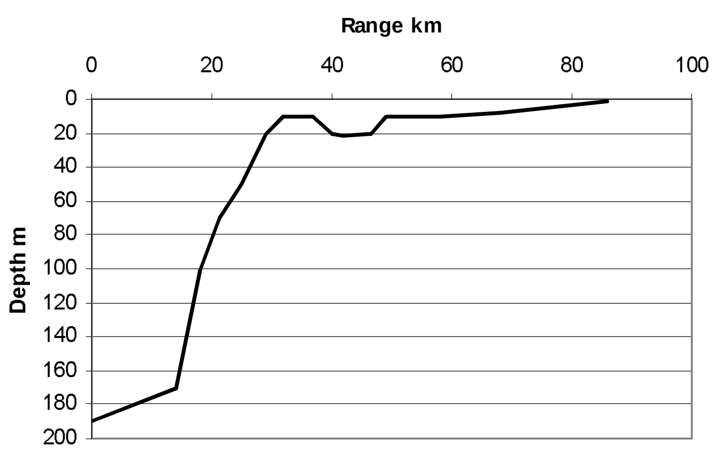

Figure 5-2: Bathymetric profile at the Chirag oilfield site

5.4. Acoustic data

This report discusses the modelling of sound from three different sources: vessel, drilling and underwater piling. These are all broadband sources of noise with unique and distinct signatures (see for example Richardson *et al.*[9]. Ideally, a broadband, time-domain propagation model should be used to represent the underwater acoustic environment. However, these tend to be difficult to use and have a considerable time overhead associated with them[28]. An alternative solution is to assume that the greater part of the acoustic energy emitted by the vessel, drilling and piling operations is contained within a 1/3rd octave band of a given frequency, then to use a single-frequency model such as one based on ray-trace or parabolic equation to propagate the sound at that frequency. Richardson *et al.*[9] show frequency spectra for a number of classes of vessels and these show a family of low frequency tonals and their harmonics superimposed upon a general noise signature. The tonals themselves are associated with the propeller blade rate and these tend to contribute most of the acoustic energy. Similarly, the drilling operation may be characterized acoustically by assuming most of the energy is transmitted over one frequency component. Precise information on the frequency spectra for the equipment used in the Chirag oilfield is not available. However, McCauley *et al.*[21] provides frequency spectra measured from a marine drilling rig and this is used as proxy data for drilling at the Chirag site.

At its simplest, sound may be considered to radiate uniformly in all directions. In practice, a given sound source has some directionality associated with it and this is expressed in terms of its beamwidth. Notional beamwidths for the three types of sound source are given in Table 5-2. For the vessel, it is assumed that the energy radiates from the horizontal downwards through an arc of 80°. By contrast, the beam pattern associated with the drilling operation ranges from near-vertical upwards to near-vertical downwards while for piling, it is assumed to be contained in an arc from around –40° to near-vertical downwards.

The sea is modelled as a plane, smooth layer where this indicates a surface boundary that is not disturbed by wind or wave action. The reflection losses associated with this condition are minimal compared to those that arise when the surface is roughened. Hence, overall sound levels at a given depth and range are higher than would otherwise occur if the surface was disturbed.

The input parameters for the acoustic sources are summarised in Table 5-2.

Table 5-2: Acoustic modelling input parameters

	Vessel	Drilling	Piling
Frequency Hz	80	60	200
Source depth m	6	170	85
Beam pattern degrees	0°/-80°	+80°/-80°	+40°/-80°

5.5. Discussion of model runs

A number of model runs were made using oceanographic data for the winter and summer months, using an upwardly sloping seabed bathymetric profile, and using the source frequencies, depths and beam patterns given in **Error! Reference source not found.** above.

The propagation loss data thus obtained is subtracted from values representing the source level for each of the three sources modelled. For the vessel noise, a broadband source level of 180 dB re 1 μPa is representative of vessels of the type that are to be used to service the Chirag field rigs. Measurements of ship noise provided by both McCauley *et al.*[21] and Richardson *et al.*[9] support this assumption. For drilling operations, McCauley *et al.*[21] indicates source levels around 170 dB re 1 μPa.

An example of the output data generated using the vessel input parameters is provided in Figure . This shows the depth-averaged sound pressure level (SPL) computed using environmental data for winter and summer oceanographic conditions. It will be seen that the results for both months follow broadly similar trends. The winter data shows a decreasing SPL with increasing range up to 7 km. Sudden changes in SPL at 7 km, 18 km and 30 km indicate regions of enhanced sound level and equally, regions where shadow zones are formed. The lower SPL at a given range computed using the summer data can be attributed to the difference in sound speed profiles between the two months and as shown in Figure . By summer, the sea surface temperature has risen sufficiently to create a seasonal thermocline with an axis at 100 m. There is a tendency for acoustic energy to become trapped at depths close to the seabed. Continual interaction with the lossy seabed sediments results in a greater attenuation of sound level than would occur during the winter months. Thus underwater sound is less likely to propagate to large distances during the summer. Figures 5-4 and 5-5 show the variation of SPL with range for the drilling noise and piling noise respectively.

The data can be used to determine the range at which each noise component has fallen below the general background noise level. For an ambient noise level of 120 dB re 1uPa (see Section 4.5 above), Figure 5-3 shows that vessel noise falls below the background noise level at a range of around 1 km, less than 1 km for drilling noise (Figure 5-4) and about 2 km for piling noise (Figure 5-5). In the event that background noise levels are as low as 85 dB re 1 μPa (representative of deep water sites), then piling noise could remain above the background noise level to a range of 32 km in winter and 26 km in summer.

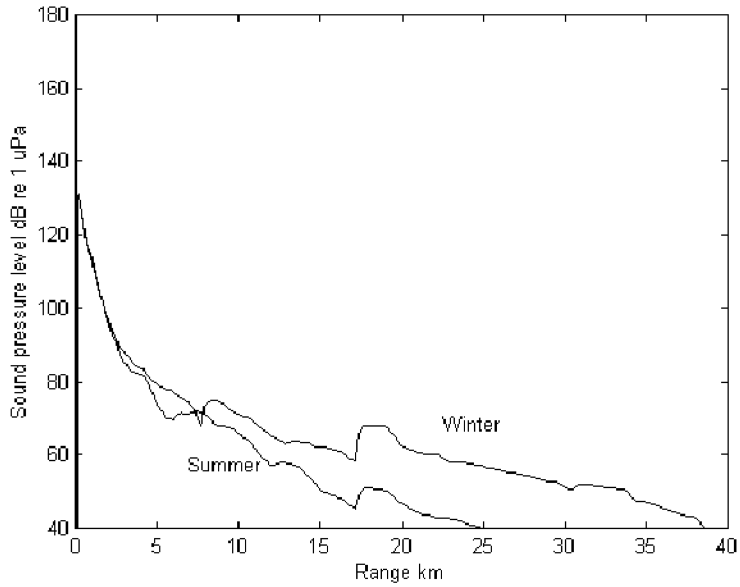

Figure 5-3: Sound pressure level as function of range for vessel noise

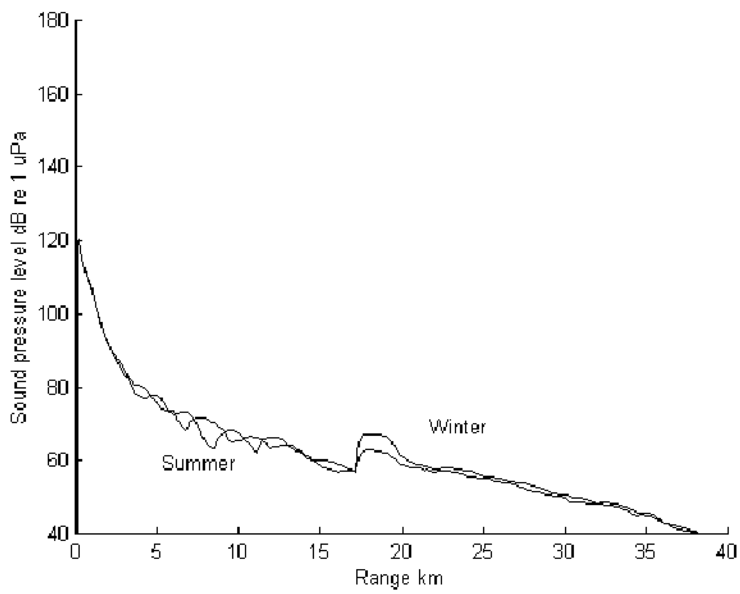

Figure 5-4: Sound pressure level as function of range for drilling noise

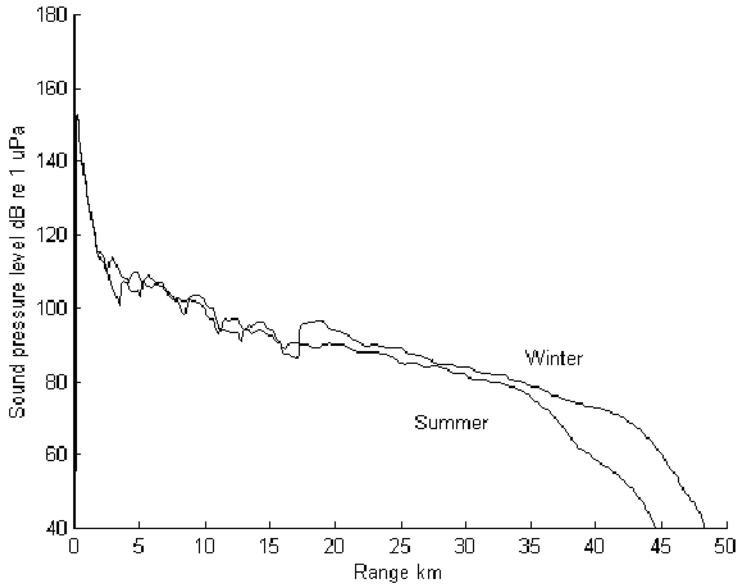

Figure 5-5: Sound pressure level as function of range for piling noise

6. ACOUSTIC IMPACT ANALYSIS

6.1. Introduction

The levels of underwater noise generated by activities associated with the Chirag oilfield, are used here to estimate impact zones for a number of target marine species *viz.* fish with no swim bladders, fish with swim bladders, and pinnipeds (representing the Caspian seal).

The ranges at which lethality, physical injury and auditory damage arise following exposure to vessel noise, drilling noise and piling noise may be determined from Figures 5-3 to 5-5. A discussion of the ranges for each impact is given below.

6.2. Lethal injury range

The source levels for both the vessel noise and the drilling operations are considerably below the levels at which lethal injury to species of marine mammal might occur (established at 240 dB re. 1 µPa). It is therefore considered unlikely that any marine animals will be killed as a consequence of the underwater noise from either the shipping, drilling or piling operations.

6.3. Physical injury range

The source levels from both the vessel noise and the piling and drilling operations is below the levels at which direct physical injury from the underwater noise might occur (established at 220 dB re. 1µPa). It is therefore unlikely that marine animals will suffer physical injury as a consequence of the underwater noise from any of the shipping, piling or drilling operations.

Based on a conservative criterion from the US NMFS, whereby auditory injury may occur to pinnipeds following prolonged exposure to underwater sound at levels above 190 dB re. 1 µPa, the source levels from both the vessel noise and the drilling operations are below the level at which a seal would receive auditory injury. However, noise from the piling operation for the 96" diameter piles has the potential to cause physical injury to seals out to a range of approximately 10 m from the piling site. Therefore, a physical injury impact zone for seals of 10 m radius exists around the piling site.

6.4. Auditory injury range

Based on the PTS and TTS impact criteria, permanent deafness would arise in a creature if it remained within 8 m of a vessel or the drilling site, for a period of 30 minutes or more. When exposed to piling noise from the 96" diameter pile, the distance has to increase to 40 m. Temporary deafness could occur in fish and seals at distances up to 350 m from the noise sources, again only if the animals remained in the vicinity for a period of 30 minutes or more. In practice, it is deemed very unlikely that either of these conditions would be met.

6.5. Behavioural avoidance range

6.5.1. Behavioural effects from shipping noise

This part of the assessment has analysed the shipping noise in comparison with the generic hearing threshold data for fish with swim bladders, fish with no swim bladders and pinnipeds.

The behavioural impact model is based on a comparison of the frequency spectrum of the noise being considered with the hearing threshold of the target species. This is illustrated in Figure 6-1 which shows the frequency spectrum for the vessel and the hearing sensitivity curve for a fish with no swimbladder. The difference between the two curves gives the apparent loudness of the vessel as perceived by the fish. The propagation loss data (computed using the acoustic modelling undertaken and discussed in Section 3) is applied to the apparent loudness of the sources for each species. Subsequently, the range at which sound pressure level has fallen to the threshold for each behavioural impact may be easily determined.

For reference, the apparent loudness of the vessel, drilling and piling noise as perceived by each target species is given in Table 6-1.

Table 6-1: Apparent loudness of vessel and drilling noise for target species

Species	Apparent loudness vessel dBht	Apparent loudness drilling dBht	Apparent loudness 30" pile dBht	Apparent loudness 96" pile dBht
Non-swimbladder fish	83.5	51.5	111.3	121.3
Swimbladder fish	98.4	58.5	133.5	143.5
Pinniped	102.7	54.7	132.4	142.4

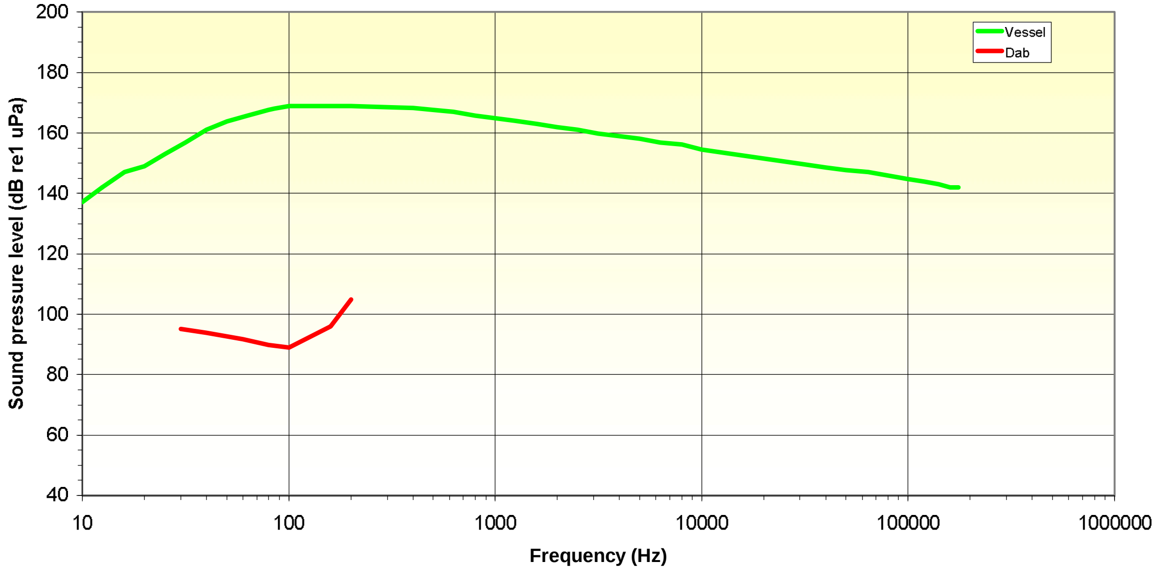

Figure 6-1: Comparison of hearing sensitivity of a fish with no swimbladder against vessel spectrum levels

The data indicates that a complete behavioural avoidance by 100% of individuals and a strong behavioural avoidance by 90% of individuals may occur at ranges of less than 1 m in each case, from the vessel for fish with no swimbladders. This very short range occurs because of two factors; firstly, non-swimbladder fish are relatively insensitive to sound in general and secondly, shipping noise from the vessel that is used for servicing the Chirag oilfield is relatively low. Fish with swimbladders are slightly more sensitive to shipping noise therefore strong avoidance reactions may be observed at distances up to 3 m. Similarly, pinnipeds may exhibit signs of strong avoidance at ranges up to 5 m from a vessel.

Mild avoidance to vessel noise may be observed up to 3 m for fish with no swimbladders, 15 m for fish with swim bladders and 15 m for pinnipeds.

A low likelihood of disturbance may be noted in non-swimbladder fish up to 47 m from the vessel, up to 490 m for swimbladder fish and up 980 m for pinnipeds. It is noted that ranges for this impact show some seasonal variation. Longer ranges tend to occur during the winter months reflecting the tendency for underwater sound to become trapped in a surface duct leading to optimal propagation conditions.

A summary of the behavioural impact ranges for each of the target species when exposed to vessel noise is given in Tables 6-2 to 6-4.

6.5.2. Behavioural effects from drilling noise

The impact of drilling noise has been assessed by means of the comparison of the drilling noise with the hearing ability of the target species. The results indicate that because of the relatively low levels of noise that arise during the drilling operations at the Chirag site, complete, strong or mild avoidance reactions are not likely to be observed in any of the species of interest.

Maximum distances from the drilling site over which a low likelihood of disturbance may be seen are 2 m for pinnipeds and 3 m for fish with swim bladders.

A summary of the behavioural impact ranges for each of the target species when exposed to drilling noise is given in Tables 6-2 to 6-4.

6.5.3. Behavioural effects from piling noise

Of all the noise sources considered in this study, noise from underwater piling may propagate to the greatest distances and thus has the potential to give rise to behavioural impacts over the greatest area.

When exposed to noise from piledriving the 30" diameter piles, complete avoidance will occur over a maximum range of 47 m by 100% of individuals of fish with swim bladders while strong avoidance and mild avoidance may be observed up to ranges of 294 m and 3.9 km respectively. A low likelihood of avoidance may be seen in fish with swimbladders out to 44 km and in pinnipeds out to 47 km. For the 96" diameter piles, the maximum range at which a low likelihood of avoidance may be observed increases to 49 km for both fish with swimbladders and pinnipeds.

6.5.4. Masking ranges

As indicated in Section 4-5, the range at which the 0 dBht criterion is met is the range at which sound, either operational noise or acoustic communication signals between animals; become no longer audible. Sound may also become inaudible when its noise level falls below the general background noise level. The range at which sound is masked, either by the animals hearing perception or by the background noise, is known as the masking range and this is given by the shorter of the two ranges. Masking ranges for each noise and for each of the target species are summarised in Tables 6-2 - 6-4.

Assuming the background noise level is as high as 120 dB re 1 μPa, then the maximum masking range for the target species is 2 km. In this case, the hearing ability for all of the target species is said to be noise-limited as opposed to being threshold-limited.

If the background noise levels in the Caspian Sea are as low as 83 dB re. 1 μPa, the hearing ability of non-swimbladder fish is threshold-limited to vessel and drilling noise and noise-limited to piling noise. Fish with swimbladders are noise-limited to piling noise and threshold-limited to drilling noise. During the winter months, they are noise-limited to vessel noise but this changes to being threshold-limited during the summer months as the sound speed profile changes due to surface heating. Pinnipeds are noise-limited to vessel noise and piling noise and threshold-limited to drilling noise.

Table 6-2: Behavioural impact ranges for non-swim bladder fish

		Near complete avoidance (100 dB_{ht})	Strong avoidance (90 dB_{ht})	Mild avoidance (75 dB_{ht})	Low likelihood of avoidance (50 dB_{ht})	Threshold of audibility (0 dB_{ht})	Masking range
Winter	**Vessel**	<1m	<1m	3 m	47 m	20 km	1 km
	Drilling	<1m	<1m	<1m	1 m	1.5 km	1 km
	Piling 30"	3 m	9 m	50 m	6.1 km	49 km	2 km
	Piling 96"	11 m	36 m	430 m	23 km	49 km	2 km
Summer	**Vessel**	<1m	<1m	3 m	47 m	11 km	1 km
	Drilling	<1m	<1m	<1m	1 m	1.5 km	1 km
	Piling 30"	3 m	9 m	50 m	5.9 km	44 km	2 km
	Piling 96"	11 m	36 m	585 m	17 km	47 km	2 km

Table 6-3: Behavioural impact ranges for fish with swim bladders

		Near complete avoidance (100 dB_{ht})	Strong avoidance (90 dB_{ht})	Mild avoidance (75 dB_{ht})	Low likelihood of avoidance (50 dB_{ht})	Threshold of audibility (0 dB_{ht})	Masking range
Winter	**Vessel**	<1m	3 m	15 m	490 m	43 km	1 km
	Drilling	<1m	<1m	<1m	3 m	3.8 km	1 km
	Piling 30"	47 m	294 m	3.9 km	44 km	49 km	2 km
	Piling 96"	294 m	1.9 km	15 km	47 km	49 km	2 km
Summer	**Vessel**	<1m	3 m	15 m	490 m	17 km	1 km
	Drilling	<1m	<1m	<1m	3 m	3.8 km	1 km
	Piling 30"	47 m	315 m	5.4 km	36 km	48 km	2 km
	Piling 96"	294 m	2.2 km	15 km	38 km	49 km	2 km

Table 6-4 : Behavioural impact ranges for pinnipeds

		Near complete avoidance (100 dB_{ht})	Strong avoidance (90 dB_{ht})	Mild avoidance (75 dB_{ht})	Low likelihood of avoidance (50 dB_{ht})	Threshold of audibility (0 dB_{ht})	Masking range
Winter	**Vessel**	1 m	5 m	14 m	980 m	44 km	1 km
	Drilling	<1m	<1m	<1m	2 m	2.1 km	1 km
	Piling 30"	42 m	234 m	3.7 km	45 km	49 km	2 km
	Piling 96"	234 m	1.5 km	14 km	47 km	49 km	2 km
Summer	**Vessel**	1 m	5 m	14 m	686 m	22 km	1 km
	Drilling	<1 m	<1 m	<1 m	2 m	2.1 km	1 km
	Piling 30"	42 m	312 m	3.9 km	35 km	48 km	2 km
	Piling 96"	312 m	2.1 km	13 km	38 km	49 km	2 km

7. SUMMARY AND CONCLUSIONS

Underwater noise will result principally from driving the foundation piles during installation, drilling and vessel movements during construction and offshore operations and have the potential to impact biological/ecological receptors (specifically seals and fish) in the marine environment. An analysis of the propagation of underwater noise during the construction, installation and HUC phase and offshore operations phase was undertaken in order to estimate distances at which various acoustic impacts on marine species may occur. The assessment has shown that levels of underwater noise from vessels and drilling are insufficient to cause lethality, physical injury or auditory damage to fish and pinnipeds.

Levels of noise from piling could cause physical injury to seals up to 10 m from the site. Auditory injury (permanent and temporary damage) could occur to fish and seals at distances up to 350 m from a vessel, the drilling site or the piling site provided the animals remained in the immediate vicinity of the site for a period of 30 minutes or more. This scenario is considered unlikely in practice.

Using the criterion of 90 dBht(species) as a level of noise at which a strong avoidance reaction by the majority of individuals may be expected, this condition is met for pinnipeds at a maximum range of 5 m from the vessel. For all other species considered, the range at which this criterion is met; is less.

Mild avoidance reactions, represented by the 75 dBht impact criterion might be expected to be observed by a majority of individuals at a range of 15 m for fish species with swimbladders and 14 m for pinnipeds.

A low likelihood of disturbance due to vessel noise and as represented by the 50 dB_{ht}(species) impact criterion, may be expected at distances ranging from 47 m for fish with no swim bladders to 490 m for fish with swimbladders and 980 m for pinnipeds.

With regards to the drilling noise, strong avoidance reactions and mild avoidance reactions are not likely for any of the species considered, even in the immediate vicinity of the marine works.

A low likelihood of disturbance may occur at distances less than 2 m from the drilling sites for the most sensitive species considered.

Strong avoidance reactions may be observed out to a maximum range of 1.9 km for fish with swimbladders when exposed to piling noise. For the same species, a mild reaction may be expected to a maximum range of 15 km. A low likelihood avoidance reaction could be experienced out to 47 km for fish with swimbladders and 38 km for pinnipeds.

Background noise levels in the Caspian Sea are unknown. If they are as high as those in the North Sea where similar offshore industrial activities take place, *viz*. 120 dB re 1 μPa, then all noise levels beyond a range of 2 km from the source will have become indistinguishable from the general noise background.

While the conclusions above indicate that noise generated by vessels and drilling operations is unlikely to create significant disturbance or disruption to the species present in the vicinity of the Chirag oilfield, the studies summarised indicate that even in cases where pinnipeds take action to move away from areas where noise levels are raised temporarily, they often return when the activities cease. In the event that pinnipeds were to be affected during the drilling and related activities, the numbers of each species are expected to recover quickly to pre-activity levels following completion of the works.

APPENDIX 11D

Drilling Discharge Modelling

Report Title	**Azeri Chirag Gunashi Field** **Drill Cuttings Dispersion Modelling**		
Client:	**BP**		
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EXECUTIVE SUMMARY

A Computational Fluid Dynamics (CFD) study was carried out by BMT Fluid Mechanics (BMT) to assess the dispersion and deposition of subsea drill cutting discharges from the Chirag Oil Project (COP) Development in the Azeri Chirag Gunashi (ACG) Field 110km off the coast of Baku, Azerbaijan in the Caspian Sea. The study was carried out for BP.

Discharges from drilling the 26" hole section were simulated. The discharges will take place vertically downward from a caisson (C5, Ø 0.8 m) at a depth of 136m. The water depth at the drilling location will be 168m.

A total of 28 wells will be drilled through the COP template. The total drilling duration for a single well is estimated to be 30 hours and will be followed by a post-drilling discharge of 4 hours.

The section will be drilled using Untradrill, a water-based mud which comprises of barite, water and minor chemicals (principally KCl). A total estimate of 500 metric tonnes is to be required to drill this section.

The discharge composition and rates in metric tonnes per hour for the drilling and post-drilling operations are summarised in Table 4.1.

Discharges from drilling the 36" hole section through the 48 well template were modelled. In this case, the material being discharged was composed of bentonite and water-based mud. Discharges take place vertically through the seabed. The total drilling duration for a single well will be 8 hours.

The discharge composition and rates in metric tonnes per hour for the drilling and post-drilling operations are summarised in Table 4.2.

Discharges from drilling the 26" hole section from the MODU were simulated. The discharges will take place vertically downward from a caisson (assumed to be C5 for reference, Ø 0.8 m) at a depth of 11m.

A total of 20 wells will be pre-drilled. The total drilling duration for a single well is estimated to be 30 hours and will be followed by a post-drilling discharge of 4 hours.

The discharge composition and rates in metric tonnes per hour for the drilling and post-drilling operations are summarised in Table 4.1.

From the results obtained in the simulations it can be observed that given a discharge rate and duration, the deposition footprint is highly dependant on both discharge depth and current speed. These factors highly influence the deposition rate, which together with particle size and shape control the height and shape of the deposited material. These influences can be observed in Table 4.4 to Table 4.6.

For the simulations carried out in this report, currents were assumed constant and unidirectional. Hence the footprint length for the predominant current cases, and maximum height for the near-stagnant current conditions, can be considered as worst-case scenarios.

Azeri Chirag Gunashi Field Drill Cuttings Dispersion Modelling

Contents

Azeri Chirag Gunashi Field Drill Cuttings Dispersion Modelling

1. Introduction

1.1. General

This report presents the results of a Computational Fluid Dynamics (CFD) study carried out by BMT Fluid Mechanics (BMT) to assess the dispersion and deposition of subsea drill cutting discharges from the Chirag Oil Project (COP) Development in the Azeri Chirag Gunashi (ACG) Field 110km off the coast of Baku, Azerbaijan in the Caspian Sea. The scope of work is based on requirements outlined in “Chirag Oil project – Outline Scope of Work for modelling dispersion and fate of cooling water and drill cuttings” issued to BMT by BP on the 28th of November 2008. The study was carried out for BP.

The COP development will require staged drilling operations. These operations will deposit mud and cuttings into the water column that will disperse and settle on the sea floor. The primary purpose of the modelling is to simulate the dispersion of these discharges and assess the impact on the environment.

1.2. Report Structure

Sections 2 and 3 of this report describe the main objectives of the study and the scope of work agreed to meet those objectives. Results of the dispersion and deposition analysis of subsea drill cutting discharges are given in section 4. Details of the modelling and supporting information are given in Appendix A.

2. Objectives

The main objectives of the subsea drill cutting dispersion and deposition modelling are as follows:

- Model dispersion and fate of drill cuttings.
- Model the fate of the drilling mud additives, barite and bentonite.

3. Scope of Work

3.1. Model Construction

- Construct a CFD model of the water column surrounding the PDQ and CWP to a depth of 150m that is suitable for dispersion modelling. The model will consist of a high-resolution domain out to a 100m radius and a lower resolution domain out to 10 km downstream of the platforms. A simple geometric representation of the risers and releases will be included in the model if required

3.2. Drill Cuttings

- Carry out steady-state single well dispersion simulations for a total of 3 release depths and an average and peak winter and summer current condition (to be agreed) (summer condition includes thermocline) – Total 12 simulations
- The drill cuttings fluid will include barite discharged at a constant concentration. The cutting fluid will also be discretized into 6 grain sizes
- Provide sea bed contour plots of deposition rates for the drill cutting and mud and barite for each scenario (24 plots)
- Provide horizontal and vertical colour contour plots of drill fluid concentrations for a selected number scenarios (maximum 12 plots)
- Combine the steady state dispersion simulation results with transient current data (to be provided) and data on drilling times and programme (to be provided), to generate contour plots of drill cuttings deposition depths and mass
- Repeat the above scope items for two multiple well scenarios (number of wells to be agreed), and an average and peak winter and summer current condition (to be agreed) (summer condition includes thermocline) – Total 8 simulations

3.3. Reporting

- Submit a technical report summarising the main results of the dispersion analysis including method, software and model description, sufficient tabular and illustrative graphical colour images, recommendations and conclusions

4. CFD Analysis

4.1. Introduction

This section presents the main results of the subsea drill cuttings dispersion analysis carried out to determine the seabed footprints of the discharged materials during the drilling of the 26” and 36” sections on the seabed.

The CFD model and methodology is described in Appendix A.

4.2. Discharge Scenarios

4.2.1. Production Drilling Discharges from 26” hole sections

Discharges from drilling the 26” hole section were simulated. The discharges will take place vertically downward from a caisson (C5, Ø 0.8 m) at a depth of 136m. The water depth at the drilling location will be 168m.

A total of 28 wells will be drilled through the COP template. The total drilling duration for a single well is estimated to be 30 hours and will be followed by a post-drilling discharge of 4 hours.

The section will be drilled using Untradrill, a water-based mud which comprises of barite, water and minor chemicals (principally KCl). A total estimate of 500 metric tonnes is to be required to drill this section.

The discharge composition and rates in metric tonnes per hour for the drilling and post-drilling operations are summarised in Table 4.1.

4.2.2. Production Drilling Discharges from 36” hole sections

Discharges from drilling the 36” hole section through the 48 well template were modelled. In this case, the material being discharged was composed of bentonite and water-based mud. Discharges take place vertically through the seabed. The total drilling duration for a single well will be 8 hours.

The discharge composition and rates in metric tonnes per hour for the drilling and post-drilling operations are summarised in Table 4.2.

4.2.3. Pre-Drilling Discharges from Mobile Offshore Drilling Unit (MODU) from 26” hole sections

Discharges from drilling the 26” hole section from the MODU were simulated. The discharges will take place vertically downward from a caisson (assumed to be C5 for reference, Ø 0.8 m) at a depth of 11m.

A total of 20 wells will be pre-drilled. The total drilling duration for a single well is estimated to be 30 hours and will be followed by a post-drilling discharge of 4 hours.

The discharge composition and rates in metric tonnes per hour for the drilling and post-drilling operations are summarised in Table 4.1.

4.3. Material Properties

The properties of the cuttings, bentonite, and barite used in the simulations are given in Table 4.3. In order to simplify the modelling, the distribution of cutting sizes was grouped into large and small cutting sizes, with the larger cuttings assumed to comprise 90% of the total mass of cuttings discharged.

4.4. Ambient Condition

Due to only small changes in the thermocline below 80m at all seasons, a constant seawater temperature of 7 ºC, obtained from [1], was used in the analysis.

4.5. Current Conditions

Two current conditions were assessed in the analysis:

- Near-stagnant flow: constant horizontal current flow velocity of 0.01 m/s
- Predominant flow: annual average current data obtained from [2], leading to a uniform constant value of 0.11 m/s

4.6. Results

4.6.1. Deposition Extent

Table 4.4 to Table 4.6 present the maximum horizontal extent of 1mm thickness deposition and the area covered by more than 1mm thickness deposition for the different discharged materials and scenarios, after the drilling of a single well and multiple wells, respectively.

4.6.2. Deposition Thickness Contour Plots

Figure 4.1 to Figure 4.3 present deposition thickness (in meters) contour plots for the different discharged materials at the seabed, after the drilling of a single well (26” hole section) and discharging from 136 m depth.

Figure 4.4 to Figure 4.6 present deposition thickness (in meters) contour plots for the different discharged materials at the seabed, after the drilling of 28 wells (26” hole section) and discharging from 136 m depth.

Figure 4.7 to Figure 4.9 present deposition thickness (in meters) contour plots for the different discharged materials at the seabed, after the drilling of a single well (36” hole section).

Figure 4.10 to Figure 4.12 present deposition thickness (in meters) contour plots for the different discharged materials at the seabed, after the drilling of 48 wells (36” hole section). The discharges for this case were modelled emulating the drilling template shown in Figure A.1.

Figure 4.13 to Figure 4.15 present deposition thickness (in meters) contour plots for the different discharged materials at the seabed, after the drilling of a single well (26” hole section) and discharging from 11 m depth.

Figure 4.16 to Figure 4.19 present deposition thickness (in meters) contour plots for the different discharged materials at the seabed, after the drilling of 28 wells (26” hole section) and discharging from 11 m depth.

Discharge points (i.e. Caisson C5) and COP platform locations are also indicated in each of these figures.

4.7. Conclusions

From the results obtained in the simulations it can be observed that given a discharge rate and duration, the deposition footprint is highly dependant on both discharge depth and current speed. These factors highly influence the deposition rate, which together with particle size and shape control the height and shape of the deposited material. These influences can be observed in Table 4.4 to Table 4.6.

For the simulations carried out in this report, currents were assumed constant and unidirectional. Hence the footprint length for the predominant current cases, and maximum height for the near-stagnant current conditions, can be considered as worst-case scenarios.

5. References

[1] ASA, "Hydrodynamic and Dispersion Modelling for the Azeri, Chirag, Gunashi Field Offshore Baku, Azerbaijan", ASA 01-007, August 2001

[2] Shah Deniz Wind Wave Surge and Current Criteria, v3.1, OceanMetriX Ltd, October 2008

6. Tables

Table 4.1: Summary of discharge rates in metric tonnes per hour for the 26" section

	Duration (hours)	Mud (Barite)	Cuttings	Total per Hour
Drilling	30	11.3 (4.5)	5.2	16.5
Post Drilling	4	40 (16)	0	40
Total Discharge for Section		500 (200)	155	655

Table 4.2: Summary of discharge rates in metric tonnes per hour for the 36" section

	Duration (hours)	Mud (Bentonite)	Cuttings	Total per Hour
Drilling	8	232.5 (2.5)	30	262.5
Total Discharge for Section		1860 (20)	240	2100

Table 4.3: Summary of particle sizes and specific gravities for the cuttings, bentonite, and barite

	Specific Gravity	Particle Diameter (microns)
Barite	4.54	20
Bentonite	2.4	1
Large Cuttings	2.5	12500
Small Cuttings	3	74

Table 4.4: Summary of maximum extent from the point of discharge and area covered by sediment greater than 1mm thick for the 26" section (136 m depth discharge)

Maximum distance (m) covered by the deposition thickness > 1 mm 26 inch caisson at 136 m depth (1 well case)			
Current Condition	**Barite**	**Large Cuttings**	**Small Cuttings**
Predominant	63	17	58
Near Stagnant	22	17	13

Area (m^2) covered by the deposition thickness > 1 mm 26 inch caisson at 136 m depth (1 well case)			
Current Condition	**Barite**	**Large Cuttings**	**Small Cuttings**
Predominant	1,634	820	605
Near Stagnant	1,321	820	374

Maximum distance (m) covered by the deposition thickness > 1 mm 26 inch caisson at 136 m depth (28 well case)			
Current Condition	**Barite**	**Large Cuttings**	**Small Cuttings**
Predominant	73	27	69
Near Stagnant	28	27	24

Area (m^2) covered by the deposition thickness > 1 mm 26 inch caisson at 136 m depth (28 well case)			
Current Condition	**Barite**	**Large Cuttings**	**Small Cuttings**
Predominant	3,041	2,120	1,950
Near Stagnant	2,042	2,120	1,448

Table 4.5: Summary of maximum extent from the point of discharge and area covered by sediment greater than 1mm thick for the 36" section (seabed discharge)

Maximum distance (m) covered by the deposition thickness > 1 mm 36 inch discharge at seabed (1 well case)			
Current Condition	**Bentonite**	**Large Cuttings**	**Small Cuttings**
Predominant	14	21	16
Near Stagnant	15	21	17

Area (m^2) covered by the deposition thickness > 1 mm 36 inch discharge at seabed (1 well case)			
Current Condition	**Bentonite**	**Large Cuttings**	**Small Cuttings**
Predominant	618	1,421	838
Near Stagnant	716	1,421	956

Maximum distance (m) covered by the deposition thickness > 1 mm 36 inch discharge at seabed (48 well case)			
Current Condition	**Bentonite**	**Large Cuttings**	**Small Cuttings**
Predominant	27	34	30
Near Stagnant	28	34	31

Area (m^2) covered by the deposition thickness > 1 mm 36 inch discharge at seabed (48 well case)			
Current Condition	**Bentonite**	**Large Cuttings**	**Small Cuttings**
Predominant	2,474	3,940	2,975
Near Stagnant	2,675	3,940	3,186

Table 4.6: Summary of maximum extent from the point of discharge and area covered by sediment greater than 1mm thick for the 26" section (11 m depth discharge)

Maximum distance (m) covered by the deposition thickness > 1 mm 26 inch caisson at 11 m depth (1 well case)			
Current Condition	**Barite**	**Large Cuttings**	**Small Cuttings**
Predominant	660	19	0 *
Near Stagnant	26	19	22

Area (m^2) covered by the deposition thickness > 1 mm 26 inch caisson at 11 m depth (1 well case)			
Current Condition	**Barite**	**Large Cuttings**	**Small Cuttings**
Predominant	19,676	855	0 *
Near Stagnant	881	855	506

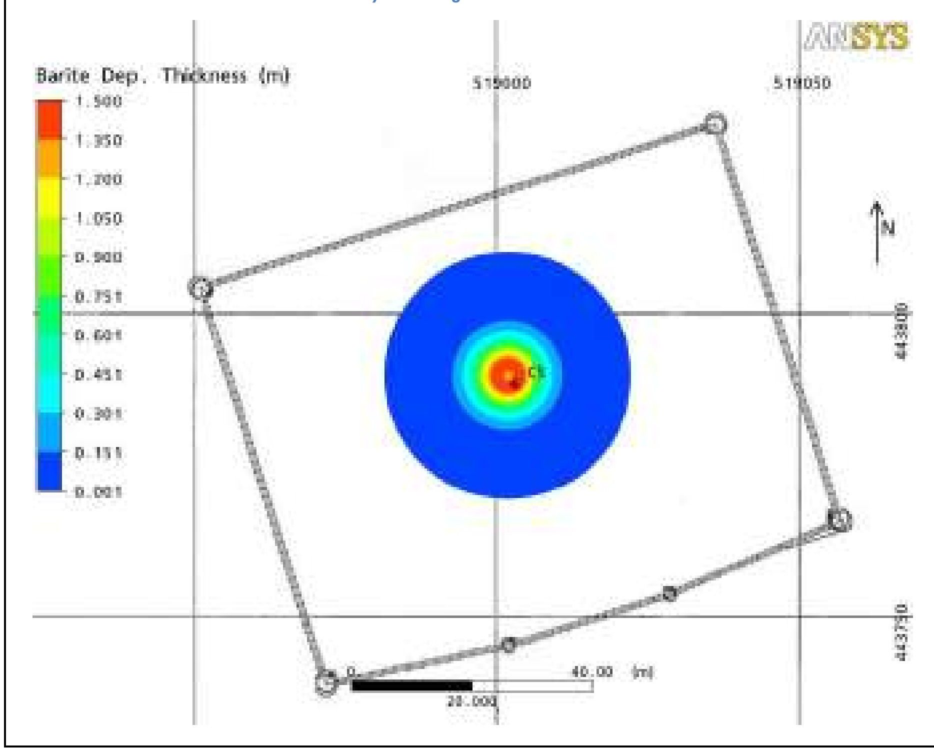
Maximum distance (m) covered by the deposition thickness > 1 mm 26 inch caisson at 11 m depth (20 well case)			
Current Condition	**Barite**	**Large Cuttings**	**Small Cuttings**
Predominant	950	32	835
Near Stagnant	38	32	33

Area (m^2) covered by the deposition thickness > 1 mm 26 inch caisson at 11 m depth (20well case)			
Current Condition	**Barite**	**Large Cuttings**	**Small Cuttings**
Predominant	59,768	2,627	29,579
Near Stagnant	2,633	2,627	1,782

* For the single well case, there is not enough material accumulated at the seabed to surpass the 1mm thickness threshold, and hence the area covered is zero. A large area of >1mm thickness is observed for both Barite and Small cuttings in the 20 well case, while a small or practically inexistent area is observed for the single well case. This is due to the settling behaviour being affected by the current conditions, physical properties of each deposited material (e.g. size and specific gravity), and the fact that it is being deposited from 11m below the sea level. The latter allows for a considerable amount of horizontal advection and diffusion (spreading) of the particles.

7. Figures

a) Near stagnant current conditions



b) Predominant current conditions

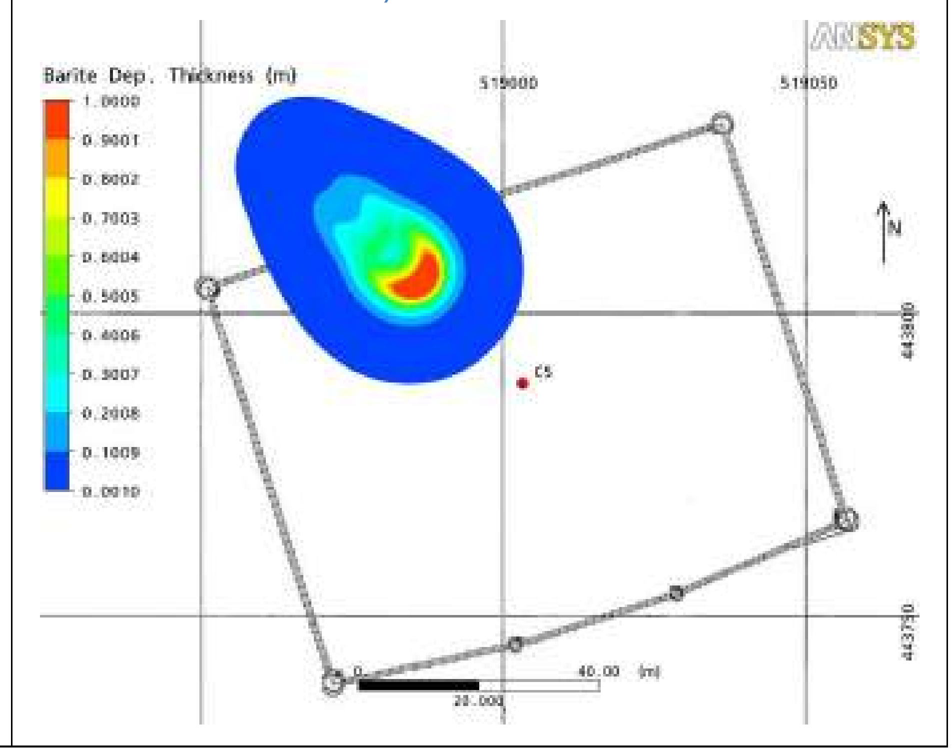


Figure 4.1: Barite deposition thickness contour plots - Discharge from Caisson at 136 m depth - Single well

a) Near stagnant current conditions

b) Predominant current conditions

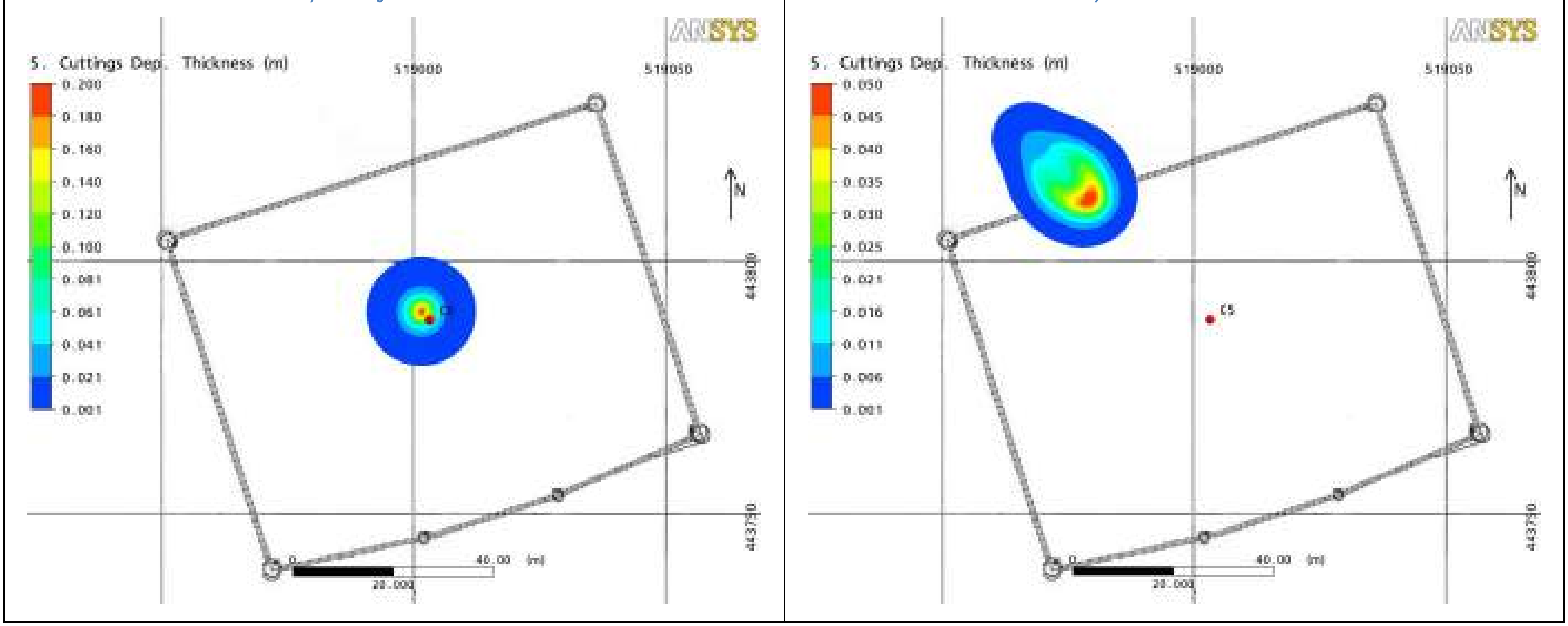
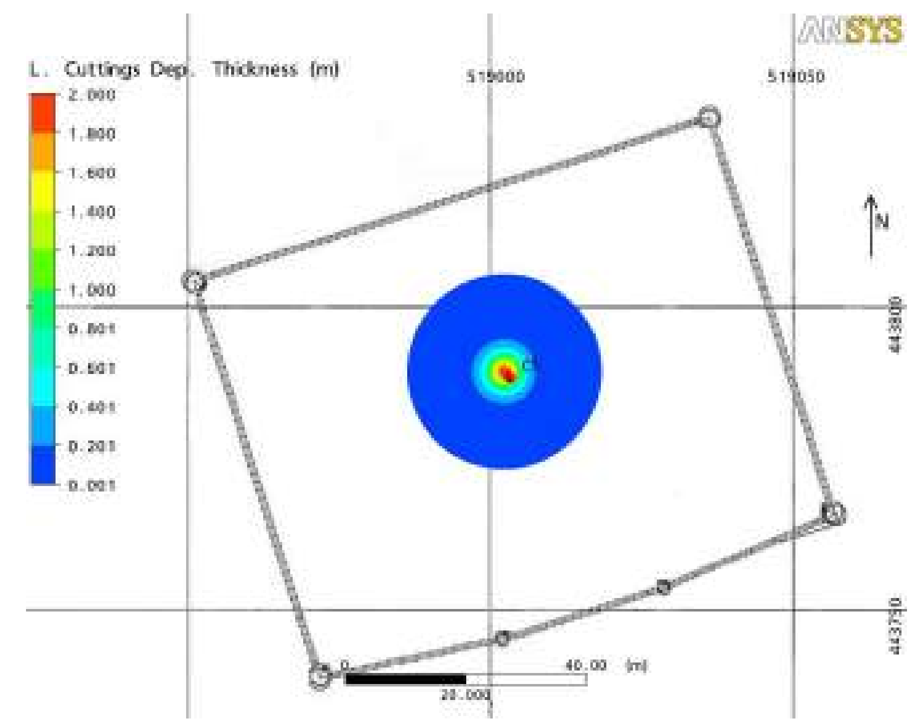


Figure 4.2: Small cuttings deposition thickness contour plots - Discharge from Caisson at 136 m depth - Single well

a) Near stagnant current conditions



b) Predominant current conditions

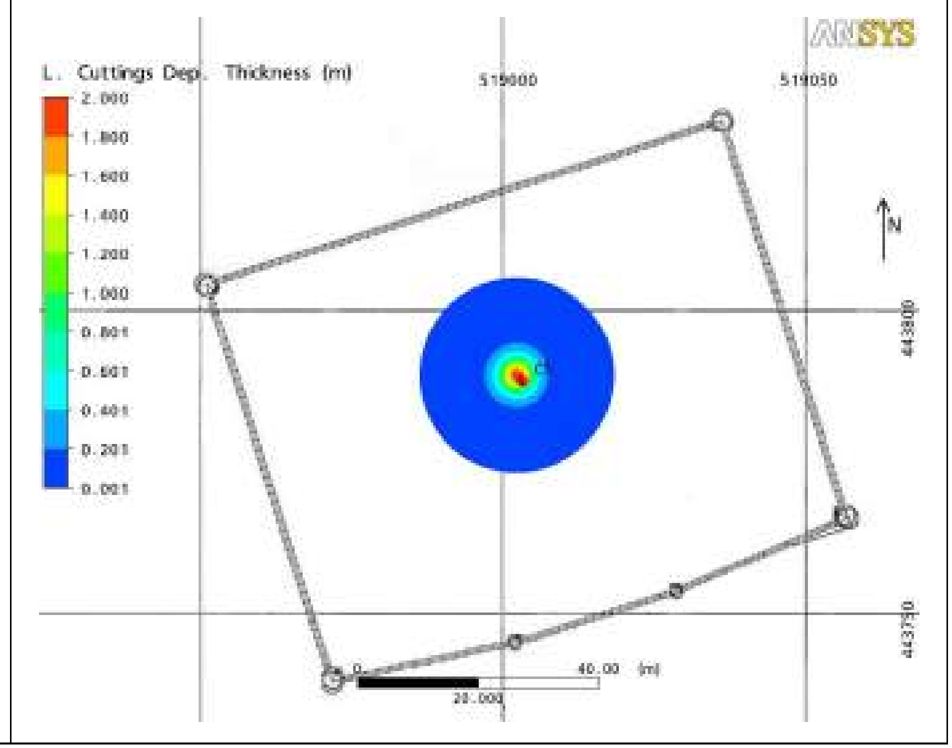


Figure 4.3: Large cuttings deposition thickness contour plots - Discharge from Caisson at 136 m depth - Single well

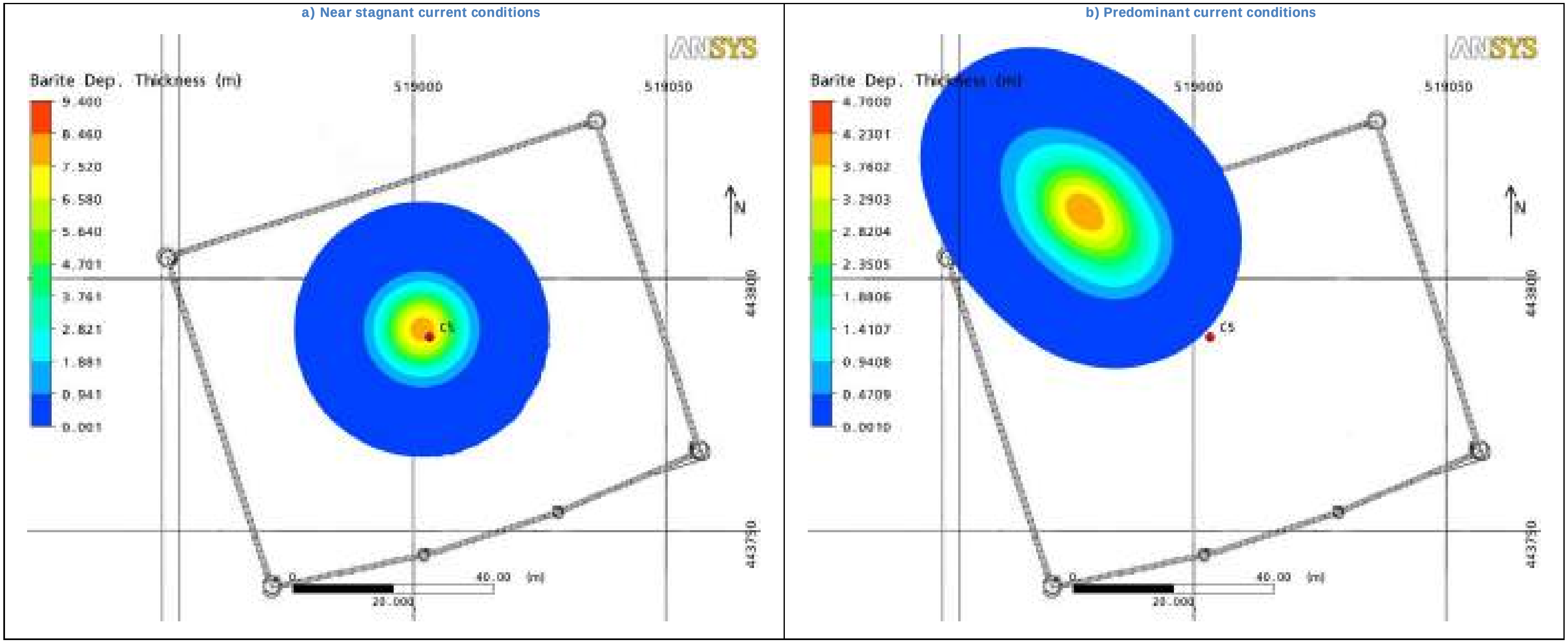
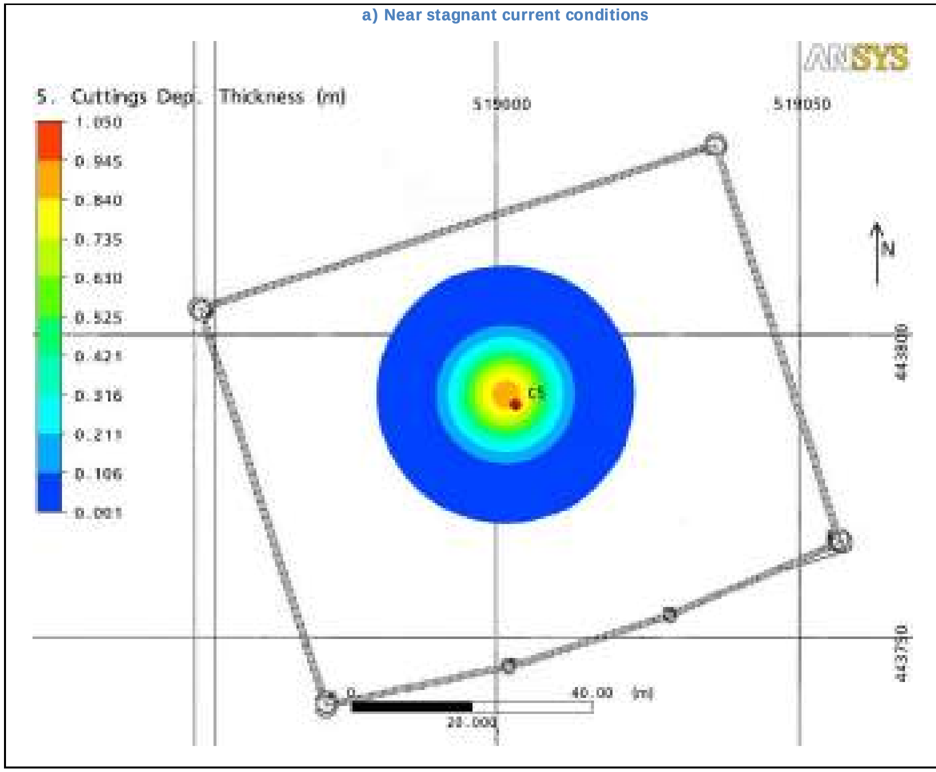


Figure 4.4: Barite deposition thickness contour plots - Discharge from Caisson at 136 m depth - 28 wells



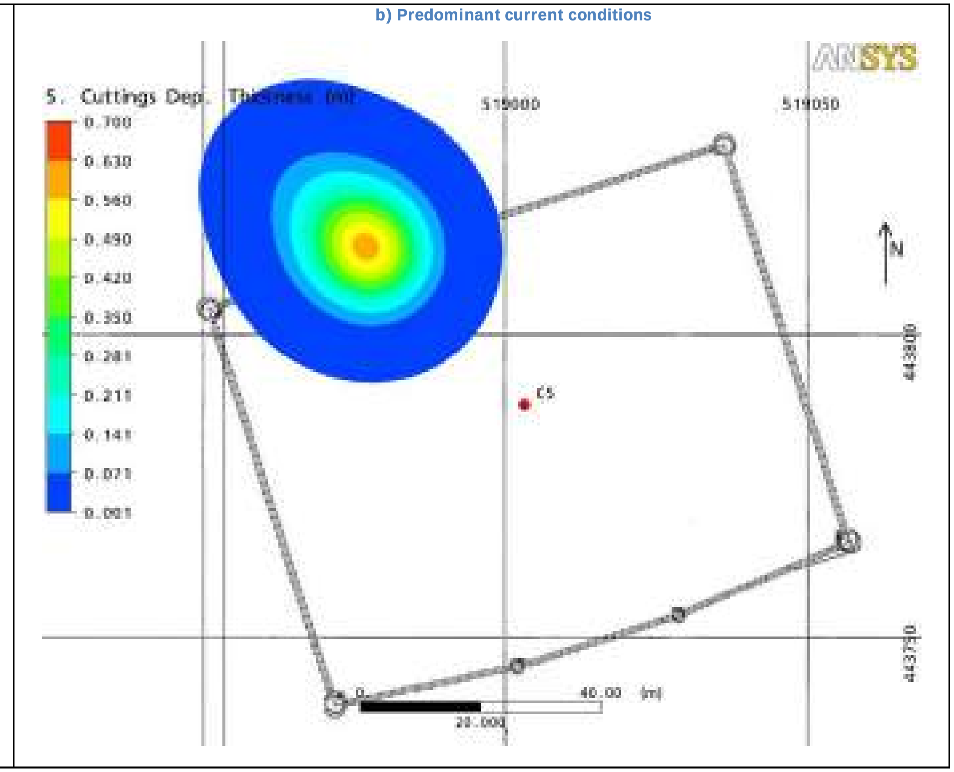


Figure 4.5: Small cuttings deposition thickness contour plots - Discharge from Caisson at 136 m depth - 28 wells

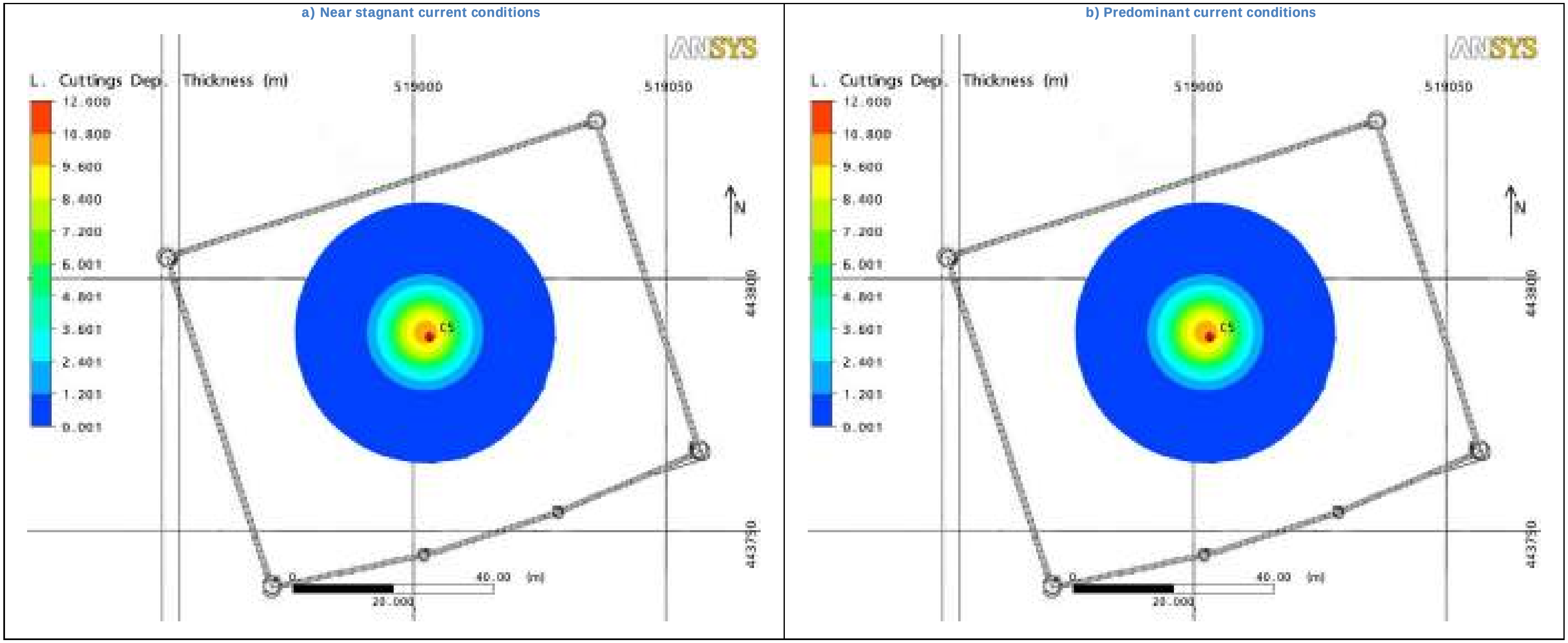


Figure 4.6: Large cuttings deposition thickness contour plots - Discharge from Caisson at 136 m depth - 28 wells

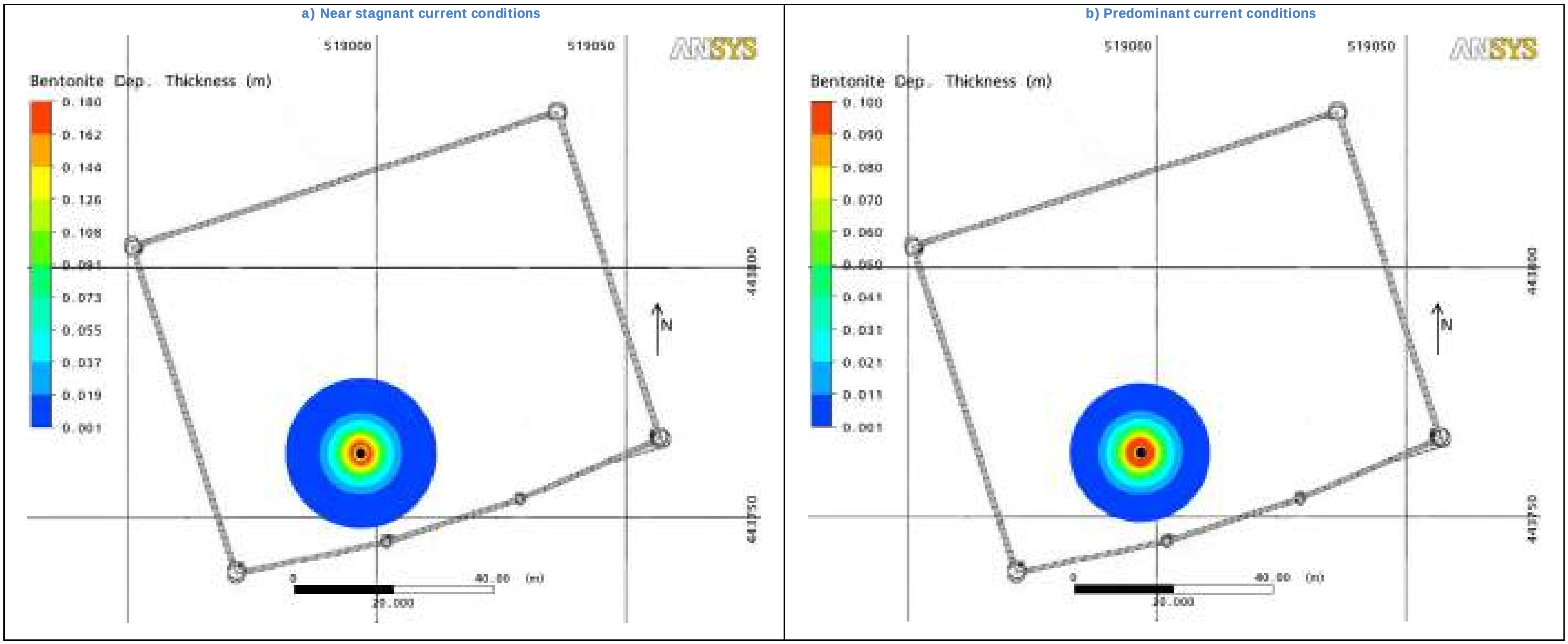


Figure 4.7: Bentonite deposition thickness contour plots - Discharge from seabed - Single well (36 inch section)

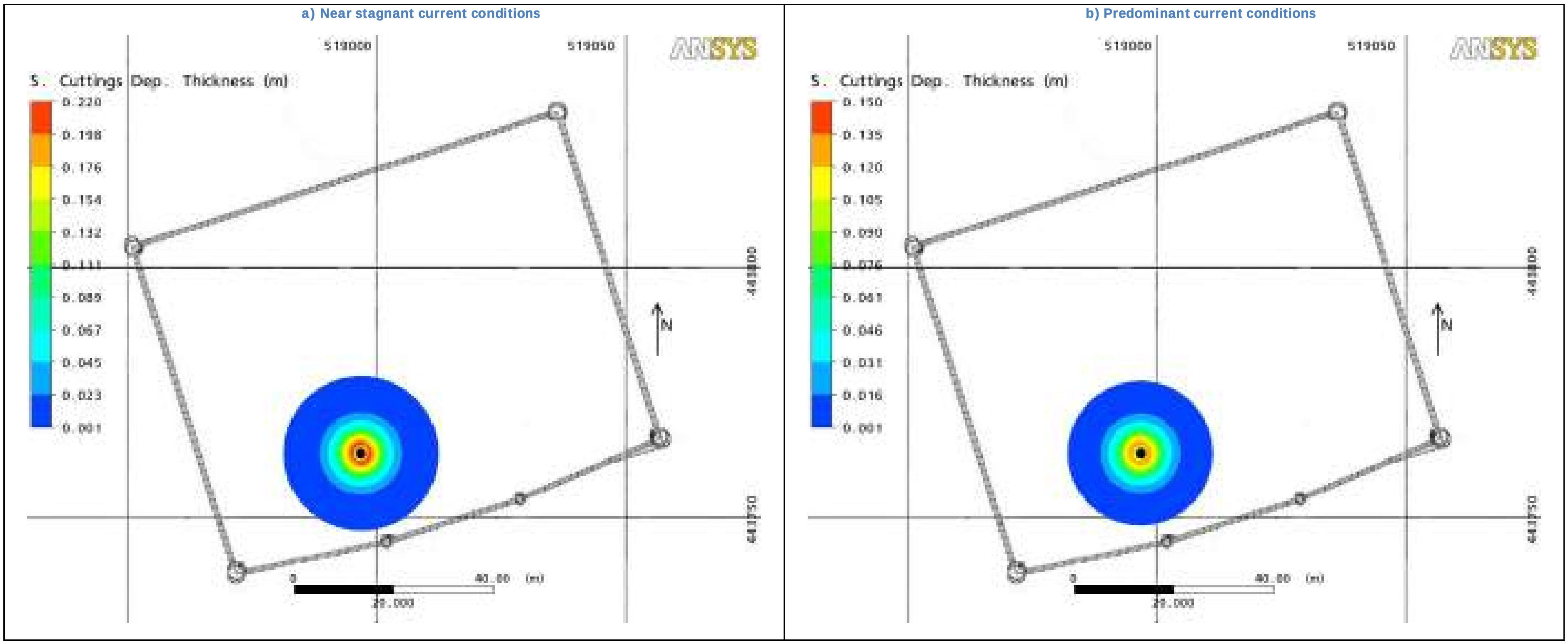


Figure 4.8: Small cuttings deposition thickness contour plots - Discharge from seabed - Single well (36 inch section)

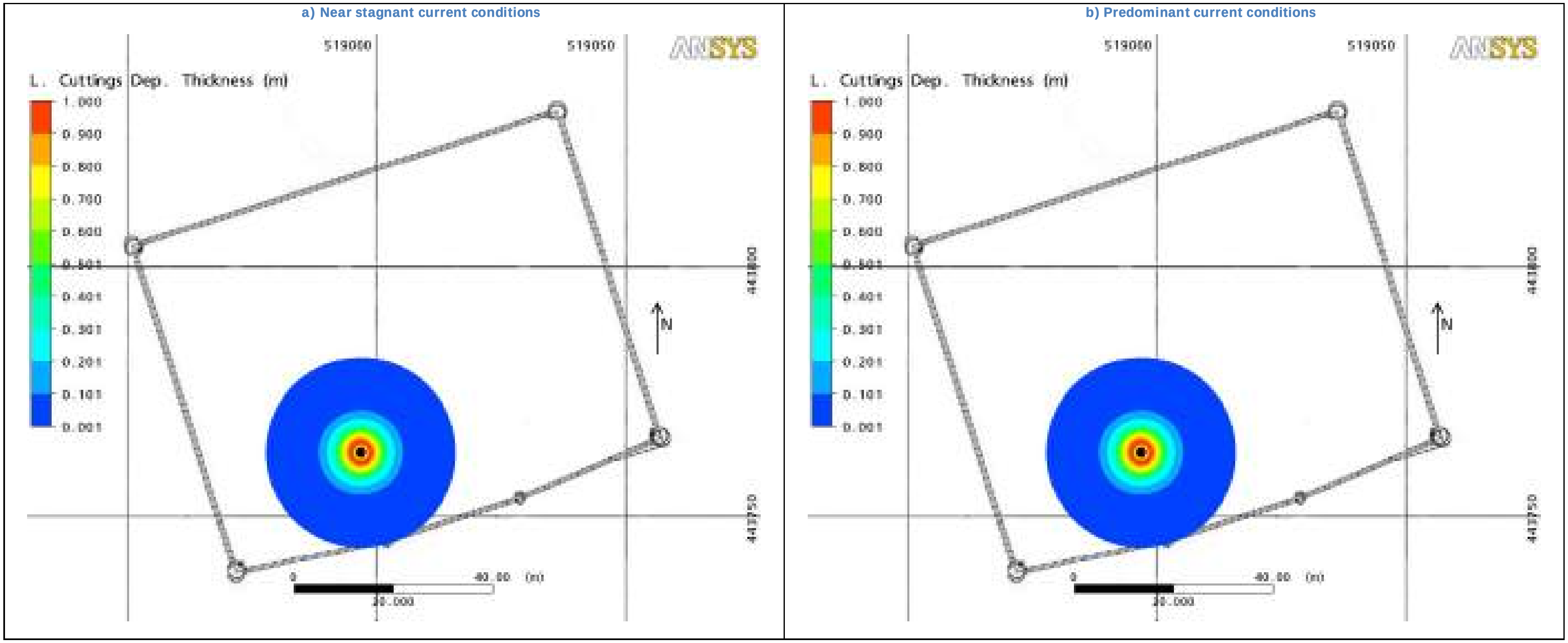


Figure 4.9: Large cuttings deposition thickness contour plots - Discharge from seabed - Single well (36 inch section)

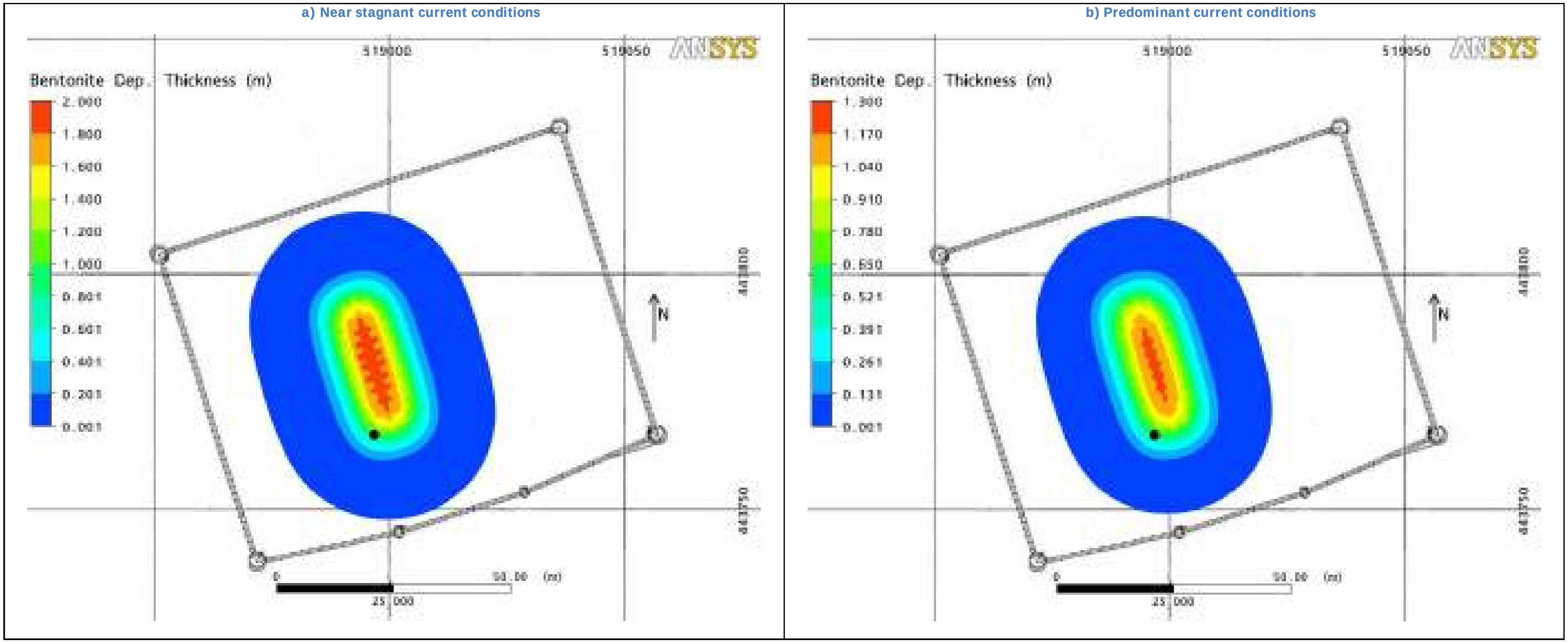


Figure 4.10: Bentonite deposition thickness contour plots - Discharge from seabed - 48 wells (36 inch section)

a) Near stagnant current conditions

b) Predominant current conditions

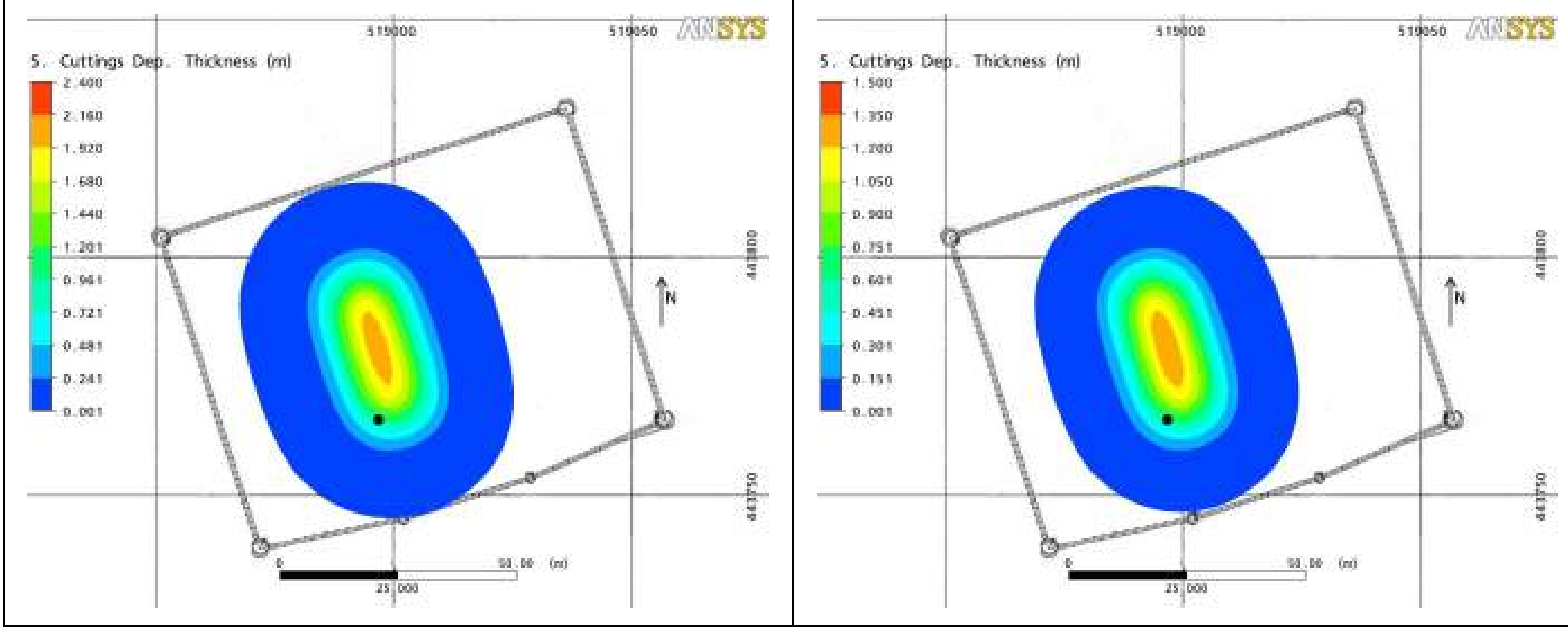
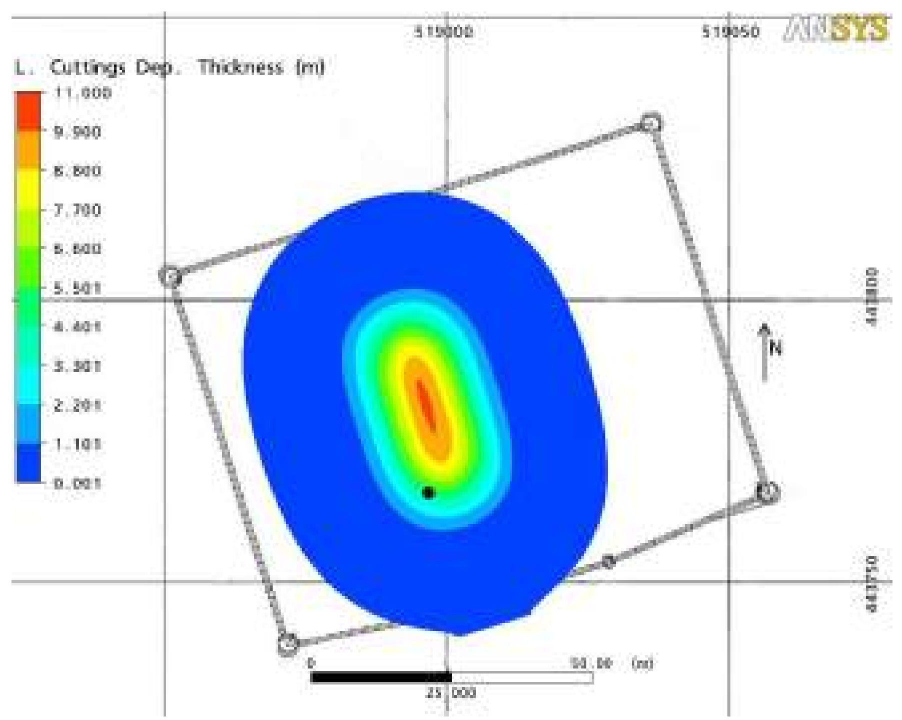


Figure 4.11: Small cuttings deposition thickness contour plots - Discharge from seabed - 48 wells (36 inch section)

a) Near stagnant current conditions



b) Predominant current conditions

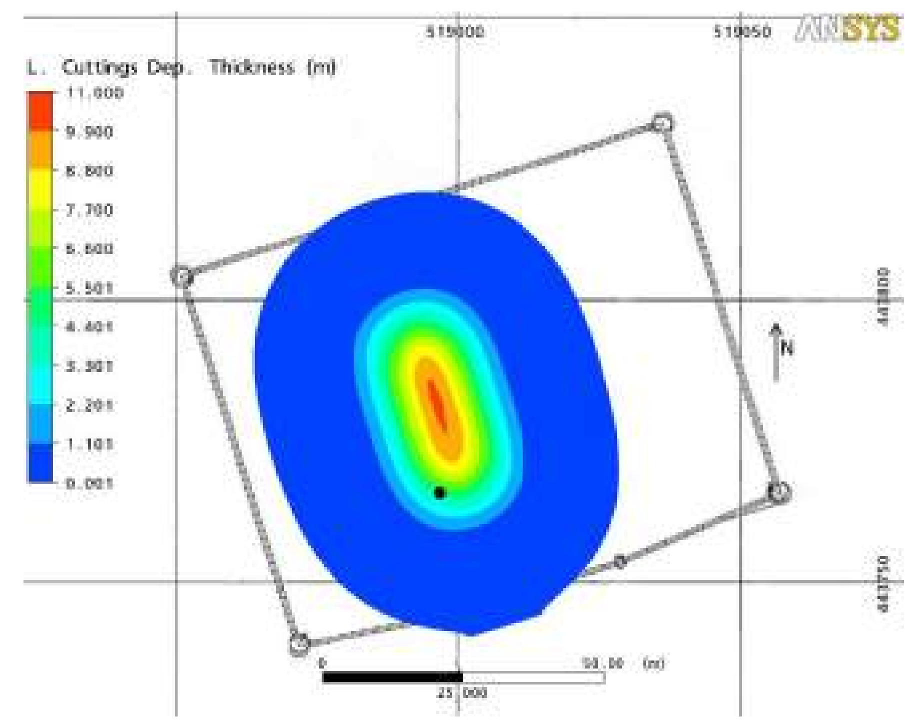
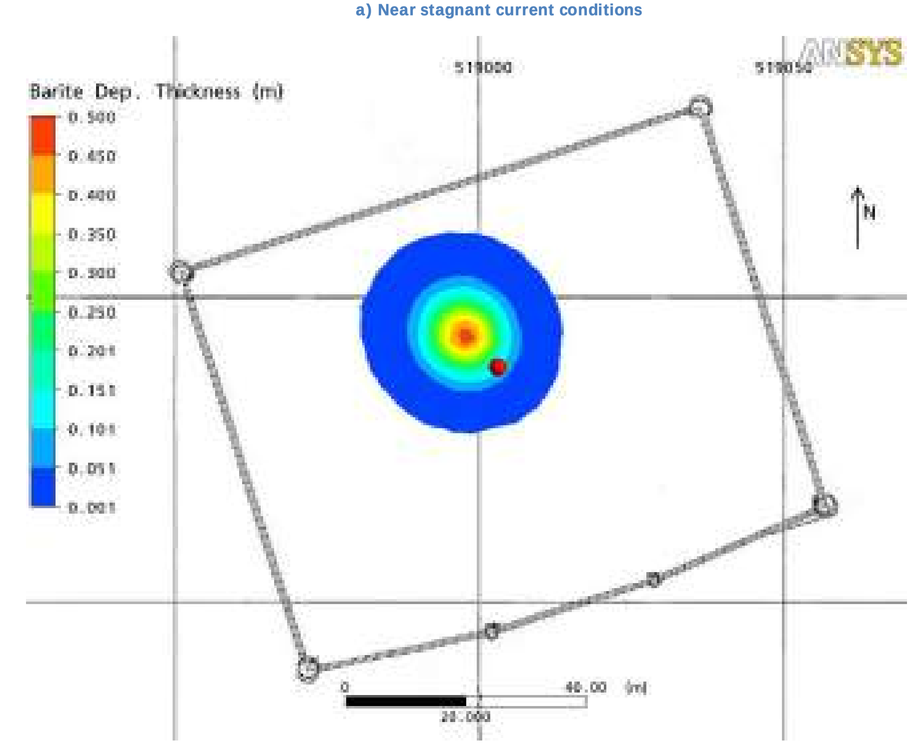


Figure 4.12: Large cuttings deposition thickness contour plots - Discharge from seabed - 48 wells (36 inch section)

a) Near stagnant current conditions



b) Predominant current conditions

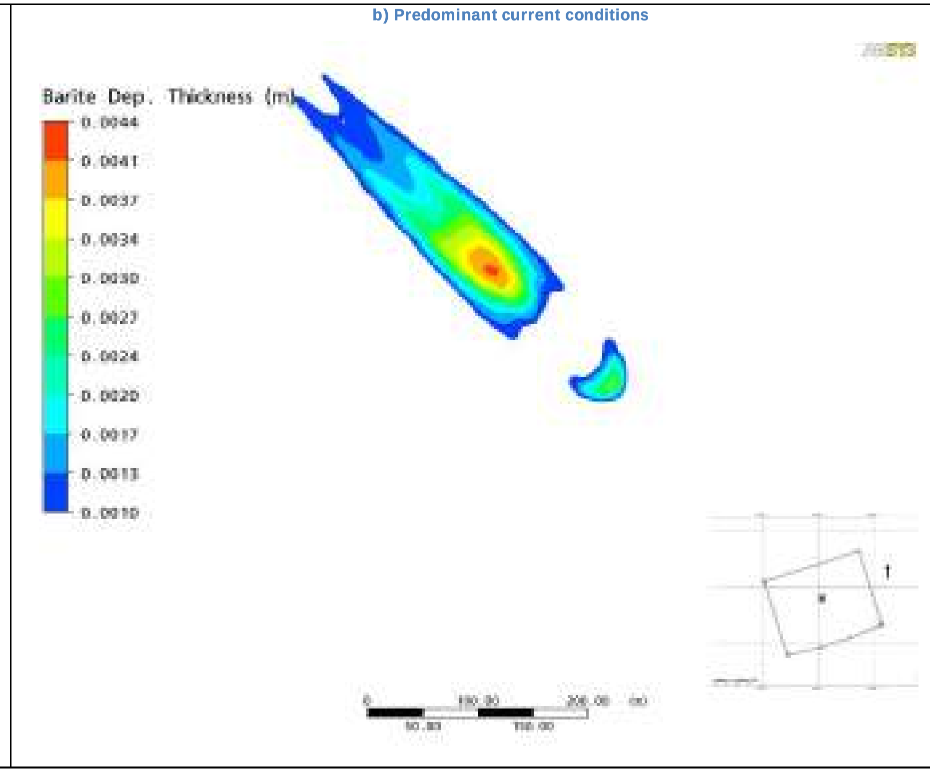


Figure 4.13 Barite deposition thickness contour plots - Discharge from Caisson at 11 m depth -Single well

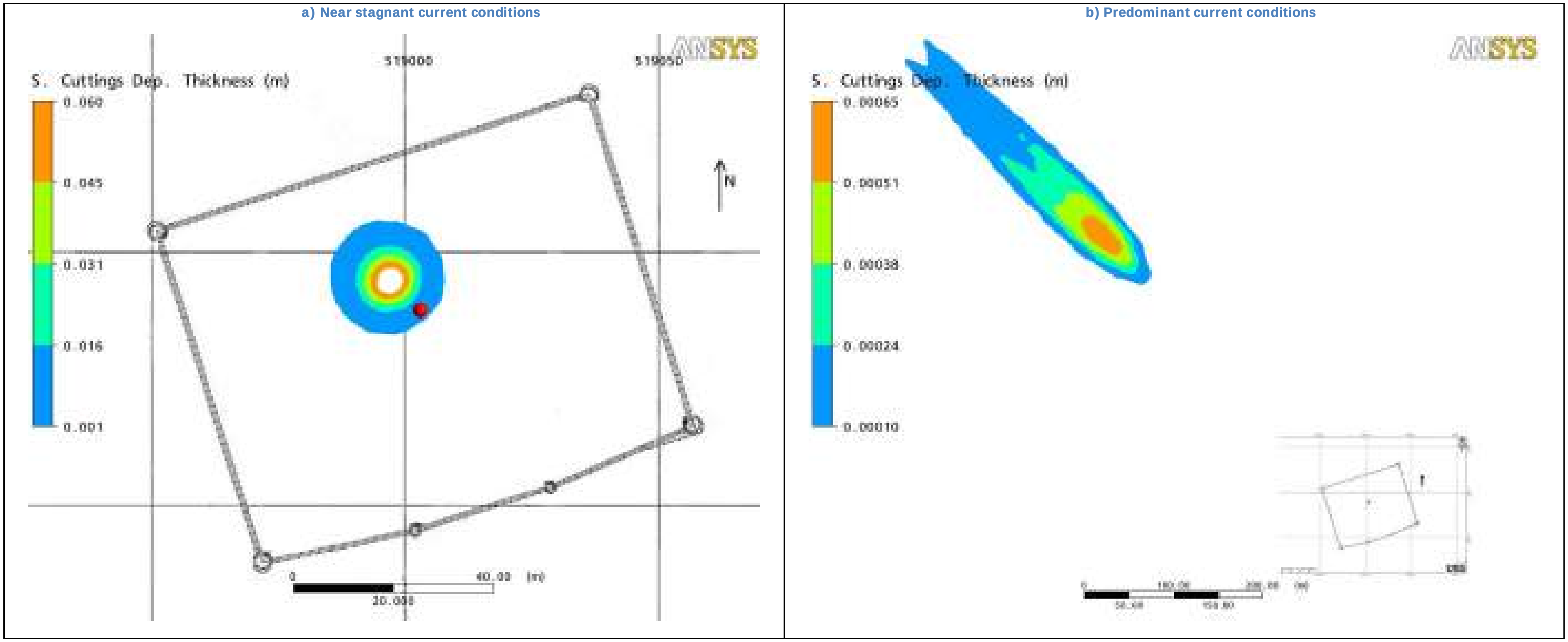


Figure 4.14: Small cuttings deposition thickness contour plots - Discharge from Caisson at 11 m depth - Single well

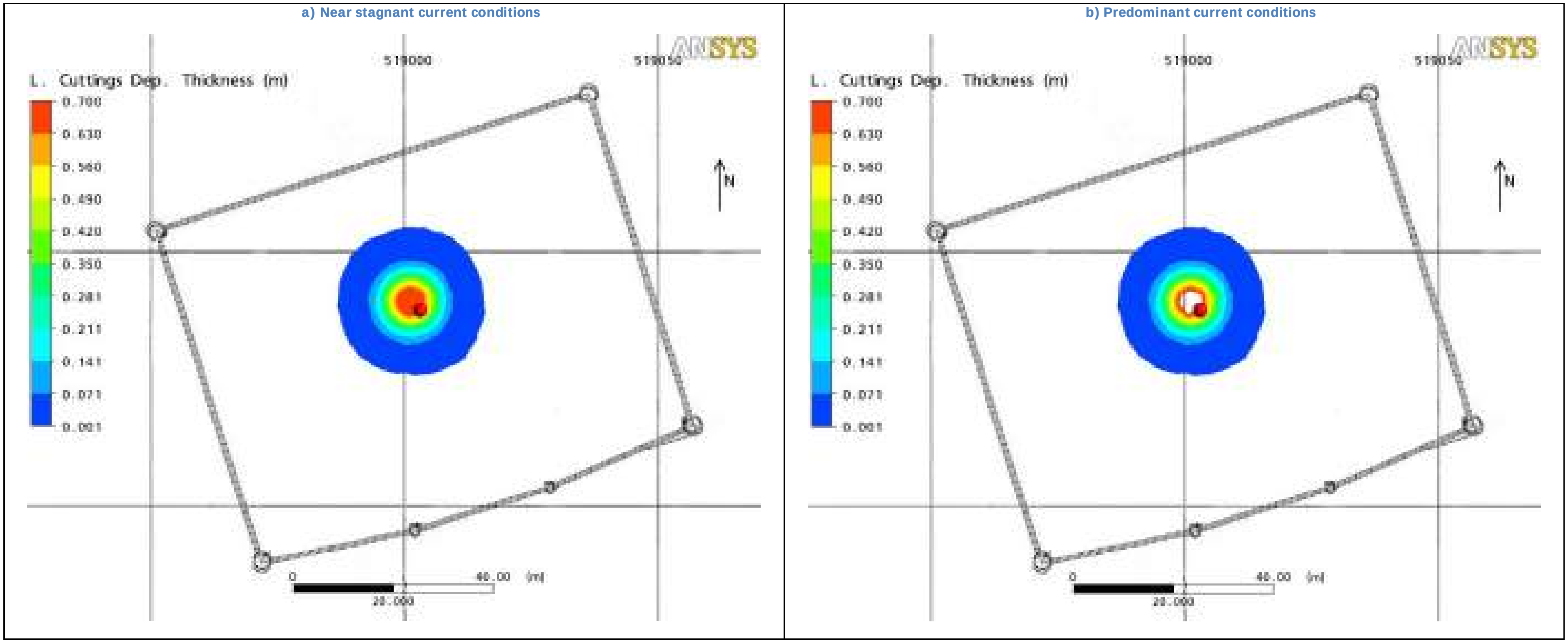


Figure 4.15: Large cuttings deposition thickness contour plots - Discharge from Caisson at 11 m depth - Single well

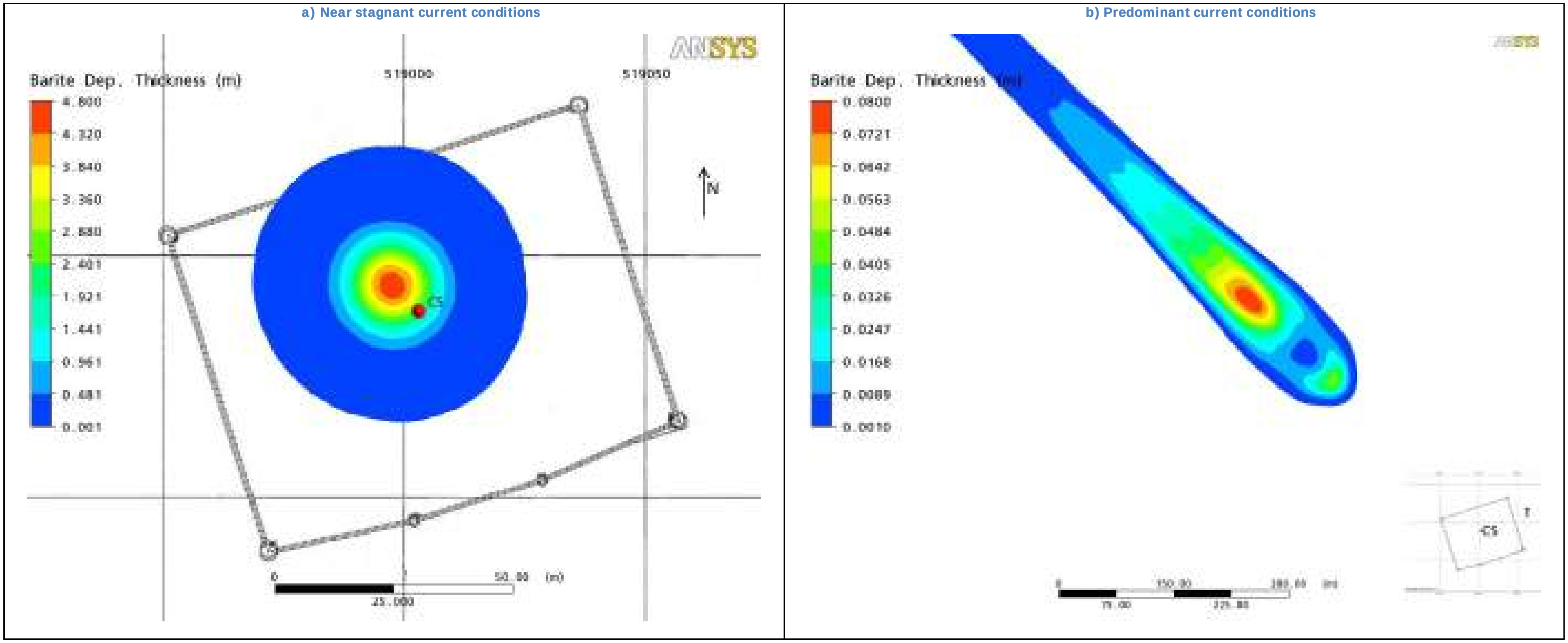
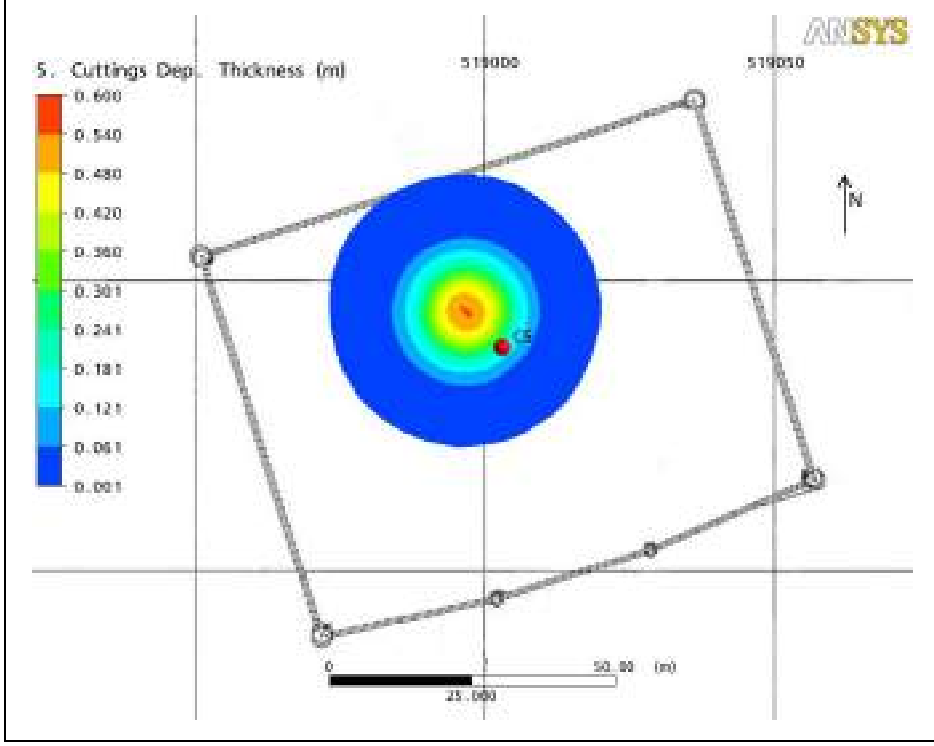


Figure 4.16: Barite deposition thickness contour plots - Discharge from Caisson at 11 m depth - 20 wells

a) Near stagnant current conditions



b) Predominant current conditions

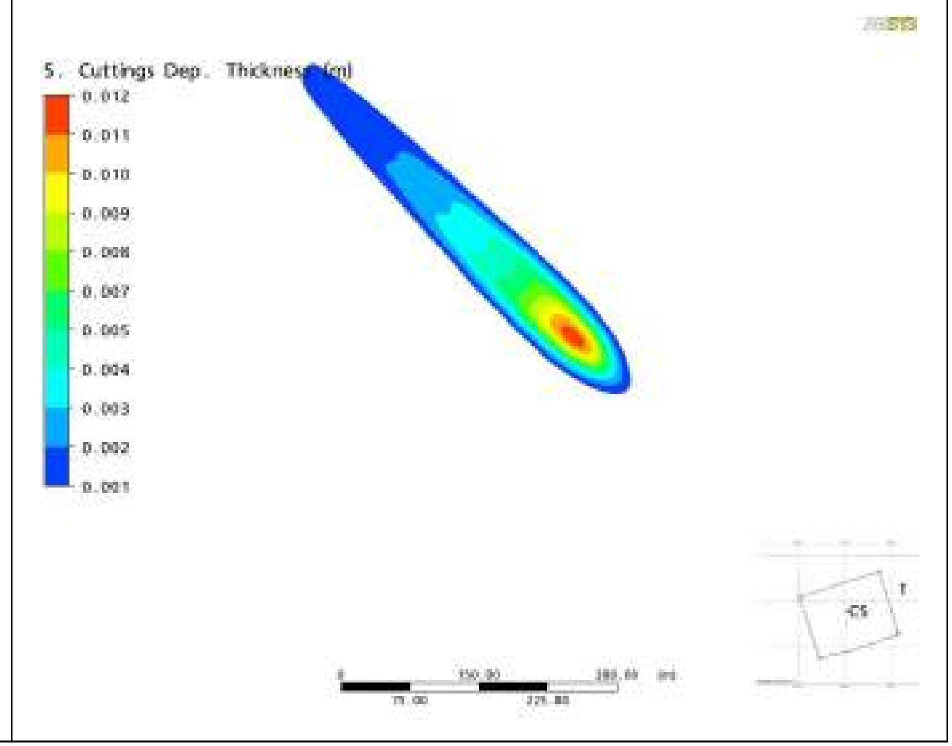


Figure 4.17: Small cuttings deposition thickness contour plots - Discharge from Caisson at 11 m depth - 20 wells

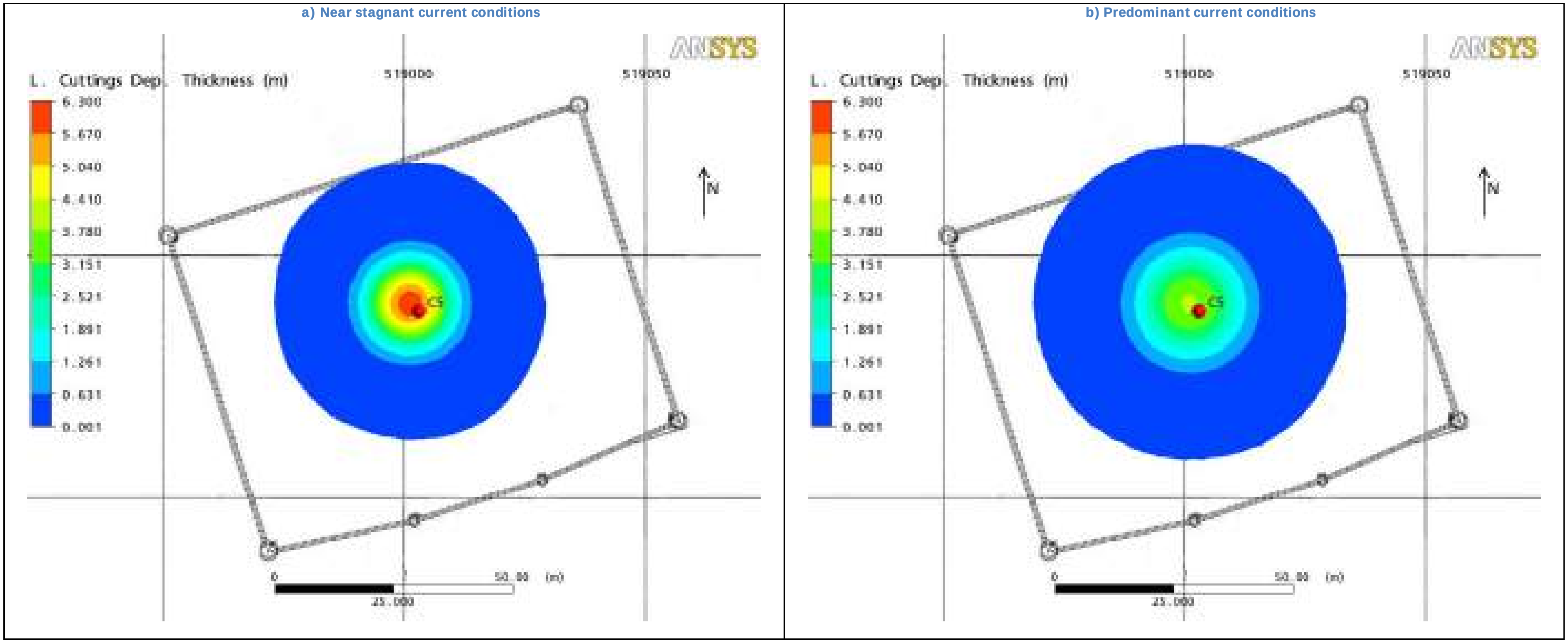


Figure 4.18: Large cuttings deposition thickness contour plots - Discharge from Caisson at 11 m depth - 20 wells

APPENDIX A. CFD MODEL

A.1. Analysis Software

CFX is regarded as a market-leading product that has been thoroughly validated for dispersion problems relevant to the oil and gas industry both by the specialists BMT and by external specialists. Publically available verification studies for a number of different fluids dynamics problems such as movement of solids through liquids and bubble plume behaviour have been undertaken at the University of Melbourne in Australia and the Paul Scherrer Institute in Switzerland[1]. Additional case studies including verification studies are provided here:

http://www.ansys.com/industries/sys-testimonials.asp?ID=10

A.2. Methodology

Dispersion of the drill cuttings was modelled using discharge parameters supplied by BP. For the 26" drilling (i.e. discharges from caissons at 11 m and 136 m depth), material was released from a 0.8 m diameter pipe. For the 36" drilling, material was released from a ring of 36" inner diameter and 50" outer diameter centred at the drilling location. For the 36" multi-well case, the discharges were modelled emulating the 48 well locations shown in Figure A.1.

The risers and legs of the platform were assumed not to represent a significant blockage to the flow, and hence were not included in the model.

No topography (i.e. flat seabed) was assumed.

A.3. Fluid Properties

A.3.1. Seawater

Table A.1 presents the properties of seawater used in the analysis.

A.3.2. Drill Cuttings

The properties of the cuttings, barite, and bentonite are presented in Table 4.3.

A.4. Computational Mesh

The computational mesh was generated in the domain bounded by the seabed (-168 m) and the sea surface. The computational domain extended sufficiently far away in each direction to avoid any boundary influence on the flow solution. The computational mesh used for the simulations comprised of approximately 4 million

[1] http://www.cfd.com.au/cfd_conf03/papers/123Hol.pdf; http://www.cfd.com.au/cfd_conf97/papers/smi002.pdf; Dispersion of neutrally buoyant solids falling vertically into stationary liquid and horizontal channel flow, K. M. Smith, M. R. Davidson and N. J. Lawson Computers & Fluids Volume 29, Issue 4, 1 May 2000, Pages 369-384; On the modelling of bubble plumes in a liquid pool, B. L. Smith, Applied Mathematical Modelling, Volume 22, Issue 10, October 1998, Pages 773-797

tetrahedral and prismatic cells. Additional mesh refinement was applied in the proximity of the individual release points.

A.5. Multiphase Model

The dispersion of the cuttings and barite were modelled explicitly using the Eulerian-Eulerian inhomogeneous multiphase model. Using this model, each phase (water, cuttings and barite) has a separate velocity field and the interactions between the phases are governed by interphase transfer terms. The principal advantages of using this model are that complete global information for the particle phase is available and the dispersion and deposition of cuttings and barite are modelled separately.

A.6. Turbulence Model

The Shear Stress Transport (SST) turbulence model was employed in the CFD simulations with standard coefficients.

The SST turbulence model is widely used for applications in the offshore industry and is generally suitable for the assessment of dispersion.

A.7. Buoyancy

Buoyancy forces due to changes in fluid density were modelled in the analysis.

A.8. Current Velocity Profile

The current velocity profile was simulated as uniform across the water column and consisted of two cases:

- Predominant current speed = 0.11m/s
- Near-stagnant current speed = 0.01m/s

Seawater	
Density (kg/m^3)	1,010
Dynamic viscosity (kg/(m.s))	0.00105
Molecular weight (kg/kmole)	18.02
Specific Heat Capacity (J/(kg.K))	4,181.7
Thermal Conductivity (W/(m.K))	0.6069
Thermal Expansivity (K^{-1})	0.000257

Table A.1 – Properties of seawater

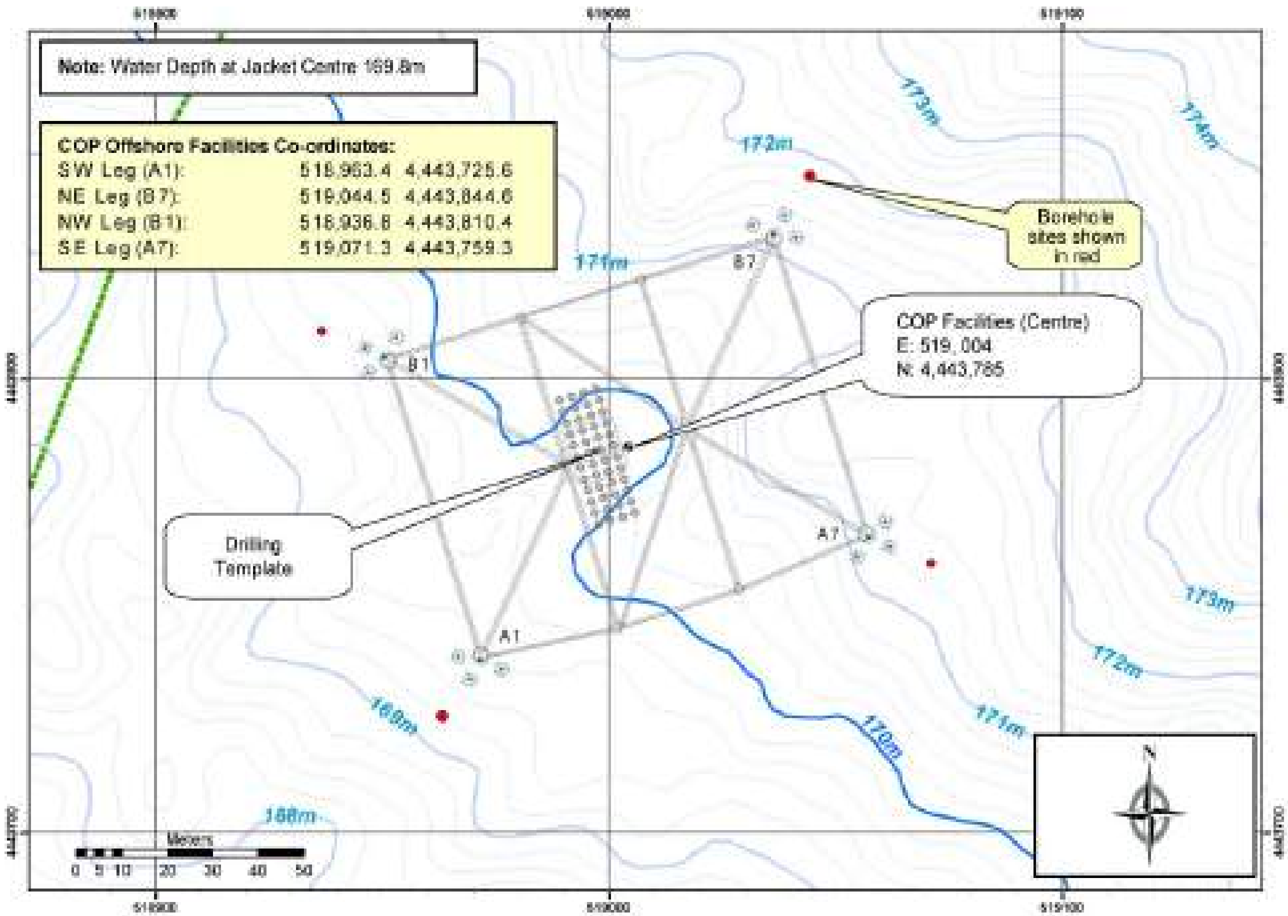


Figure A.1 – Drilling template for the 36" section – Discharge at seabed.

APPENDIX 11E

Produced Water Modelling

Chirag Oil Project Produced Water Discharge Modelling

For
BP

Report Title	**Chirag Oil Project Produced Water Discharge Modelling**		
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Document No:	46220 Report01v2	**Release:** 2	**Copy No:**
Status	Final Report		
Report Date:	04 June 2009		
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EXECUTIVE SUMMARY

A Computational Fluid Dynamics (CFD) study was carried out by BMT Fluid Mechanics (BMT) to assess the dispersion of produced water discharges from platforms located in the Chirag Oil Project (COP) in Azerbaijan. The study was carried out for BP.

A total of 8 produced water discharge scenarios were considered in the analysis, represented through a downward discharge from a caisson (diameter of 0.9m) at 45 m depth.

Two current speeds (i.e. near-stagnant and predominant) and three discharge durations (i.e. 12 h, 24 h, and 72 h) were modelled. Two seawater ambient temperatures (summer and winter conditions) were considered for the shortest discharge period only (i.e. 12 h).

A discharge temperature of 25 ºC was assumed for all discharges.

The maximum distance reached by the discharge plume (for a dilution of 1:100) occurred for the summer predominant current discharge (Scenario 4), where the plume reached a distance of 39 m from the point of discharge.

In all near-stagnant current scenarios (i.e. Scenarios 1, 3, 5, and 7), the three lowest concentration plumes reached the sea surface, while the highest concentration plume (i.e. 30-fold) reached a maximum of 5 m depth. For predominant current scenarios (i.e. Scenarios 2, 4, 6, and 8), the 100-fold discharge plumes reached a maximum of 28 m depth.

A maximum width of 13 m for the 100-fold discharge plume was obtained for the summer near-stagnant case (Scenario 3).

Discharge plumes at dilution of 1:100 were observed to persist between 1 and 2 hours from the cessation of discharge, for all discharge scenarios investigated.

Chirag Oil Project Produced Water Discharge Modelling

Contents

Chirag Oil Project Produced Water Discharge Modelling

1. Introduction

1.1. General

This report presents the main results of a Computational Fluid Dynamics (CFD) study carried out by BMT Fluid Mechanics (BMT) to assess the dispersion of produced water discharges from platforms located in the Chirag Oil Project (COP) in Azerbaijan. The scope of work is based on requirement outlined in "COP Produced Water Discharge Modelling" issued to BMT by BP on the 6th of April 2009.

1.2. Report Structure

Section 2 of this report describes the main objectives of the study. Description of the CFD analysis and its results are presented in section 3. Details of the modelling methodology and supporting information are given in Appendix A.

2. Objectives

The main objectives of the CFD produced water dispersion analysis were as follows:

- Model dispersion and fate of produced water fluid
- Assess persistence and distance travelled by discharge plume
- Determine concentrations of discharged fluid within plume

3. CFD Analysis

3.1. Introduction

This section presents the results of the produced water dispersion analysis carried out to determine the persistence and distance travelled by the discharge plumes for a range of subsea ambient, current conditions and discharge scenarios.

The CFD model and methodology is described in APPENDIX A.

3.2. Ambient Conditions

Two seasonal options were assessed and compared in the analysis:

- Summer condition: in this case, a constant seawater temperature of 12 ºC was used (i.e. no thermocline)
- Winter condition: in this case, a constant seawater temperature of 7 ºC was used (i.e. no thermocline)

3.3. Current Conditions

For each ambient condition, two current conditions were assessed in the analysis, as indicated in [1]:

- Near-stagnant flow: constant horizontal current flow velocity of 0.01 m/s
- Predominant flow: constant horizontal current flow velocity of 0.1 m/s

3.4. Chemical Concentration Limits

The produced water discharges will comprise chemically treated Caspian seawater. The relevant degree of dilution assessed lies in the range of 1:300 to 1:30.

3.5. Assessment Scenarios

A total of 8 produced water discharge scenarios were considered in the analysis, represented through a downward discharge from a caisson (diameter of 0.9m) at 45 m depth.

Two current speeds (i.e. near-stagnant and predominant) and three discharge durations (i.e. 12 h, 24 h, and 72 h) were modelled. Two seawater ambient temperatures (summer and winter conditions) were considered for the shortest discharge period only (i.e. 12 h).

A discharge temperature of 25 ºC was assumed for all discharges.

The produced water discharge scenarios investigated in the analysis are summarised in Table 3.1.

3.6. Results

3.6.1. Discharge Plume Dimension

Table 3.2 to Table 3.5 presents the discharge plume dimensions measured at relevant degrees of dilution (300-fold, 200-fold, 100-fold, and 30-fold). The corresponding volume time histories are shown in Figure 3.1.

3.6.2. Discharge Plume Persistence

Table 3.6 presents the total persistence time (in hours) of the plumes at each concentration of interest for all scenarios investigated.

Table 3.7 presents the persistence time (in hours), measured from the cessation of discharge, of the plumes at each concentration of interest for all scenarios investigated.

Table 3.8 presents the time (in hours) needed for the discharge plumes to reach a steady state at each concentration of interest for all scenarios investigated.

3.6.3. Discharge Plume Visualisations

Figure 3.2 depicts the vertical centreline contour plots of the plume concentrations of interest, while Figure 3.4 shows a plan view of the same contours for each of the scenarios investigated.

4. Conclusions

- The maximum distance reached by the discharge plume (for a dilution of 1:100) occurred for the summer predominant current discharge (Scenario 4), where the plume reached a distance of 39 m from the point of discharge.
- In all near-stagnant current scenarios (i.e. Scenarios 1, 3, 5, and 7), the three lowest concentration plumes reached the sea surface, while the highest concentration plume (i.e. 30-fold) reached a maximum of 5 m depth. For predominant current scenarios (i.e. Scenarios 2, 4, 6, and 8), the 100-fold discharge plumes reached a maximum of 28 m depth.
- A maximum width of 13 m for the 100-fold discharge plume was obtained for the summer near-stagnant case (Scenario 3).
- Discharge plumes at dilution of 1:100 were observed to persist between 1 and 2 hours from the cessation of discharge, for all discharge scenarios investigated.

5. References

[1] Shah Deniz Wind Wave Surge and Current Criteria, v3.1, OceanMetriX Ltd, October 2008

6. Tables

Table 3.1: Summary of discharge scenarios

Scenario	Location	Discharge Depth [m]	Discharge Diameter [m]	Discharge Orientation	Amount of Discharge [m^3]	Discharge Vol. Flow [m^3/s]	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Average Discharge Velocity [m/s]	Current Velocity [m/s]	Ambient condition	Discharge Temperature [ºC]
1	Caisson	45	0.9	Downwards	5400	0.125	126.25	43200	0.196	0.01	Winter	25
2	Caisson	45	0.9	Downwards	5400	0.125	126.25	43200	0.196	0.1	Winter	25
3	Caisson	45	0.9	Downwards	5400	0.125	126.25	43200	0.196	0.01	Summer	25
4	Caisson	45	0.9	Downwards	5400	0.125	126.25	43200	0.196	0.1	Summer	25
5	Caisson	45	0.9	Downwards	10800	0.125	126.25	86400	0.196	0.01	Winter	25
6	Caisson	45	0.9	Downwards	10800	0.125	126.25	86400	0.196	0.1	Winter	25
7	Caisson	45	0.9	Downwards	32400	0.125	126.25	259200	0.196	0.01	Winter	25
8	Caisson	45	0.9	Downwards	32400	0.125	126.25	259200	0.196	0.1	Winter	25

Table 3.2: Maximum plume volumes at steady state

Scenario	Location	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Current Velocity [m/s]	Maximum Plume Volume (m^3)			
					300-fold	200-fold	100-fold	30-fold
1	Caisson	126.25	43200.0	0.01	6,520	3,633	1,374	225
2	Caisson	126.25	43200.0	0.1	12,520	5,983	1,730	223
3	Caisson	126.25	43200.0	0.01	8,150	4,535	1,808	279
4	Caisson	126.25	43200.0	0.1	14,310	6,811	1,952	251
5	Caisson	126.25	86400.0	0.01	6,534	3,636	1,374	225
6	Caisson	126.25	86400.0	0.1	12,520	5,983	1,730	223
7	Caisson	126.25	259200.0	0.01	6,534	3,636	1,374	225
8	Caisson	126.25	259200.0	0.1	12,520	5,983	1,730	223

Table 3.3: Maximum plume widths at steady state

Scenario	Location	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Current Velocity [m/s]	Maximum Plume Width [m]			
					300-fold	200-fold	100-fold	30-fold
1	Caisson	126.25	43200.0	0.01	38	29	12	4
2	Caisson	126.25	43200.0	0.1	16	12	8	5
3	Caisson	126.25	43200.0	0.01	43	33	13	4
4	Caisson	126.25	43200.0	0.1	16	12	8	4
5	Caisson	126.25	86400.0	0.01	38	29	12	4
6	Caisson	126.25	86400.0	0.1	16	12	8	5
7	Caisson	126.25	259200.0	0.01	38	29	12	4
8	Caisson	126.25	259200.0	0.1	16	12	8	5

Table 3.4: Maximum distances travelled by plume (measured from discharge location)

Scenario	Location	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Current Velocity [m/s]	Maximum Distance Travelled [m]			
					300-fold	200-fold	100-fold	30-fold
1	Caisson	126.25	43200.0	0.01	85	55	27	10
2	Caisson	126.25	43200.0	0.1	99	68	37	15
3	Caisson	126.25	43200.0	0.01	50	31	16	6
4	Caisson	126.25	43200.0	0.1	111	74	39	17
5	Caisson	126.25	86400.0	0.01	93	57	28	9
6	Caisson	126.25	86400.0	0.1	99	68	37	15
7	Caisson	126.25	259200.0	0.01	93	57	28	9
8	Caisson	126.25	259200.0	0.1	99	68	37	15

Table 3.5: Maximum plume heights at steady state (depth from sea surface)

Scenario	Location	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Current Velocity [m/s]	Maximum Height reached [m]			
					300-fold	200-fold	100-fold	30-fold
1	Caisson	126.25	43200.0	0.01	0	0	0	-5
2	Caisson	126.25	43200.0	0.1	-11	-20	-28	-36
3	Caisson	126.25	43200.0	0.01	0	0	0	-6
4	Caisson	126.25	43200.0	0.1	-14	-23	-31	-37
5	Caisson	126.25	86400.0	0.01	0	0	0	-5
6	Caisson	126.25	86400.0	0.1	-11	-20	-28	-36
7	Caisson	126.25	259200.0	0.01	0	0	0	-5
8	Caisson	126.25	259200.0	0.1	-11	-20	-28	-36

Table 3.6: Total plume persistence

Scenario	Location	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Current Velocity [m/s]	Plume Persistence (in hr)			
					300-fold	200-fold	100-fold	30-fold
1	Caisson	126.25	43200.0	0.01	15	14	14	13
2	Caisson	126.25	43200.0	0.1	15	14	13	12
3	Caisson	126.25	43200.0	0.01	14	13	13	13
4	Caisson	126.25	43200.0	0.1	14	14	13	12
5	Caisson	126.25	86400.0	0.01	27	26	26	26
6	Caisson	126.25	86400.0	0.1	27	27	25	24
7	Caisson	126.25	259200.0	0.01	75	74	74	74
8	Caisson	126.25	259200.0	0.1	75	75	73	72

Table 3.7: Plume persistence from cessation of discharge

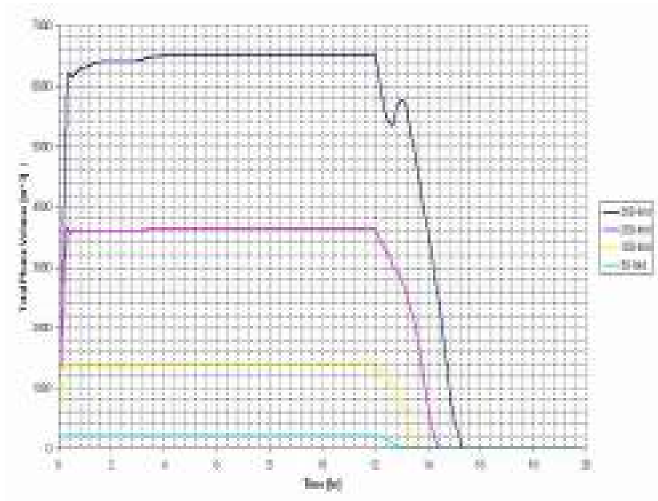
Scenario	Location	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Current Velocity [m/s]	Plume Persistence (in hr)			
					300-fold	200-fold	100-fold	30-fold
1	Caisson	126.25	43200.0	0.01	3	2	2	1
2	Caisson	126.25	43200.0	0.1	3	2	1	0
3	Caisson	126.25	43200.0	0.01	2	1	1	1
4	Caisson	126.25	43200.0	0.1	2	2	1	0
5	Caisson	126.25	86400.0	0.01	3	2	2	2
6	Caisson	126.25	86400.0	0.1	3	3	1	0
7	Caisson	126.25	259200.0	0.01	3	2	2	2
8	Caisson	126.25	259200.0	0.1	3	3	1	0

Table 3.8: Durations required to reach steady state

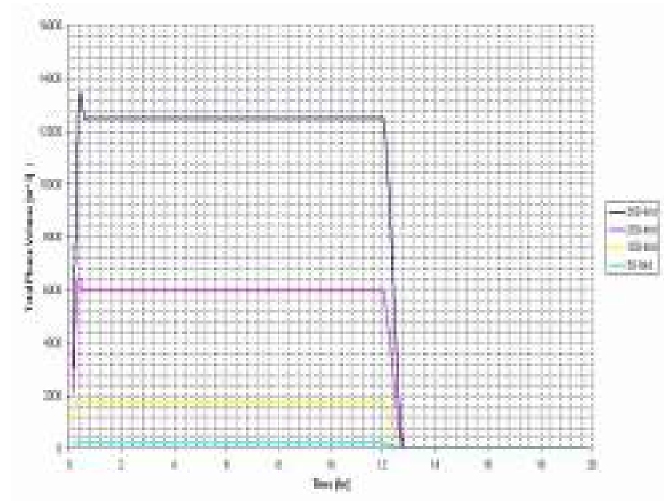
Scenario	Location	Discharge Mass Flow [Kg/s]	Discharge Duration [s]	Current Velocity [m/s]	Plume steady state (in hr)			
					300-fold	200-fold	100-fold	30-fold
1	Caisson	126.25	43200.0	0.01	4	4	1	0
2	Caisson	126.25	43200.0	0.1	1	0	0	0
3	Caisson	126.25	43200.0	0.01	5	4	1	0
4	Caisson	126.25	43200.0	0.1	1	1	0	0
5	Caisson	126.25	86400.0	0.01	4	3	1	0
6	Caisson	126.25	86400.0	0.1	1	1	0	0
7	Caisson	126.25	259200.0	0.01	4	3	1	1
8	Caisson	126.25	259200.0	0.1	1	1	0	0

7. Figures

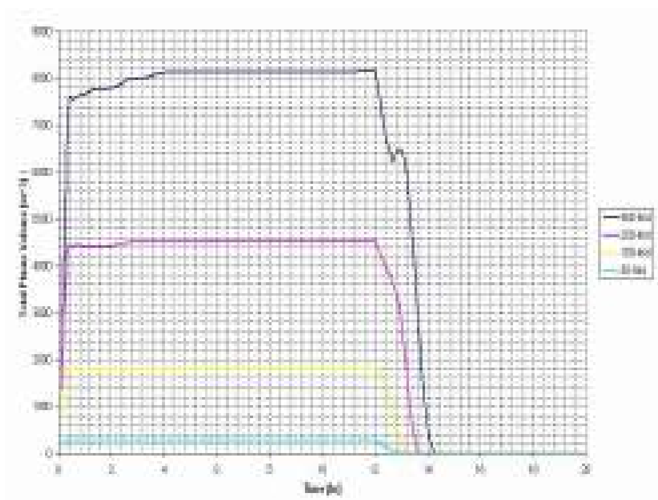
a) Caisson discharge (12 hr), winter near-stagnant current condition (Scenario 1)



b) Caisson discharge (12 hr), winter predominant current condition (Scenario 2)



c) Caisson discharge (12 hr), summer near-stagnant current condition (Scenario 3)



d) Caisson discharge (12 hr), summer predominant current condition (Scenario 4)

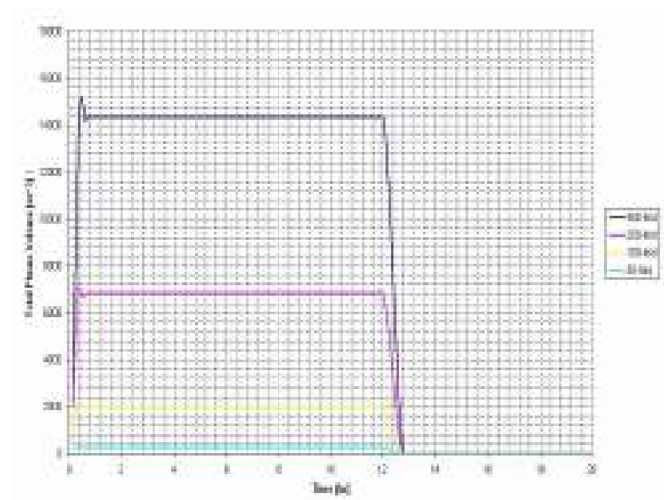
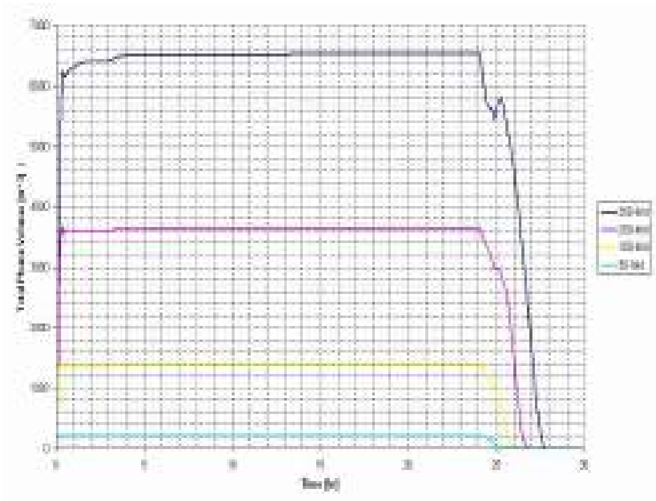
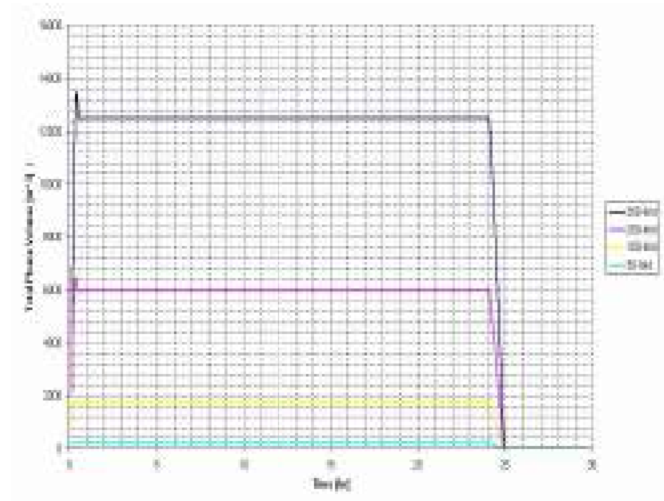


Figure 3.1: COP produced water discharge plume volume time histories (Scenarios 1 to 4)

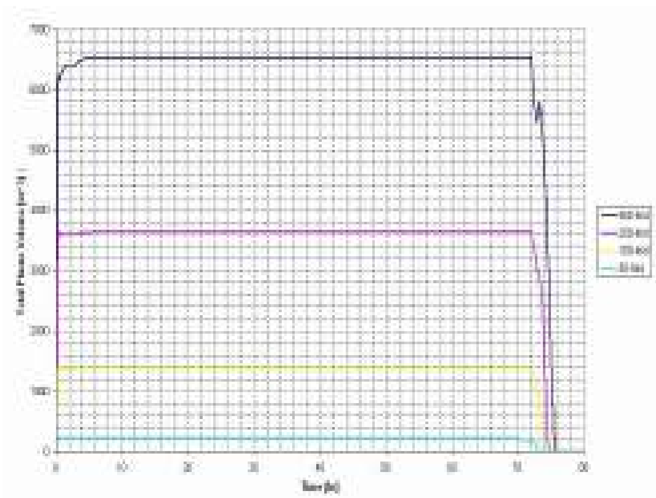
a) Caisson discharge (24 hr), winter near-stagnant current condition (Scenario 5)



b) Caisson discharge (24 hr), winter predominant current condition (Scenario 6)



c) Caisson discharge (72 hr), summer near-stagnant current condition (Scenario 7)



d) Caisson discharge (72 hr), summer predominant current condition (Scenario 8)

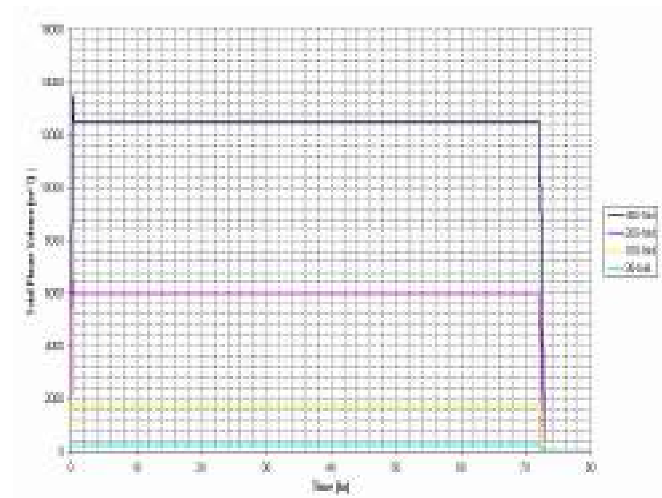


Figure 3.: COP produced water discharge plume volume time histories (Scenarios 5 to 8)

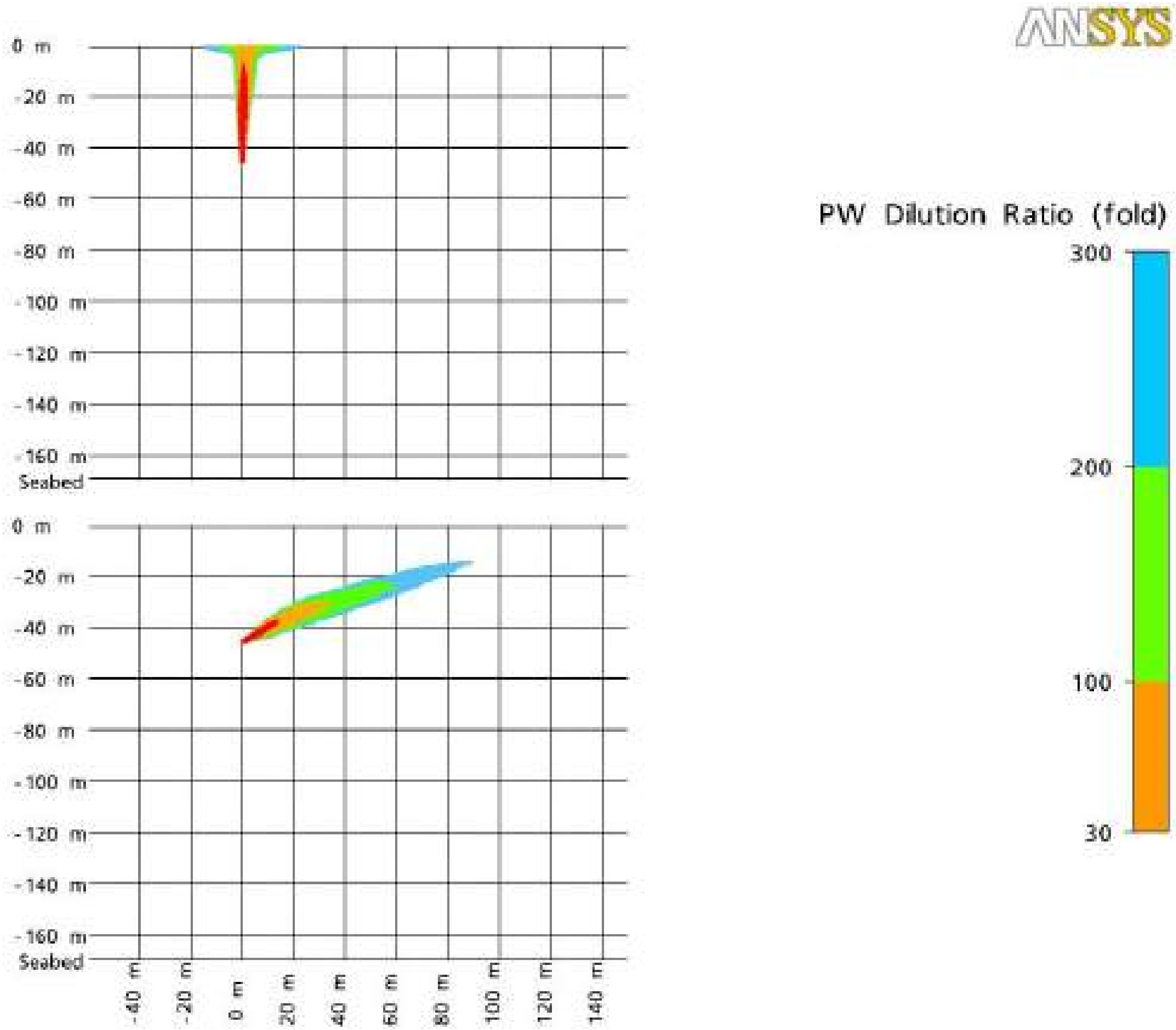


Figure 3.2: Produced water discharge plume vertical centreline view at the end of the discharge period (From top to bottom, Scenarios 1 and 2)

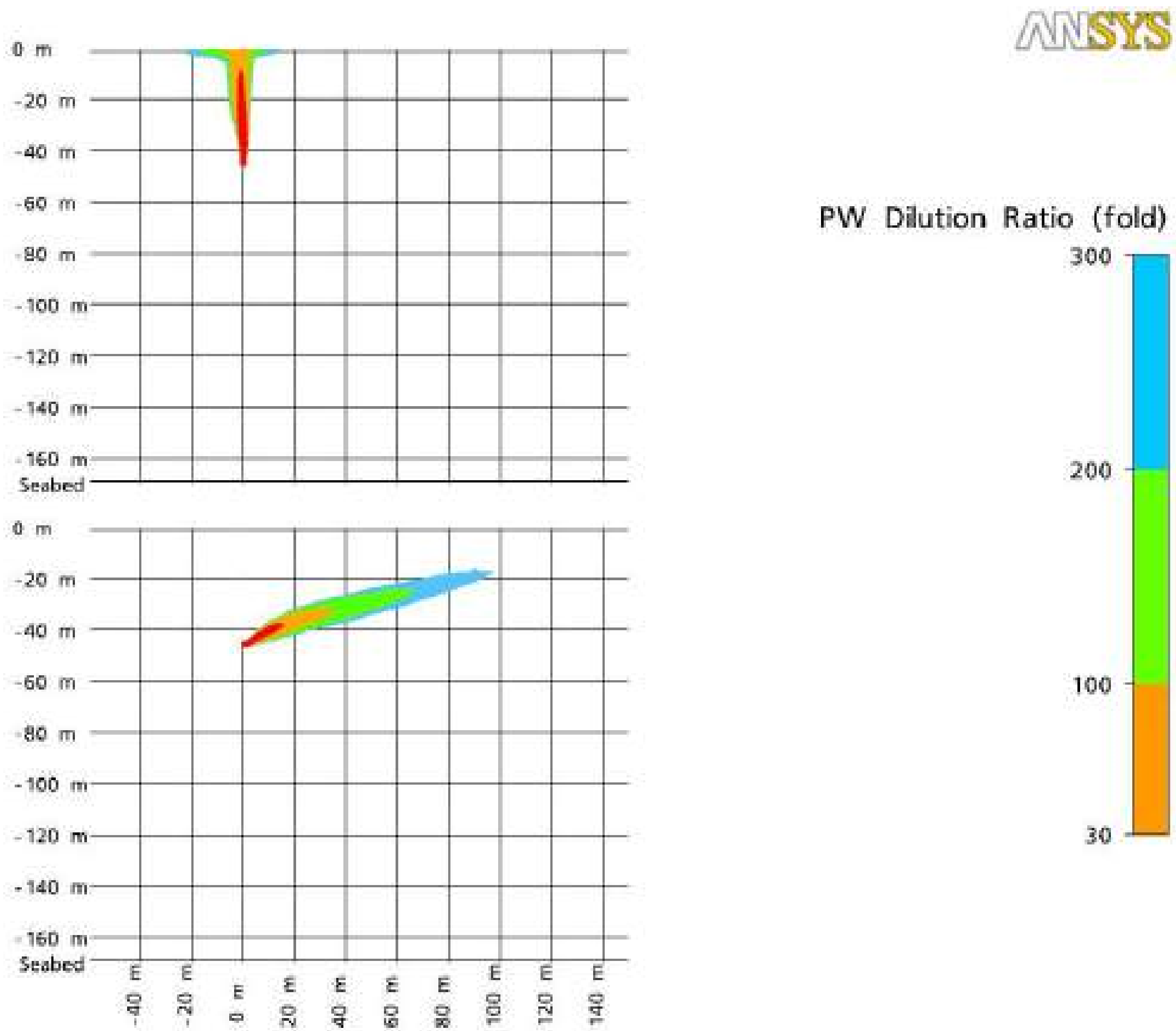


Figure 3. : Produced water discharge plume vertical centreline view at the end of the discharge period (From top to bottom, Scenarios 3 and 4)

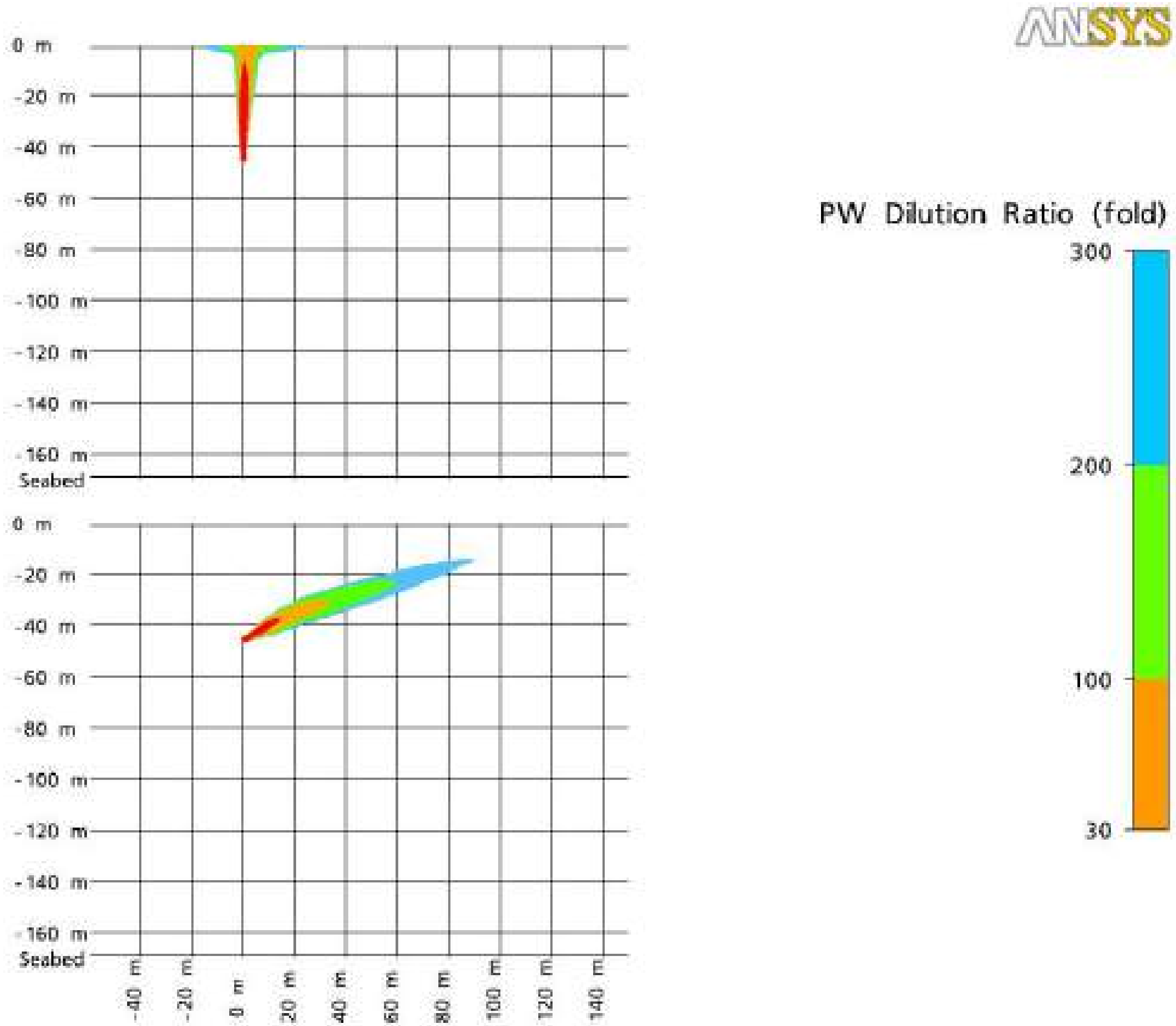


Figure 3.2 Continued: Produced water discharge plume vertical centreline view at the end of the discharge period (From top to bottom, Scenarios 5 and 6)

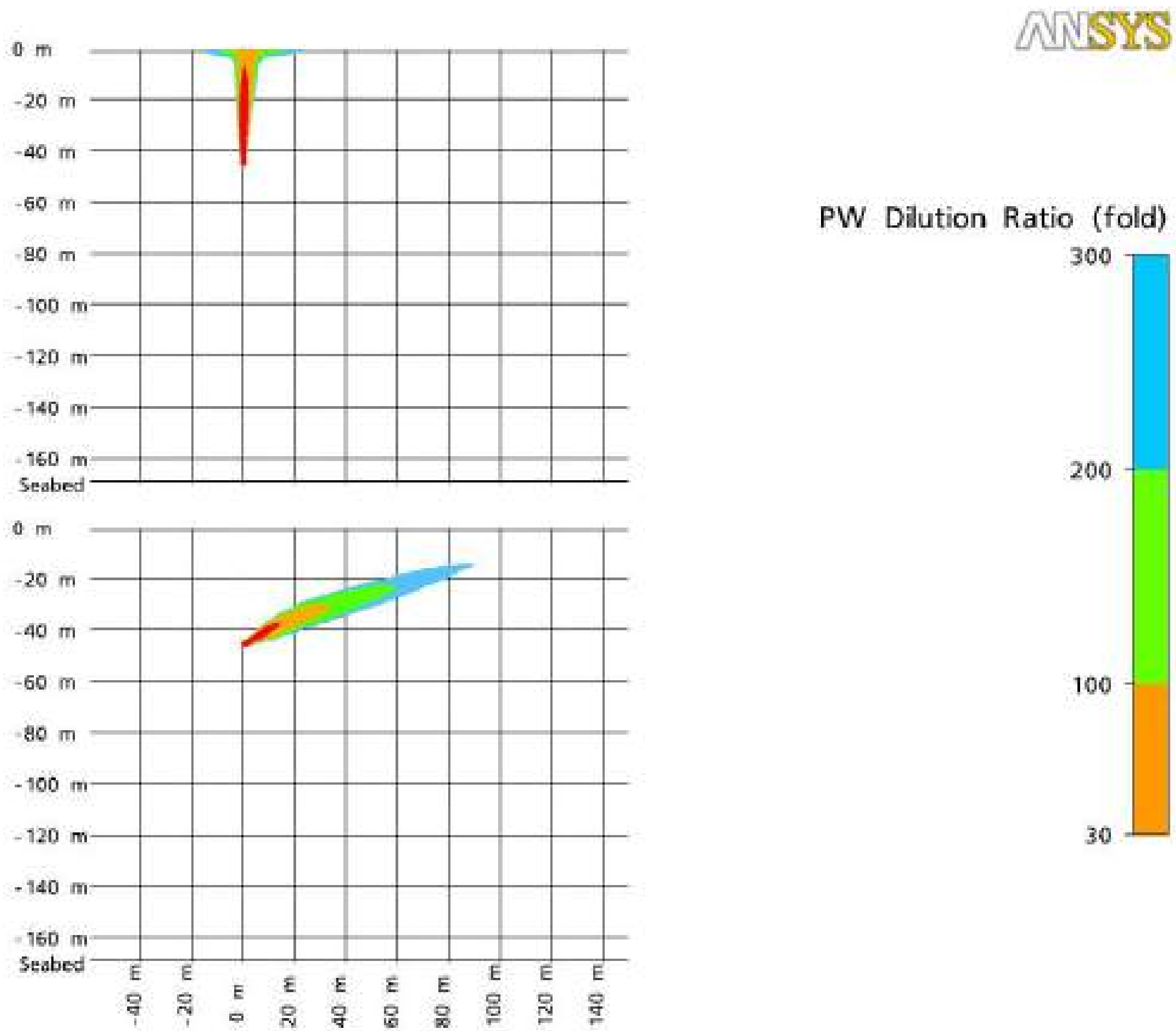


Figure 3.2 Continued: Produced water discharge plume vertical centreline view at the end of the discharge period (From top to bottom, Scenarios 7 and 8)

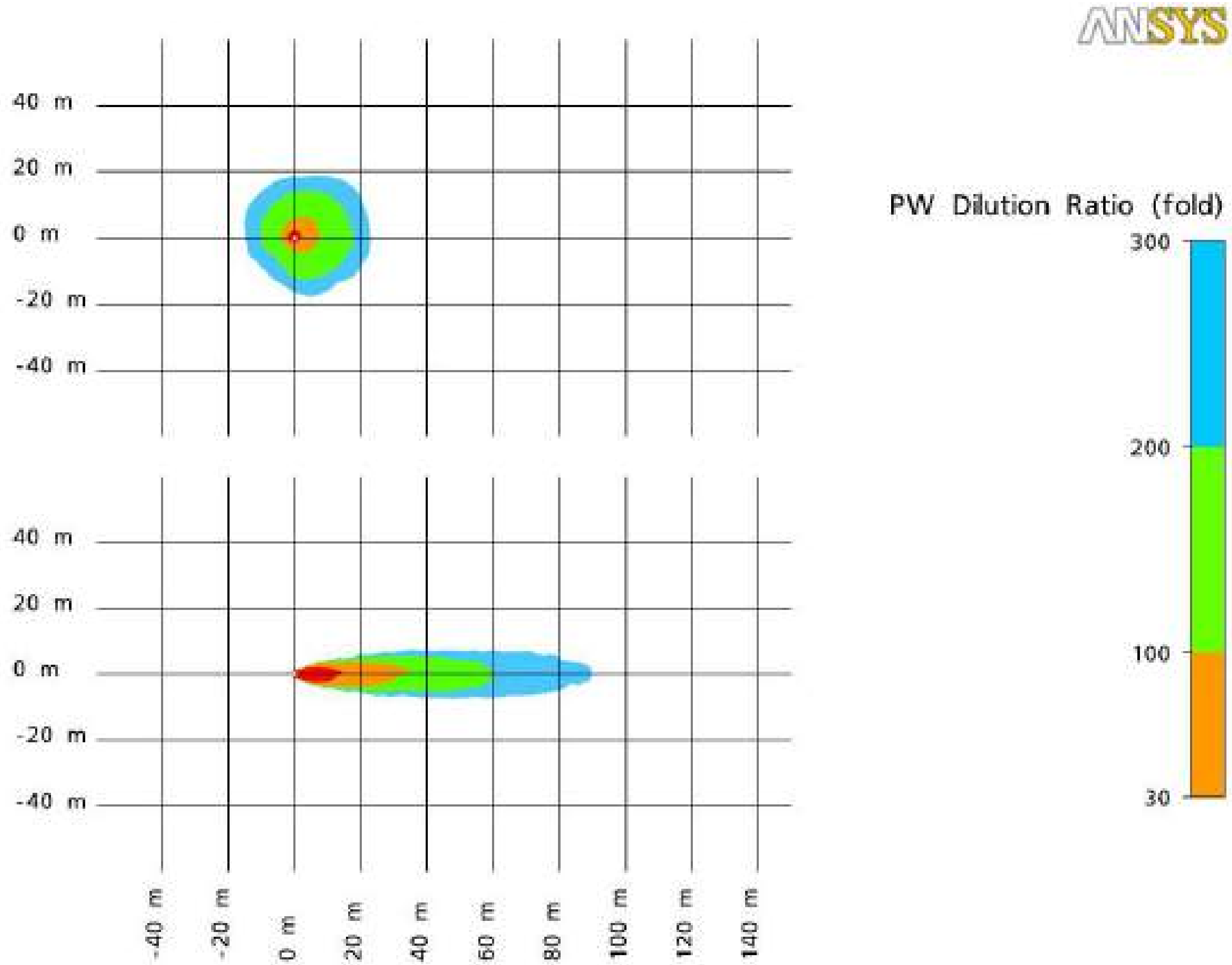


Figure 3.3: Produced water discharge plume plan view at the end of the discharge period (From top to bottom, Scenarios 1 and 2)

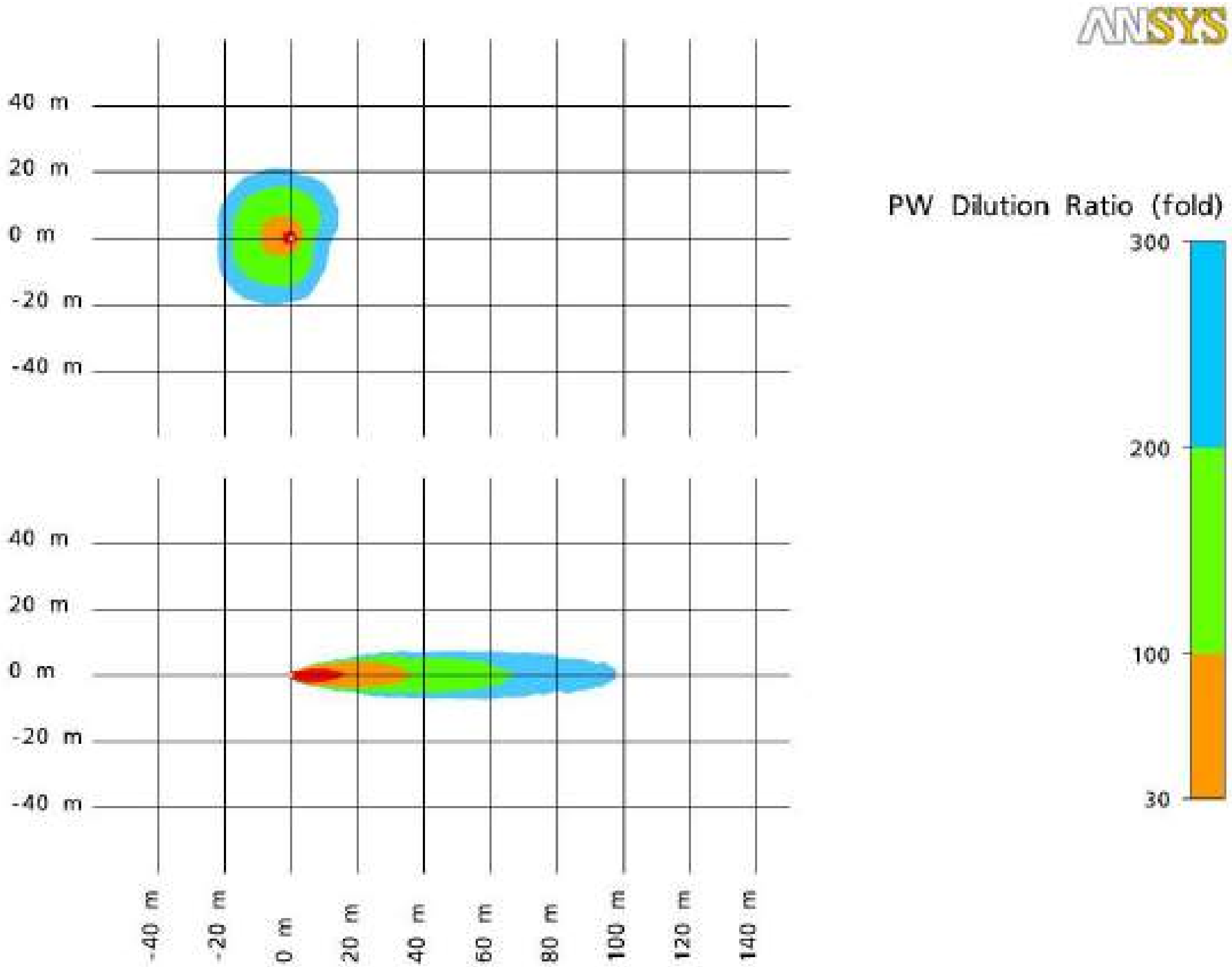


Figure 3.3 Continued: Produced water discharge plume plan view at the end of the discharge period (From top to bottom, Scenarios 3 and 4)

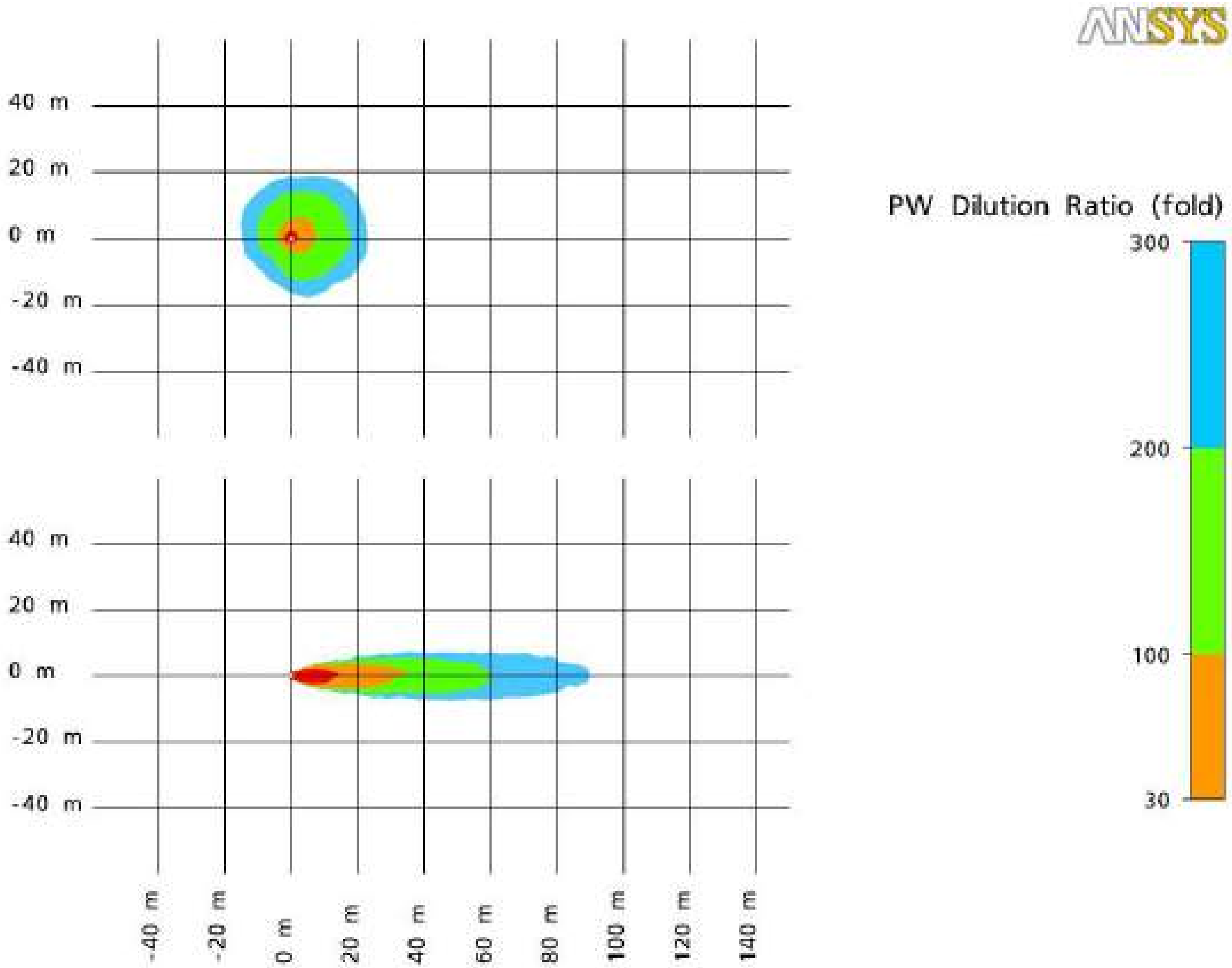


Figure 3.3 Continued: Produced water discharge plume plan view at the end of the discharge period (From top to bottom, Scenarios 5 and 6)

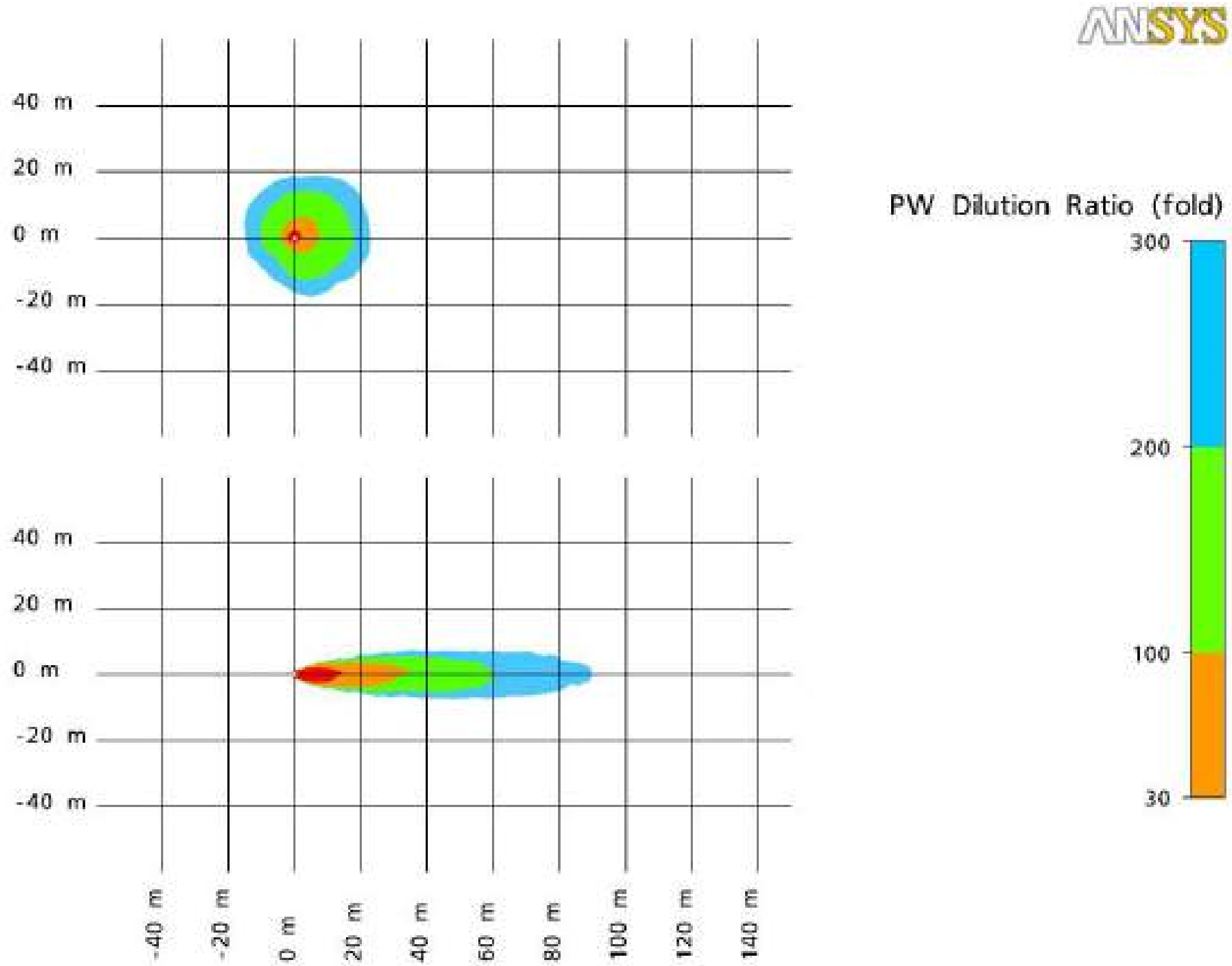


Figure 3.3 Continued: Produced water discharge plume plan view at the end of the discharge period (From top to bottom, Scenarios 7 and 8)

APPENDIX A. CFD MODEL

A.1. Analysis Software

CFX is regarded as a market-leading product that has been thoroughly validated for dispersion problems relevant to the oil and gas industry both by the specialists BMT and by external specialists. Publically available verification studies for a number of different fluids dynamics problems such as movement of solids through liquids and bubble plume behaviour have been undertaken at the University of Melbourne in Australia and the Paul Scherrer Institute in Switzerland[1]. Additional case studies including verification studies are provided here:

http://www.ansys.com/industries/sys-testimonials.asp?ID=10

A.2. Methodology

A.2.1. General

Dispersion of COP produced water fluid was modelled using discharge parameters supplied by BP, which included volumetric flow and duration of discharges.

Transient dispersion simulations were carried out to determine the extent of the relevant concentration plumes for a release from a caisson at a depth of 45m. The diameter of the discharge was 0.9 m. Different seawater temperatures (summer and winter conditions) and two current speeds (i.e. near-stagnant and predominant) were considered. Constant temperature profiles (7 ºC for winter and 12 ºC for summer) were assumed (i.e. no thermocline). Discharges from the caisson were directed downwards, assumed to be constant during the discharge period and at 25 ºC.

No topography (i.e. flat seabed) was included.

A.3. Fluid Properties

A.3.1. Seawater

Table A.1 presents the properties of seawater used in the analysis.

A.3.2. Hydrotest Water

The COP water discharges will comprise chemically treated Caspian seawater. The relevant degree of dilution will lie in the range of 1:300 to 1:30.

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[1] http://www.cfd.com.au/cfd_conf03/papers/123Hol.pdf; http://www.cfd.com.au/cfd_conf97/papers/smi002.pdf; Dispersion of neutrally buoyant solids falling vertically into stationary liquid and horizontal channel flow, K. M. Smith, M. R. Davidson and N. J. Lawson Computers & Fluids Volume 29, Issue 4, 1 May 2000, Pages 369-384; On the modelling of bubble plumes in a liquid pool, B. L. Smith, Applied Mathematical Modelling, Volume 22, Issue 10, October 1998, Pages 773-797

A.4. Computational Mesh

The computational mesh was generated in the domain bounded by the seabed and the sea surface. The computational domain extended sufficiently far away in each direction to avoid any boundary influence on the flow solution. The computational mesh used for the simulations comprised approximately 4 million tetrahedral cells. Additional mesh refinement was applied in the proximity regions of the release location.

A.5. Turbulence Model

The K-ε turbulence model was employed in the CFD simulations with standard coefficients.

The K-ε turbulence model is widely used for applications in the offshore industry and is generally suitable for the assessment of dispersion.

A.6. Heat Transfer Model

Heat transfer was modelled in the dispersion simulations. The ambient seawater temperature varied depending on the season condition.

A.7. Buoyancy

Buoyancy forces due to changes in fluid density were modelled in the analysis using the Boussinesq approximation.

A.8. Current Velocity Profile

The current velocity profile was simulated as uniform across the water column and consisted of two distinguished cases:

- Predominant current speed = 0.1 m/s
- Near-stagnant current speed = 0.01m/s

A.9. Boundary Conditions

A.9.1. Upstream and Downstream Boundaries

Current properties were applied at the upstream domain boundary.

A.9.2. Seabed

A no-slip wall boundary condition (u, v, w = 0) was applied at the seabed.

A.9.3. Sea surface

A free-slip wall boundary condition (w = 0) was applied at the sea surface.

Seawater	
Density (kg/m^3)	1,010
Dynamic viscosity (kg/(m.s))	See Figure A.1
Molecular weight (kg/kmole)	18.02
Specific Heat Capacity (J/(kg.K))	4,181.7
Thermal Conductivity (W/(m.K))	0.6069
Thermal Expansivity (K^{-1})	0.000257

Table A.1 – Properties of seawater

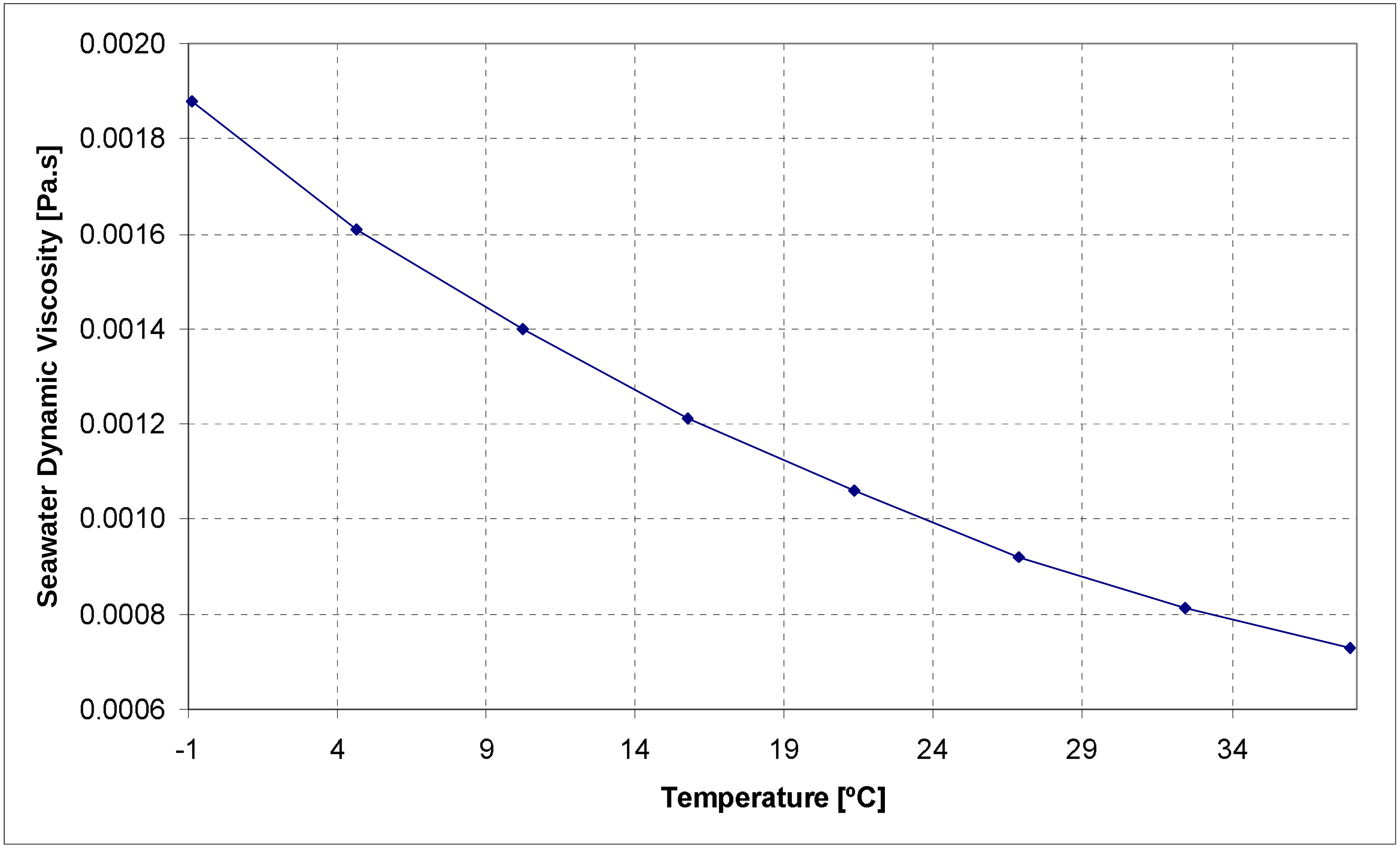

Figure A.1: Seawater viscosity variation with temperature

APPENDIX 11F

Cooling Water Dispersion Modelling

BMT Fluid Mechanics

Azeri Chirag Gunashi Field
Cooling Water Dispersion Modelling

For
BP

Report Title	**Azeri Chirag Gunashi Field Cooling Water Dispersion Modelling**		
Client:	**BP**		
Document No:	46211 Report01v2	**Release:** 2	**Copy No:**
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EXECUTIVE SUMMARY

A Computational Fluid Dynamics (CFD) study was carried out by BMT Fluid Mechanics (BMT) to assess the dispersion of subsea cooling water discharges from the Chirag Oil Project (COP) Development in the Azeri Chirag Gunashi (ACG) Field 110km off the coast of Baku, Azerbaijan in the Caspian Sea. The analysis was carried out for BP.

A total of four baseline scenarios were considered for the cooling water discharge analysis:

- two winter simulations were carried out, using a constant temperature profile of 7ºC and two current speeds (i.e. near-stagnant and predominant)
- two summer simulations were carried out, using the temperature profile obtained from [1] and two current speeds (i.e. near-stagnant and predominant)

Sensitivity analyses were also carried out by varying the temperature and the depth of the discharge (i.e. 75 ºC at a depth of 75 m and 45 m and 25 ºC at a depth of 45 m).

The cooling water dispersion scenarios investigated in the analysis are summarised in Table 4.2.

A total of two scenarios were considered for the cooling water intake analysis:

- near-stagnant current condition
- predominant current condition

A constant, uniform ambient temperature of 7 ºC was assumed for both intake scenarios.

For the baseline scenarios (i.e. 25 ºC discharge at a depth of 75 m), the maximum height reached by the thermal plume occurred for the winter near-stagnant scenario, where the top of the plume reaches a depth of 65m.

For the baseline scenarios (i.e. 25 ºC discharge at a depth of 75 m), the maximum length of the thermal plume occurred for the summer predominant current scenario, where the tip of the plume reached a distance of 13 m from the point of discharge.

For the baseline scenarios (i.e. 25 ºC discharge at a depth of 75 m), the thermal plumes generated by the cooling water discharge met the limit recommended by the IFC and also never reached the sea surface for all conditions investigated.

Significant impact on the thermal plume sizes was observed by increasing the discharge temperature to 75 ºC. The maximum plume height reached was 42 m in depth for a 75 m deep discharge. If the discharge was moved to a depth of 45 m, the maximum plume height reached was 12 m. However, the plume extent was still within the 100 m radius prescribed by the IFC and did not reach the sea surface.

Small impact on the thermal plume sizes was observed by varying the discharge depth to 45 m. The maximum plume height reached was 33 m in depth. However, the plume extent was still within the 100 m radius prescribed by the IFC and did not reach the sea surface.

Copper and chlorine levels discharged with the cooling water were assumed to be of no interest, as the dosing rates were already below the guidelines set by the Environmental Quality Standards.

In terms of the effect on the free stream flow velocity, the intake imposes a 5% disturbance to a maximum distance of 6 m from the pipe for near-stagnant current conditions and 2 m for predominant current conditions.

Azeri Chirag Gunashi Field Cooling Water Dispersion Modelling

Contents

Azeri Chirag Gunashi Field Cooling Water Dispersion Modelling

1. Introduction

1.1. General

This progress note presents preliminary results of a Computational Fluid Dynamics (CFD) study carried out by BMT Fluid Mechanics (BMT) to assess the dispersion of subsea cooling water discharges from the Chirag Oil Project (COP) Development in the Azeri Chirag Gunashi (ACG) Field 110km off the coast of Baku, Azerbaijan in the Caspian Sea. The scope of work is based on requirement outlined in “Chirag Oil Project – Outline Scope of Work for modelling dispersion and fate of cooling water and drill cuttings” issued to BMT by BP on the 28th of November 2008.

The COP development will require staged drilling operations. Once the platform is in place, the predominate release into the water column will be cooling water and associated anti-corrosion fluid from the platform. The purpose of the modelling is to simulate the dispersion of these discharges and assess the impact on the environment.

1.2. Report Structure

Sections 2 and 3 of this report describe the main objectives of the study and the scope of work agreed to meet those objectives. Results of the cooling water dispersion analysis are given in section 4. Details of the modelling and supporting information are given in Appendix A.

2. Objectives

The main objectives of the subsea dispersion modelling presented in this progress note are as follows:

- Model near- and far-field dispersion of the cooling water discharge and assess the potential for affecting seawater quality
- Determine temperatures of discharged fluid within the water column
- Model the cooling water intake and assess its effects on the seawater quality

3. Scope of Work

3.1. Model Construction

- Construct a CFD model of the water column surrounding the PDQ and CWP to a depth of 150m that is suitable for dispersion modelling. The model will consist of a high-resolution domain out to a 100m radius and a lower resolution domain out to 10 km downstream of the platforms. A simple geometric representation of the risers and releases will be included in the model if required

3.2. Cooling Water

- Carry out steady-state[1] dispersion simulations for a total of 3 discharge conditions (PDQ, CWP & both), an average and peak winter and summer current condition (to be agreed) (summer condition includes thermocline), and vertical and horizontal port orientation – Total 24 simulations
- The cooling water fluid will include aqueous copper and chlorine discharged at a constant concentration. If reaction equations can be provided, the reactivity of these fluids with the seawater can be modelled
- Provide horizontal and vertical colour contour plots of cooling water temperature and concentrations for each scenario
- Provide sea bed contour plots of copper deposition rates
- Determine the length, height and width of the plume extent
- Determine the local flow velocity patterns resulting from the discharge to assess risk of interference with other discharges and water surface disruption

3.3. Reporting

- Submit a technical report summarising the main results of the dispersion analysis including method, software and model description, sufficient tabular and illustrative graphical colour images, recommendations and conclusions

[1] Since the plume response time is less than the variational time scale of the hydrodynamics [1], simulations are to be carried out for constant current conditions

3.4. Definitions of Abbreviations and Acronyms

Term / Acronym / Abbreviation	Explanation / Definition
BMT	BMT Fluid Mechanics Limited
CAD	Computer Aided Drawing
cc	Cubic centimetre
CFD	Computational Fluid Dynamics
ppb	Parts Per Billion by volume

4. CFD Analysis

4.1. Introduction

This section presents the results of the subsea cooling water dispersion analysis carried out to determine the distances travelled by the discharge plumes for a range of subsea ambient and current conditions. It also presents the results of the intake flow analysis.

The CFD model and methodology is described in APPENDIX A.

4.2. Ambient Conditions

Two seasonal options were assessed and compared in the analysis:

- Summer condition: in this case, a vertical seawater temperature profile was obtained from [1]. The thermal profile's prime characteristic is a sudden increase from 9 ºC to 24 ºC in the range of 30 m to 50 m depth. Details of the thermal profile used are shown in Figure 4.1
- Winter condition: in this case, a constant seawater temperature of 7 ºC was obtained from [1] (i.e. no thermocline)

4.3. Current Conditions

For each ambient condition, two current conditions were assessed in the analysis:

- Near-stagnant flow: constant horizontal current flow velocity of 0.01 m/s
- Predominant flow: annual average current data obtained from [2], leading to a uniform constant value of 0.11 m/s

4.4. Discharge conditions

Details of the discharge conditions are shown in Table 4.1.

4.5. Intake conditions

Details of the intake conditions are shown in Table 4.1.

4.6. Chemical Concentration Limits

Copper and chlorine levels discharged with the cooling water were assumed to be of no interest, as the dosing rates are already below the guidelines set by the Environmental Quality Standards (EQS). Modelling of the evolution of concentration values for these chemicals was therefore not carried out.

4.7. Assessment Scenarios

4.7.1. Cooling Water Discharge

A total of four baseline scenarios were considered for the cooling water discharge analysis:

- two winter simulations were carried out, using a constant temperature profile of 7ºC and two current speeds (i.e. near-stagnant and predominant)
- two summer simulations were carried out, using the temperature profile obtained from [1] and two current speeds (i.e. near-stagnant and predominant)

Sensitivity analyses were also carried out by varying the temperature and the depth of the discharge (i.e. 75 ºC at a depth of 75 m and 45 m and 25 ºC at a depth of 45 m).

The cooling water dispersion scenarios investigated in the analysis are summarised in Table 4.2.

4.7.2. Cooling Water Intake

A total of two scenarios were considered for the cooling water intake analysis:

- near-stagnant current condition
- predominant current condition

A constant, uniform ambient temperature of 7 ºC was assumed for both intake scenarios.

4.8. Results

4.8.1. Thermal Plume Dimensions

The thermal plume dimensions were assessed and compared with the requirement (recommended by the IFC) that thermal discharges should not increase ambient water temperatures by more than 3 ºC at the edge of a 100 m mixing zone.

A summary of the results, giving the main dimensions of the 3 ºC above ambient plumes, is provided in **Error! Reference source not found.**3.

For the baseline scenarios (i.e. 25 ºC discharge at a depth of 75 m), the maximum height reached by the thermal plume occurred for the winter near-stagnant scenario (Scenario 1), where the top of the plume reached a depth of 65 m.

The maximum length of the thermal plume occurred for the summer predominant current scenario (Scenario 4), where the tip of the plume reached a distance of 13 m from the point of discharge.

The thermal plume width reached a maximum value of 4 m for each scenario assessed.

The thermal plumes generated by the cooling water discharge met the limit recommended by the IFC and also never reached the sea surface for all conditions investigated.

Small impact on the thermal plume sizes was observed by varying the discharge depth to 45 m. The maximum plume height reached was 33 m in depth. However, the plume extent was still within the 100 m radius prescribed by the IFC and did not reach the sea surface.

Significant impact on the thermal plume sizes was observed by increasing the discharge temperature to 75 ºC. The maximum plume height reached was 42 m in depth for a 75 m deep discharge. If the discharge was moved to a depth of 45 m, the maximum plume height reached was 12 m. However, the plume extent was still within the 100 m radius prescribed by the IFC and did not reach the sea surface.

4.8.2. Thermal Plumes Visualisations

Figure 4.2 to Figure 4.5 present vertical contour plots of temperature for each scenario investigated. A thick black contour line is also shown on each figure to depict the 3 ºC difference limit with ambient temperature.

4.8.3. Intake flow effects

Results of the simulations carried out to model the effects of the water intake on the surrounding current conditions can be seen in Figure 4.5 to Figure 4.7.

In terms of the effect on the free stream flow velocity, the intake imposes a 5% disturbance to a maximum distance of approximately 6 m from the pipe for near-stagnant current conditions and 2 m for predominant current conditions.

5. Conclusions

- For the baseline scenarios (i.e. 25 ºC discharge at a depth of 75 m), the maximum height reached by the thermal plume occurred for the winter near-stagnant scenario, where the top of the plume reaches a depth of 65m.

- For the baseline scenarios (i.e. 25 ºC discharge at a depth of 75 m), the maximum length of the thermal plume occurred for the summer predominant current scenario, where the tip of the plume reached a distance of 13 m from the point of discharge.

- For the baseline scenarios (i.e. 25 ºC discharge at a depth of 75 m), the thermal plumes generated by the cooling water discharge met the limit recommended by the IFC and also never reached the sea surface for all conditions investigated.

- Significant impact on the thermal plume sizes was observed by increasing the discharge temperature to 75 ºC. The maximum plume height reached was 42 m in depth for a 75 m deep discharge. If the discharge was moved to a depth of 45 m, the maximum plume height reached was 12 m. However, the plume extent was still within the 100 m radius prescribed by the IFC and did not reach the sea surface.

- Small impact on the thermal plume sizes was observed by varying the discharge depth to 45 m. The maximum plume height reached was 33 m in depth. However, the plume extent was still within the 100 m radius prescribed by the IFC and did not reach the sea surface.

- Copper and chlorine levels discharged with the cooling water were assumed to be of no interest, as the dosing rates were already below the guidelines set by the Environmental Quality Standards.

- In terms of the effect on the free stream flow velocity, the intake imposes a 5% disturbance to a maximum distance of 6 m from the pipe for near-stagnant current conditions and 2 m for predominant current conditions.

6. References

[1] ASA, "Hydrodynamic and Dispersion Modelling for the Azeri, Chirag, Gunashi Field Offshore Baku, Azerbaijan", ASA 01-007, August 2001

[2] Shah Deniz Wind Wave Surge and Current Criteria, v3.1, OceanMetriX Ltd, October 2008

7. Tables

Table 4.1: Summary of discharge and intake conditions of cooling water

Property	Cooling water discharge (for baseline)	Cooling water intake (for each intake)
Depth	75 [m]	105 [m]
Caisson Diameter	0.8 [m]	1.1 [m]
Flow Rate	3000 [m^3/hr]	1500 [m^3/hr]
Flow temperature	25 [°C]	7 [°C]
BFCC Corrosion control	Copper: 5 [ppb] Chlorine: 50 [ppb]	N/A
Flow Orientation	Downwards	Upwards

Table 4.2: Dispersion scenarios of cooling water discharges

Scenario	Ambient Condition	Current Condition	Discharge Depth	Discharge Temperature
1	Winter	0.01 [m/s]	75 [m]	25 [°C]
2	Winter	0.11 [m/s]	75 [m]	25 [°C]
3	Summer	0.01 [m/s]	75 [m]	25 [°C]
4	Summer	0.11 [m/s]	75 [m]	25 [°C]
5	Winter	0.01 [m/s]	75 [m]	75 [°C]
6	Winter	0.11 [m/s]	75 [m]	75 [°C]
7	Summer	0.01 [m/s]	75 [m]	75 [°C]
8	Summer	0.11 [m/s]	75 [m]	75 [°C]
9	Winter	0.01 [m/s]	45 [m]	25 [°C]
10	Winter	0.11 [m/s]	45 [m]	25 [°C]
11	Summer	0.01 [m/s]	45 [m]	25 [°C]
12	Summer	0.11 [m/s]	45 [m]	25 [°C]
13	Winter	0.01 [m/s]	45 [m]	75 [°C]
14	Winter	0.11 [m/s]	45 [m]	75 [°C]
15	Summer	0.01 [m/s]	45 [m]	75 [°C]
16	Summer	0.11 [m/s]	45 [m]	75 [°C]

Table 4.3: 3ºC above ambient plume dimensions

Scenario	Ambient Condition	Current Condition [m/s]	3ºC above ambient plume dimensions								
			Maximum X [m]	Maximum Y [m]	Maximum Z [m]	Minimum X [m]	Minimum Y [m]	Minimum Z [m]	Length [m]	Width [m]	Height [m]
1	Winter	0.01	3	2	-65	-2	-2	-84	5	4	19
2	Winter	0.1	12	2	-75	-1	-2	-86	13	4	11
3	Summer	0.01	3	2	-68	-2	-2	-84	5	4	16
4	Summer	0.1	13	2	-75	-1	-2	-86	14	4	11
5	Winter	0.01	4	2	-42	-2	-2	-80	5	4	38
6	Winter	0.1	10	3	-49	-1	-2	-81	11	5	31
7	Summer	0.01	3	2	-50	-2	-2	-80	5	4	30
8	Summer	0.1	10	2	-55	-1	-2	-81	11	4	26
9	Winter	0.01	3	2	-33	-3	-3	-52	6	5	19
10	Winter	0.1	12	2	-44	-1	-2	-55	13	4	11
11	Summer	0.01	5	3	-40	-2	-3	-52	7	6	13
12	Summer	0.1	11	2	-45	-1	-3	-55	11	5	10
13	Winter	0.01	4	2	-12	-2	-2	-49	6	5	37
14	Winter	0.1	10	3	-20	-2	-3	-50	12	5	30
15	Summer	0.01	3	2	-34	-60	-2	-50	6	4	16
16	Summer	0.1	6	3	-37	-2	-3	-50	9	6	13

8. Figures

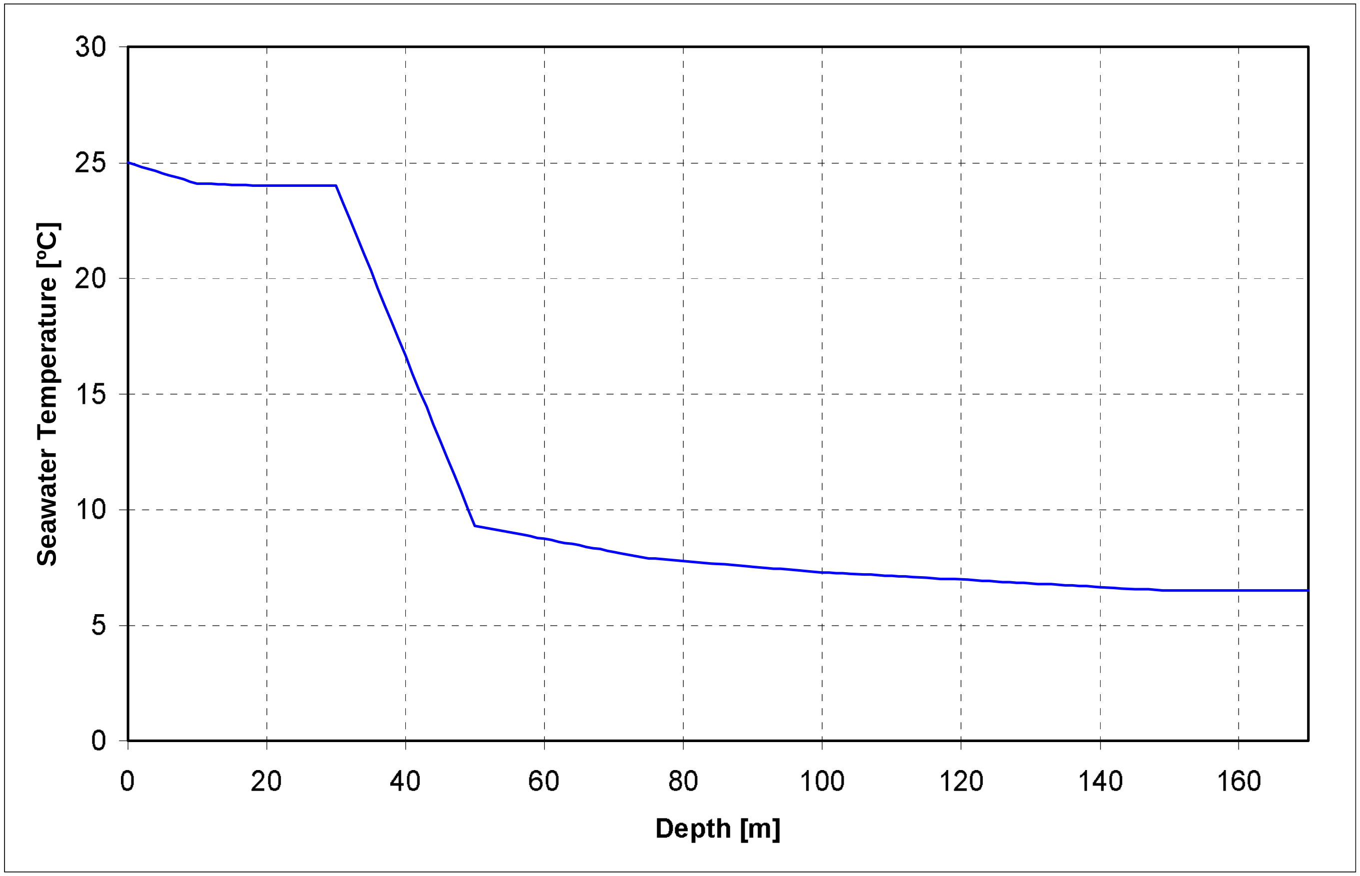


Figure 4.1: Summer seawater temperature variation with depth

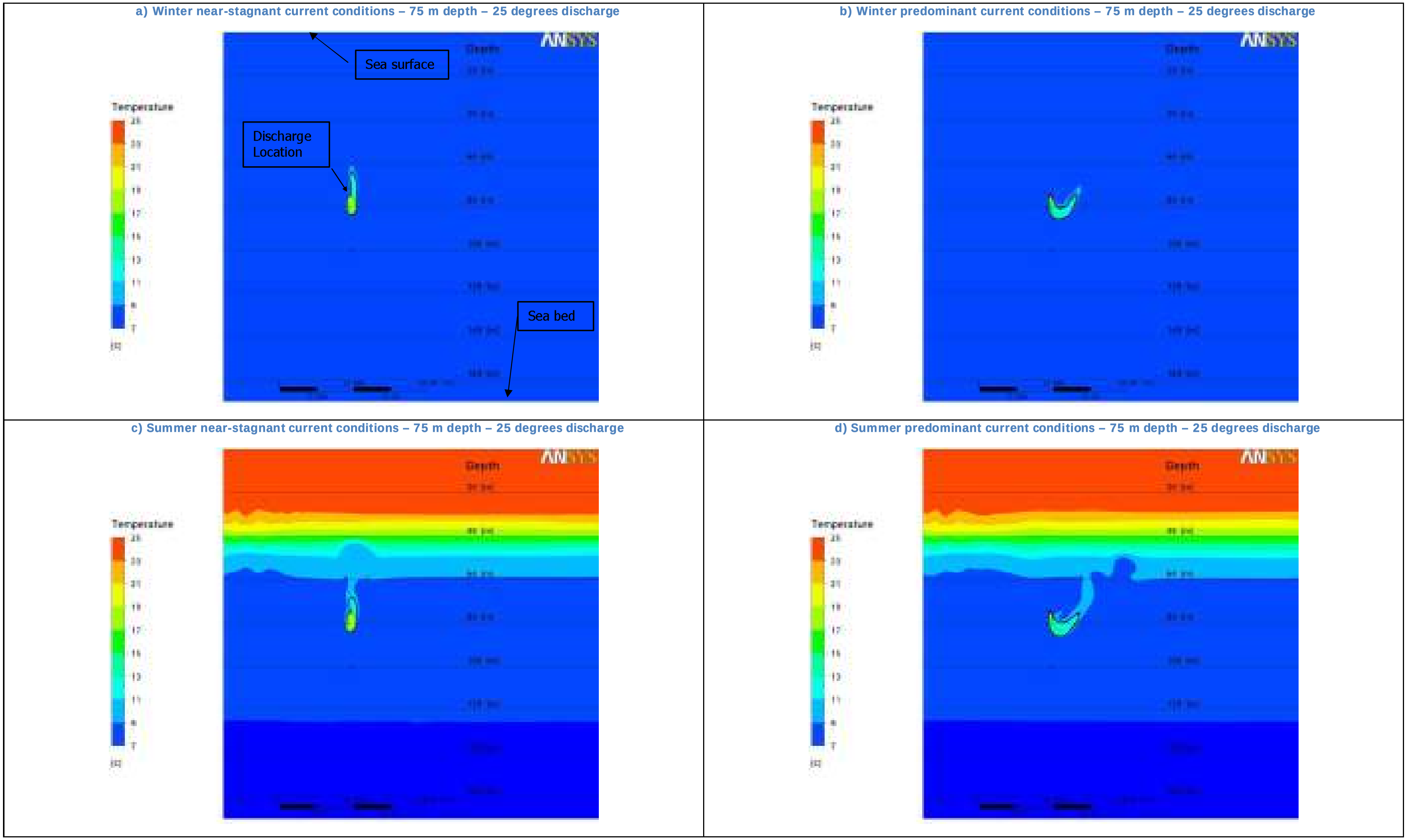
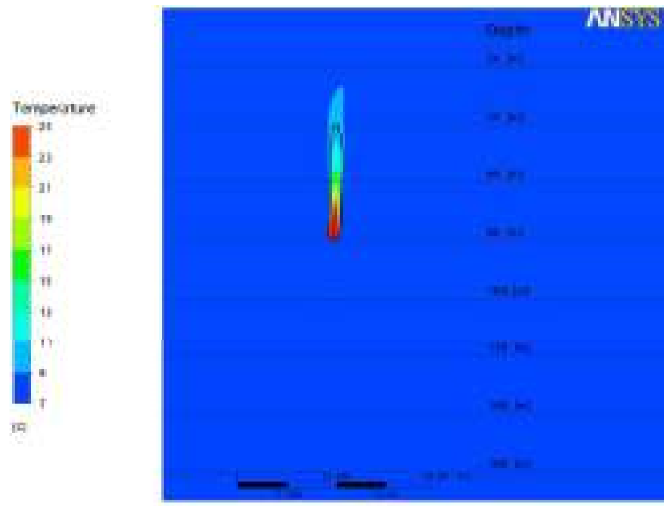
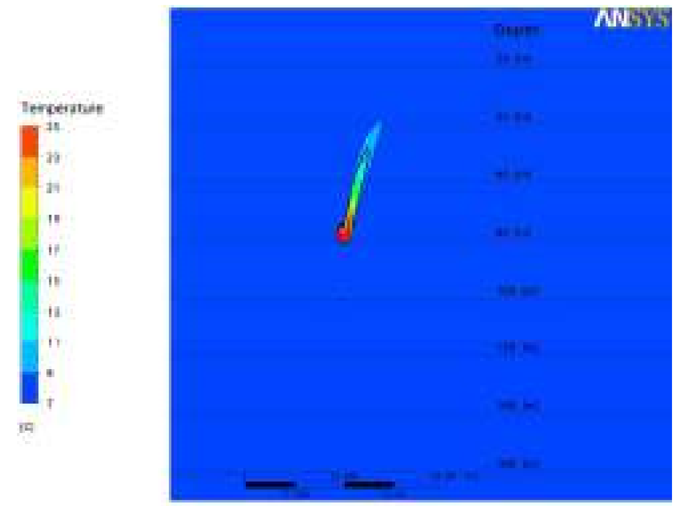


Figure 4.2: Temperature contour plots across the plume centreline, also depicting (thick black line) the limit of 3 degrees above ambient temperature (Scenarios 1 to 4)

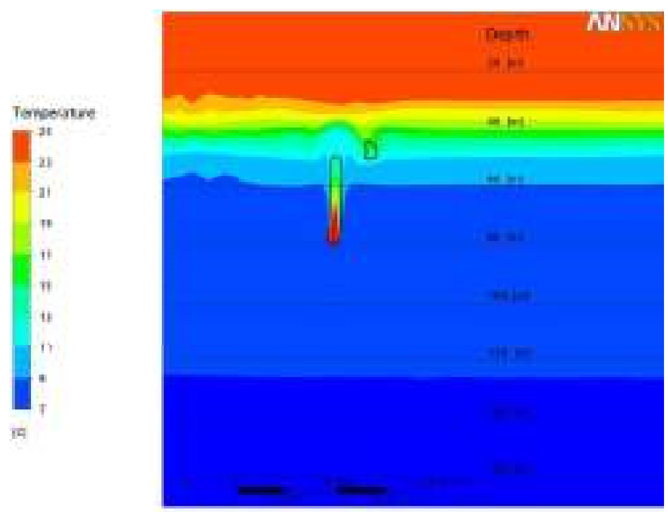
a) Winter near-stagnant current conditions – 75 m depth – 75 degrees discharge



b) Winter predominant current conditions – 75 m depth – 75 degrees discharge



c) Summer near-stagnant current conditions – 75 m depth – 75 degrees discharge



d) Summer predominant current conditions – 75 m depth – 75 degrees discharge

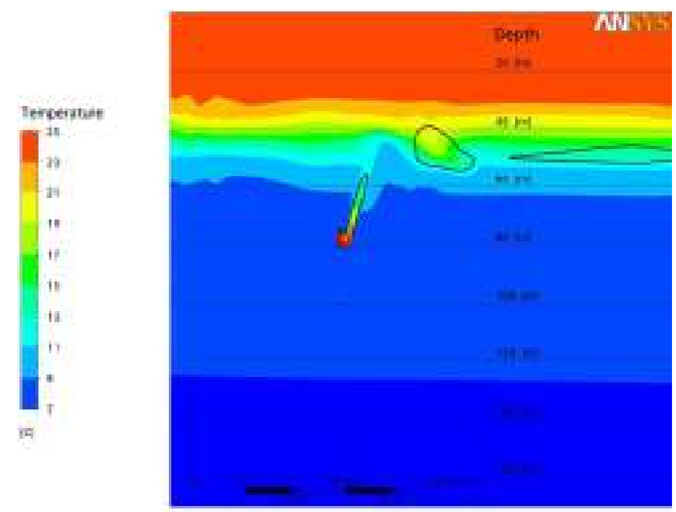
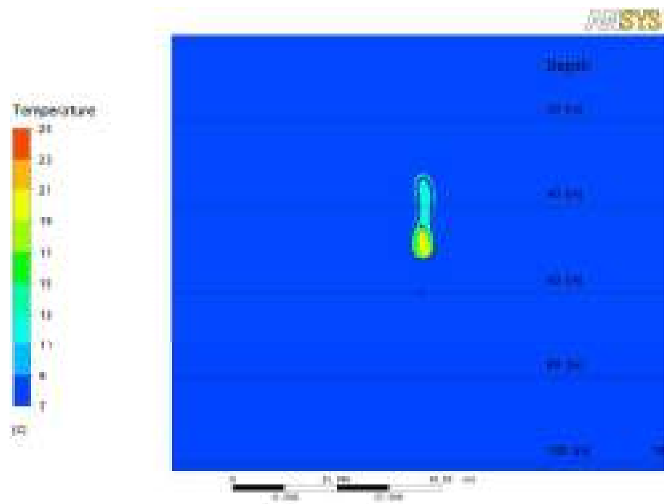
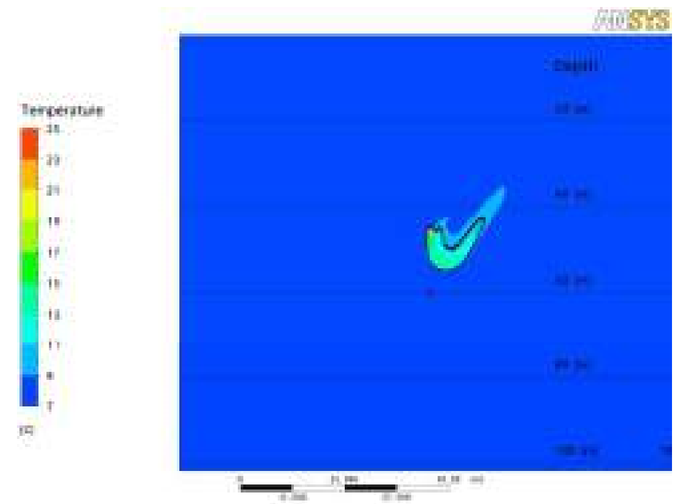


Figure 4.3: Temperature contour plots across the plume centreline, also depicting (thick black line) the limit of 3 degrees above ambient temperature (Scenarios 5 to 8)

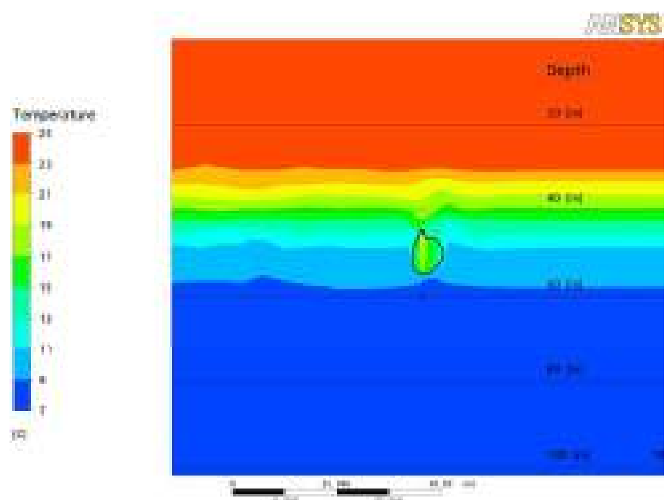
a) Winter near-stagnant current conditions – 45 m depth – 25 degrees discharge



b) Winter predominant current conditions – 45 m depth – 25 degrees discharge



c) Summer near-stagnant current conditions – 45 m depth – 25 degrees discharge



d) Summer predominant current conditions – 45 m depth – 25 degrees discharge

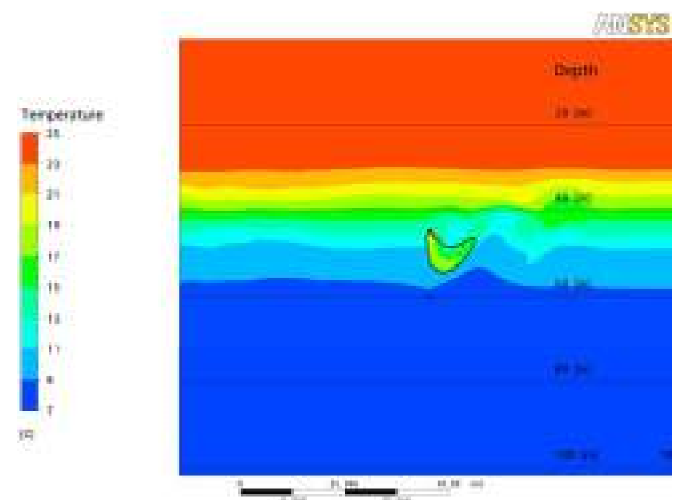
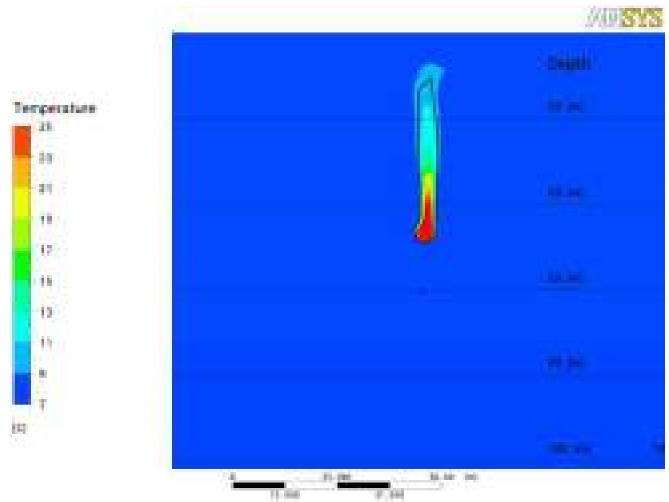
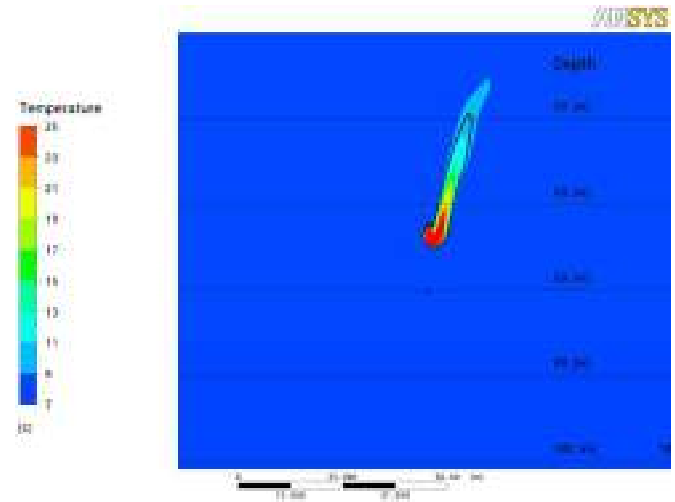


Figure 4.4: Temperature contour plots across the plume centreline, also depicting (thick black line) the limit of 3 degrees above ambient temperature. (Scenarios 9 to 12)

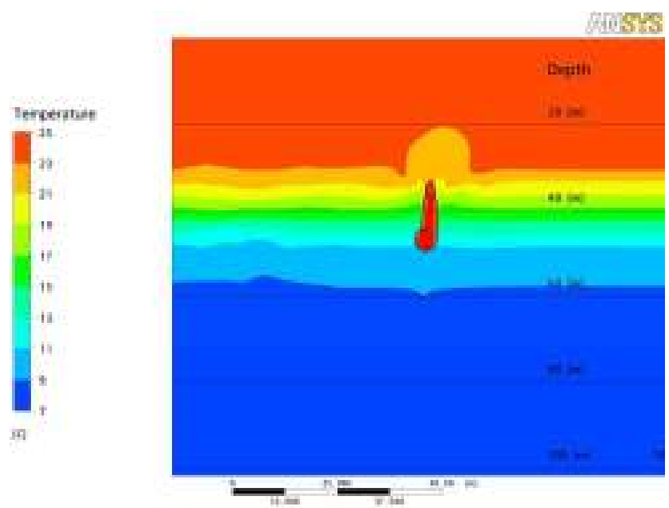
a) Winter near-stagnant current conditions – 45 m depth – 75 degrees discharge



b) Winter predominant current conditions – 45 m depth – 75 degrees discharge



c) Summer near-stagnant current conditions – 45 m depth – 75 degrees discharge



d) Summer predominant current conditions – 45 m depth – 75 degrees discharge

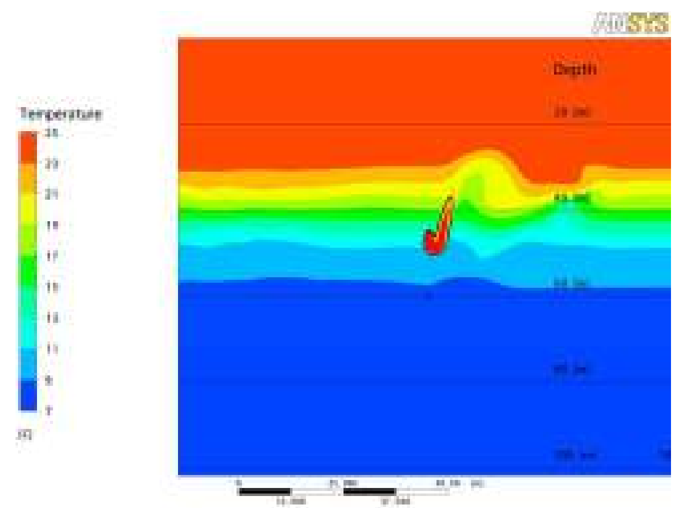
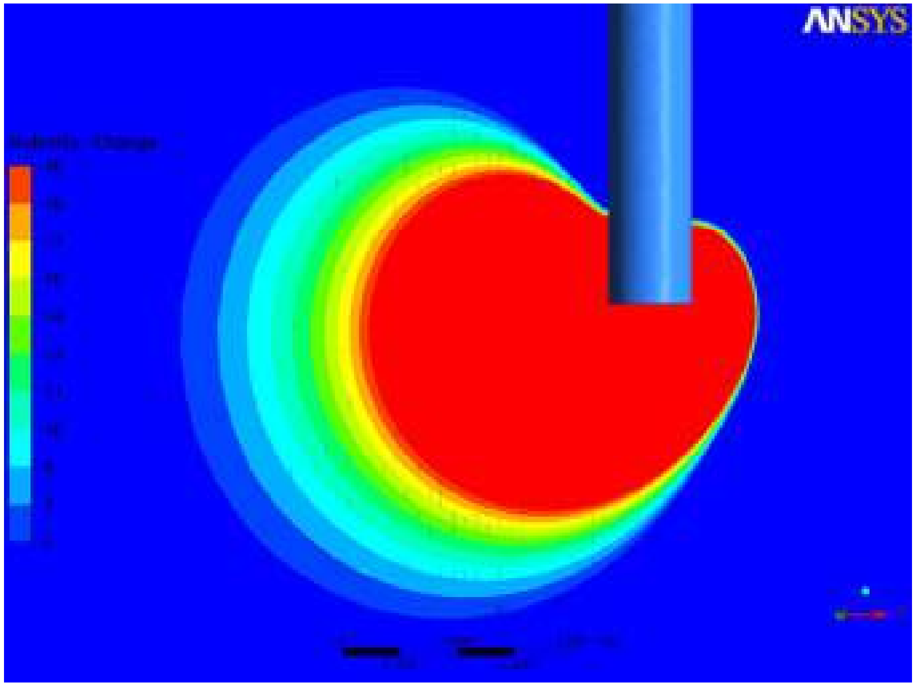


Figure 4.5: Temperature contour plots across the plume centreline, also depicting (thick black line) the limit of 3 degrees above ambient temperature. (Scenarios 13 to 16)

a) Near-stagnant current condition



b) Predominant current conditions

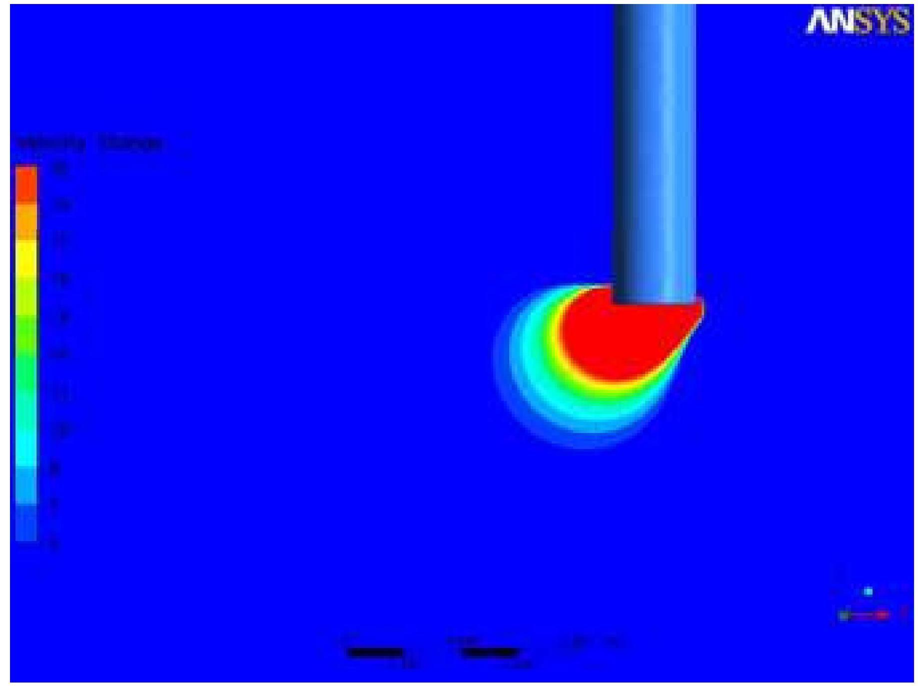
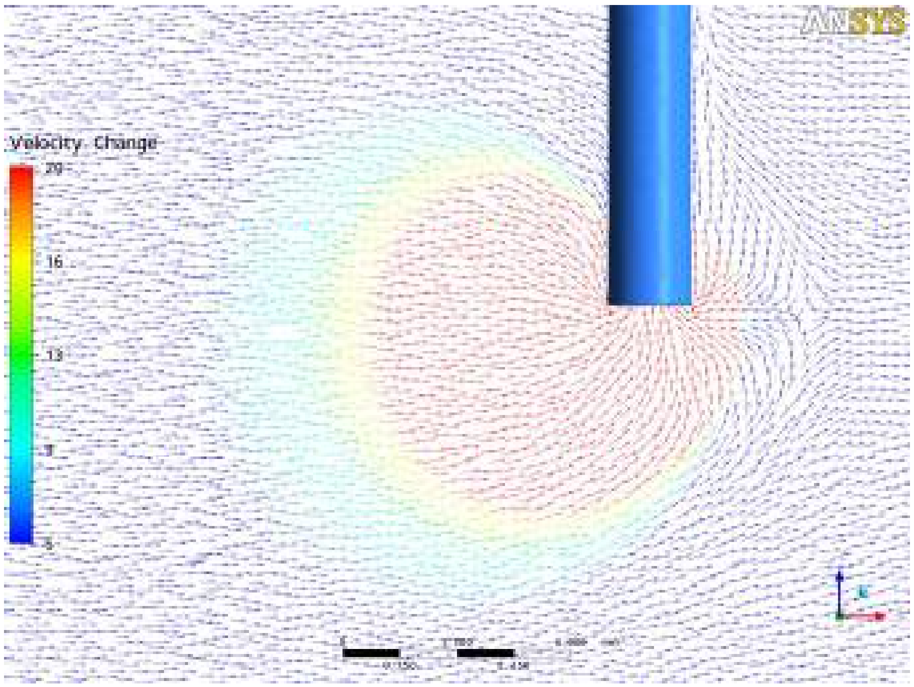


Figure 4.6: Contour plots of velocity change from current mean velocity (colour depicts velocity percentage change with respect to current condition)

a) Near-stagnant current condition



b) Predominant current condition

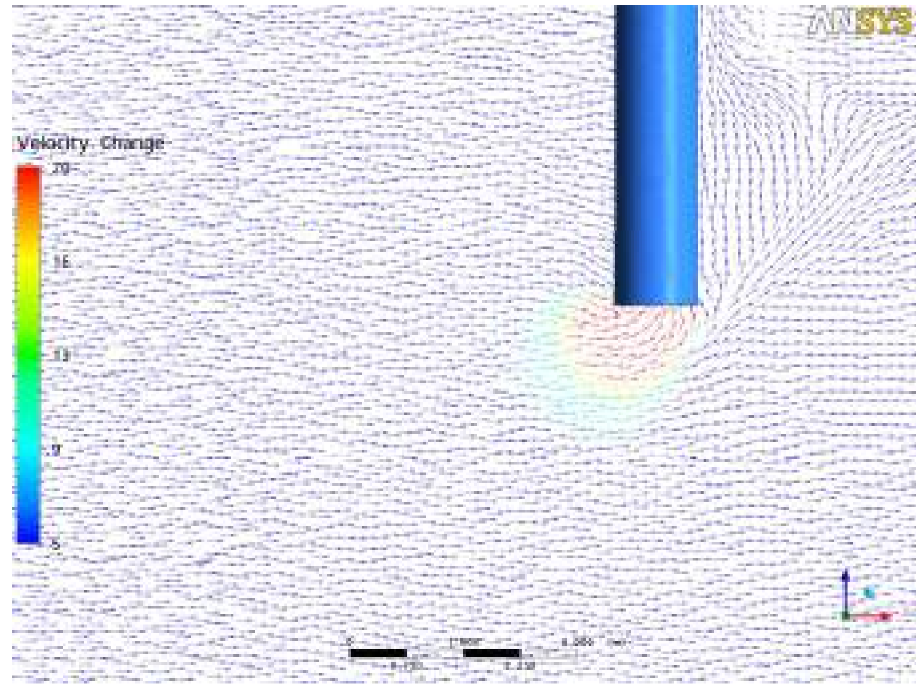
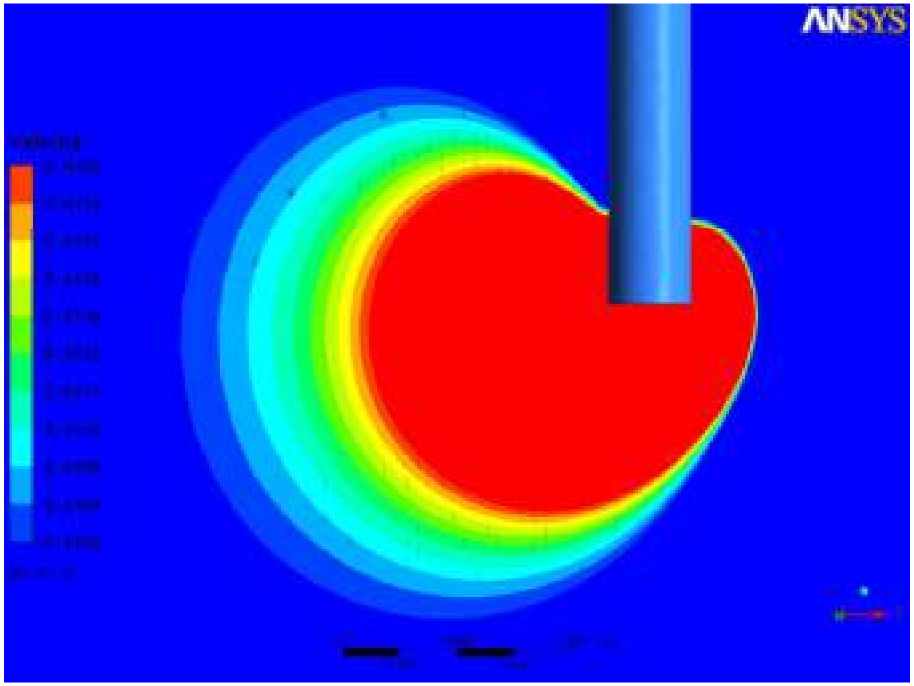


Figure 4.7: Velocity vector plots of the flow surrounding the intake pipe (colour depicts velocity percentage change with respect to current condition)

a) Near-stagnant current condition



b) Predominant current condition

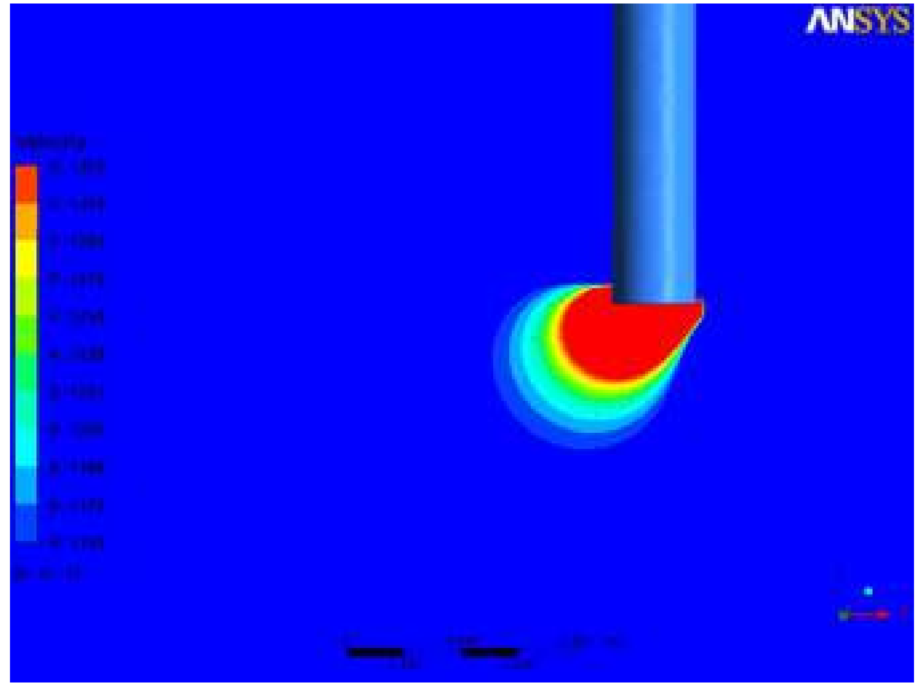


Figure 4.8: Velocity magnitude contour plots of the flow surrounding the intake pipe

APPENDIX A. CFD MODEL

A.1. Analysis Software

CFX is regarded as a market-leading product that has been thoroughly validated for dispersion problems relevant to the oil and gas industry both by the specialists BMT and by external specialists. Publically available verification studies for a number of different fluids dynamics problems such as movement of solids through liquids and bubble plume behaviour have been undertaken at the University of Melbourne in Australia and the Paul Scherrer Institute in Switzerland[2]. Additional case studies including verification studies are provided here:

http://www.ansys.com/industries/sys-testimonials.asp?ID=10

A.2. Methodology

A.2.1. General

Dispersion of cooling water was modelled using discharge parameters supplied by BP. The cooling water release was modelled explicitly as a 0.8m diameter pipe opening.

The risers and the legs of the platform were assumed not to represent a significant blockage to the flow, and hence they were not included in the model.

No topography (i.e. flat seabed) was included.

A.3. Fluid Properties

A.3.1. Seawater

Table A.1 presents the properties of seawater used in the analysis.

A.4. Computational Mesh

The computational mesh was generated in the domain bounded by the seabed and the sea surface. The computational domain extended sufficiently far away in each direction to avoid any boundary influence on the flow solution. The computational mesh used for the simulations comprised approximately 4 million tetrahedral cells. Additional mesh refinement was applied in the proximity regions of the release location.

A.5. Turbulence Model

[2] http://www.cfd.com.au/cfd_conf03/papers/123Hol.pdf; http://www.cfd.com.au/cfd_conf97/papers/smi002.pdf; Dispersion of neutrally buoyant solids falling vertically into stationary liquid and horizontal channel flow, K. M. Smith, M. R. Davidson and N. J. Lawson Computers & Fluids Volume 29, Issue 4, 1 May 2000, Pages 369-384; On the modelling of bubble plumes in a liquid pool, B. L. Smith, Applied Mathematical Modelling, Volume 22, Issue 10, October 1998, Pages 773-797

The Shear Stress Transport (SST) turbulence model was employed in the CFD simulations with standard coefficients.

The SST turbulence model is widely used for applications in the offshore industry and is generally suitable for the assessment of dispersion.

A.6. Heat Transfer Model

Heat transfer was modelled in the dispersion simulations. The ambient seawater temperature varied depending on the season condition. Summer and winter thermal conditions were obtained from [1].

A.7. Buoyancy

Buoyancy forces due to changes in fluid density were modelled in the analysis using the Boussinesq approximation.

A.8. Current Velocity Profile

The current velocity profile was simulated as uniform across the water column and consisted of two distinguished cases:

- Predominant current speed = 0.11m/s
- Near-stagnant current speed = 0.01m/s

A.9. Boundary Conditions

A.9.1. Upstream and Downstream Boundaries

Current properties and temperature profile for each scenario (see Section 4.2) were applied at the upstream domain boundary.

A.9.2. Seabed

A no-slip wall boundary condition (u, v, w = 0) was applied at the seabed.

A.9.3. Sea surface

A free-slip wall boundary condition (w = 0) was applied at the sea surface.

A.9.4. Side Surfaces

A free-slip wall boundary condition (v = 0) was applied at the surfaces on the sides.

Seawater	
Density (kg/m^3)	1,010
Dynamic viscosity (kg/(m.s))	See Figure A.1
Molecular weight (kg/kmole)	18.02
Specific Heat Capacity (J/(kg.K))	4,181.7
Thermal Conductivity (W/(m.K))	0.6069
Thermal Expansivity (K^{-1})	0.000257

Table A.1 – Properties of seawater

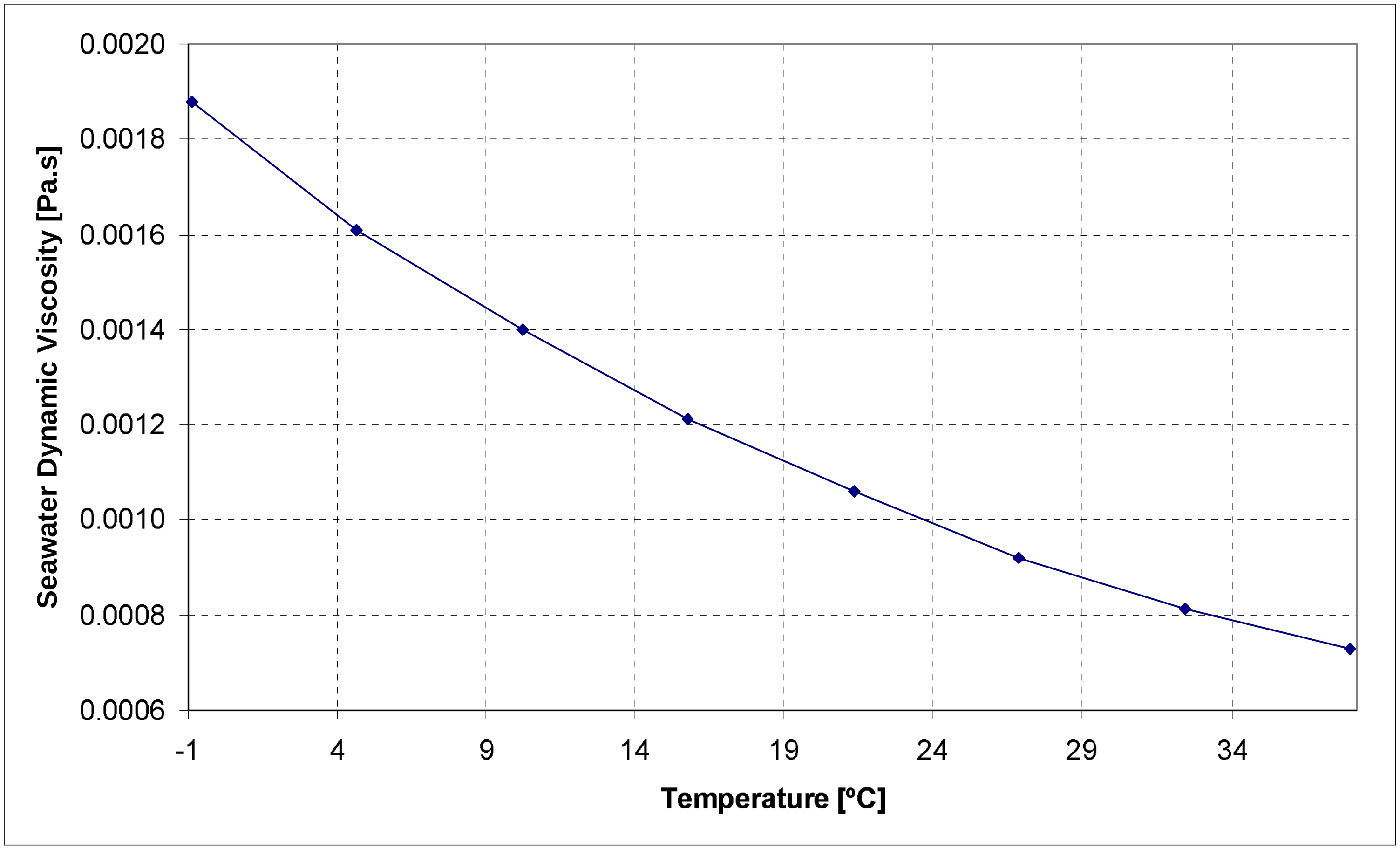


Figure A.1: Seawater viscosity variation with temperature

APPENDIX 13A

Routine and Non Routine Discharge Parameters

Over the lifetime of the project, a number of routine and non routine discharges may take place. Table 1 presents details of the routine and non routine discharges expected for the COP during the predrill and operational phases.

Table 1 Routine and Non Routine Discharge Parameters

Discharge	Routine/ Non Routine* Discharge	Duration of each discharge event	Approximate volume of discharge per event	Approximate Rate of Discharge	Discharge Caisson	Depth of Discharge (m below sea level)	Discharge composition	Frequency and likelihood of discharge	Fate of discharge	Potential for Cumulative Impact
MODU Discharge										
Seawater, Viscous Sweeps & Cuttings	Routine	30 hours	Per well: - 20 tonnes bentonite - 230 tonnes cuttings	8.33 tonnes/hr	N/A	Seabed	Bentonite and cuttings	Each of the 20 predrill wells will take approximately 40 days to drill and 40 days to complete. Discharge events will be separated by intervals of at least 4-5 weeks.	Seabed	No - Cement, excess cement, and coarse cuttings will be deposited primarily within the footprint of the template, where accumulations will be sufficient to completely exclude benthic organisms. Finer cuttings and barite may be transported up to 500m from the template, but routine monitoring of existing platforms demonstrates that this has minimal impact and that there is no cumulative effect over time.
WBM & Cuttings	Routine	30 hours	Per well: - 340 tonnes mud (comprising 135 tonnes of barite) - 155 tonnes cuttings	16.5 tonnes/hr	MODU Cutting Caisson	11	WBM and cuttings		Seabed	
Cement	Routine	1 hour per section - 3 hours in total	Per well: - 25 tonnes (12 tonnes Class G cement, 8 tonnes barite & remainder chemicals)	8.33 tonnes/hr	At seabed	169 (seabed)	Class G cement, barite & chemicals	3 discharge events per well for each of the 20 platform predrill wells	Seabed	
Excess WBM	Non Routine	4 hours	18 tonnes of mud per well	4.5 tonnes/hr	MODU Cutting Caisson	11	WBM	Excess WBM from the MODU mud system may be discharged at end of top hole section drilling if it is not practicable to recover for technical or safety reasons.	Seabed	
Excess cement	Non Routine	1 hour	0.7 tonnes per well	0.7 tonnes/hr	MODU Cutting Caisson	11	Class G cement, barite, chemicals and seawater	Discharge will only occur if excess cement cannot be recovered at the end of casing cementing. Only cement mixed with water will be discharged.	Seabed	
Cooling Water	Routine	N/A	N/A	$575m^3$/hr	N/A	Surface	Seawater(4-5 ^{0}C higher than intake temperature) with trace amounts of copper and chlorine, both of which will react with organic material during the antifouling process and which will be present in the discharge at concentrations below the level of environmental concern	Continuous discharge during predrill	Water column/ surface	No - Discharged at surface, will not interact with MODU cuttings discharge and will be diluted and cooled within a short distance of discharge. No persistent effect
WC-PDQ Discharges										
WBM & Cuttings	Routine	30 hours	Per well: - 340 tonnes mud (comprising 135 tonnes of barite) - 155 tonnes cuttings	16.5 tonnes/hr	Cutting Caisson (C5)	136	WBM and cuttings	Each of the 26 platform wells will take approximately 40 days to drill and 40 days to complete. Discharge events will be separated by intervals of more than 10 weeks.	Seabed	No - As with the pre-drilled wells, cement and excess cement would be restricted to within the footprint of the template. The impact of pre-drill operations would, as indicated above, exclude benthic organisms from within the footprint, so any further accumulation of cement and cuttings could have no further impact. It is not expected that the benthos immediately under the template would have any potential for recovery over the lifetime of the platform, but the area thus affected is very small
Cement	Routine	1 hour per section - 3 hours in total	Per well: - 25 tonnes (12 tonnes Class G cement, 8 tonnes barite & remainder chemicals)	8.33 tonnes/hr	At seabed	169 (seabed)	Class G cement, barite & chemicals	3 discharge events per well for each of the 26 platform drilled wells	Seabed	
Excess WBM	Non Routine	4 hours	18 tonnes of mud per well	4.5 tonnes/hr	Cutting Caisson (C5)	136	WBM	Excess WBM from the platform mud system may be discharged at end of top hole section drilling if it is not practicable to recover for technical or safety reasons.	Water column	
Excess cement	Non Routine	1 hour	0.7 tonnes per well	0.7 tonnes/hr	Cutting Caisson (C5)	136	Class G cement, barite, chemicals and seawater	Discharge will only occur if excess cement cannot be recovered at the end of casing cementing. Only cement mixed with water will be discharged.	Water column	
Produced Water	Non Routine	Between 12 and 72 hours as a worst case	N/A	400 -$500m^3$/hr	Produced Water Caisson (C9)	46	Separated water contains typical levels of aliphatic and aromatic hydrocarbons, but higher levels of more soluble organic and volatile fatty acids. Toxicity tests indicate that ACG produced water samples are not of high toxicity, and that the treated discharge will be rapidly diluted to concentrations sufficiently low to cause no long-term effects	Discharge will only occur • If the volume of produced water exceeds that required for reservoir pressure maintenance; or • Due to a downtime event such as an emergency, accident or mechanical failure.	Water column	**Yes - Potential for cumulative impact associated with concurrent discharge**
Pigging of IW pipeline	Routine	2 hours	$950m^3$	475 m^3/hr	Produced Water Caisson (C9)	46	DWG produced water and/or seawater	The injection water pipeline will be pigged once a week from the DWG-PCWU platform using produced water/seawater from the DWG-PCWU platform	Water column	
Cooling Water	Routine	N/A	N/A	3,$000m^3$/hr	Seawater Discharge Caisson (C8)	45	Seawater with trace amounts of copper and chlorine, both of which will react with organic material during the antifouling process and which will be present in the discharge at concentrations below the level of environmental concern	Continuous operational discharge	Water column	

APPENDIX 13B

OSIS Study for COP

A part of BMT in Energy and Environment

OSIS Study for COP (Caspian Sea)

Reference: L40030.1
Date: 15 January 2010

Prepared for:
Azerbaijan International Operating Company

Document status sheet

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Issue	: 1.0
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Approved by : M. Rymell (BMT ARGOSS)

Distribution : A. Lewis

Contents

1. Introduction

Azerbaijan International Operating Company (AIOC) has commissioned BMT Argoss Limited (BMT) to conduct a modelling study on the expected fate of a release of oil from a blowout, a separator failure and a diesel tank located at the COP platform in the Caspian Sea. BMT's Oil Spill Information System (OSIS) was used to model 20 deterministic spill scenarios to assess potential beaching events and oil weathering.

OSIS is a particle-tracking model that can simulate the fate and dispersion of surface oil slicks. OSIS can be used to run individual deterministic model scenarios providing results of the trajectory of the slick, together with the evaporated, dispersed, beached and slick volumes.

The results of the oil spill modelling study are presented in this report.

2. Modelling

Modelling of the oil dispersion was conducted using BMT Cordah's OSIS system. OSIS has been jointly developed by BMT Cordah and AEA Technology plc. An overview of OSIS is given in the following section. More detailed background documentation can be found in Appendix A.

2.1. The OSIS Model

OSIS is a particle-tracking model that can simulate the fate and dispersion of surface oil slicks. It represents an oil slick as a collection of free moving particles which simulate the spreading slick. Simultaneously, weathering algorithms determine the changes in physical properties of the slick as it spreads.

The transport model takes into account the three dimensional transport processes acting on the oil due to the current, wind, waves, diffusion and buoyancy. As these effects can be parameterised in terms of environmental conditions, predictions can be made allowing for a wide variety of weather conditions.

The hydrocarbon properties model uses algorithms to calculate the changes in the hydrocarbon properties due to evaporation, emulsification and natural dispersion. As a result, physical properties such as density, viscosity and flash point changes are also predicted. The OSIS model and its algorithms are fully explained in Walker (1995), which is included in full in Appendix A.

OSIS supports several model types, but they can be generally characterised as being either deterministic or stochastic:

- Deterministic models simulate a point source spill scenario under a single set of metocean conditions. The final results from this type of model are presented on a map indicating the trajectory of the oil, the area of the slick, and beaching location of the spill after a specified period. An approximation of the area over which oil sheening will occur is also shown. In addition, graphs of the variation of spilled oil properties with time are presented (these include the variation in volumes of slick, evaporated, dispersed and beached oil).
- Stochastic models allow the simulation of a point source spill under a specified number of different probable metocean conditions, defined as wind speed and direction percentage frequencies as either a wind rose or a time series. This module provides results as contour plots showing the probabilities of surface oiling and a map of beaching locations. No volume outputs are available from the stochastic module.

2.2. Model scenarios

Spill scenarios were provided by BP and are shown in Table 1. In total 20 deterministic runs were conducted across three scenarios:

- Scenario 1A. COP Blowout.
- Scenario 1B. Separator failure.
- Scenario 1C. Diesel spill.

2.2.1. Oil type

In order to consider weathering of oil within its model, OSIS contains a database of physical and chemical information for over 120 oil types. These have been characterised by AEA Technology's laboratories specifically for use in OSIS. Hydrocarbon releases of Chirag Blend Caspian Sea and DWG Caspian were modelled in this study.

2.2.2. Meteorological Data

The meteorological data used within the model was supplied by AIOC for each model run.

2.2.3. Hydrodynamic Data

BMT obtained and processed residual surface currents for the Caspian Sea region from the U.S. Naval Research Laboratory HYCOM Caspian Sea Model. This model operates with a 1/25 degree resolution and provides monthly mean surface velocities.

As standard, the model assumes a uniform (horizontal) bathymetry, which is generally suitable for surface spill scenarios.

3. RESULTS AND DISCUSSION

3.1. Deterministic modelling

In the deterministic scenarios constant meteorological conditions have been applied throughout the model run.

3.1.1. COP Blowout Scenario

Figures 1 - 24 show the spill trajectory and beaching locations, along with variations of oil in different phases, for the 12 deterministic model runs in the blowout scenario.

Table 4 shows the volume of beached oil at the final time for a 24 hour release, along with the expected final time and beached volume for a 42 day release.

The maximum beached volume predicted for a 1 day release occurred in Run 2 ($5615.28m^3$), indicating that after a 42 day release a volume of approximately $236000m^3$ could be expected to come onshore.

Run 11 exhibited the shortest time to beaching after a 24 hour release at 34 hours.

Two runs (7 and 10) exhibited no beaching.

3.1.2. Separator failure of $81m^3$ crude oil

Figures 25 – 33 show the spill trajectory and beaching locations, along with variations of oil in different phases, for the 4 deterministic model runs in the separator failure scenario.

Table 5 shows the volume of beached oil at the final time for an instantaneous release of crude oil. Run 1 exhibited the maximum beached volume ($132.81m^3$). Run’s 2 and 3 jointly demonstrated the shortest time to beaching (33 hours).

3.1.3. Diesel spill

Figures 33 – 40 show the spill trajectory variations of oil in different phases, for the 4 deterministic model runs in the diesel spill scenario.

No scenarios exhibited beaching. The diesel evaporated within 11 hours in all cases.

Tables and Figures

Run No.	Location (Lat/Long WGS84 datum)	Start Date/ Time	Oil Type	Sea Temp (°C)	Air Temp (°C)	Wind		Spill Characteristics	
						Speed (m/s)	Direction (°)	Release Rate (m^3/hr)	Release Duration (hrs)
1	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	5	45	132.5	24 (*42)
2	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	5	110	132.5	24 (*42)
3	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	5	270	132.5	24 (*42)
4	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	10	45	132.5	24 (*42)
5	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	10	110	132.5	24 (*42)
6	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	10	270	132.5	24 (*42)
7	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	5	45	132.5	24 (*42)
8	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	5	110	132.5	24 (*42)
9	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	5	270	132.5	24 (*42)
10	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	10	45	132.5	24 (*42)
11	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	10	110	132.5	24 (*42)
12	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	10	270	132.5	24 (*42)

Table 1 Run descriptions for Scenario 1A COP blowout

Run No.	Location (Lat/Long WGS84 datum)	Start Date/ Time	Oil Type	Sea Temp (°C)	Air Temp (°C)	Wind		Spill Characteristics	
						Speed (m/s)	Direction (°)	Release Rate (m^3/hr)	Release Duration (hrs)
1	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	5	110	81	Instantaneous
2	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	10	110	81	Instantaneous
3	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	5	110	81	Instantaneous
4	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	10	110	81	Instantaneous

Table 2 Run descriptions for Scenario 1B separator failure crude oil

1C. 180m^3 diesel spill

Run No.	Location (Lat/Long WGS84 datum)	Start Date/ Time	Oil Type	Sea Temp (°C)	Air Temp (°C)	Wind		Spill Characteristics	
						Speed (m/s)	Direction (°)	Release Rate (m^3/hr)	Release Duration (hrs)
1	40° 11' 15.59"N 51°10' 4.75"E	1/02/2010 00:00	Diesel	6	6	5	110	180	Instantaneous
2	40° 11' 15.59"N 51°10' 4.75"E	1/02/2010 00:00	Diesel	6	6	10	110	180	Instantaneous
3	40° 11' 15.59"N 51°10' 4.75"E	1/08/2010 00:00	Diesel	27	27	5	110	180	Instantaneous
4	40° 11' 15.59"N 51°10' 4.75"E	1/08/2010 00:00	Diesel	27	27	10	110	180	Instantaneous

Table 3 Run description for Scenario 1C diesel spill

Run No.	Final Time (hours)	Beached Volume	Expected final time for 42 blowout	Expected Beached Volume after 42 day blowout
1	523	154.7	1531	6497.4
2	75	5615.28	1083	235841.8
3	305	1594.25	1313	66958.5
4	211	698.35	1219	29330.7
5	70	4374.94	1078	183747.5
6	114	2702.52	1122	113505.8
7	350	0	1358	0
8	74	4952.45	1082	208002.9
9	302	407.77	1310	17126.34
10	178	0	1186	0
11	69	3986	1077	167412
12	115	2102.67	1123	88312.14

Table 4 Beaching volume results for Scenario 1A COP blowout after a 24 hour model run and expected volumes for a 42 day blowout

Run No.	Final Time (hours)	Beached Volume
1	53	132.81
2	49	96.35
3	53	114.78
4	49	82.33

Table 5 Beaching volume results for Scenario 1B separator failure crude oil

Run No.	Final Time (hours)	Beached Volume
1	11	0
2	8	0
3	10	0
4	7	0

Table 6 Beaching volume results for Scenario 1C diesel spill

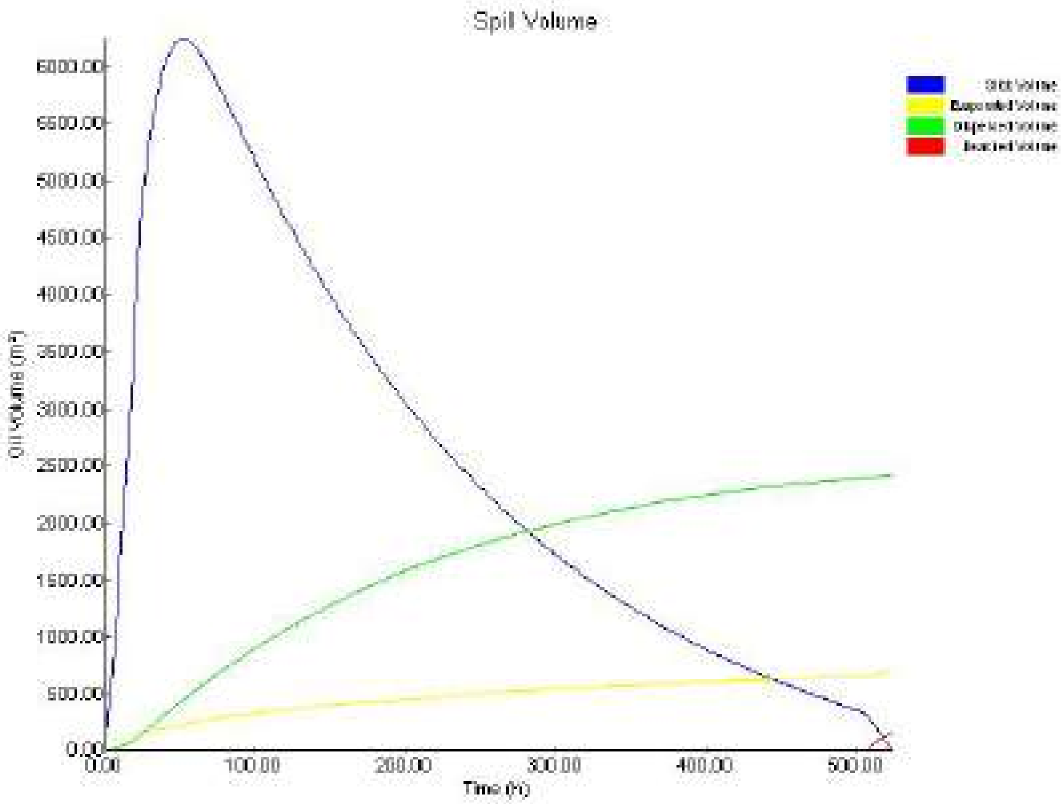

Figure 1 The volumes of oil in different phases over time for Scenario 1A.1.

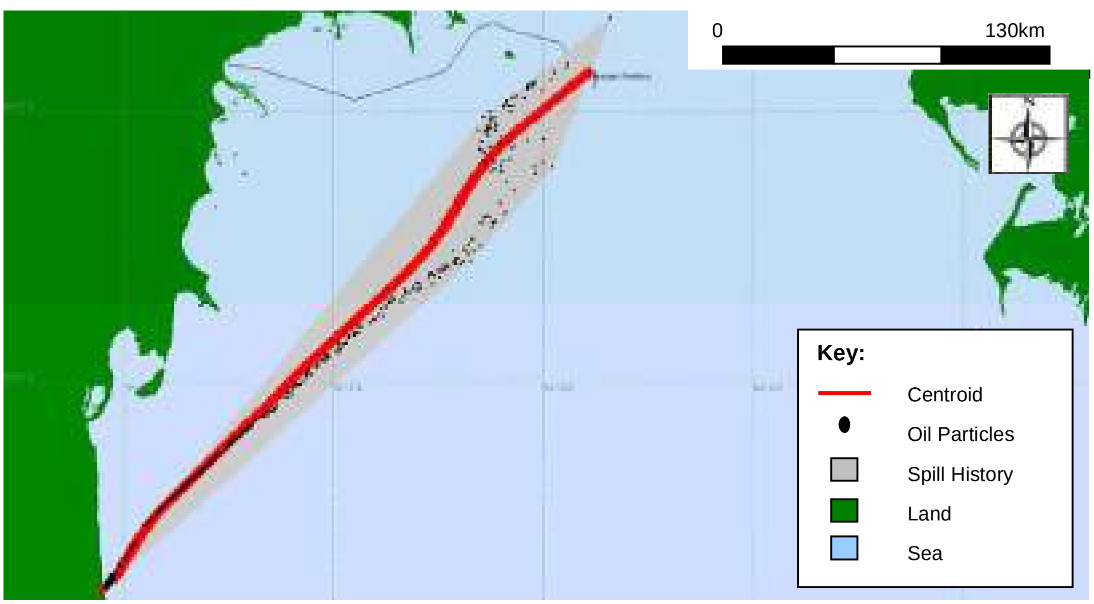

Figure 2 Spill history for Scenario 1A.1 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

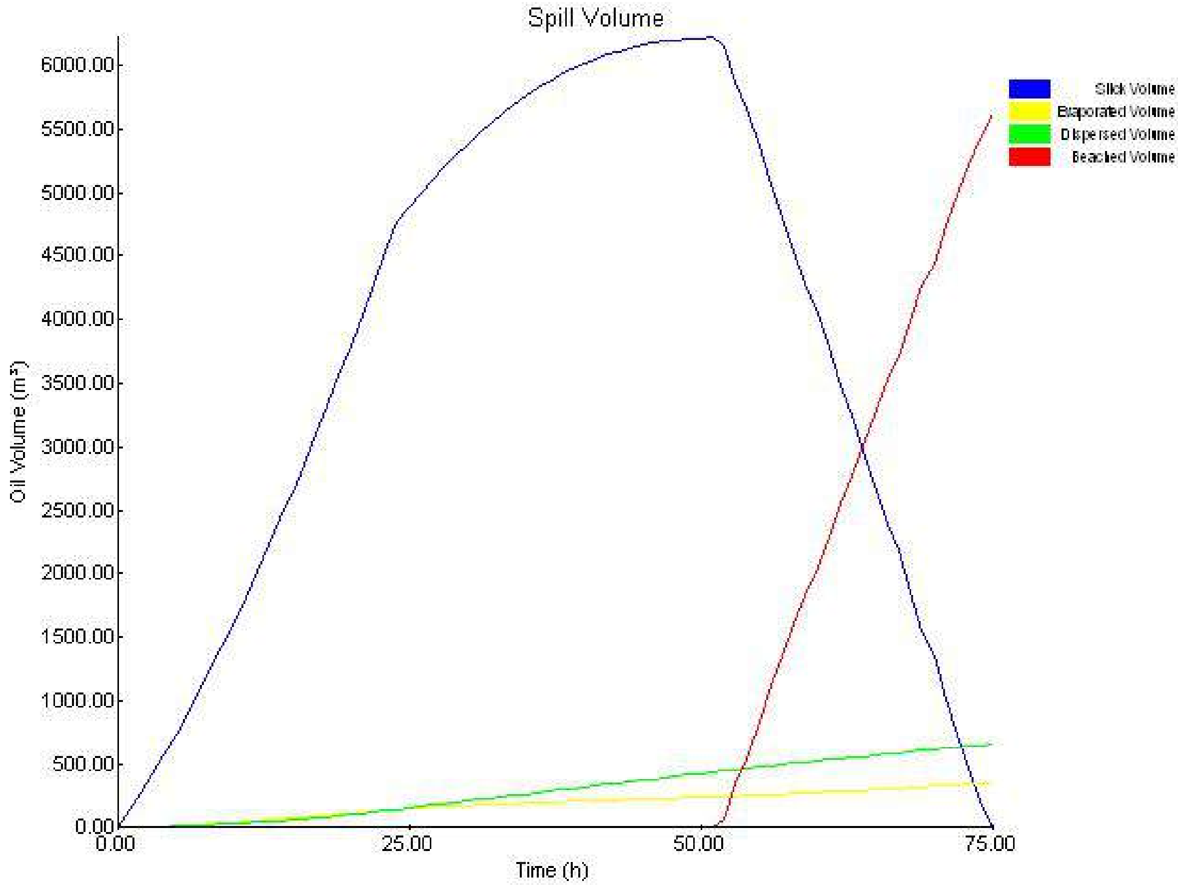

Figure 3 The volumes of oil in different phases over time for Scenario 1A.2.

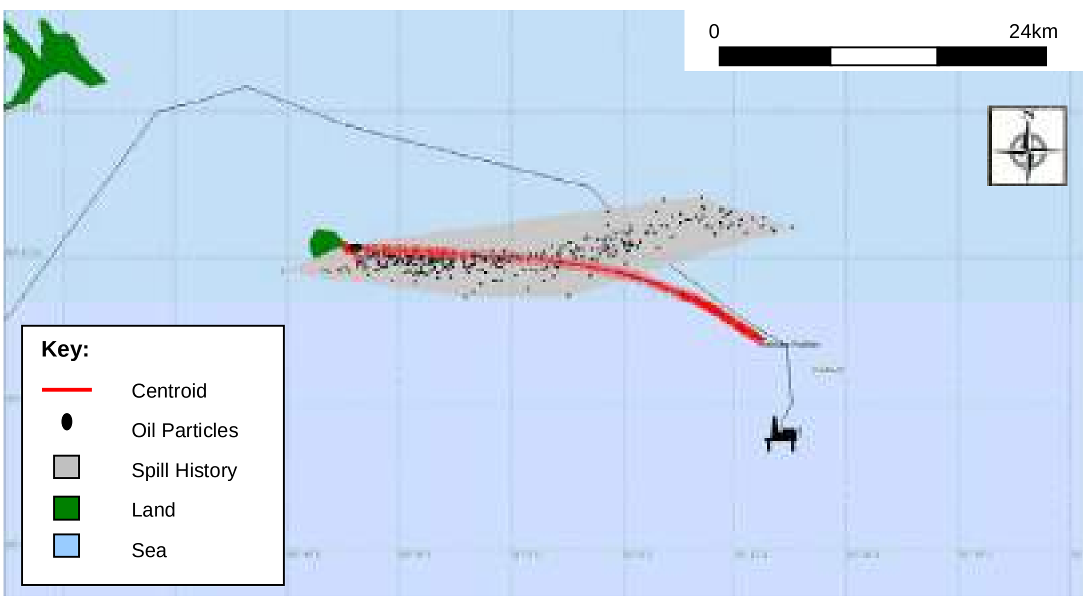

Figure 4 Spill history for Scenario 1A.2 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

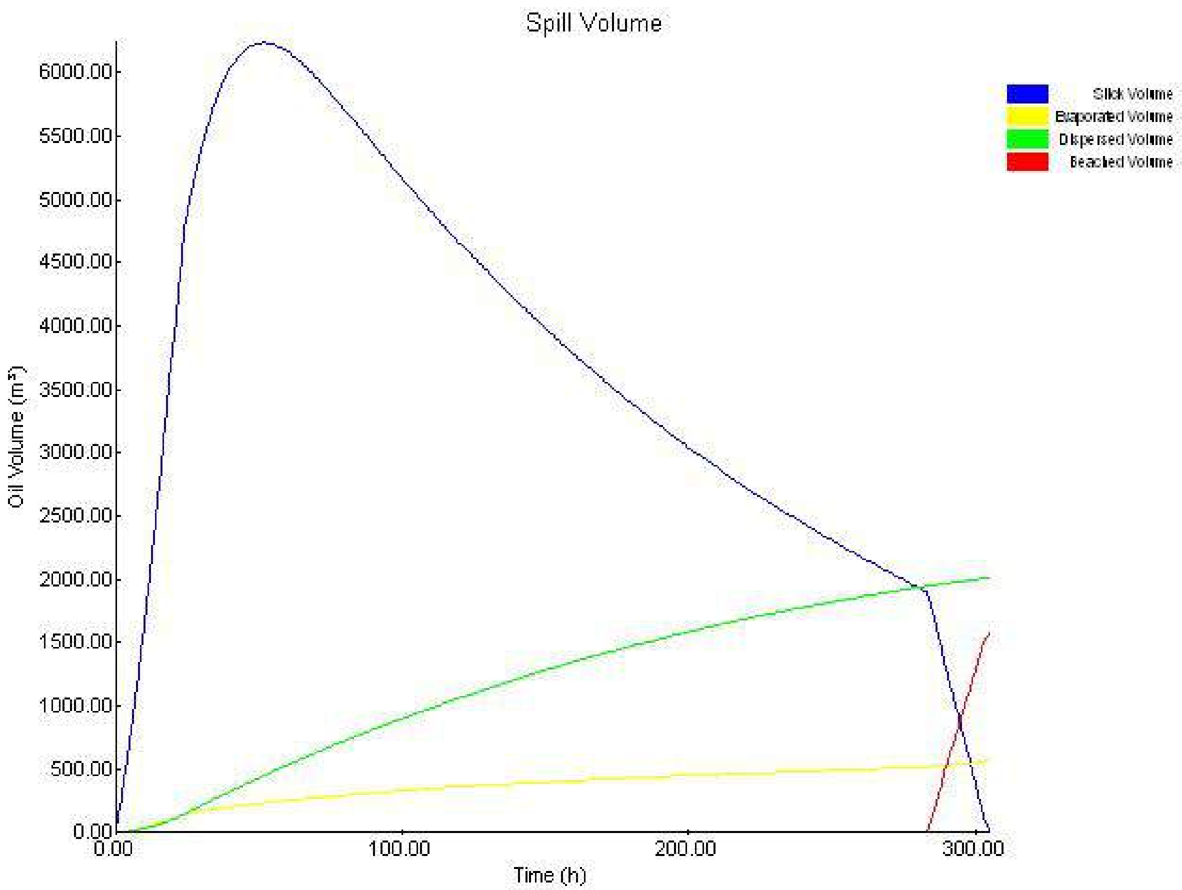

Figure 5 The volumes of oil in different phases over time for Scenario 1A.3.

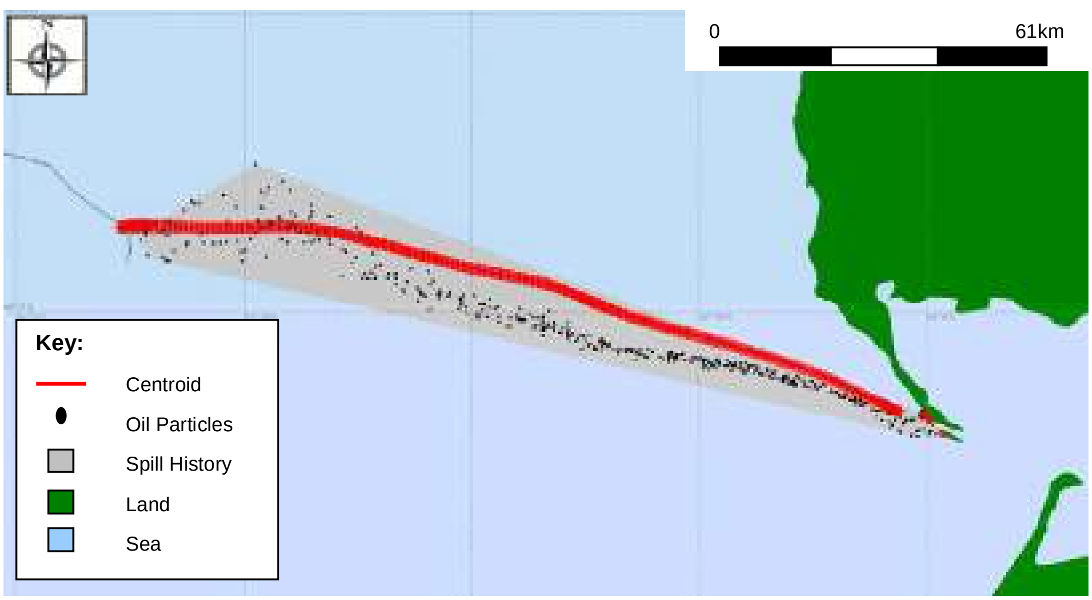

Figure 6 Spill history for Scenario 1A.3 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

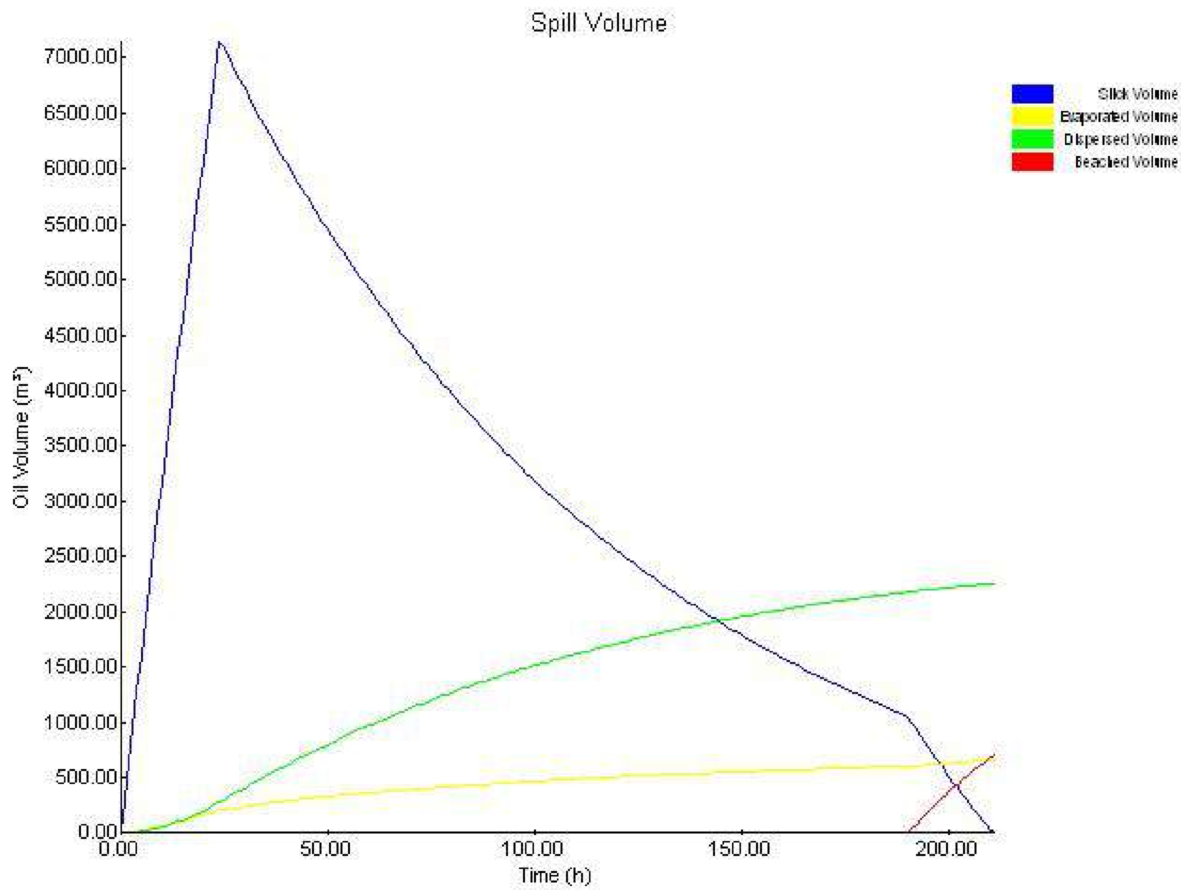

Figure 7 The volumes of oil in different phases over time for Scenario 1A.4.

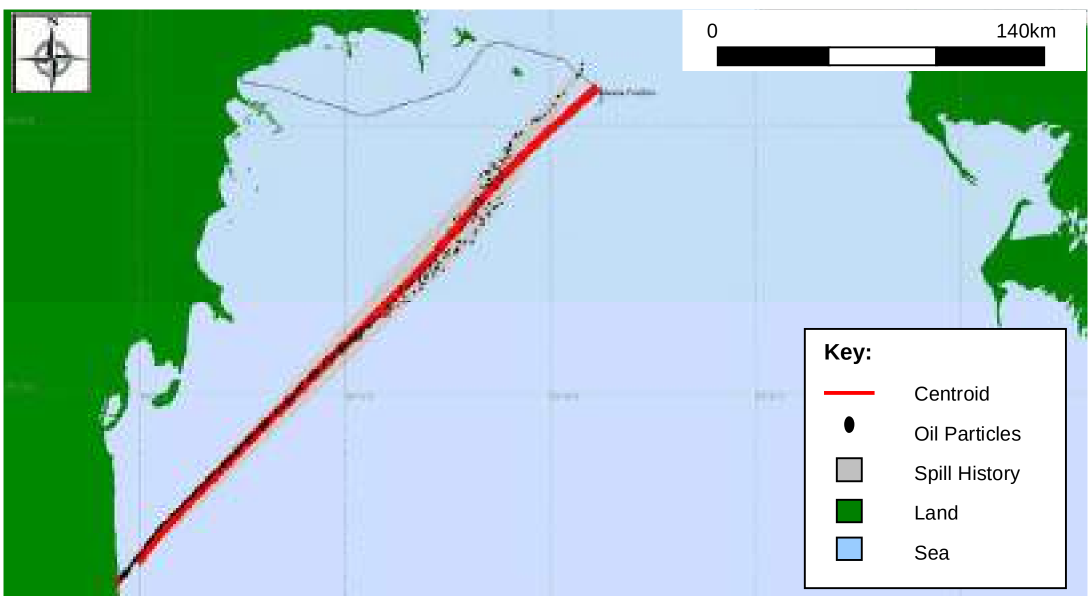

Figure 8 Spill history for Scenario 1A.4 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

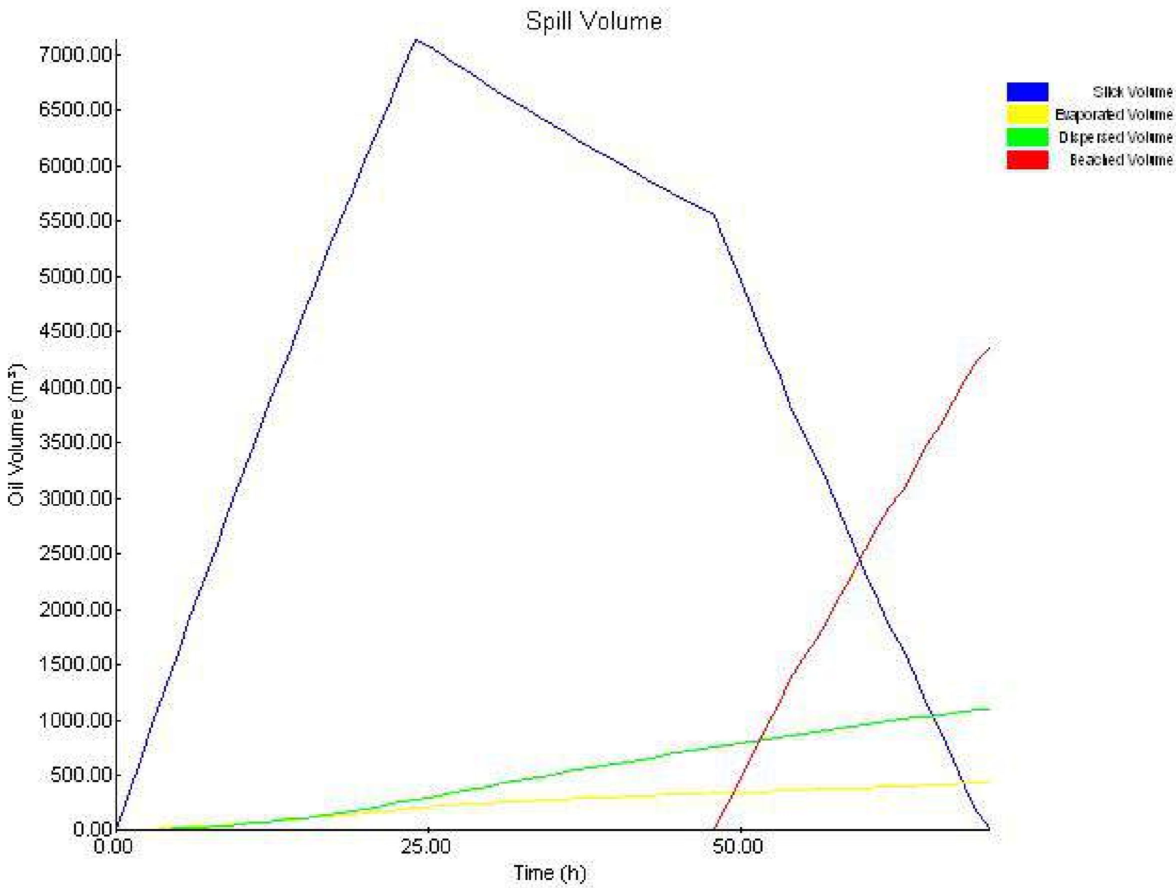

Figure 9 The volumes of oil in different phases over time for Scenario 1A.5.

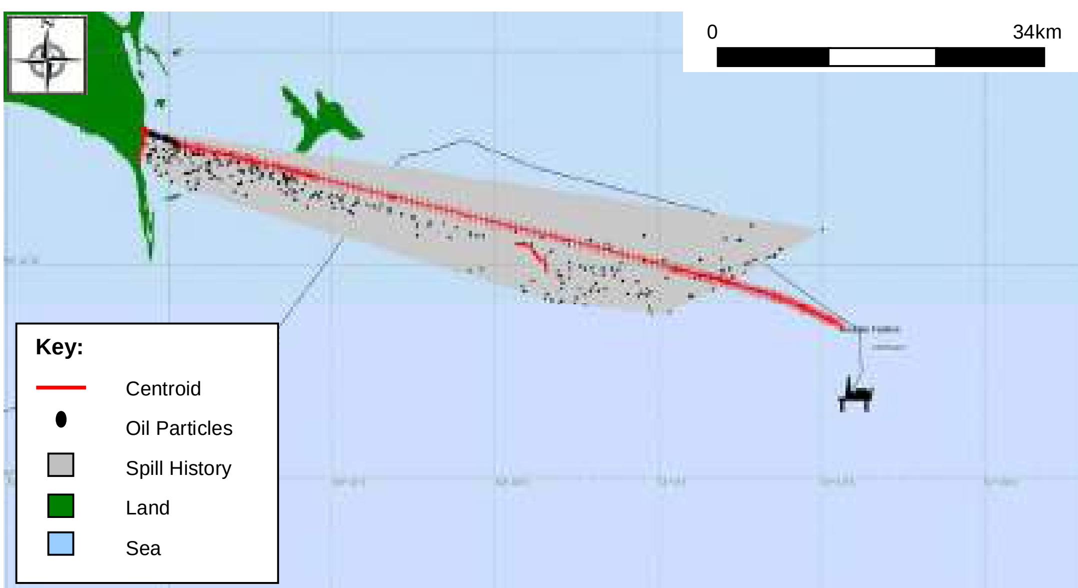

Figure 10 Spill history for Scenario 1A.5 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

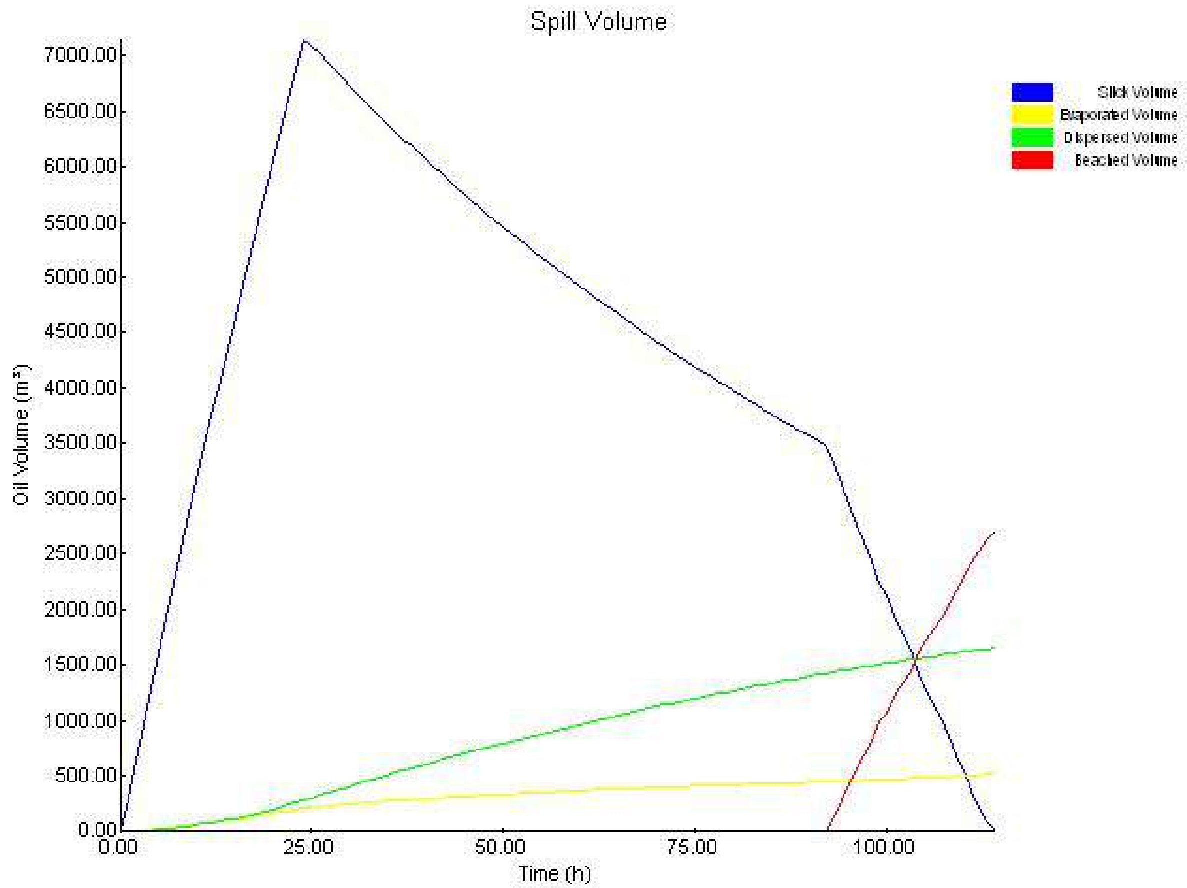

Figure 11 The volumes of oil in different phases over time for Scenario 1A.6.

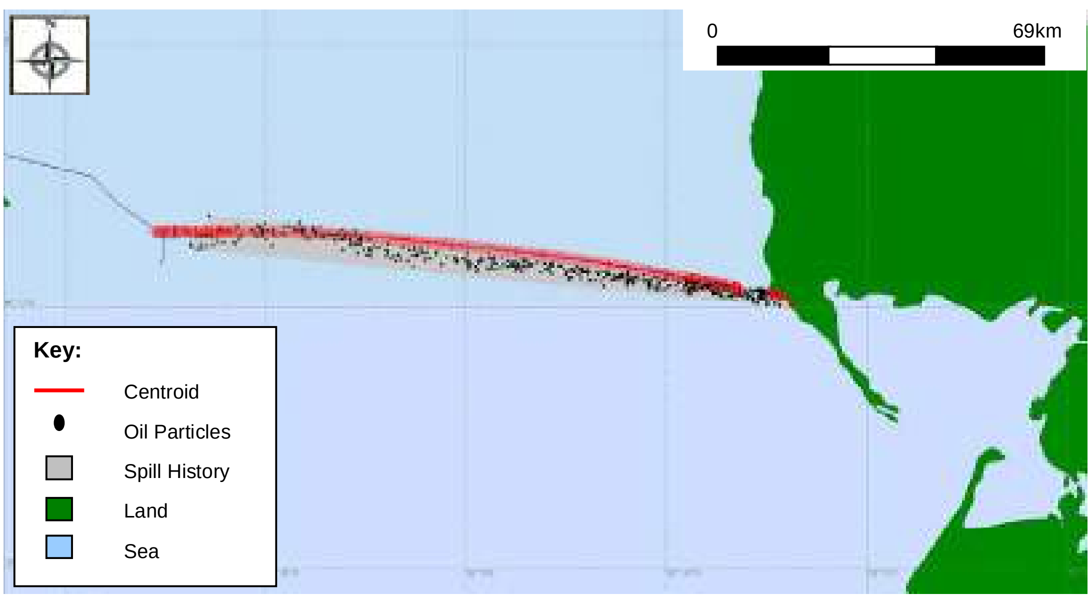

Figure 12 Spill history for Scenario 1A.6 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

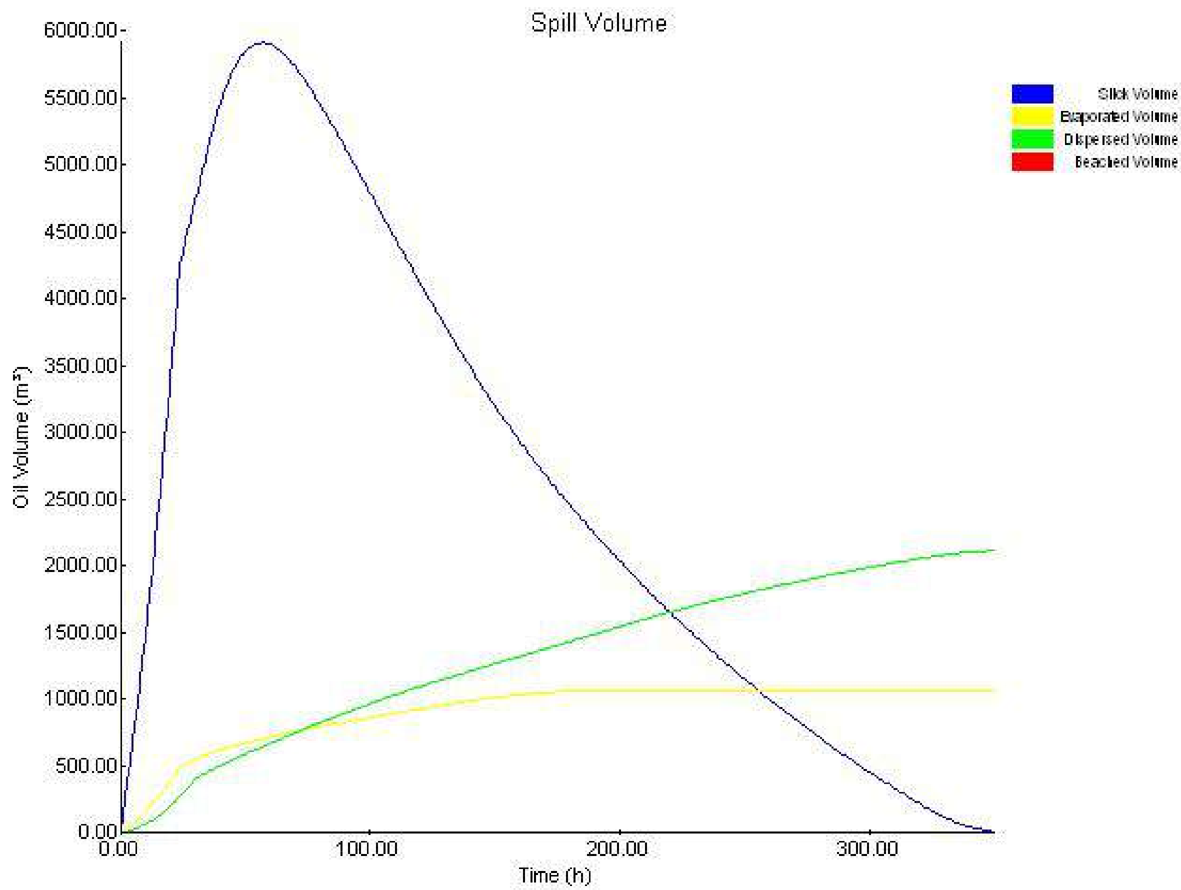

Figure 13 The volumes of oil in different phases over time for Scenario 1A.7.

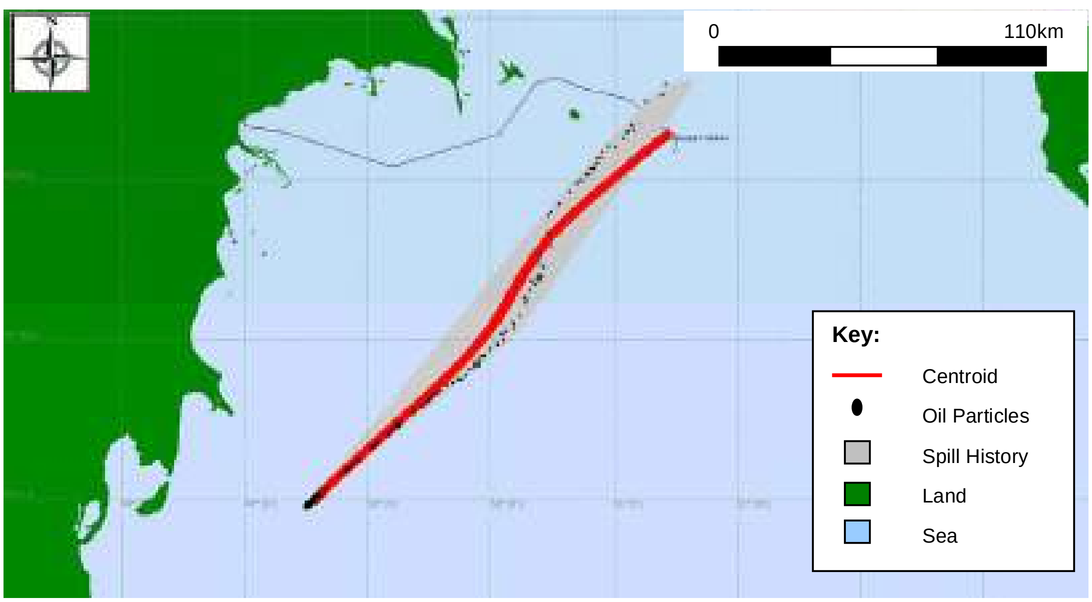

Figure 14 Spill history for Scenario 1A.7 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

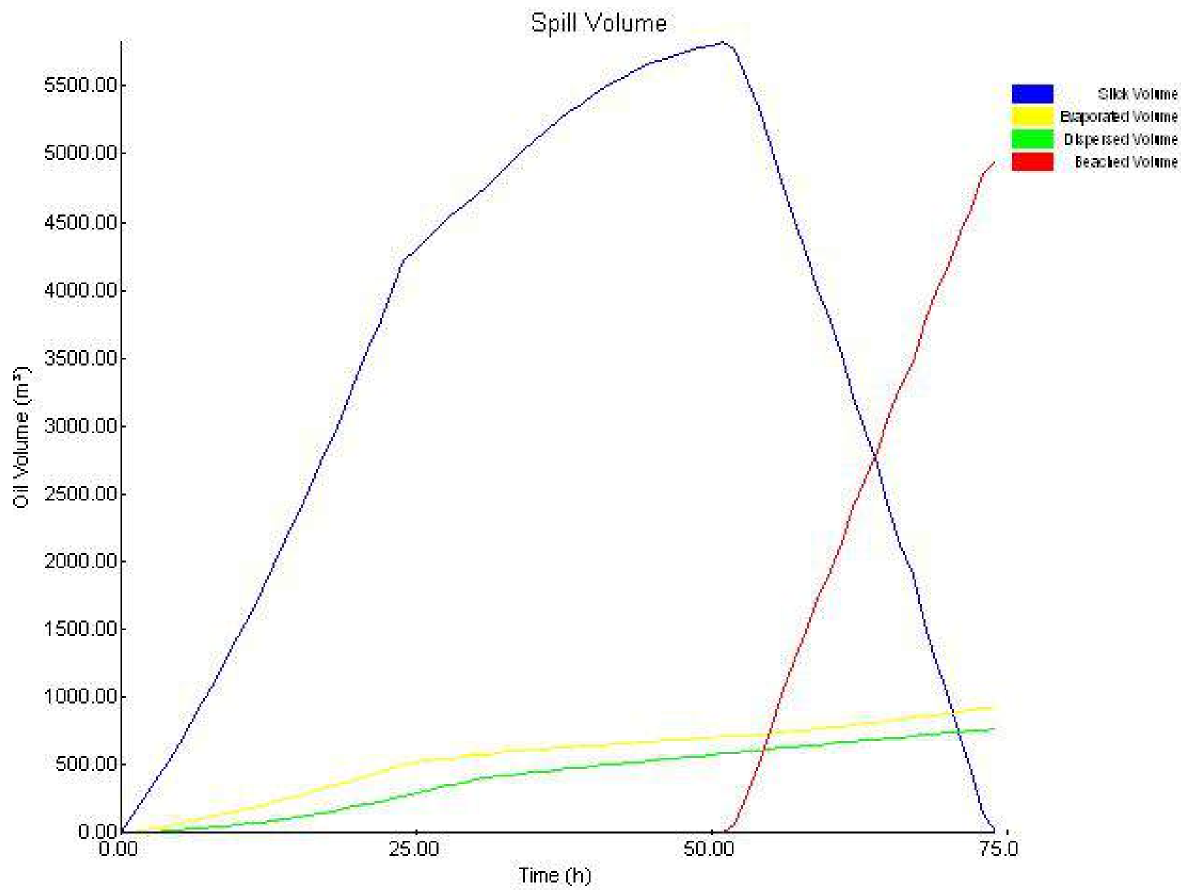

Figure 15 The volumes of oil in different phases over time for Scenario 1A.8.

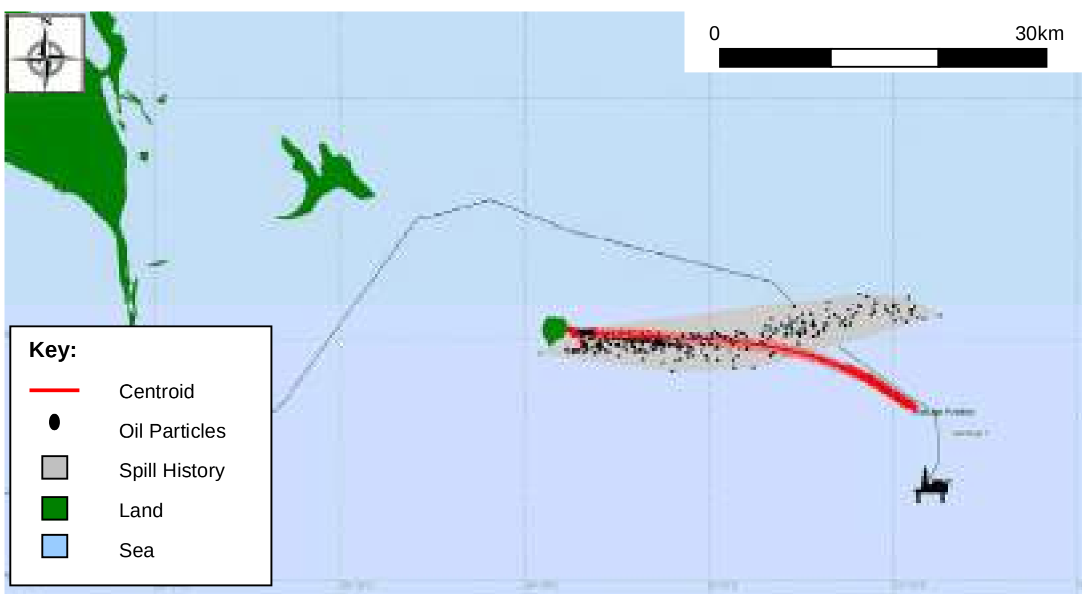

Figure 16 Spill history for Scenario 1A.8 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

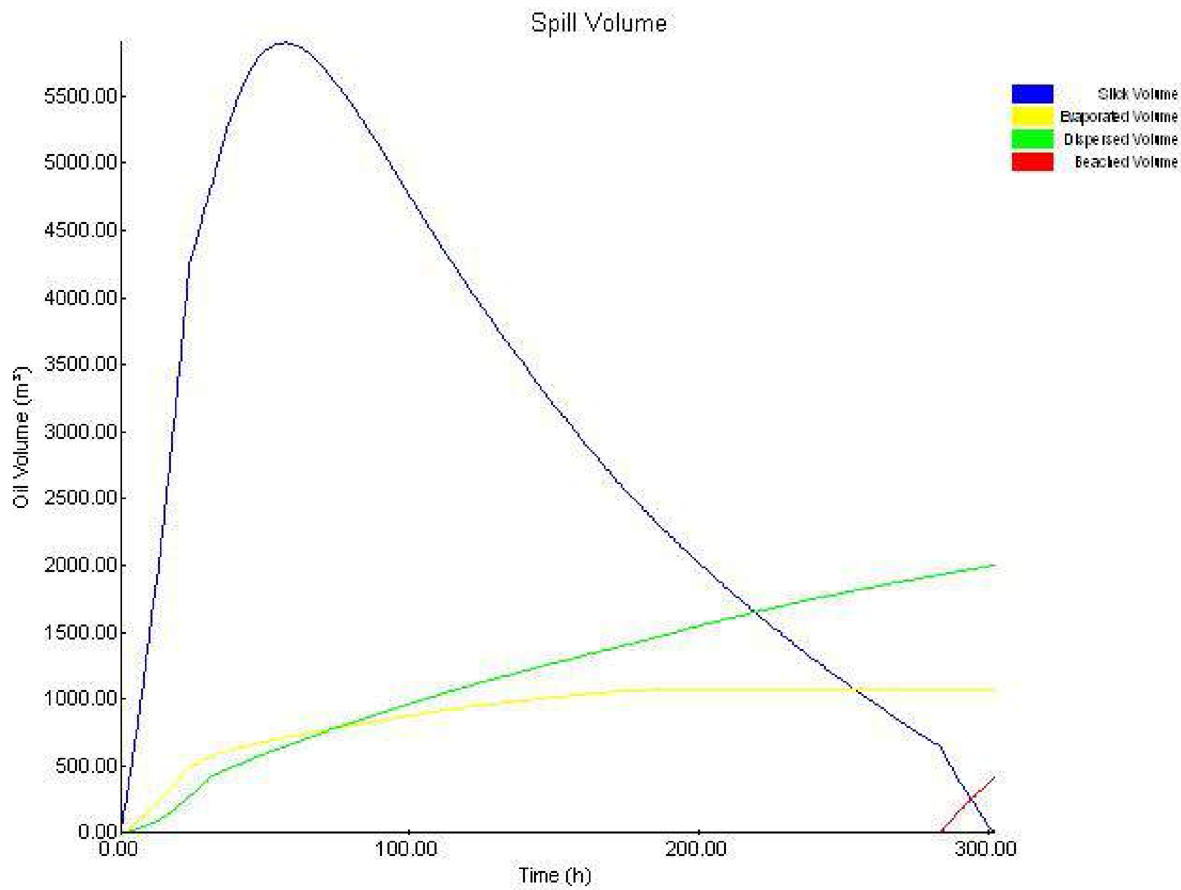

Figure 17 The volumes of oil in different phases over time for Scenario 1A.9.

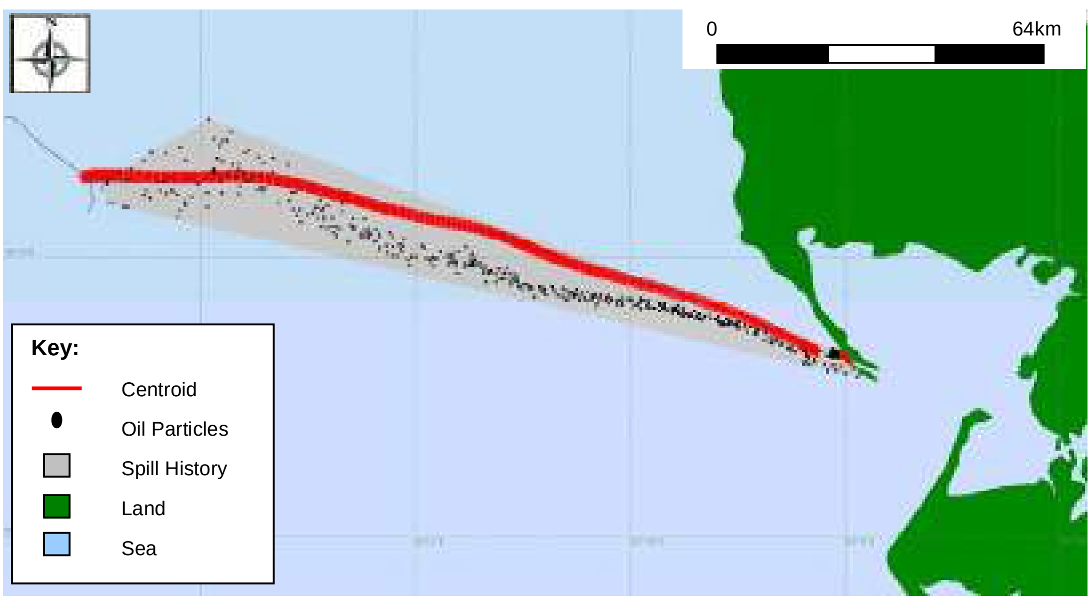

Figure 18 Spill history for Scenario 1A.9 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

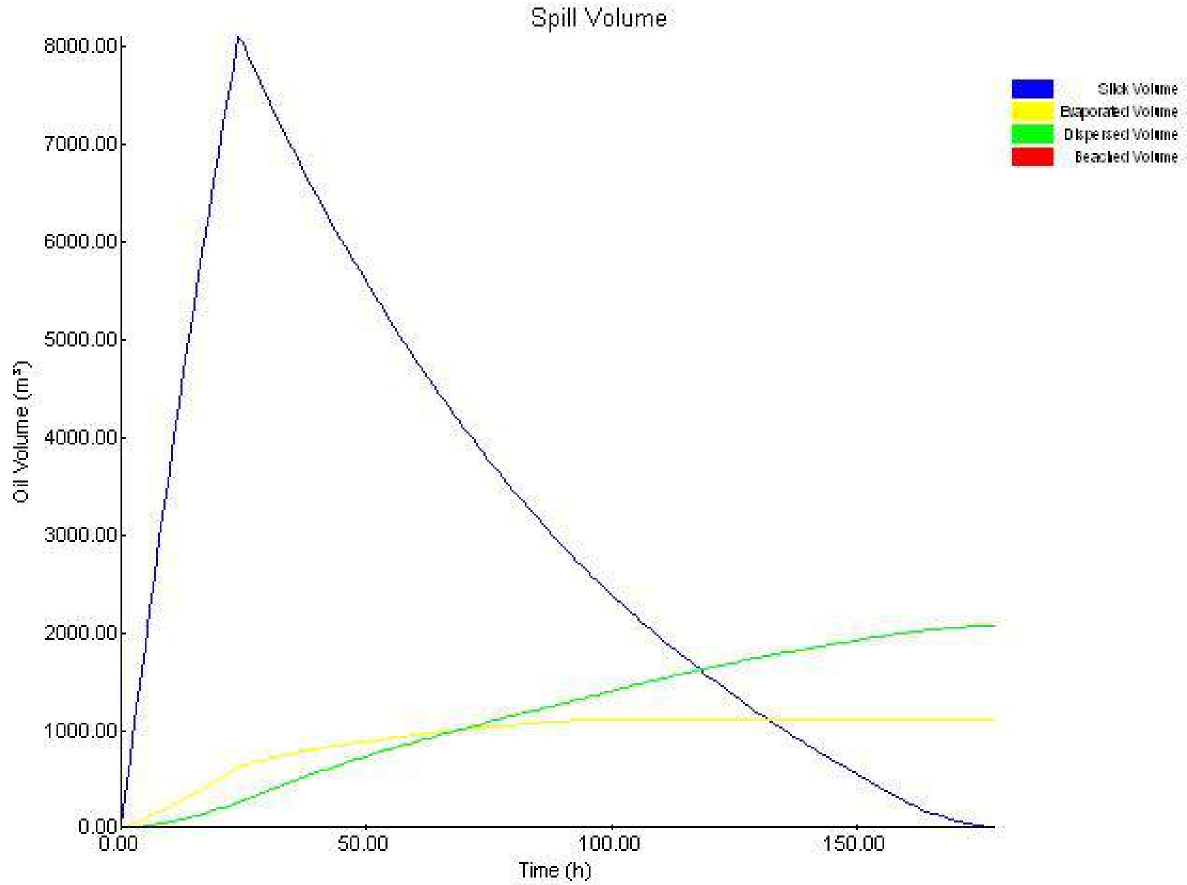

Figure 19 The volumes of oil in different phases over time for Scenario 1A.10.

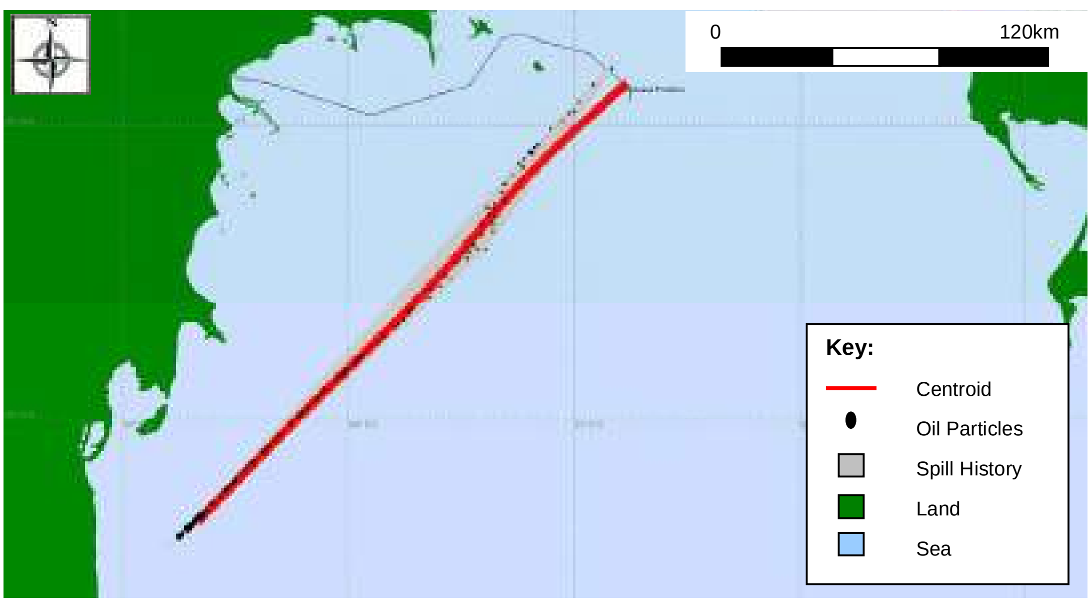

Figure 20 Spill history for Scenario 1A.10 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

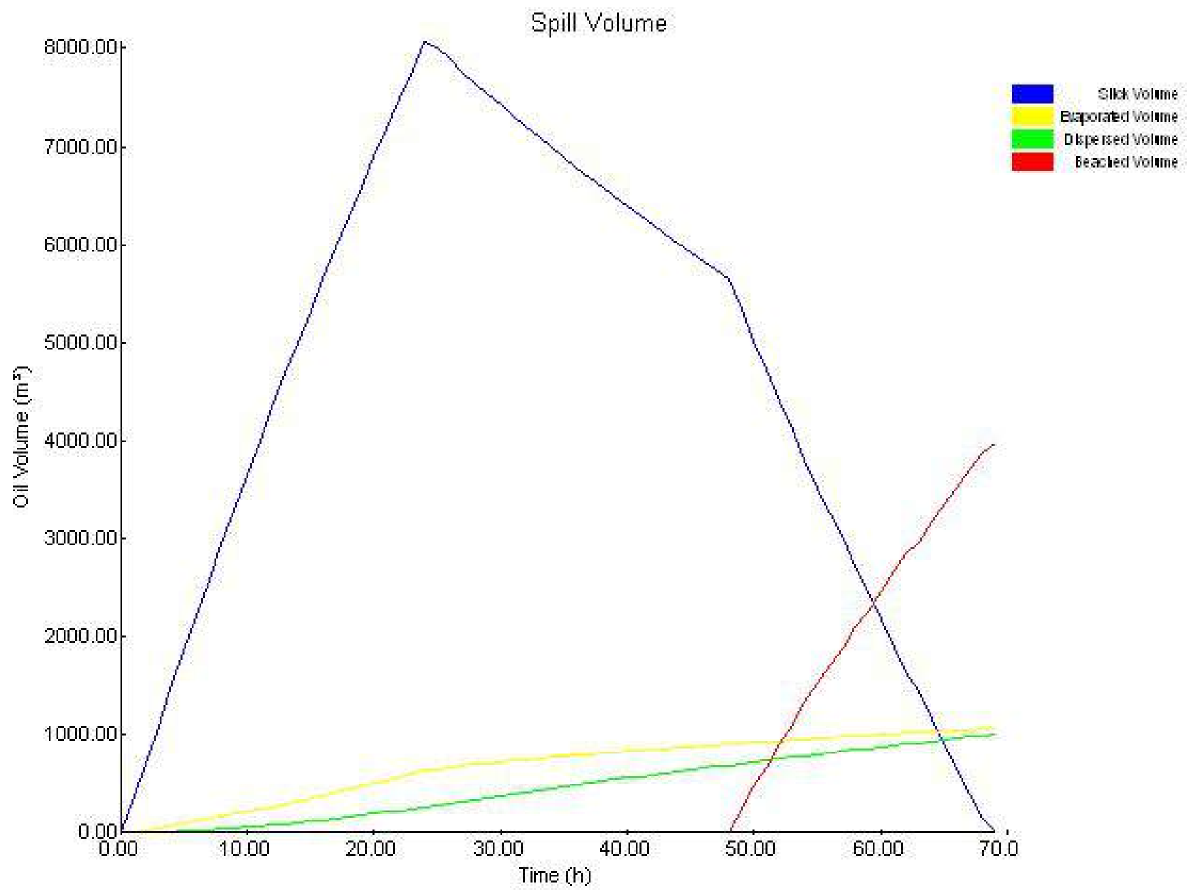

Figure 21 The volumes of oil in different phases over time for Scenario 1A.11.

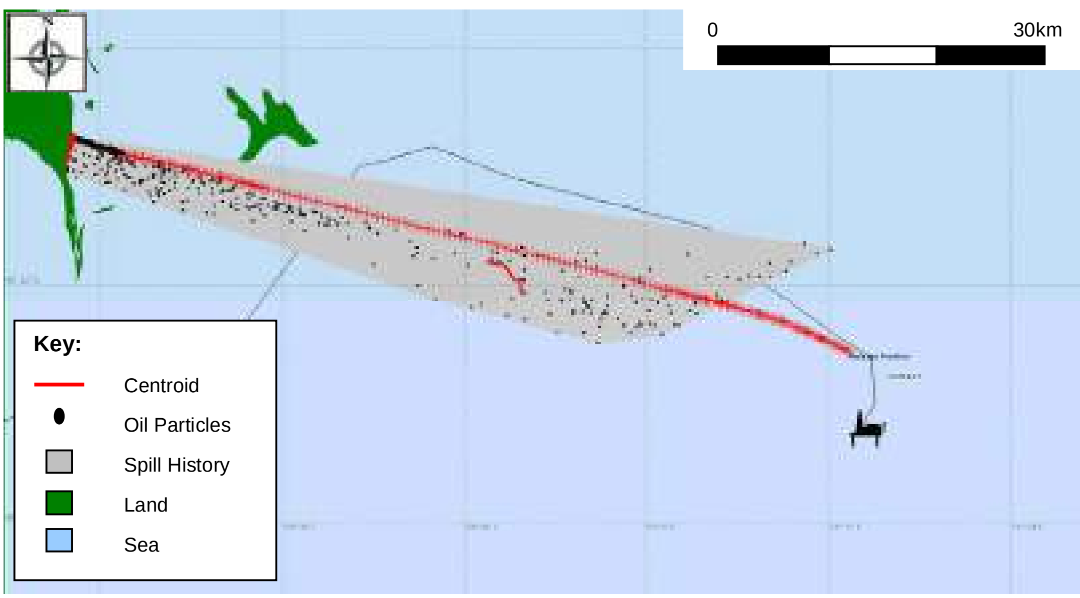

Figure 22 Spill history for Scenario 1A.11 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

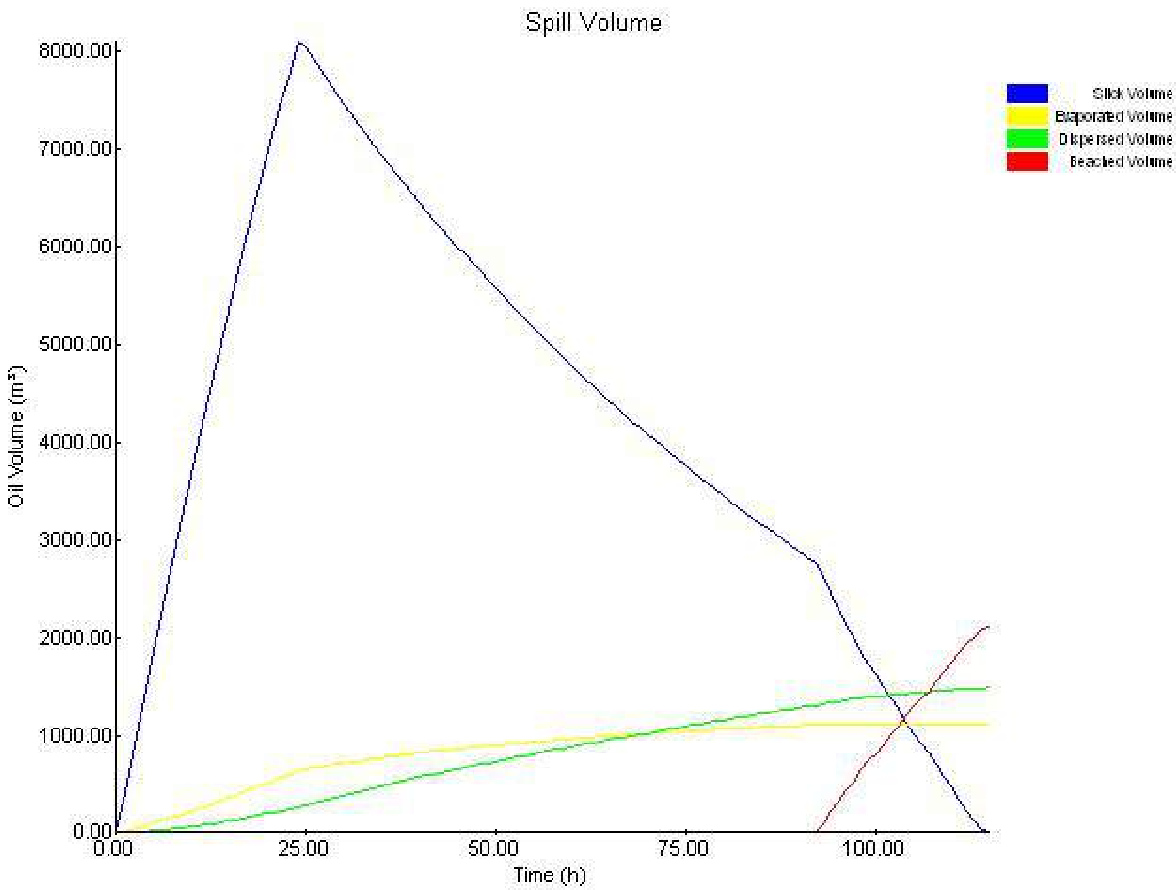

Figure 23 The volumes of oil in different phases over time for Scenario 1A.12.

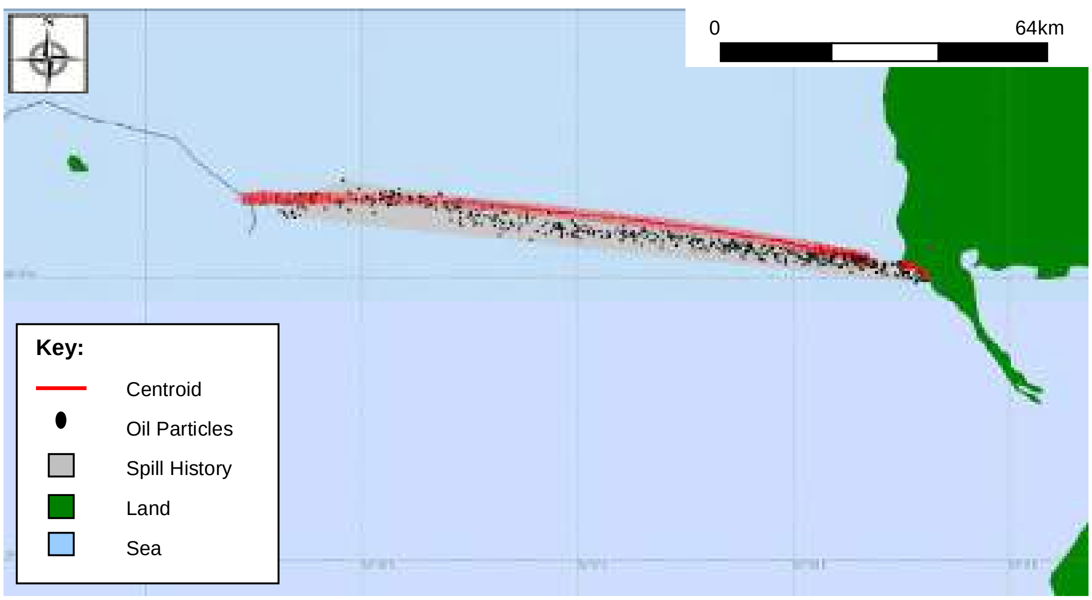

Figure 24 Spill history for Scenario 1A.12 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

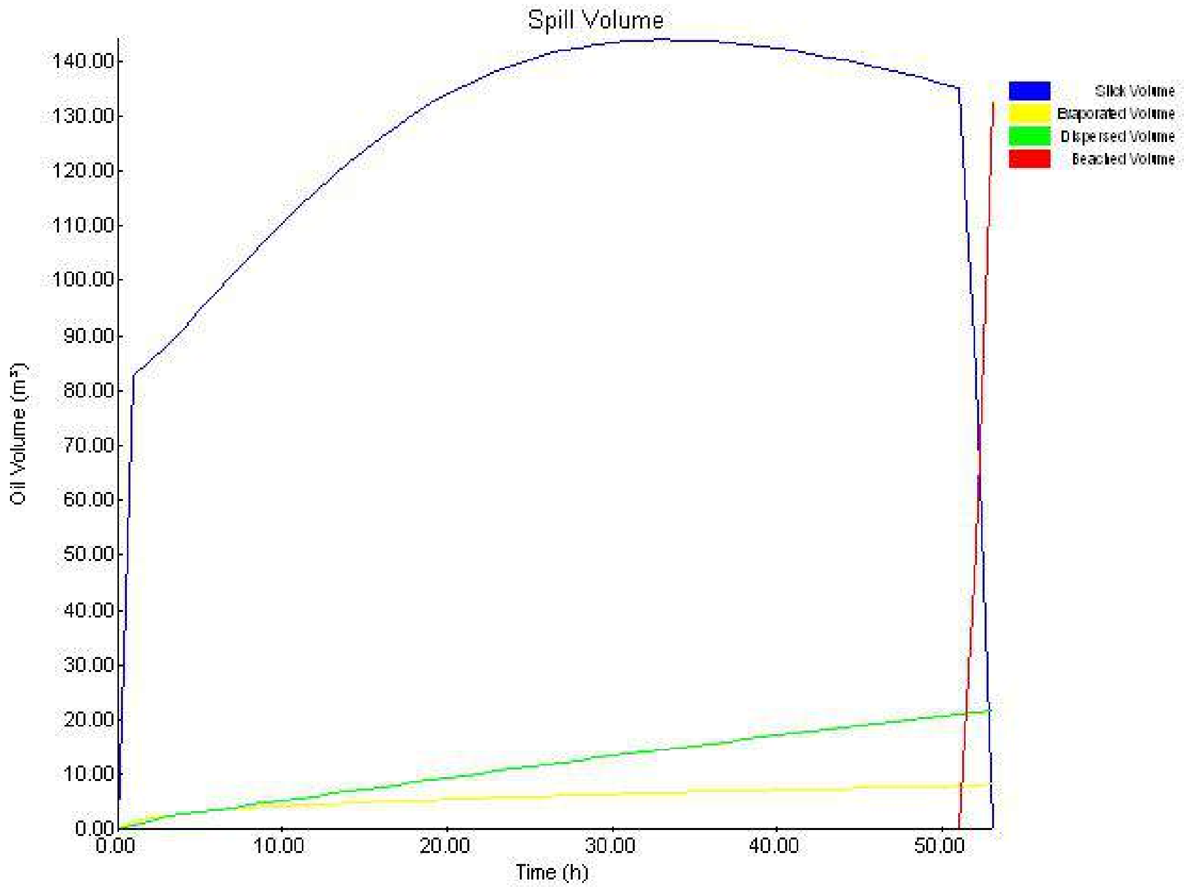

Figure 25 The volumes of oil in different phases over time for Scenario 1B.1.

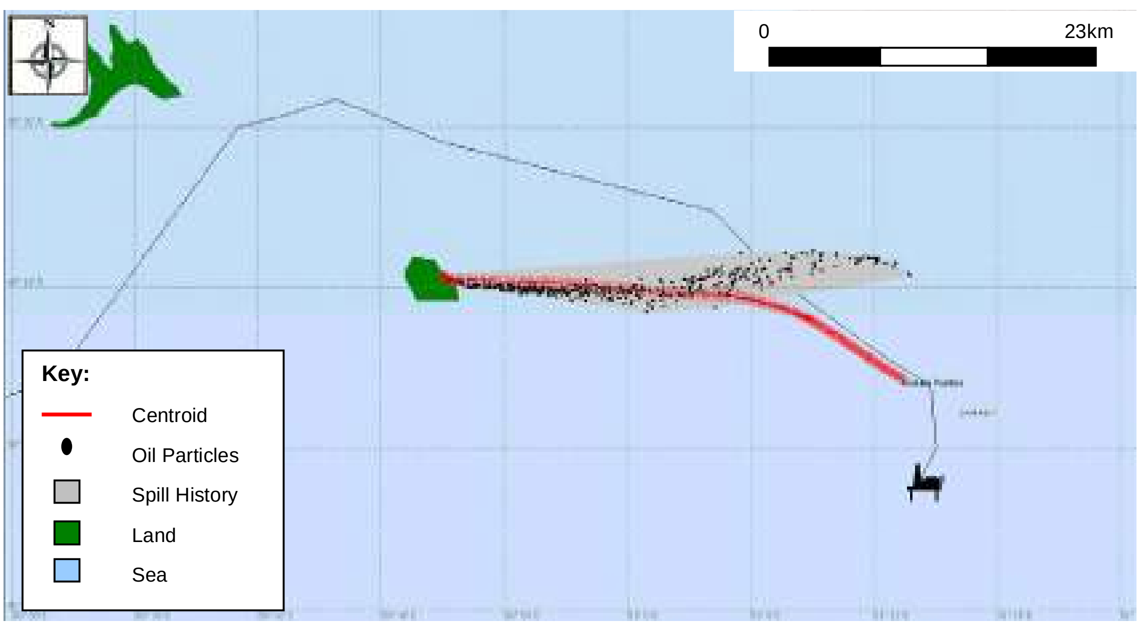

Figure 26 Spill history for Scenario 1B.1 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

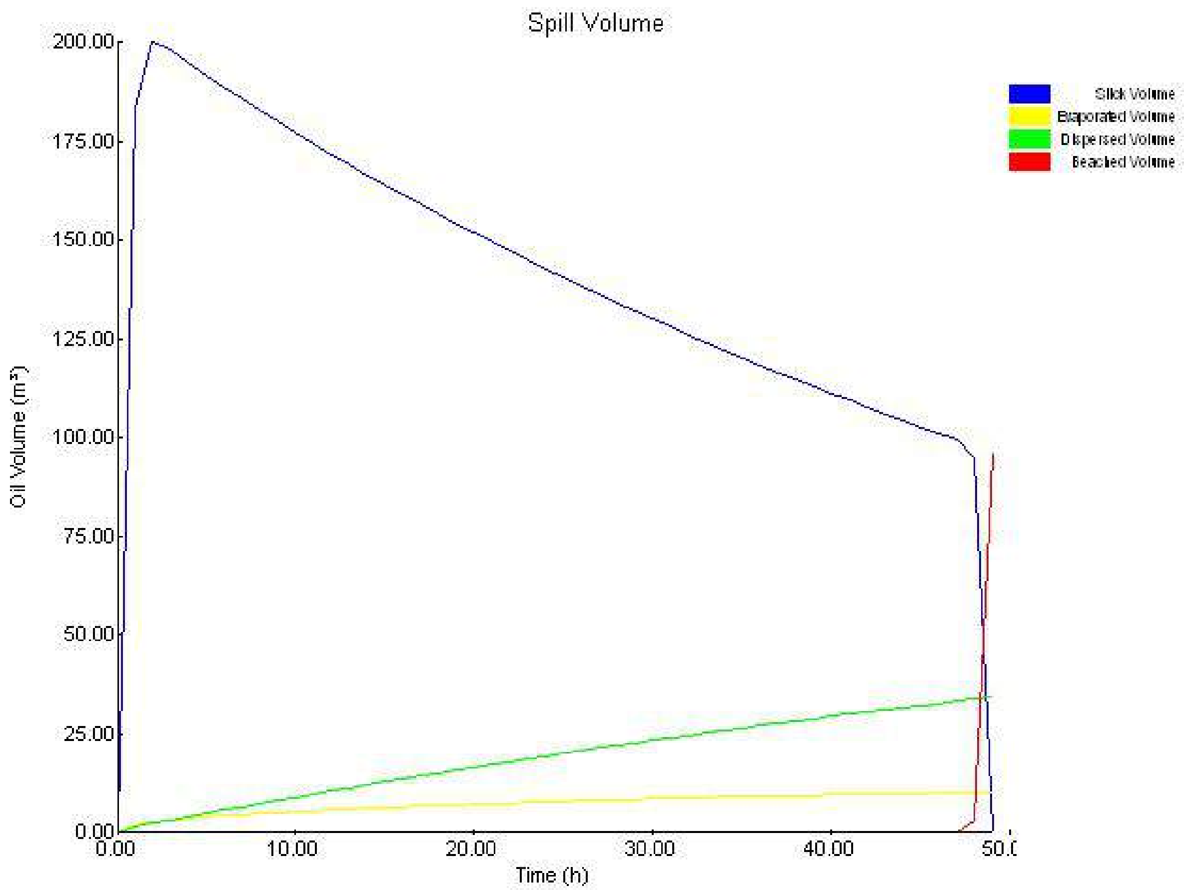

Figure 27 The volumes of oil in different phases over time for Scenario 1B.2.

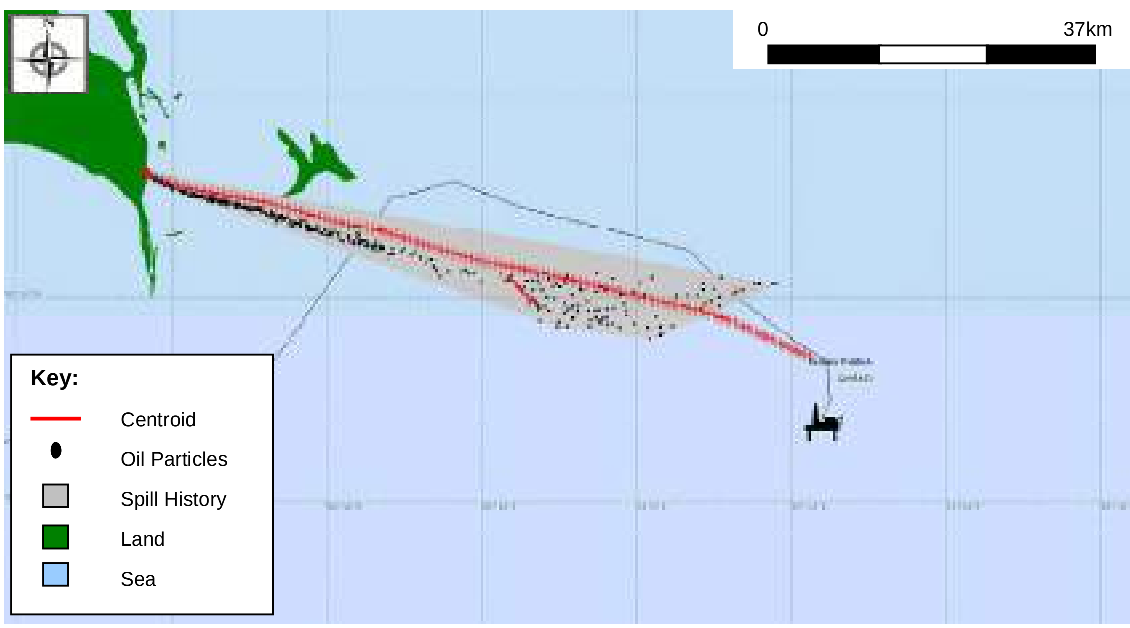

Figure 28 Spill history for Scenario 1B.2 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

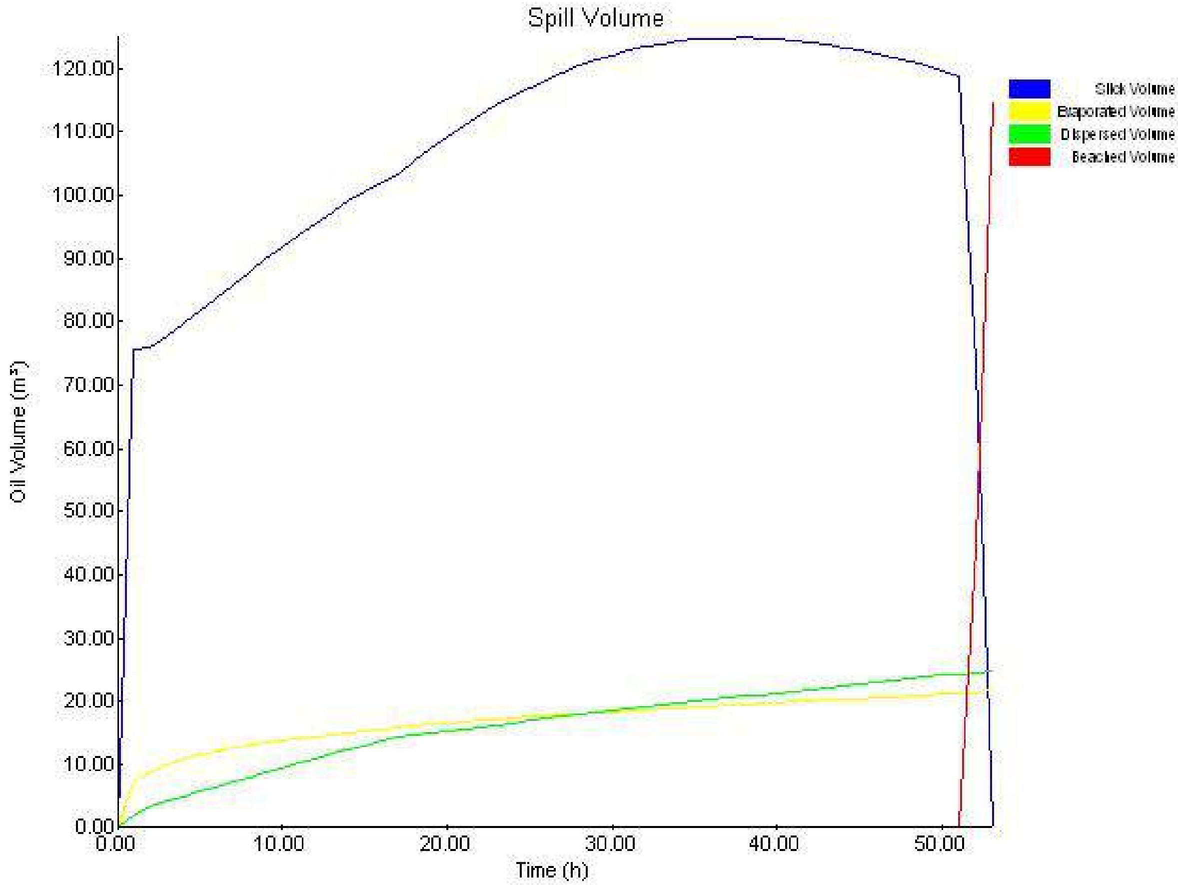

Figure 29 The volumes of oil in different phases over time for Scenario 1B.3.

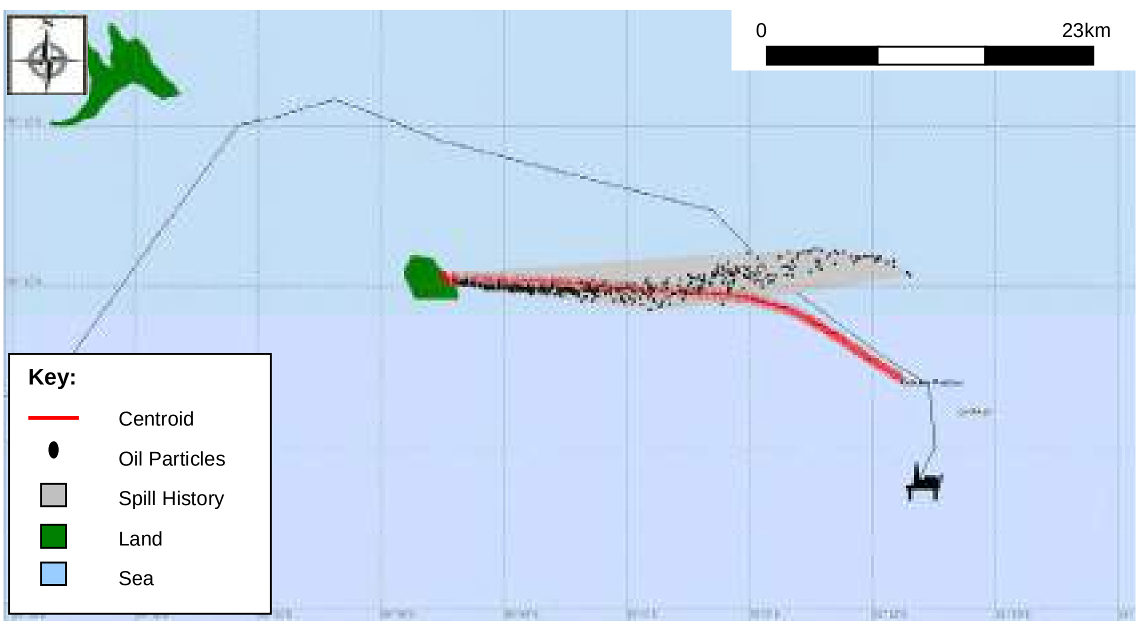

Figure 30 Spill history for Scenario 1B.3 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

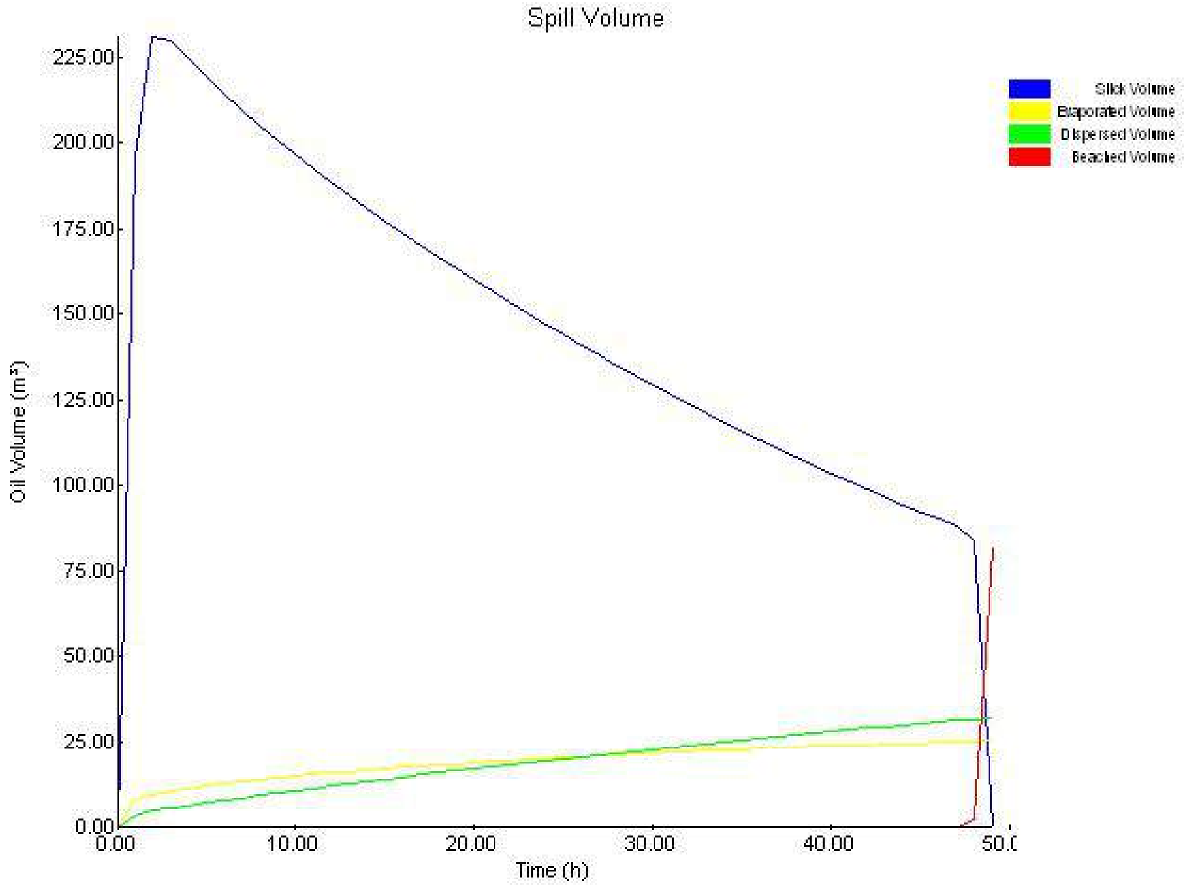

Figure 31 The volumes of oil in different phases over time for Scenario 1B.4.

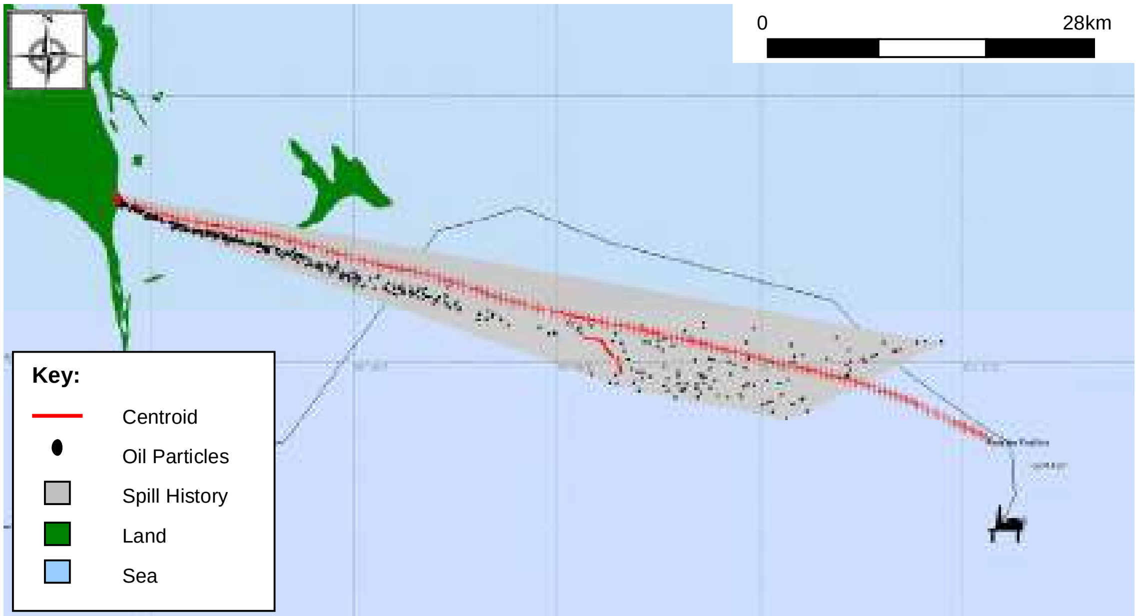

Figure 32 Spill history for Scenario 1B.4 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

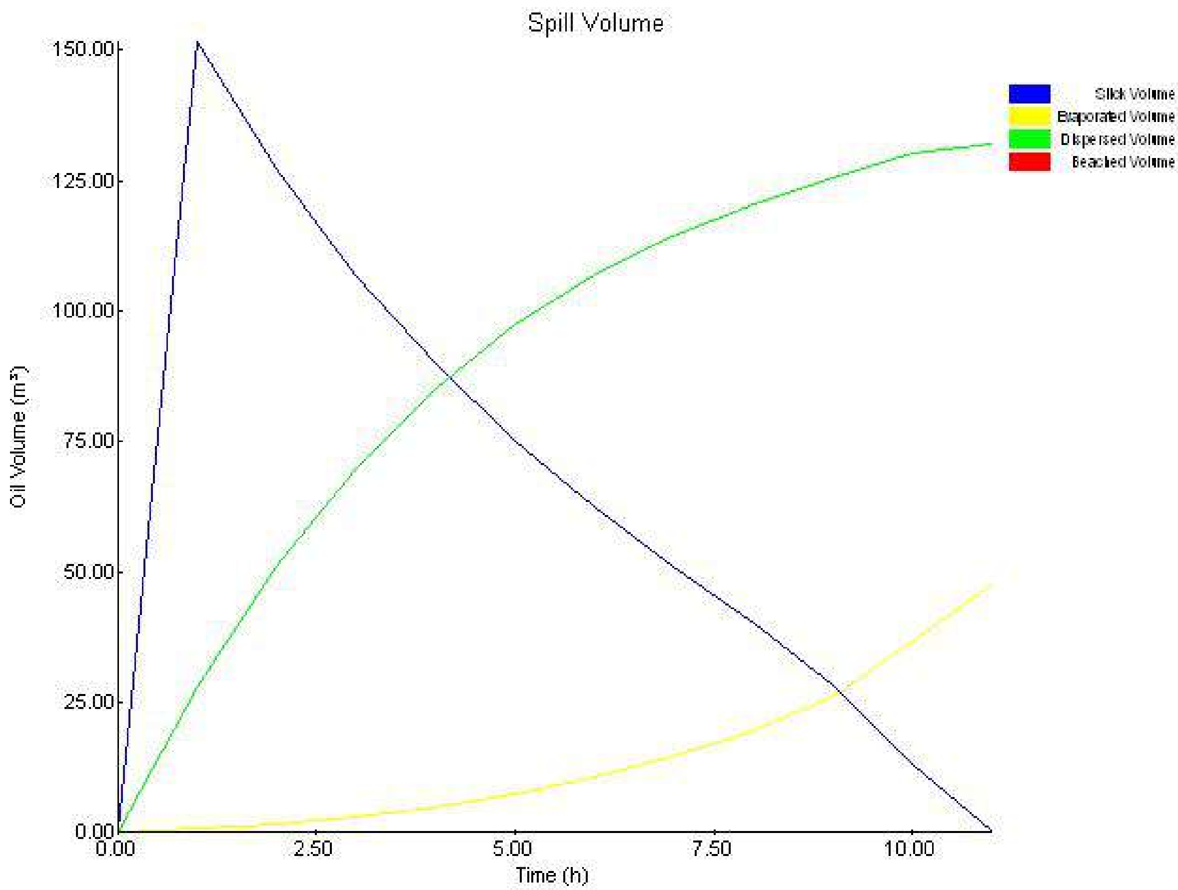

Figure 33 The volumes of oil in different phases over time for Scenario 1C.1.

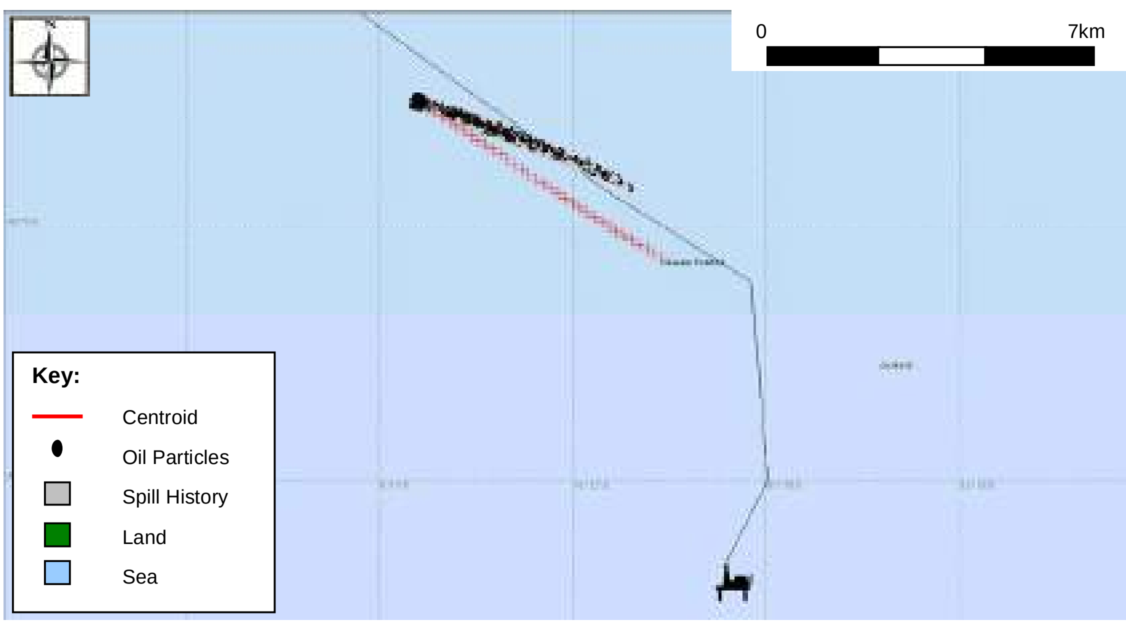

Figure 34 Spill history for Scenario 1C.1 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

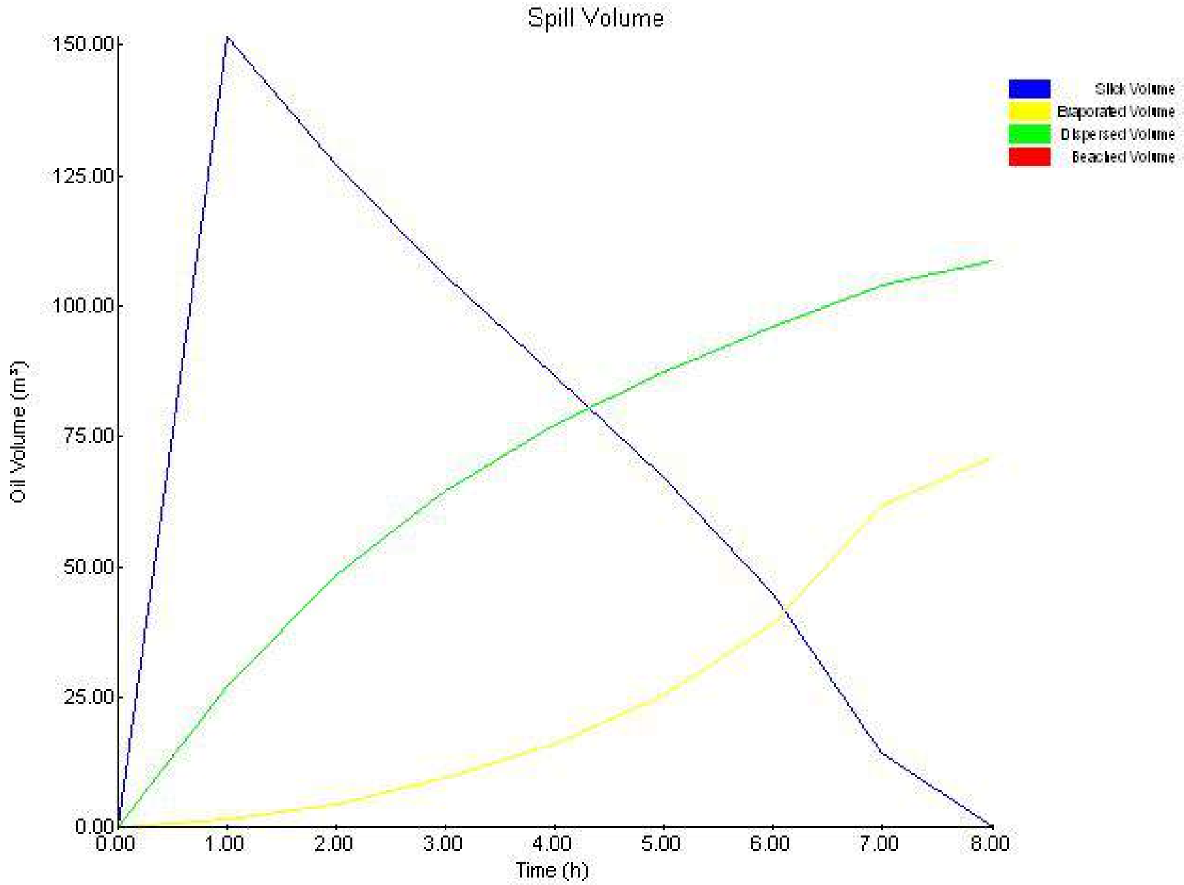

Figure 35 The volumes of oil in different phases over time for Scenario 1C.2.

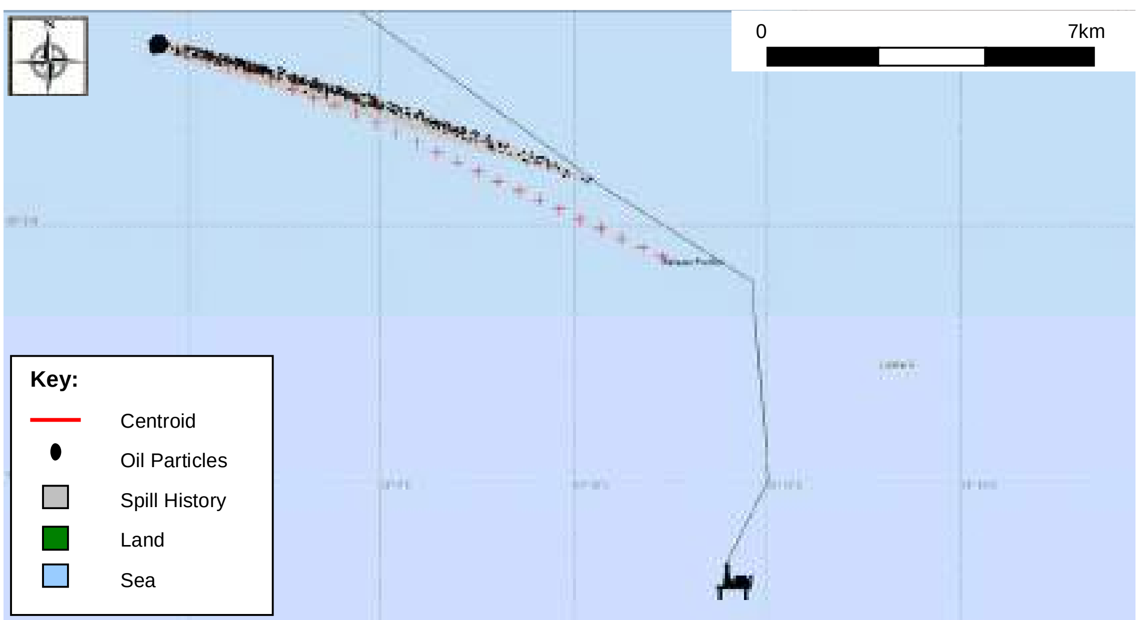

Figure 36 Spill history for Scenario 1C.2 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

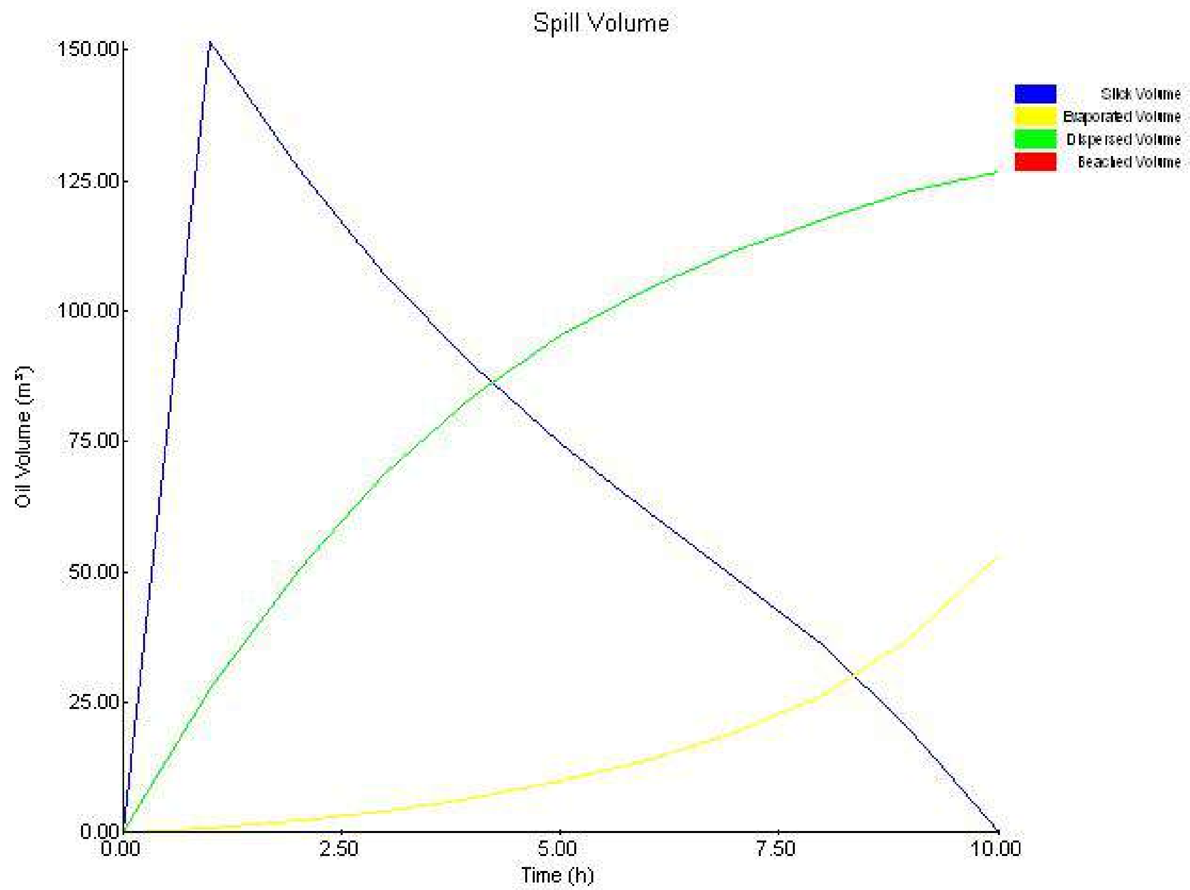

Figure 37 The volumes of oil in different phases over time for Scenario 1C.3.

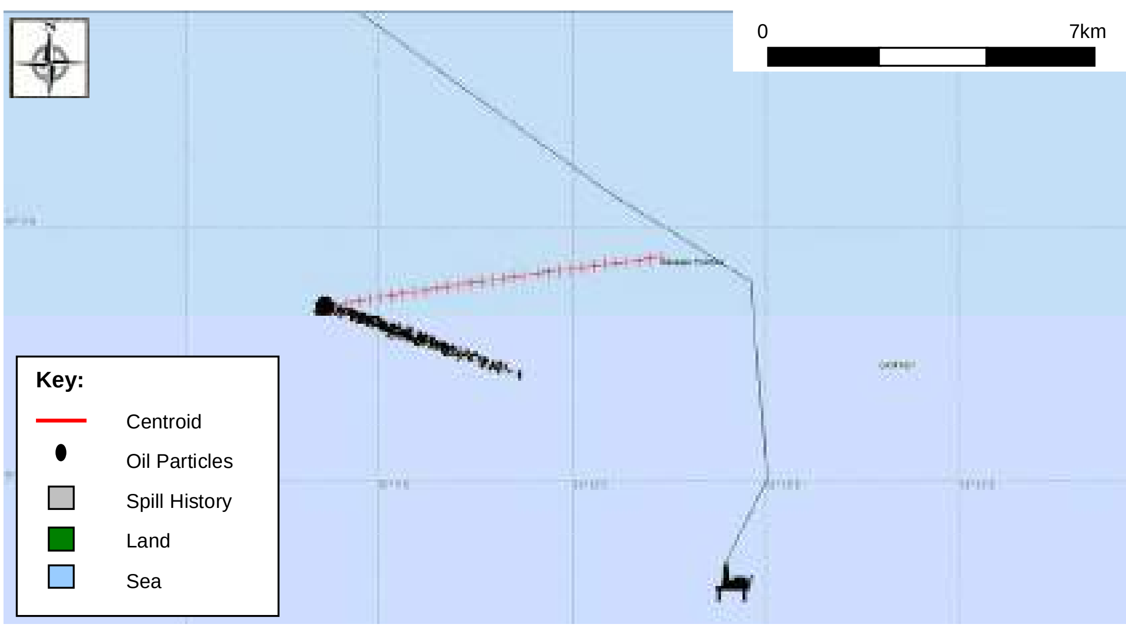

Figure 38 Spill history for Scenario 1C.3 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

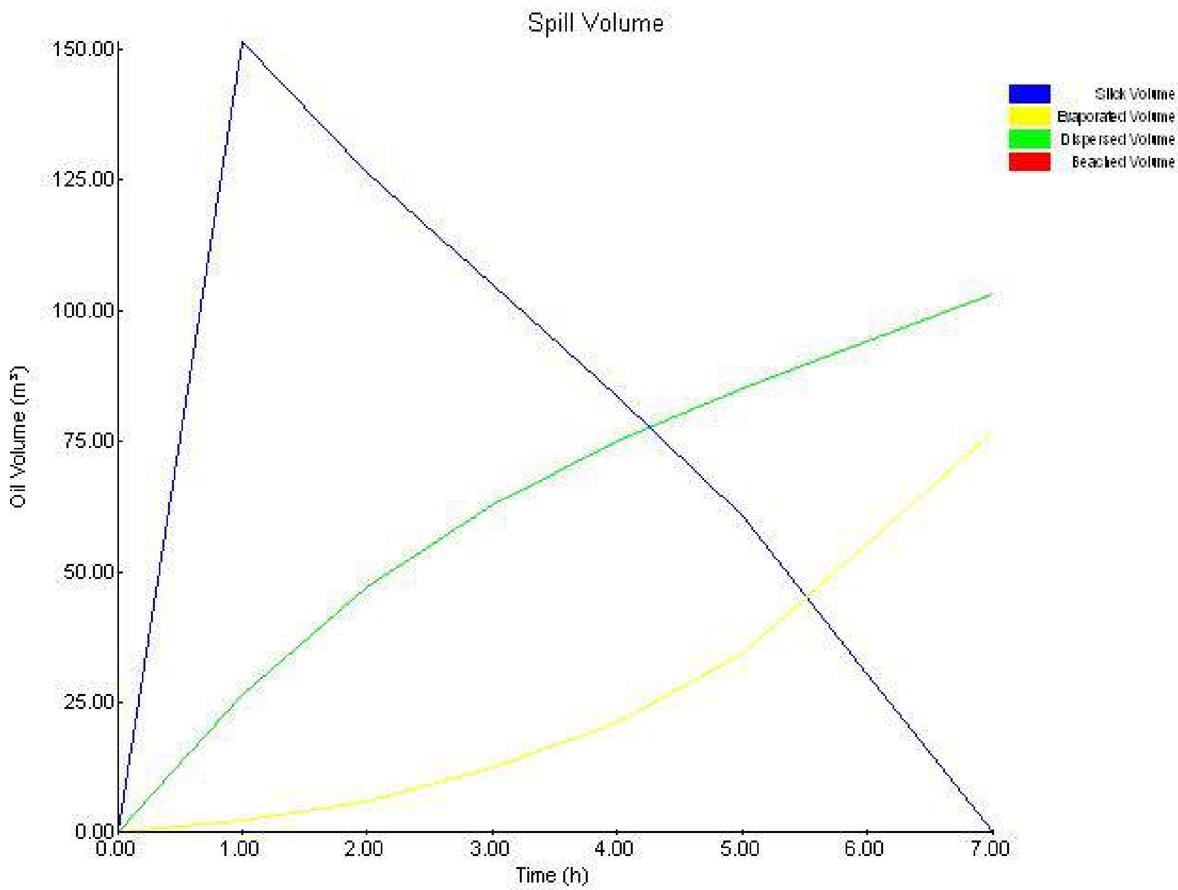

Figure 39 The volumes of oil in different phases over time for Scenario 1C.4.

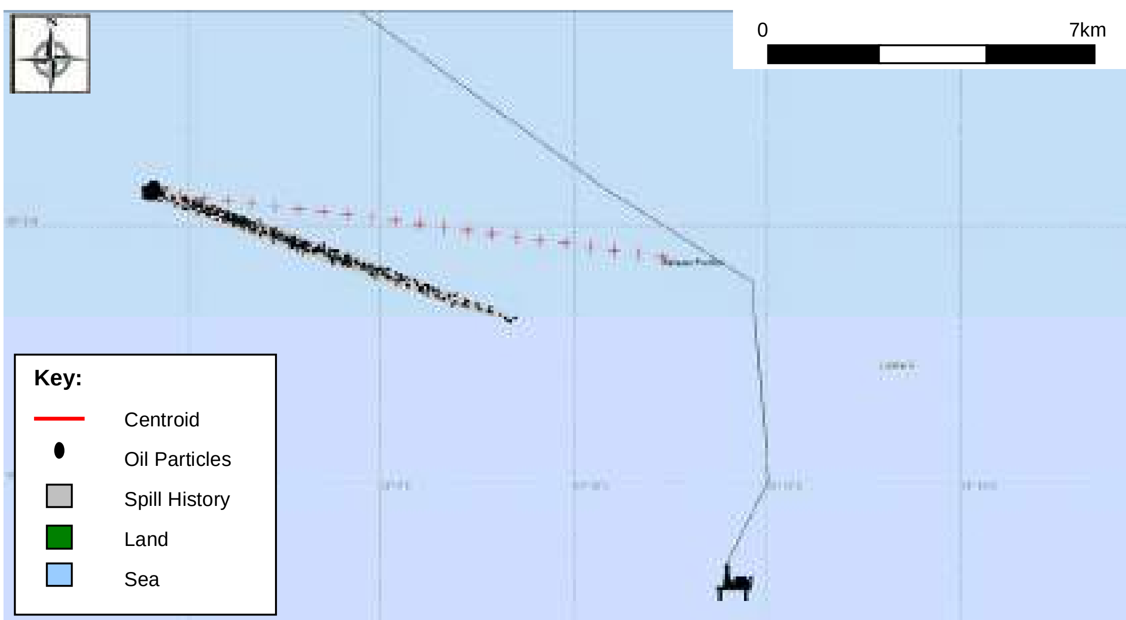

Figure 40 Spill history for Scenario 1C.4 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

Annex A: OSIS Model Suitability and Verification

OSIS Version 4.2.2 is the latest release of the long-established oil spill modelling system jointly developed by BMT Cordah and AEA Technology. The system provides a total capability to predict the movement, spreading, weathering and coastal impact of oil spilt in the marine environment. Most importantly, the model has been extensively validated during scientific sea trials (through a licence exclusively held in the UK by AEA Technology) and real incidents (e.g. Braer, Sea Empress). 18 sea trials have been conducted, up to 3 days in duration and using 10 different oil types.

The system has been the primary oil spill modelling system in the UK for many years and is used by the UK Government's Maritime and Coastguard Agency, other governments including all 9 Arabian Gulf states, major spill response companies such as Oil Spill Response Ltd. and Briggs Marine Environmental Services, and most of the UK-based oil companies. It is also used internationally in areas such as SE Asia, Mediterranean, Pacific Asia and the Caspian by many of the world's largest oil companies.

Annex B: Additional scenarios

Two additional runs were undertaken for the COP blowout scenario (Scenario 1A) and are listed in Table 1 below:

Run no	Location (La t/ Long WGS84 datum)	Start Date / Time	Oil Type	Sea Temp (oC)	Air Temp (oC)	Wind		Spill Characteristics	
						Speed (m/s)	Direction (o)	Release Rate (m3/hr)	Release Duration (hrs)
13	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	5	105	132.5	24 (42 days)
14	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	5	115	132.5	24 (42 days)
15	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	5	105	132.5	24 (42 days)
16	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	5	115	132.5	24 (42 days)

Table 1 Run descriptions for Scenario 1A COP blowout

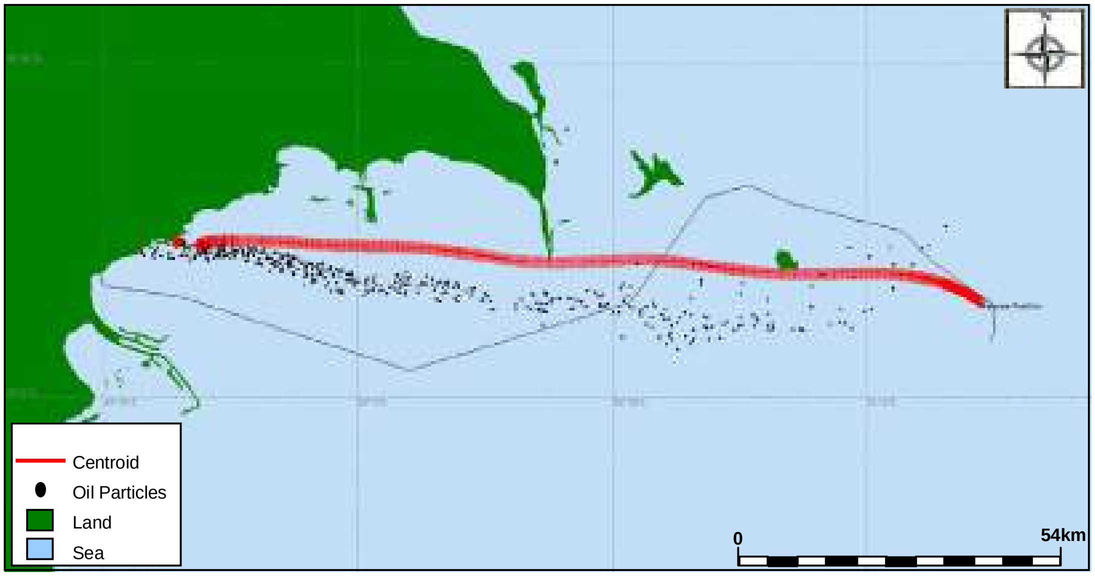

Figure 1 Spill history for Scenario 1A.13 showing the trajectory of the 24 hour oil spill

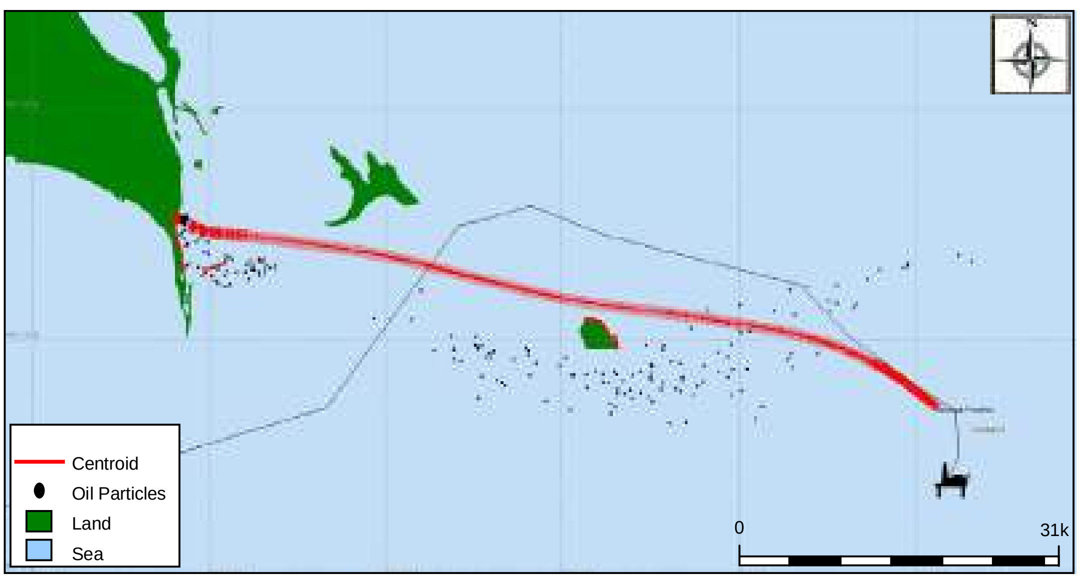

Figure 2 Spill history for Scenario 1A.14 showing the trajectory of the 24 hour oil spill

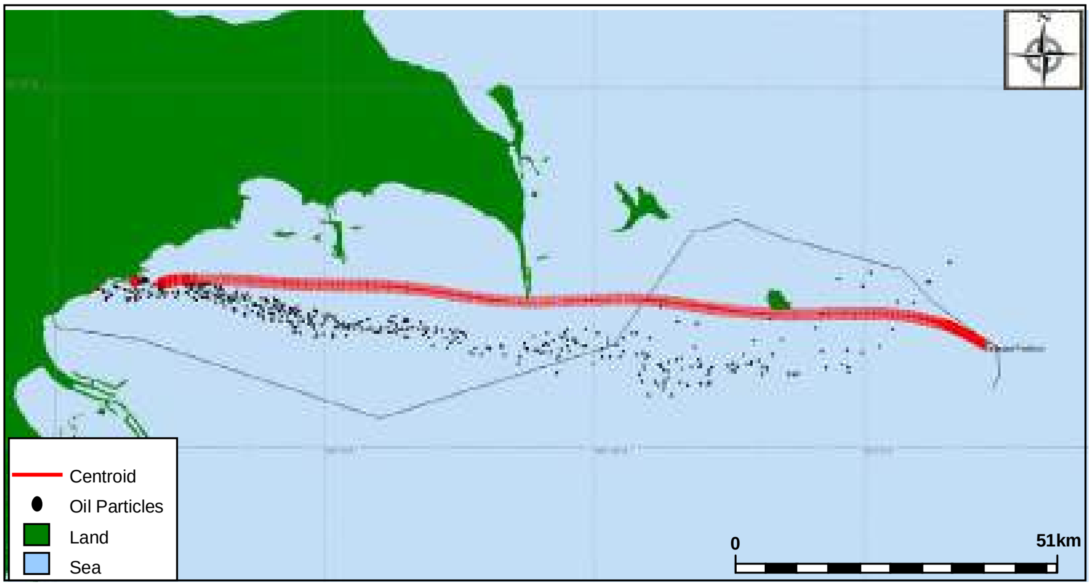

Figure 3 Spill history for Scenario 1A.15 showing the trajectory of the 24 hour oil spill

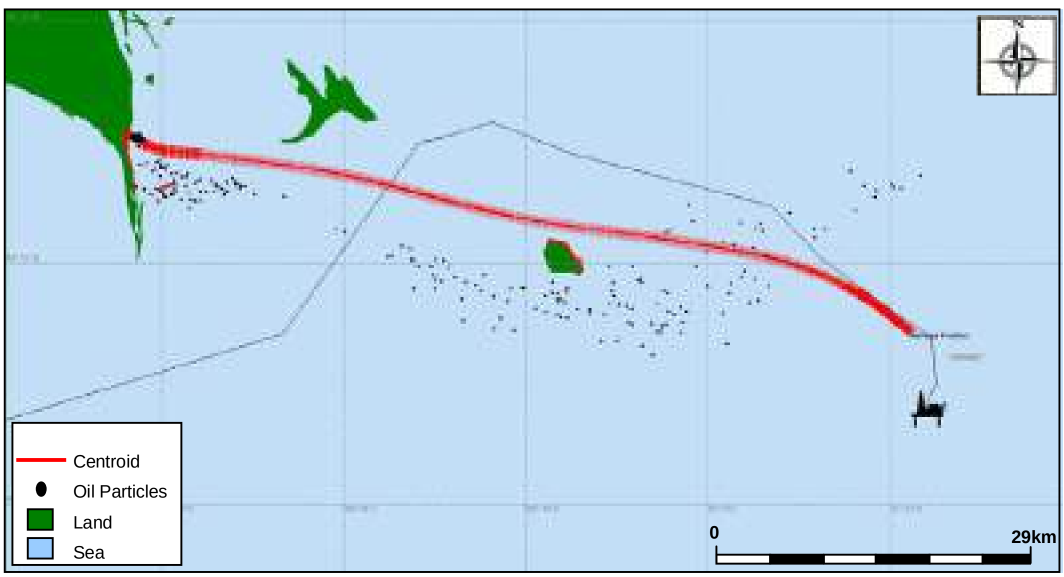

Figure 4 Spill history for Scenario 1A.16 showing the trajectory of the 24 hour oil spill.

APPENDIX 13A

Routine and Non Routine Discharge Parameters

Over the lifetime of the project, a number of routine and non routine discharges may take place. Table 1 presents details of the routine and non routine discharges expected for the COP during the predrill and operational phases.

Table 1 Routine and Non Routine Discharge Parameters

Discharge	Routine/ Non Routine* Discharge	Duration of each discharge event	Approximate volume of discharge per event	Approximate Rate of Discharge	Discharge Caisson	Depth of Discharge (m below sea level)	Discharge composition	Frequency and likelihood of discharge	Fate of discharge	Potential for Cumulative Impact
MODU Discharge										
Seawater, Viscous Sweeps & Cuttings	Routine	30 hours	Per well: - 20 tonnes bentonite - 230 tonnes cuttings	8.33 tonnes/hr	N/A	Seabed	Bentonite and cuttings	Each of the 20 predrill wells will take approximately 40 days to drill and 40 days to complete. Discharge events will be separated by intervals of at least 4-5 weeks.	Seabed	No - Cement, excess cement, and coarse cuttings will be deposited primarily within the footprint of the template, where accumulations will be sufficient to completely exclude benthic organisms. Finer cuttings and barite may be transported up to 500m from the template, but routine monitoring of existing platforms demonstrates that this has minimal impact and that there is no cumulative effect over time.
WBM & Cuttings	Routine	30 hours	Per well: - 340 tonnes mud (comprising 135 tonnes of barite) - 155 tonnes cuttings	16.5 tonnes/hr	MODU Cutting Caisson	11	WBM and cuttings		Seabed	
Cement	Routine	1 hour per section - 3 hours in total	Per well: - 25 tonnes (12 tonnes Class G cement, 8 tonnes barite & remainder chemicals)	8.33 tonnes/hr	At seabed	169 (seabed)	Class G cement, barite & chemicals	3 discharge events per well for each of the 20 platform predrill wells	Seabed	
Excess WBM	Non Routine	4 hours	18 tonnes of mud per well	4.5 tonnes/hr	MODU Cutting Caisson	11	WBM	Excess WBM from the MODU mud system may be discharged at end of top hole section drilling if it is not practicable to recover for technical or safety reasons.	Seabed	
Excess cement	Non Routine	1 hour	0.7 tonnes per well	0.7 tonnes/hr	MODU Cutting Caisson	11	Class G cement, barite, chemicals and seawater	Discharge will only occur if excess cement cannot be recovered at the end of casing cementing. Only cement mixed with water will be discharged.	Seabed	
Cooling Water	Routine	N/A	N/A	575m^3/hr	N/A	Surface	Seawater(4-5 ^{0}C higher than intake temperature) with trace amounts of copper and chlorine, both of which will react with organic material during the antifouling process and which will be present in the discharge at concentrations below the level of environmental concern	Continuous discharge during predrill	Water column/ surface	No - Discharged at surface, will not interact with MODU cuttings discharge and will be diluted and cooled within a short distance of discharge. No persistent effect
WC-PDQ Discharges										
WBM & Cuttings	Routine	30 hours	Per well: - 340 tonnes mud (comprising 135 tonnes of barite) - 155 tonnes cuttings	16.5 tonnes/hr	Cutting Caisson (C5)	136	WBM and cuttings	Each of the 26 platform wells will take approximately 40 days to drill and 40 days to complete. Discharge events will be separated by intervals of more than 10 weeks.	Seabed	No - As with the pre-drilled wells, cement and excess cement would be restricted to within the footprint of the template. The impact of pre-drill operations would, as indicated above, exclude benthic organisms from within the footprint, so any further accumulation of cement and cuttings could have no further impact. It is not expected that the benthos immediately under the template would have any potential for recovery over the lifetime of the platform, but the area thus affected is very small
Cement	Routine	1 hour per section - 3 hours in total	Per well: - 25 tonnes (12 tonnes Class G cement, 8 tonnes barite & remainder chemicals)	8.33 tonnes/hr	At seabed	169 (seabed)	Class G cement, barite & chemicals	3 discharge events per well for each of the 26 platform drilled wells	Seabed	
Excess WBM	Non Routine	4 hours	18 tonnes of mud per well	4.5 tonnes/hr	Cutting Caisson (C5)	136	WBM	Excess WBM from the platform mud system may be discharged at end of top hole section drilling if it is not practicable to recover for technical or safety reasons.	Water column	
Excess cement	Non Routine	1 hour	0.7 tonnes per well	0.7 tonnes/hr	Cutting Caisson (C5)	136	Class G cement, barite, chemicals and seawater	Discharge will only occur if excess cement cannot be recovered at the end of casing cementing. Only cement mixed with water will be discharged.	Water column	
Produced Water	Non Routine	Between 12 and 72 hours as a worst case	N/A	400 -500m^3/hr	Produced Water Caisson (C9)	46	Separated water contains typical levels of aliphatic and aromatic hydrocarbons, but higher levels of more soluble organic and volatile fatty acids. Toxicity tests indicate that ACG produced water samples are not of high toxicity, and that the treated discharge will be rapidly diluted to concentrations sufficiently low to cause no long-term effects	Discharge will only occur • If the volume of produced water exceeds that required for reservoir pressure maintenance; or • Due to a downtime event such as an emergency, accident or mechanical failure.	Water column	**Yes - Potential for cumulative impact associated with concurrent discharge**
Pigging of IW pipeline	Routine	2 hours	950m^3	475 m^3/hr	Produced Water Caisson (C9)	46	DWG produced water and/or seawater	The injection water pipeline will be pigged once a week from the DWG-PCWU platform using produced water/seawater from the DWG-PCWU platform	Water column	
Cooling Water	Routine	N/A	N/A	3,000m^3/hr	Seawater Discharge Caisson (C8)	45	Seawater with trace amounts of copper and chlorine, both of which will react with organic material during the antifouling process and which will be present in the discharge at concentrations below the level of environmental concern	Continuous operational discharge	Water column	

APPENDIX 13B

OSIS Study for COP

A part of BMT in Energy and Environment

OSIS Study for COP (Caspian Sea)

Reference: L40030.1
Date: 15 January 2010

Prepared for:
Azerbaijan International Operating Company

Document status sheet

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Author(s) : Z. Roberts (BMT ARGOSS)

Approved by : M. Rymell (BMT ARGOSS)

Distribution : A. Lewis

Contents

1. Introduction

Azerbaijan International Operating Company (AIOC) has commissioned BMT Argoss Limited (BMT) to conduct a modelling study on the expected fate of a release of oil from a blowout, a separator failure and a diesel tank located at the COP platform in the Caspian Sea. BMT's Oil Spill Information System (OSIS) was used to model 20 deterministic spill scenarios to assess potential beaching events and oil weathering.

OSIS is a particle-tracking model that can simulate the fate and dispersion of surface oil slicks. OSIS can be used to run individual deterministic model scenarios providing results of the trajectory of the slick, together with the evaporated, dispersed, beached and slick volumes.

The results of the oil spill modelling study are presented in this report.

2. Modelling

Modelling of the oil dispersion was conducted using BMT Cordah's OSIS system. OSIS has been jointly developed by BMT Cordah and AEA Technology plc. An overview of OSIS is given in the following section. More detailed background documentation can be found in Appendix A.

2.1. The OSIS Model

OSIS is a particle-tracking model that can simulate the fate and dispersion of surface oil slicks. It represents an oil slick as a collection of free moving particles which simulate the spreading slick. Simultaneously, weathering algorithms determine the changes in physical properties of the slick as it spreads.

The transport model takes into account the three dimensional transport processes acting on the oil due to the current, wind, waves, diffusion and buoyancy. As these effects can be parameterised in terms of environmental conditions, predictions can be made allowing for a wide variety of weather conditions.

The hydrocarbon properties model uses algorithms to calculate the changes in the hydrocarbon properties due to evaporation, emulsification and natural dispersion. As a result, physical properties such as density, viscosity and flash point changes are also predicted. The OSIS model and its algorithms are fully explained in Walker (1995), which is included in full in Appendix A.

OSIS supports several model types, but they can be generally characterised as being either deterministic or stochastic:

- Deterministic models simulate a point source spill scenario under a single set of metocean conditions. The final results from this type of model are presented on a map indicating the trajectory of the oil, the area of the slick, and beaching location of the spill after a specified period. An approximation of the area over which oil sheening will occur is also shown. In addition, graphs of the variation of spilled oil properties with time are presented (these include the variation in volumes of slick, evaporated, dispersed and beached oil).
- Stochastic models allow the simulation of a point source spill under a specified number of different probable metocean conditions, defined as wind speed and direction percentage frequencies as either a wind rose or a time series. This module provides results as contour plots showing the probabilities of surface oiling and a map of beaching locations. No volume outputs are available from the stochastic module.

2.2. Model scenarios

Spill scenarios were provided by BP and are shown in Table 1. In total 20 deterministic runs were conducted across three scenarios:

- Scenario 1A. COP Blowout.
- Scenario 1B. Separator failure.
- Scenario 1C. Diesel spill.

2.2.1. Oil type

In order to consider weathering of oil within its model, OSIS contains a database of physical and chemical information for over 120 oil types. These have been characterised by AEA Technology's laboratories specifically for use in OSIS. Hydrocarbon releases of Chirag Blend Caspian Sea and DWG Caspian were modelled in this study.

2.2.2. Meteorological Data

The meteorological data used within the model was supplied by AIOC for each model run.

2.2.3. Hydrodynamic Data

BMT obtained and processed residual surface currents for the Caspian Sea region from the U.S. Naval Research Laboratory HYCOM Caspian Sea Model. This model operates with a 1/25 degree resolution and provides monthly mean surface velocities.

As standard, the model assumes a uniform (horizontal) bathymetry, which is generally suitable for surface spill scenarios.

3. RESULTS AND DISCUSSION

3.1. Deterministic modelling

In the deterministic scenarios constant meteorological conditions have been applied throughout the model run.

3.1.1. COP Blowout Scenario

Figures 1 - 24 show the spill trajectory and beaching locations, along with variations of oil in different phases, for the 12 deterministic model runs in the blowout scenario.

Table 4 shows the volume of beached oil at the final time for a 24 hour release, along with the expected final time and beached volume for a 42 day release.

The maximum beached volume predicted for a 1 day release occurred in Run 2 (5615.28m^3), indicating that after a 42 day release a volume of approximately 236000m^3 could be expected to come onshore.

Run 11 exhibited the shortest time to beaching after a 24 hour release at 34 hours.

Two runs (7 and 10) exhibited no beaching.

3.1.2. Separator failure of 81m^3 crude oil

Figures 25 – 33 show the spill trajectory and beaching locations, along with variations of oil in different phases, for the 4 deterministic model runs in the separator failure scenario.

Table 5 shows the volume of beached oil at the final time for an instantaneous release of crude oil. Run 1 exhibited the maximum beached volume (132.81m^3). Run's 2 and 3 jointly demonstrated the shortest time to beaching (33 hours).

3.1.3. Diesel spill

Figures 33 – 40 show the spill trajectory variations of oil in different phases, for the 4 deterministic model runs in the diesel spill scenario.

No scenarios exhibited beaching. The diesel evaporated within 11 hours in all cases.

Tables and Figures

Run No.	Location (Lat/Long WGS84 datum)	Start Date/ Time	Oil Type	Sea Temp (°C)	Air Temp (°C)	Wind		Spill Characteristics	
						Speed (m/s)	Direction (°)	Release Rate (m^3/hr)	Release Duration (hrs)
1	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	5	45	132.5	24 (*42)
2	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	5	110	132.5	24 (*42)
3	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	5	270	132.5	24 (*42)
4	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	10	45	132.5	24 (*42)
5	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	10	110	132.5	24 (*42)
6	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	10	270	132.5	24 (*42)
7	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	5	45	132.5	24 (*42)
8	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	5	110	132.5	24 (*42)
9	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	5	270	132.5	24 (*42)
10	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	10	45	132.5	24 (*42)
11	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	10	110	132.5	24 (*42)
12	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	10	270	132.5	24 (*42)

Table 1 Run descriptions for Scenario 1A COP blowout

Run No.	Location (Lat/Long WGS84 datum)	Start Date/ Time	Oil Type	Sea Temp (°C)	Air Temp (°C)	Wind		Spill Characteristics	
						Speed (m/s)	Direction (°)	Release Rate (m^3/hr)	Release Duration (hrs)
1	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	5	110	81	Instantaneous
2	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	10	110	81	Instantaneous
3	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	5	110	81	Instantaneous
4	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	10	110	81	Instantaneous

Table 2 Run descriptions for Scenario 1B separator failure crude oil

1C. 180m^3 diesel spill

Run No.	Location (Lat/Long WGS84 datum)	Start Date/ Time	Oil Type	Sea Temp (°C)	Air Temp (°C)	Wind		Spill Characteristics	
						Speed (m/s)	Direction (°)	Release Rate (m^3/hr)	Release Duration (hrs)
1	40° 11' 15.59"N 51°10' 4.75"E	1/02/2010 00:00	Diesel	6	6	5	110	180	Instantaneous
2	40° 11' 15.59"N 51°10' 4.75"E	1/02/2010 00:00	Diesel	6	6	10	110	180	Instantaneous
3	40° 11' 15.59"N 51°10' 4.75"E	1/08/2010 00:00	Diesel	27	27	5	110	180	Instantaneous
4	40° 11' 15.59"N 51°10' 4.75"E	1/08/2010 00:00	Diesel	27	27	10	110	180	Instantaneous

Table 3 Run description for Scenario 1C diesel spill

Run No.	Final Time (hours)	Beached Volume	Expected final time for 42 blowout	Expected Beached Volume after 42 day blowout
1	523	154.7	1531	6497.4
2	75	5615.28	1083	235841.8
3	305	1594.25	1313	66958.5
4	211	698.35	1219	29330.7
5	70	4374.94	1078	183747.5
6	114	2702.52	1122	113505.8
7	350	0	1358	0
8	74	4952.45	1082	208002.9
9	302	407.77	1310	17126.34
10	178	0	1186	0
11	69	3986	1077	167412
12	115	2102.67	1123	88312.14

Table 4 Beaching volume results for Scenario 1A COP blowout after a 24 hour model run and expected volumes for a 42 day blowout

Run No.	Final Time (hours)	Beached Volume
1	53	132.81
2	49	96.35
3	53	114.78
4	49	82.33

Table 5 Beaching volume results for Scenario 1B separator failure crude oil

Run No.	Final Time (hours)	Beached Volume
1	11	0
2	8	0
3	10	0
4	7	0

Table 6 Beaching volume results for Scenario 1C diesel spill

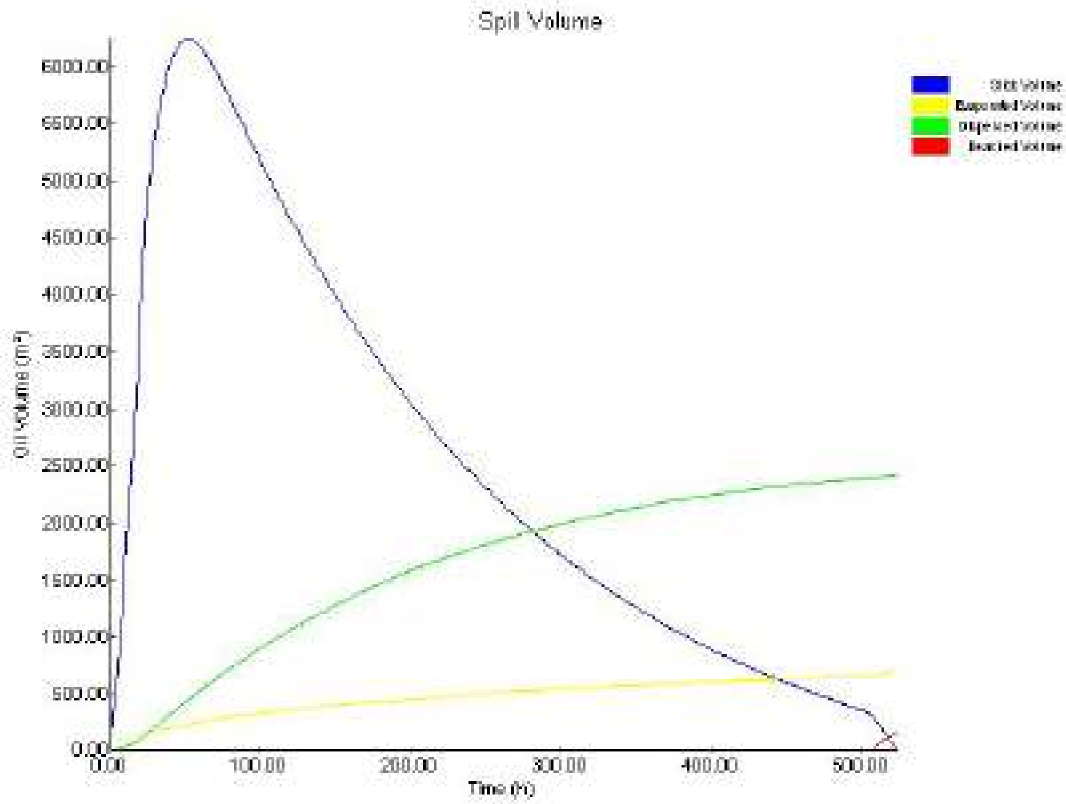

Figure 1 The volumes of oil in different phases over time for Scenario 1A.1.

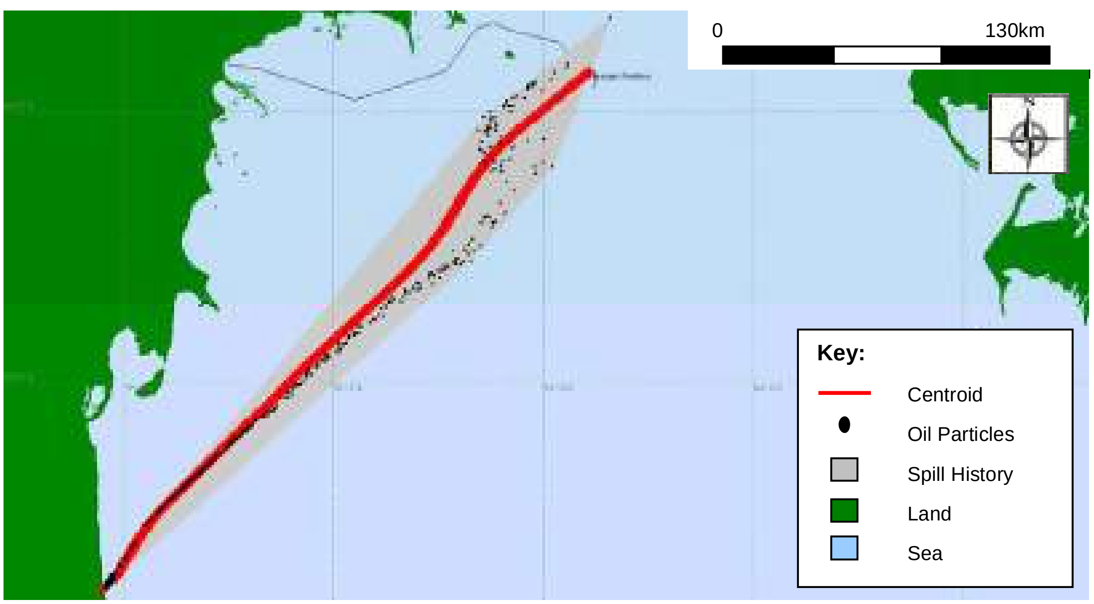

Figure 2 Spill history for Scenario 1A.1 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

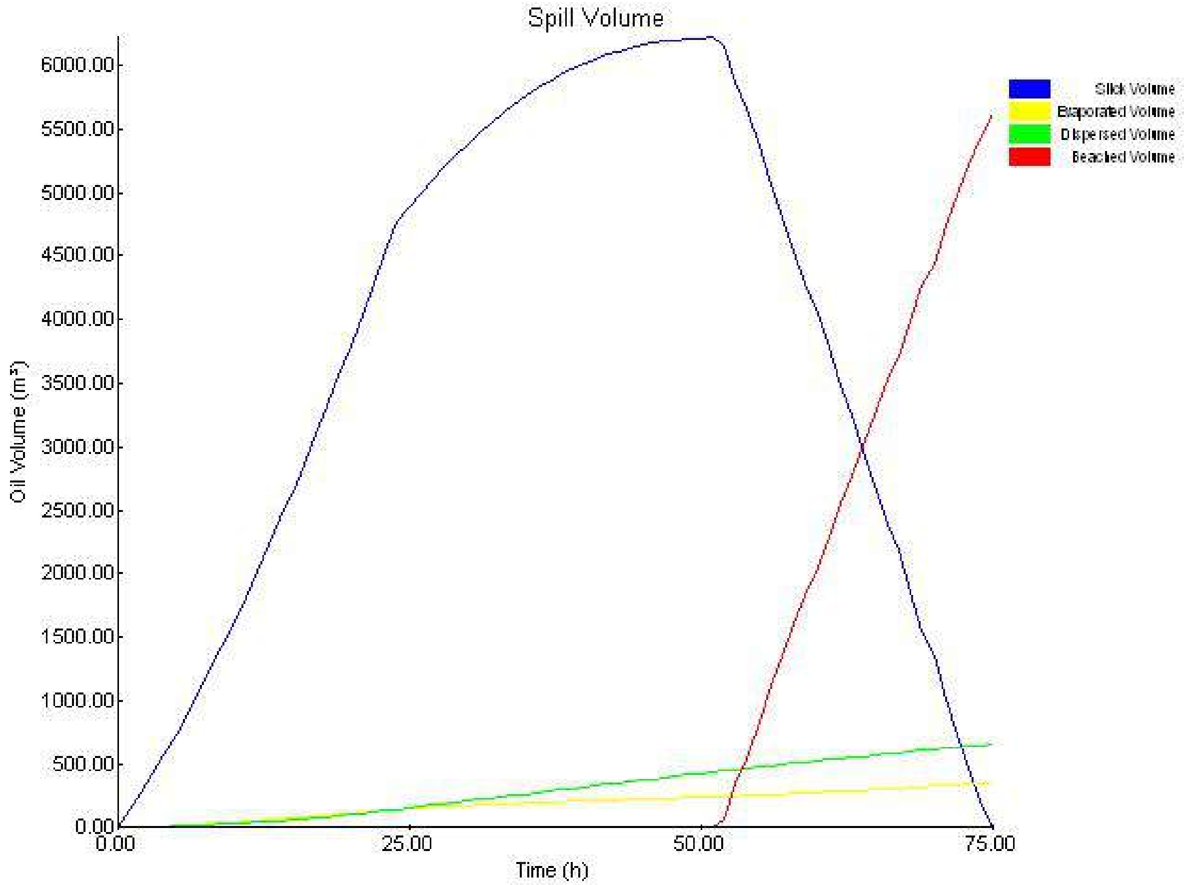

Figure 3 The volumes of oil in different phases over time for Scenario 1A.2.

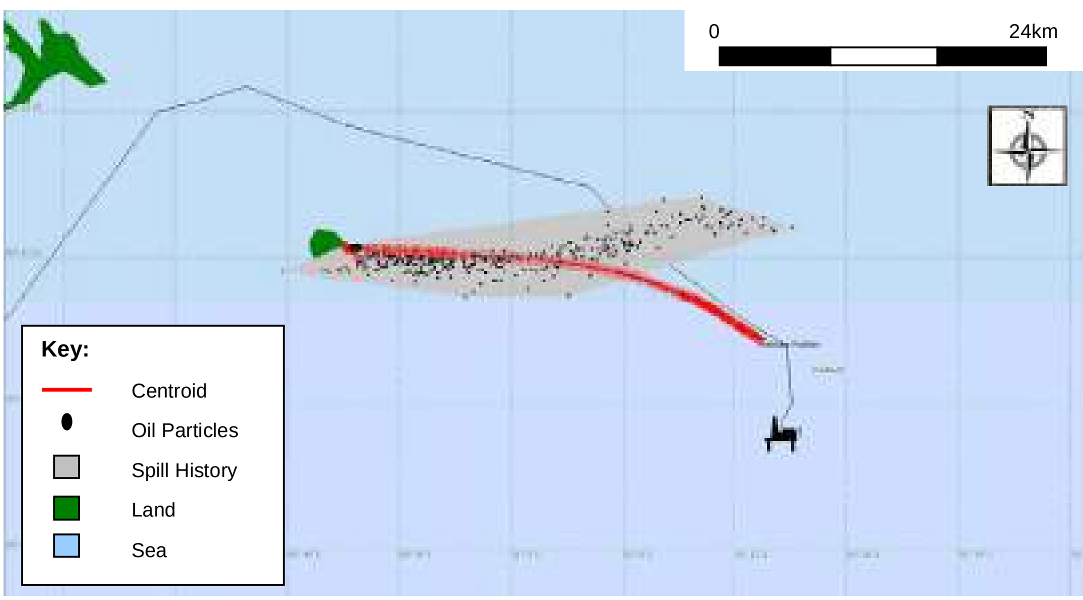

Figure 4 Spill history for Scenario 1A.2 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

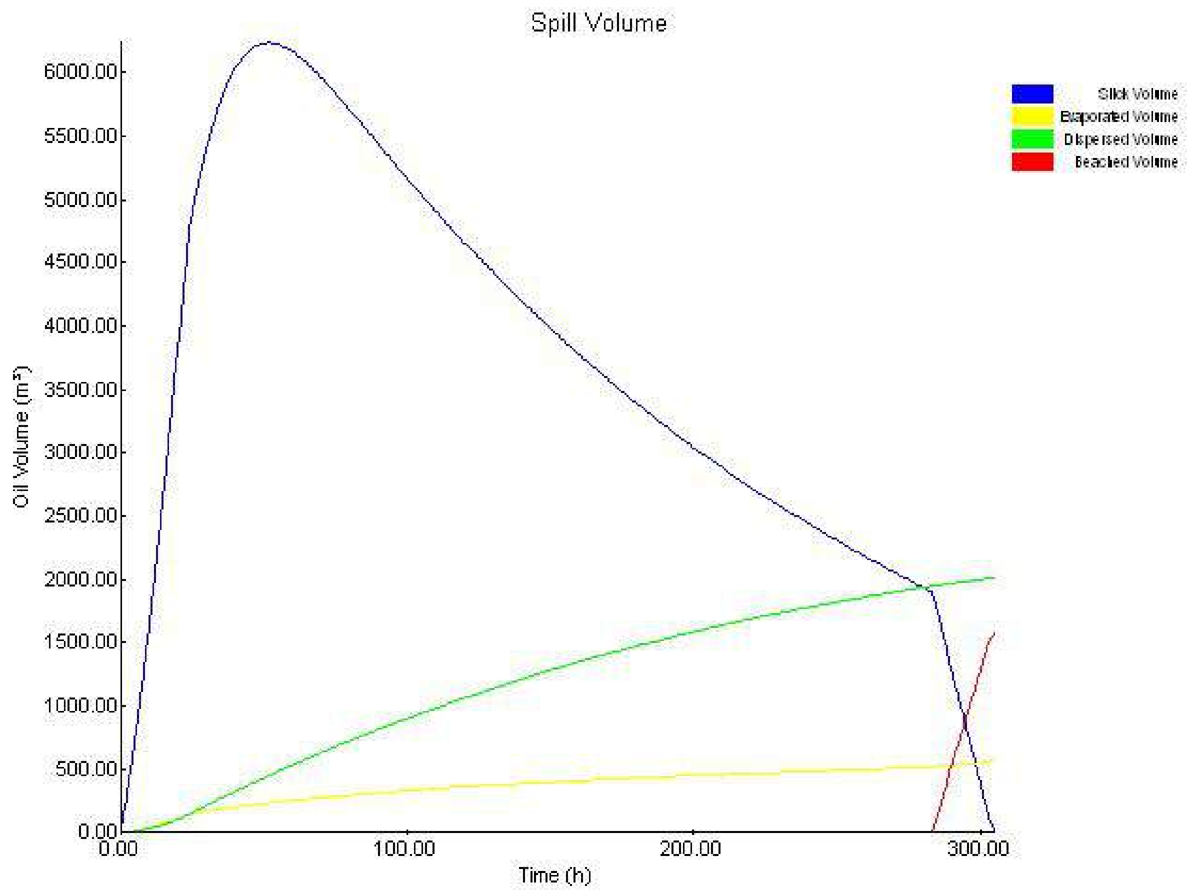

Figure 5 The volumes of oil in different phases over time for Scenario 1A.3.

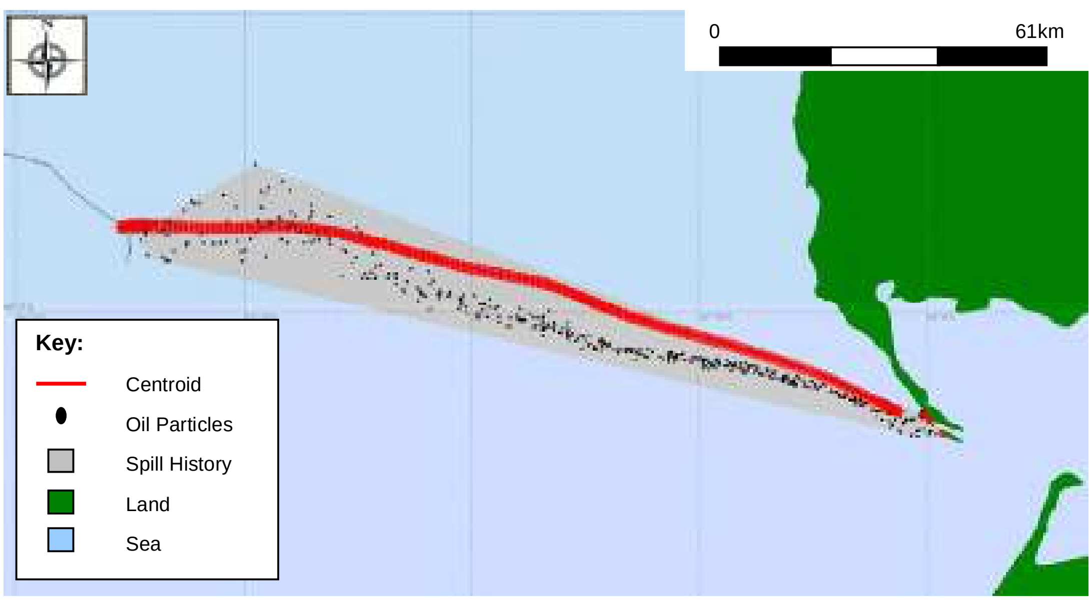

Figure 6 Spill history for Scenario 1A.3 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

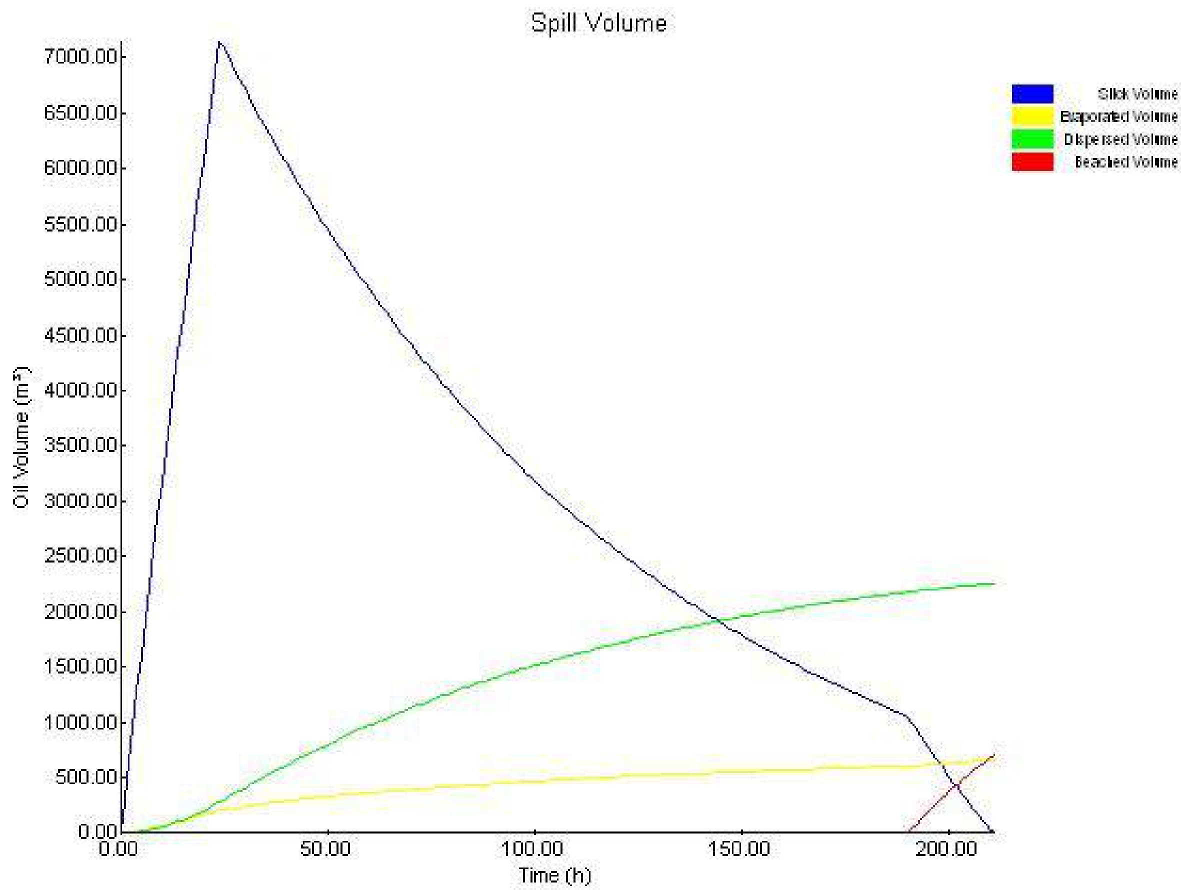

Figure 7 The volumes of oil in different phases over time for Scenario 1A.4.

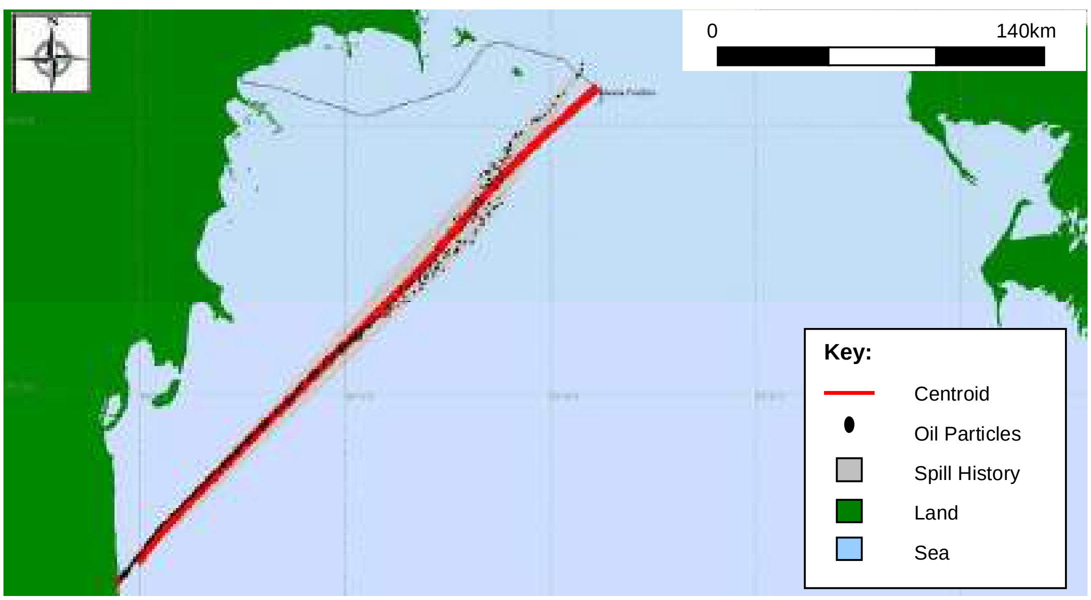

Figure 8 Spill history for Scenario 1A.4 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

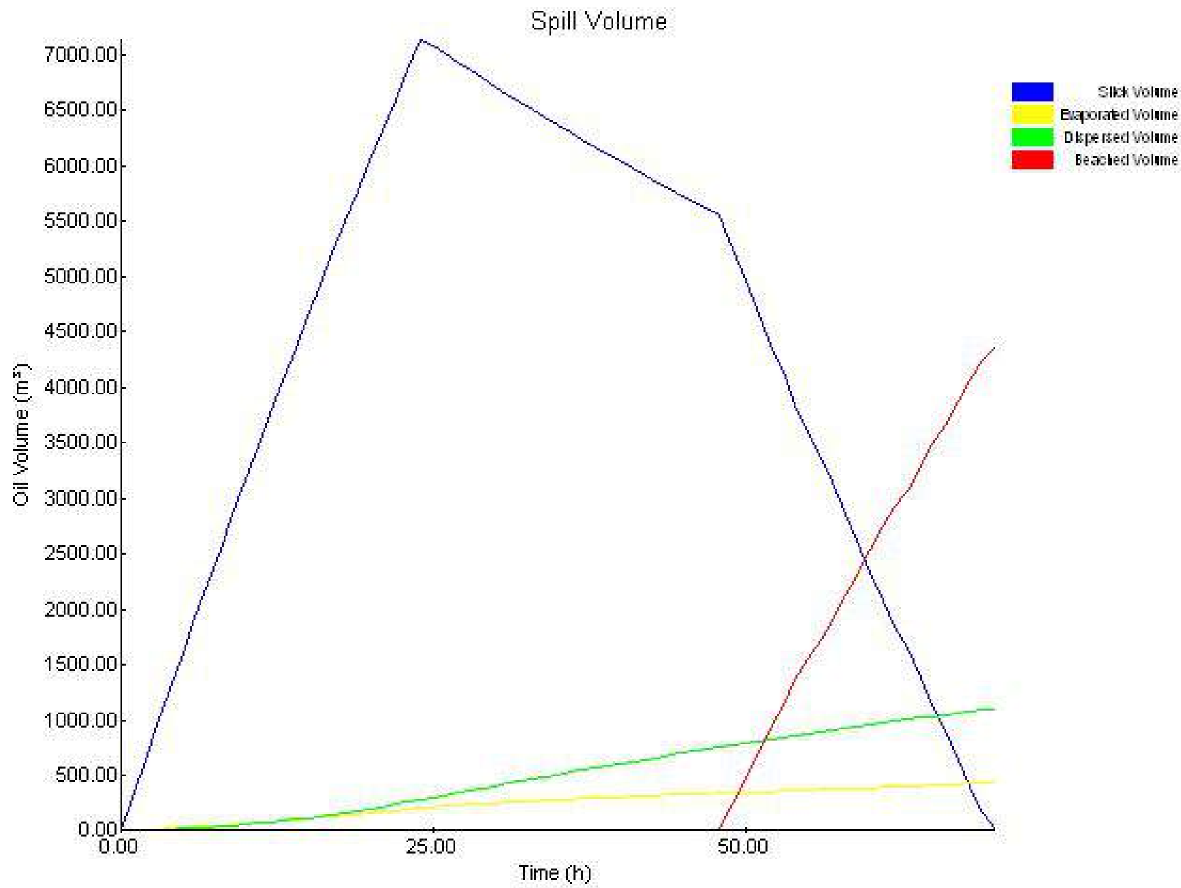

Figure 9 The volumes of oil in different phases over time for Scenario 1A.5.

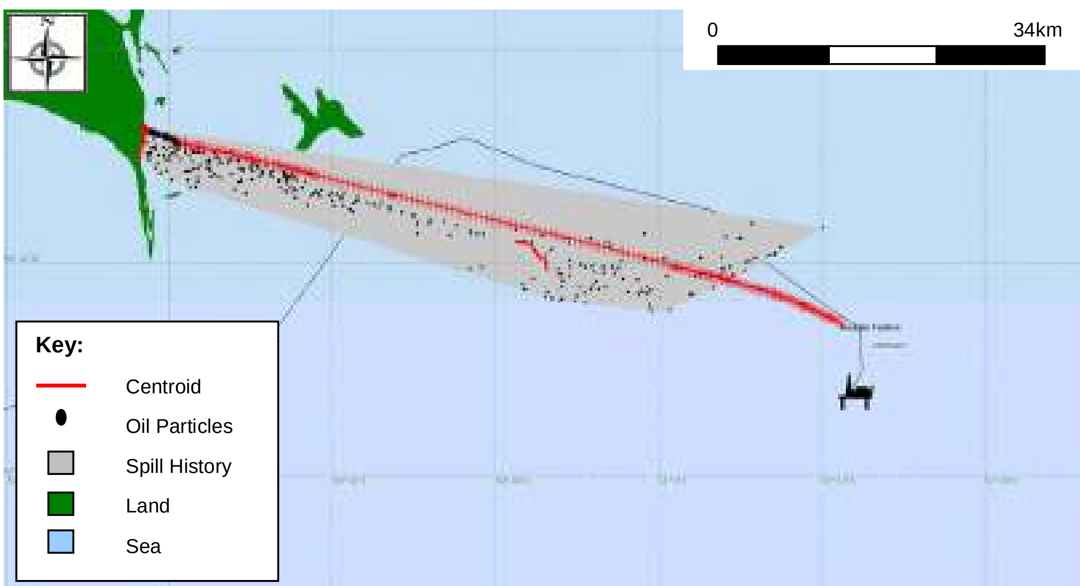

Figure 10 Spill history for Scenario 1A.5 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

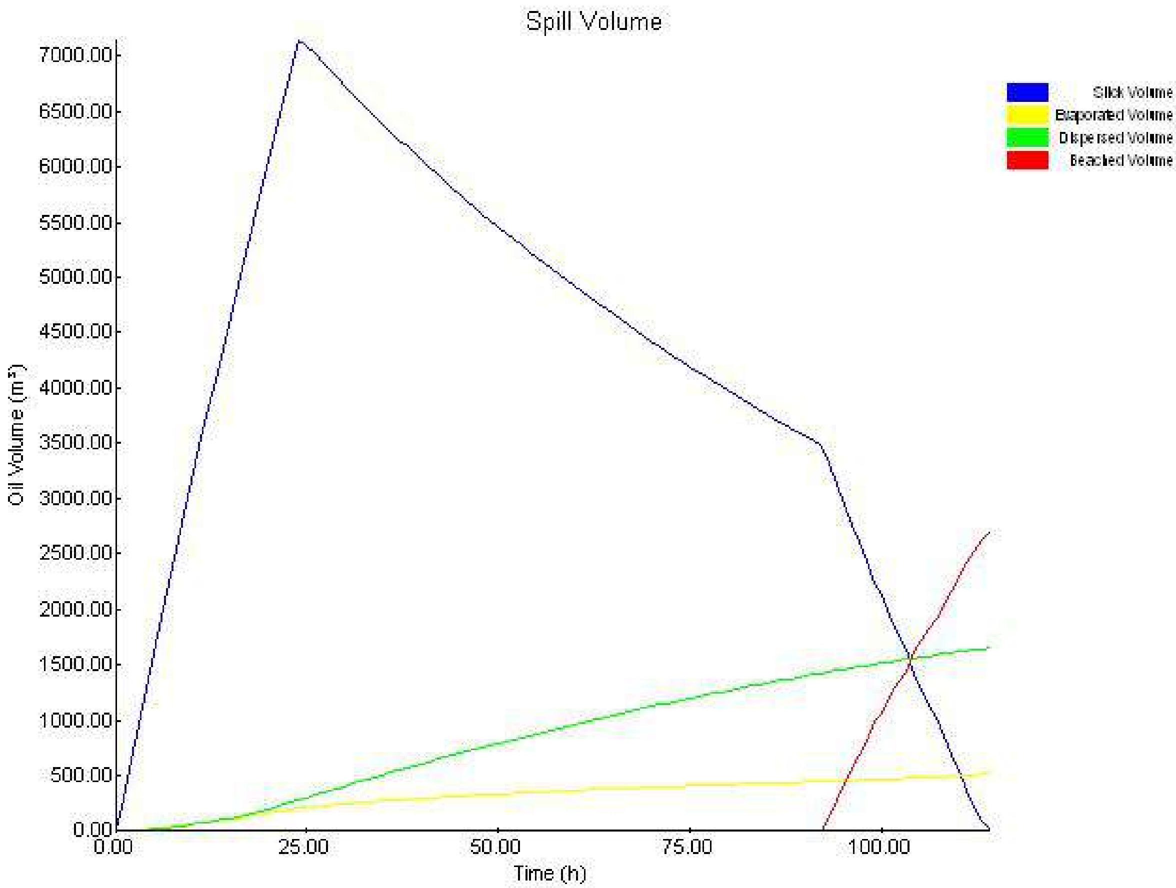

Figure 11 The volumes of oil in different phases over time for Scenario 1A.6.

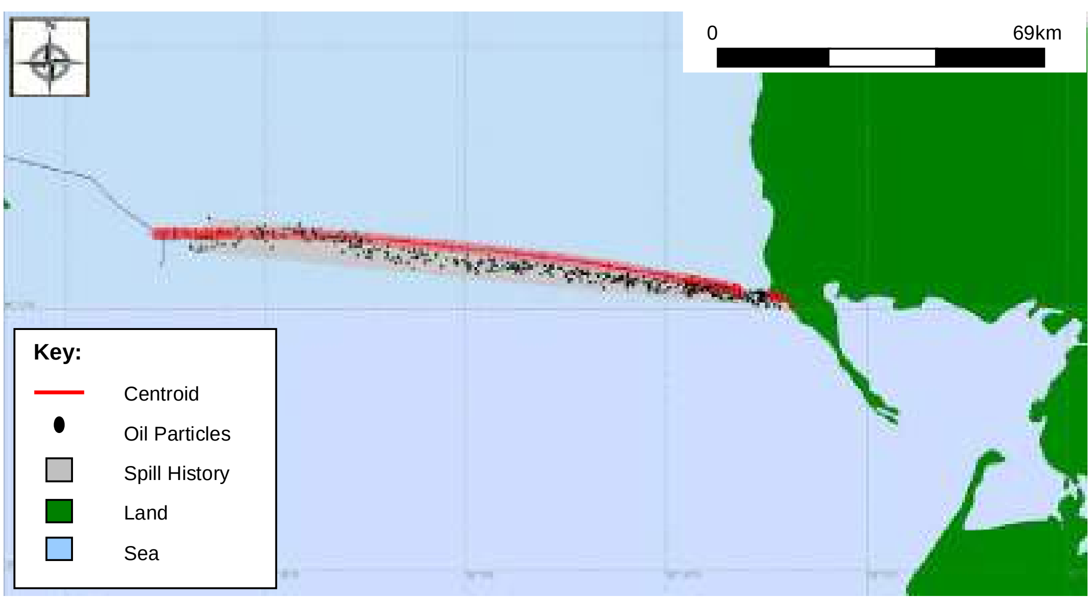

Figure 12 Spill history for Scenario 1A.6 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

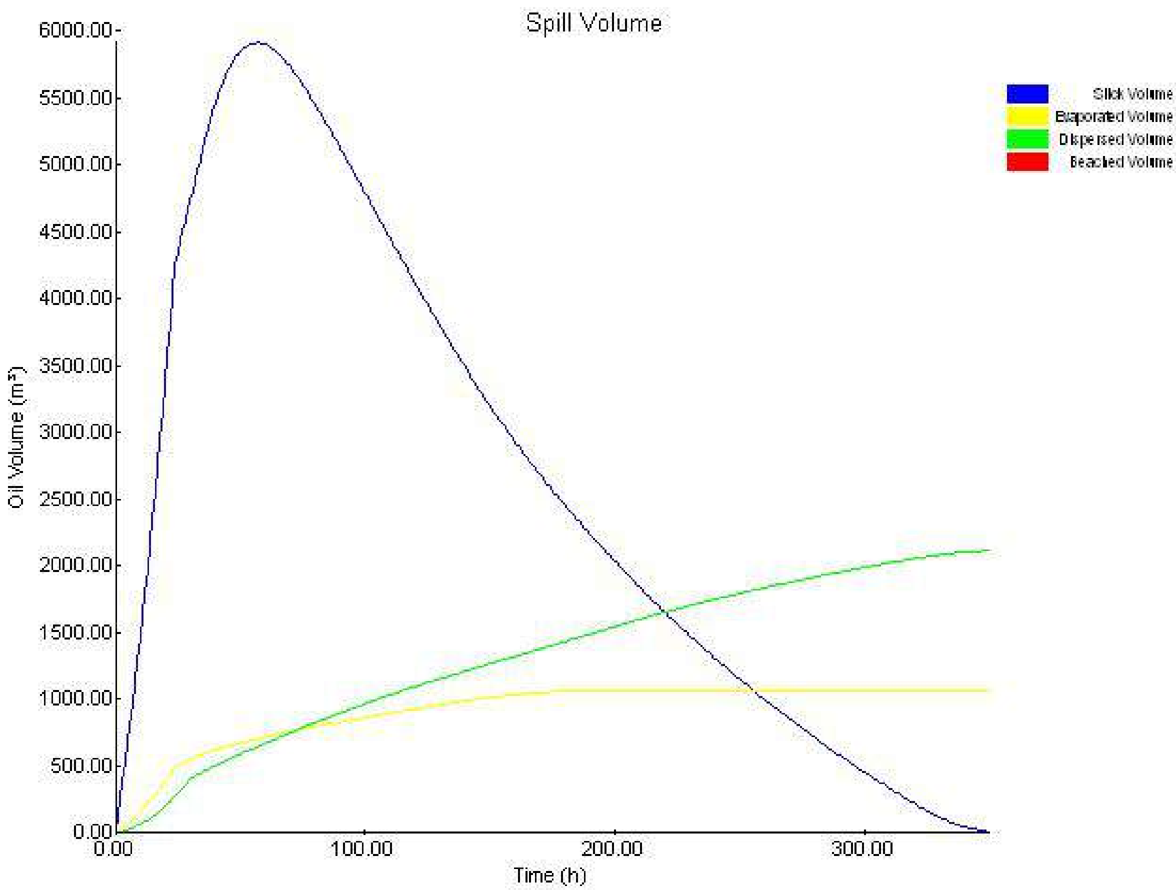

Figure 13 The volumes of oil in different phases over time for Scenario 1A.7.

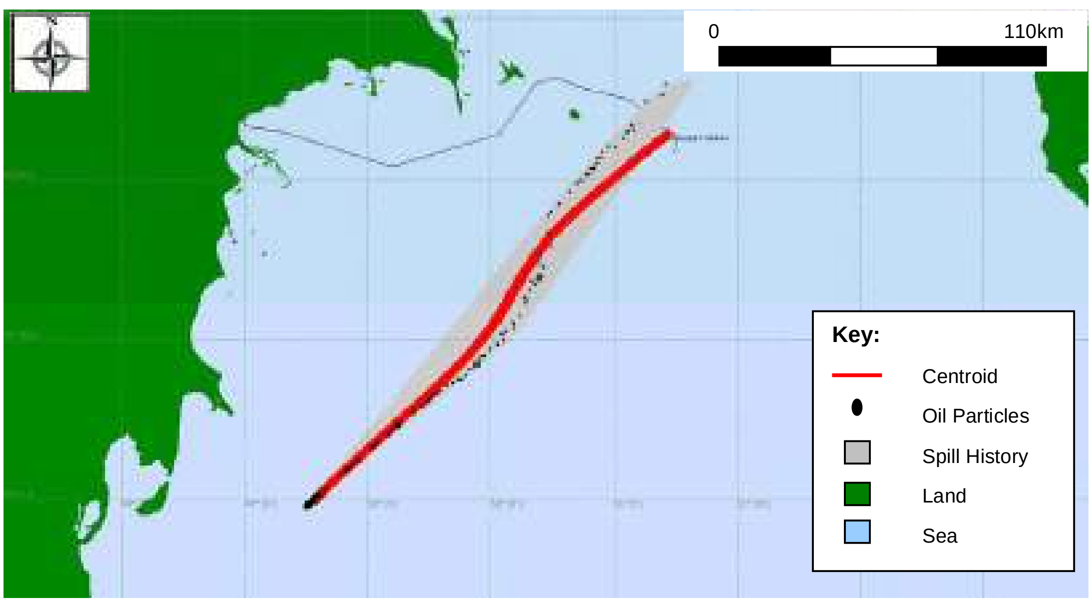

Figure 14 Spill history for Scenario 1A.7 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

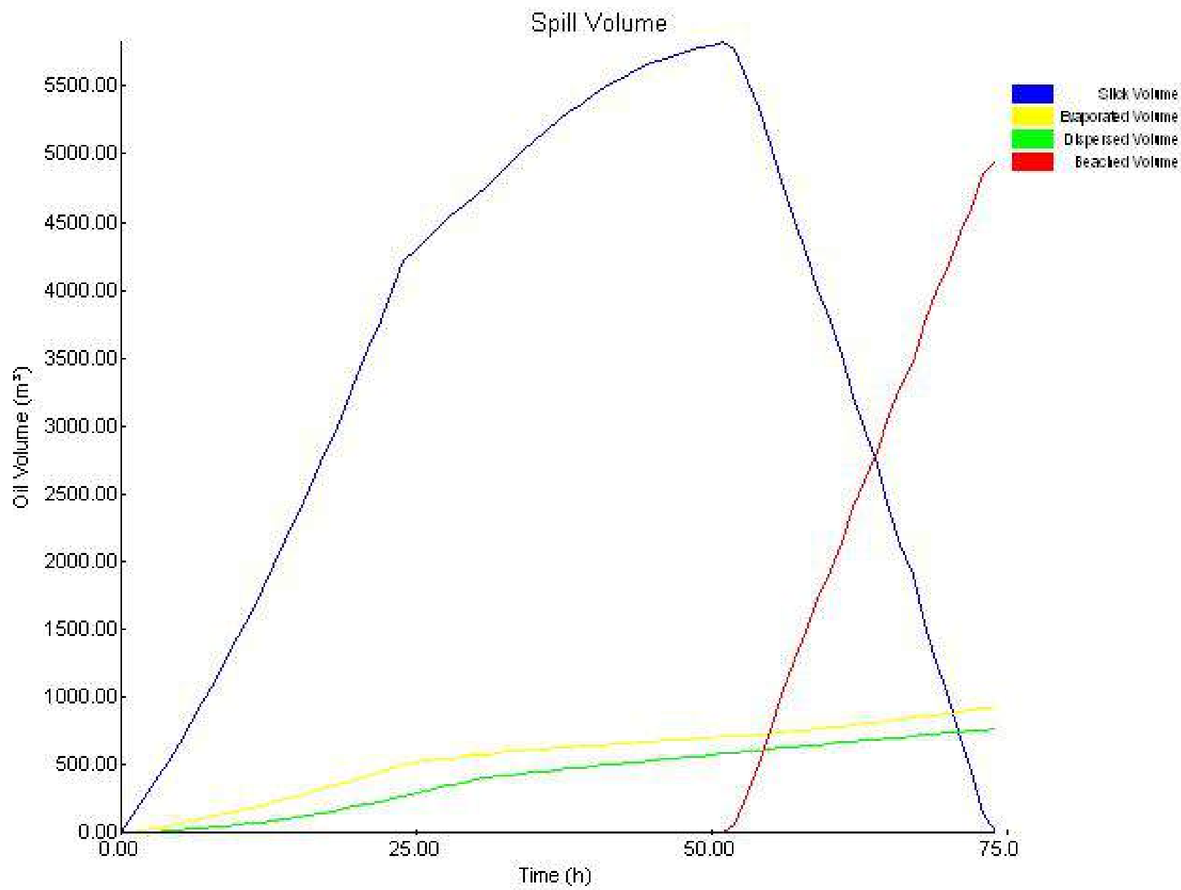

Figure 15 The volumes of oil in different phases over time for Scenario 1A.8.

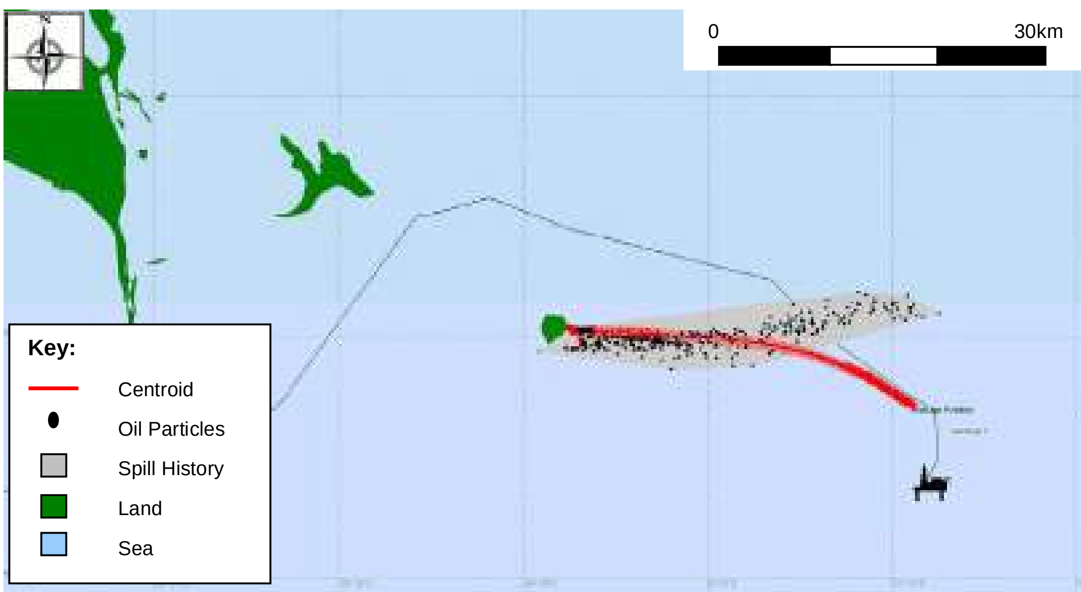

Figure 16 Spill history for Scenario 1A.8 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

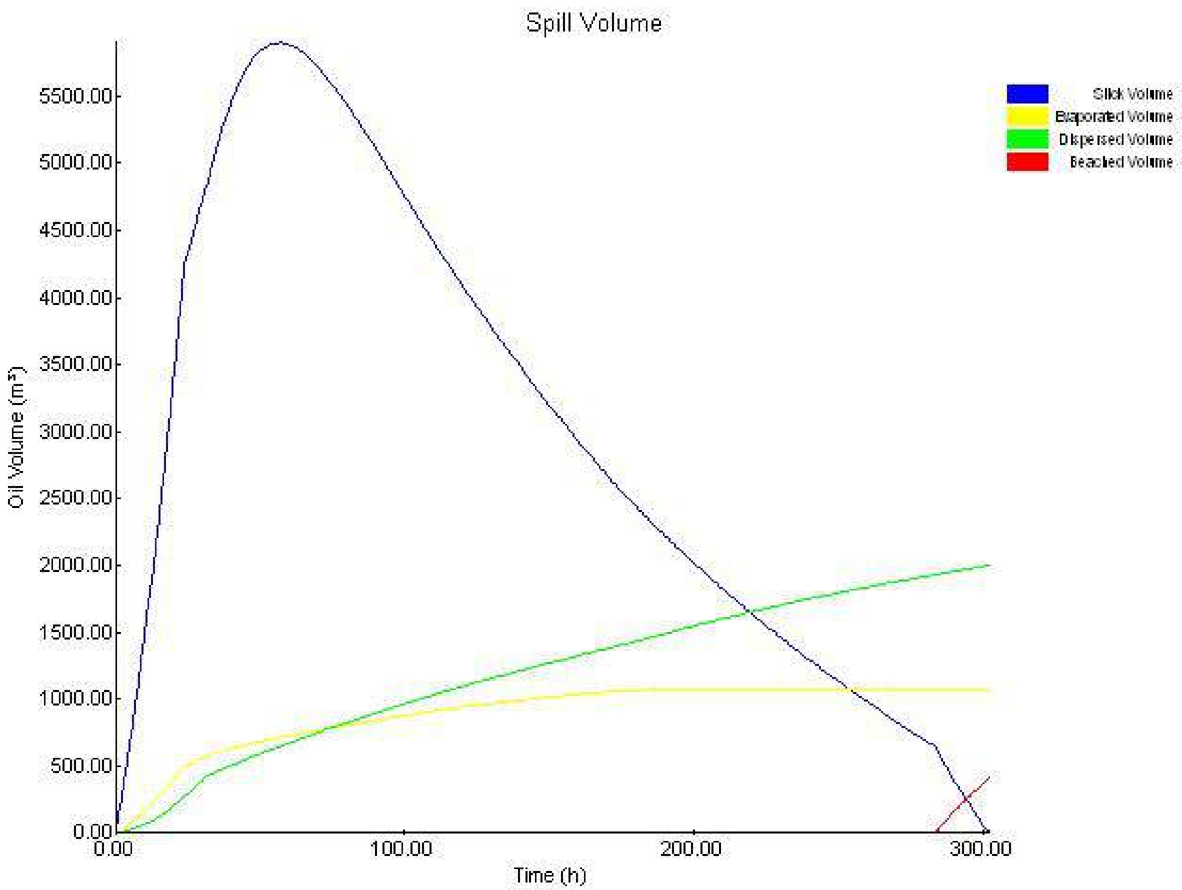

Figure 17 The volumes of oil in different phases over time for Scenario 1A.9.

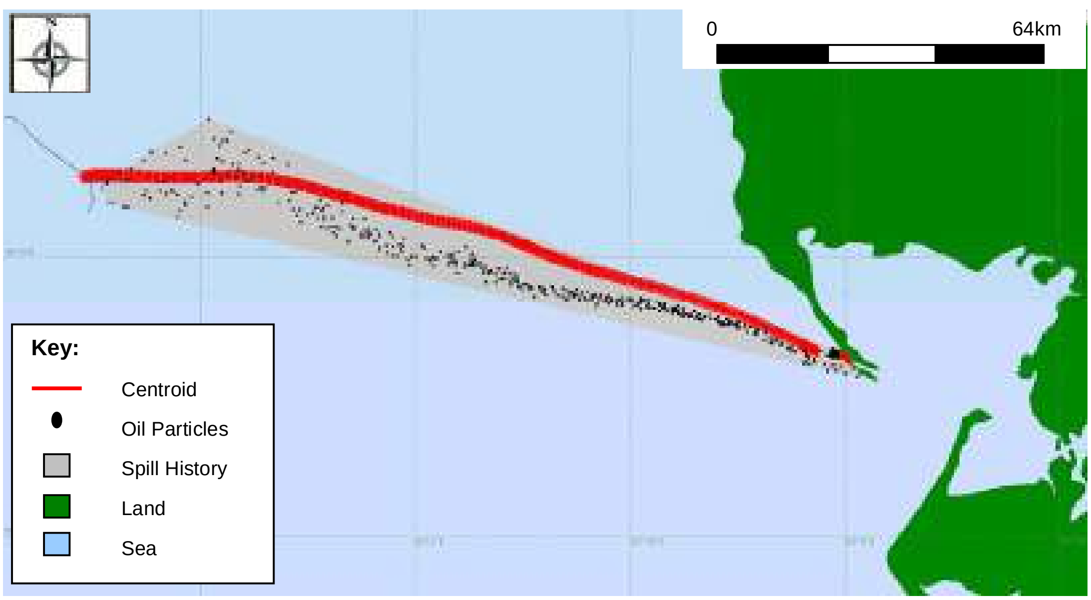

Figure 18 Spill history for Scenario 1A.9 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

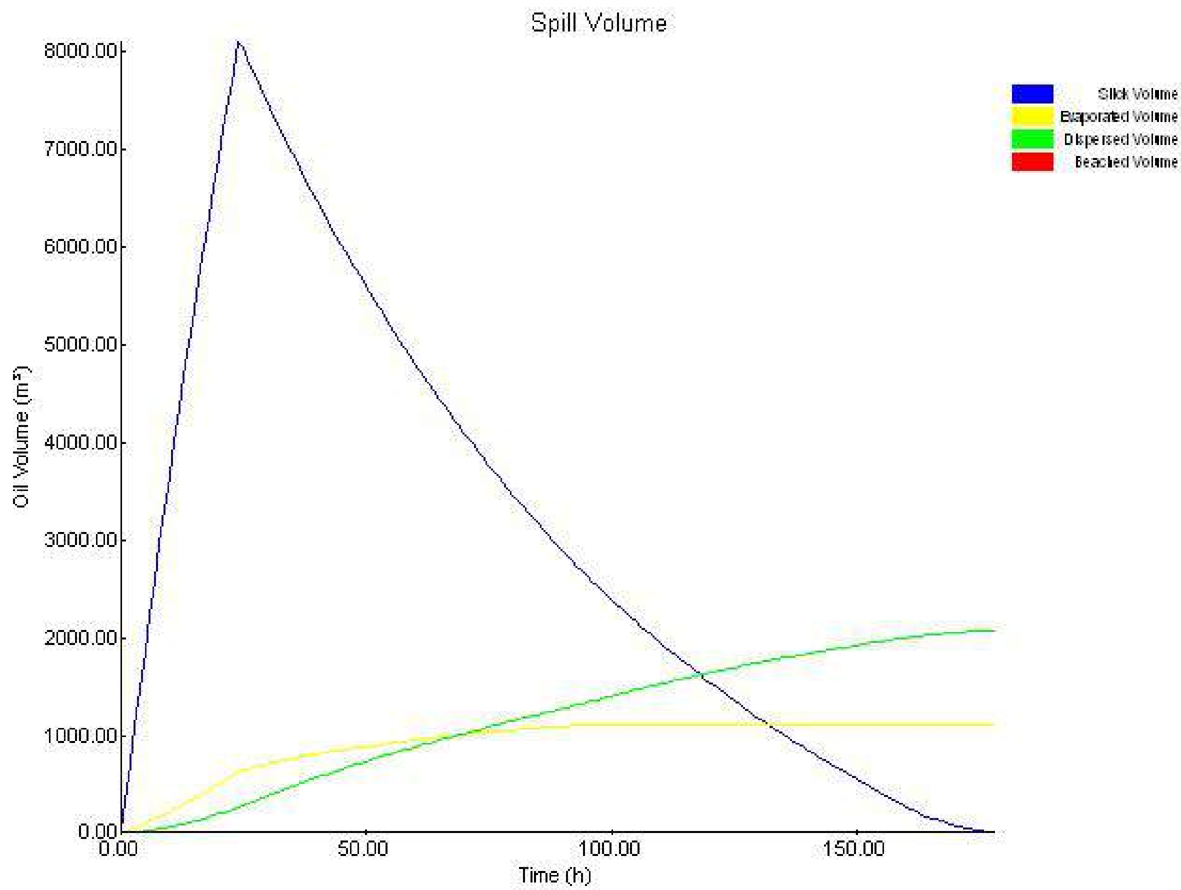

Figure 19 The volumes of oil in different phases over time for Scenario 1A.10.

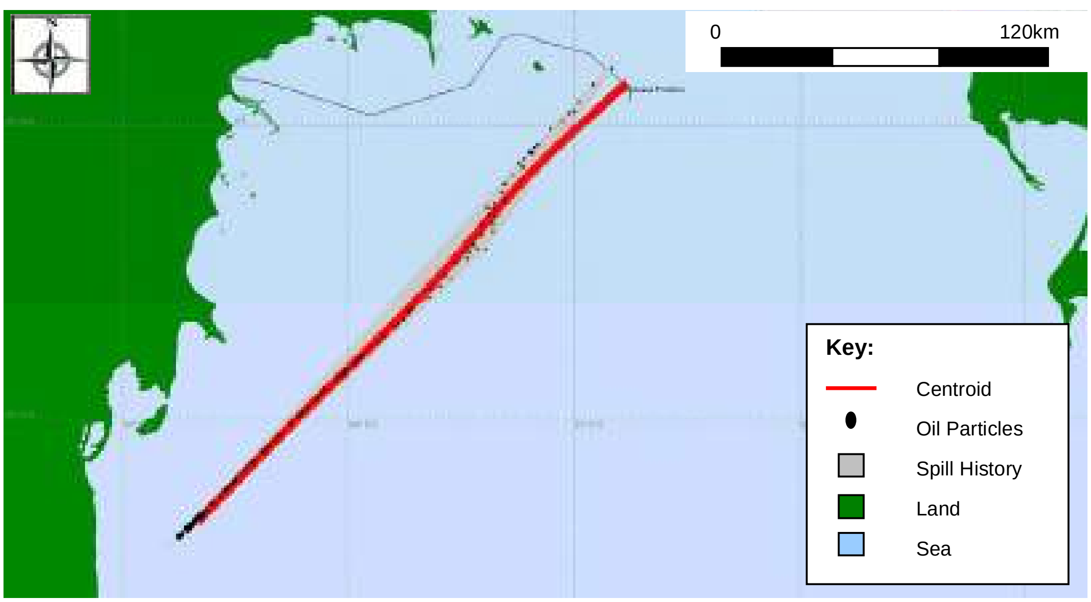

Figure 20 Spill history for Scenario 1A.10 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

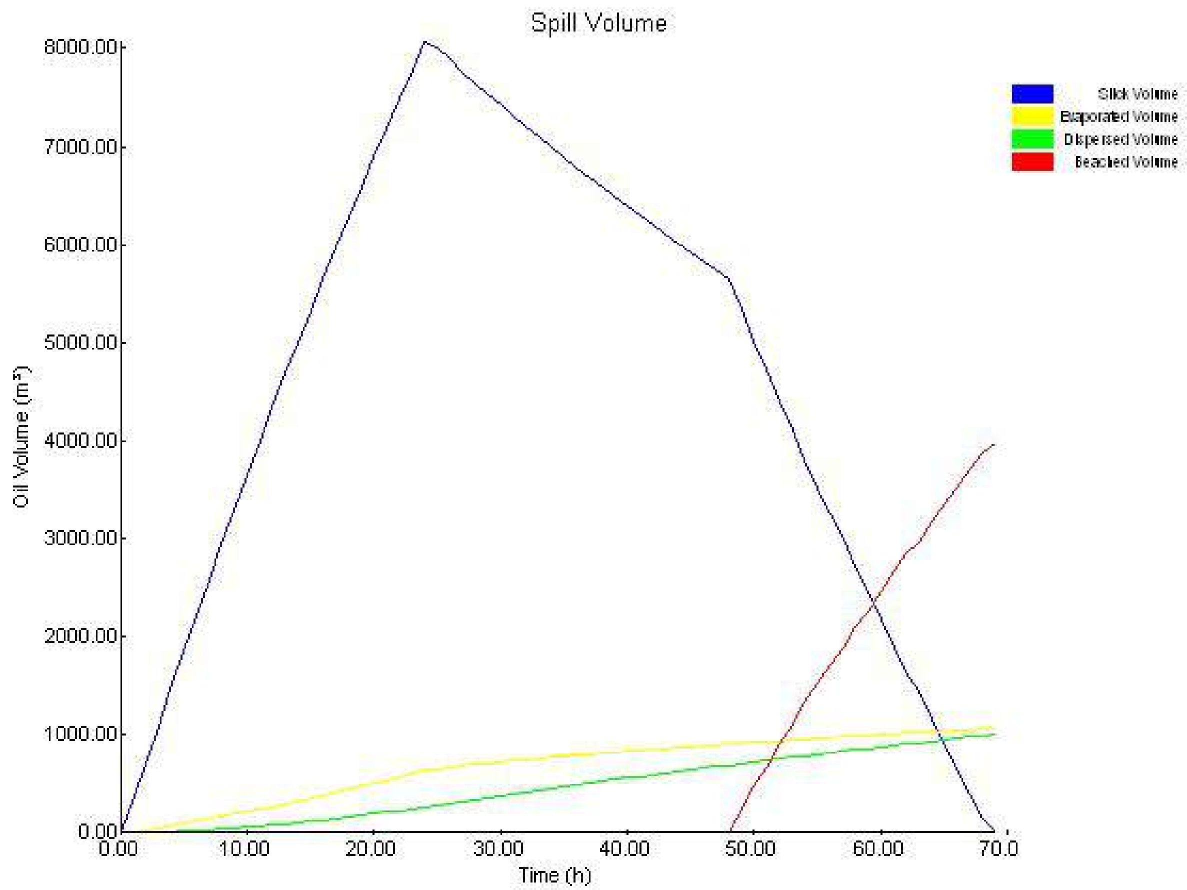

Figure 21 The volumes of oil in different phases over time for Scenario 1A.11.

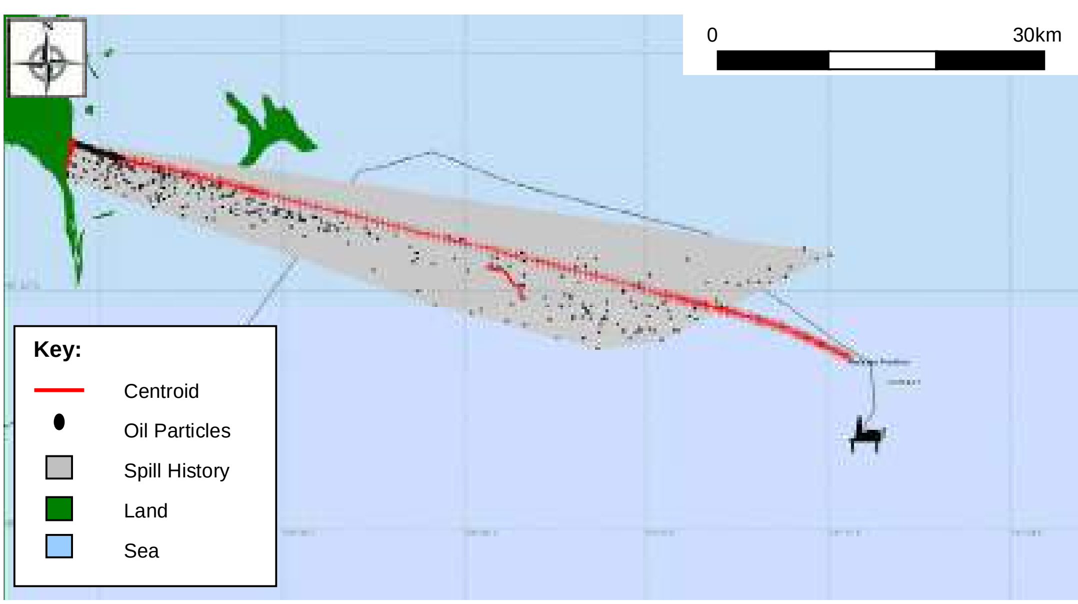

Figure 22 Spill history for Scenario 1A.11 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

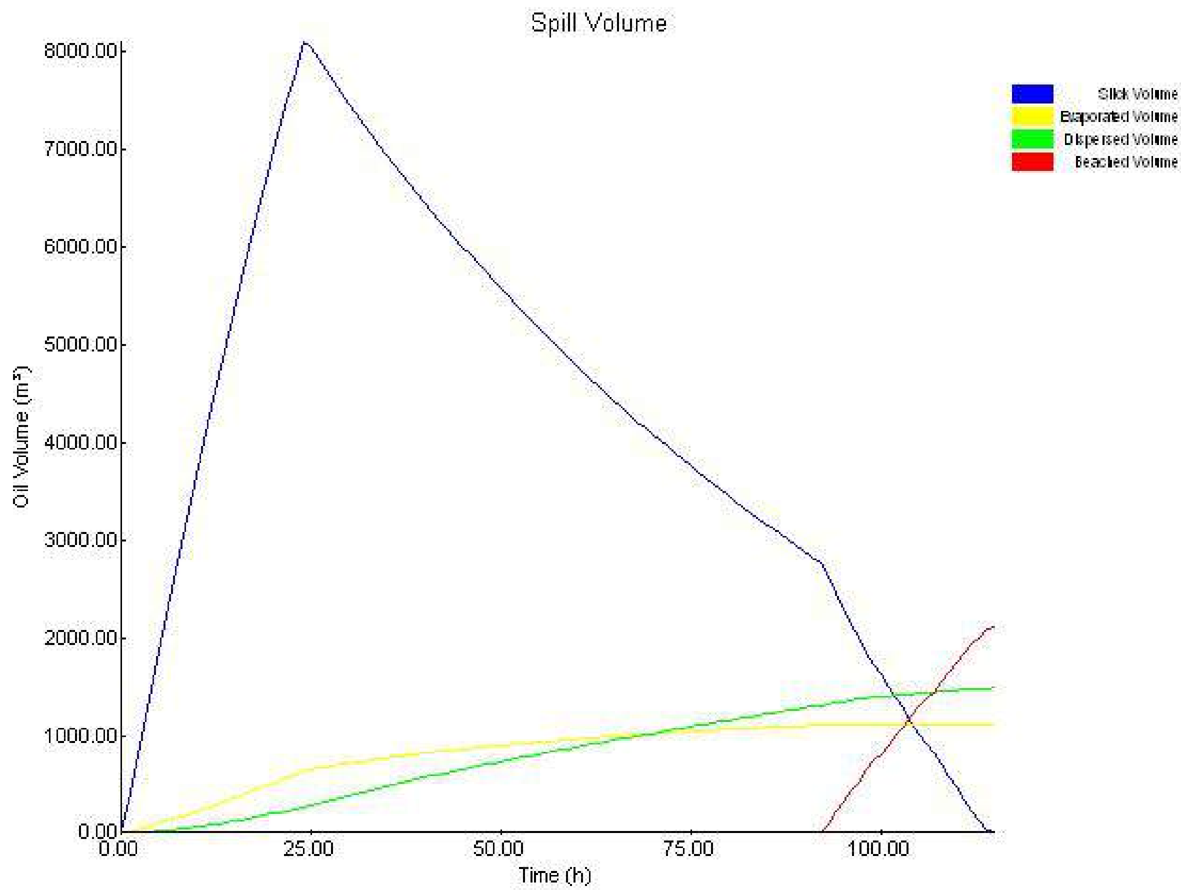

Figure 23 The volumes of oil in different phases over time for Scenario 1A.12.

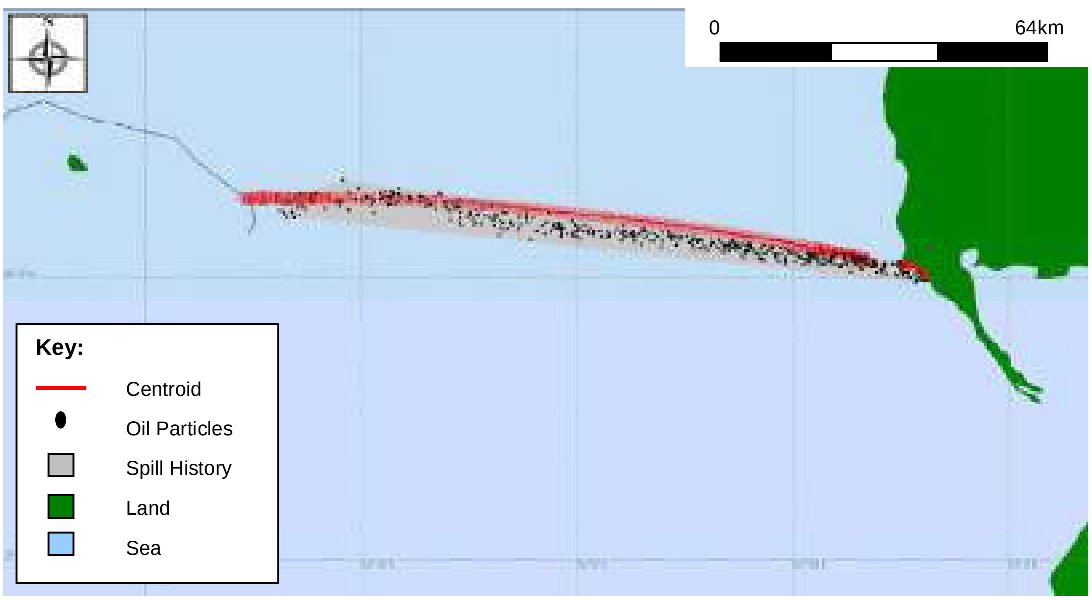

Figure 24 Spill history for Scenario 1A.12 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

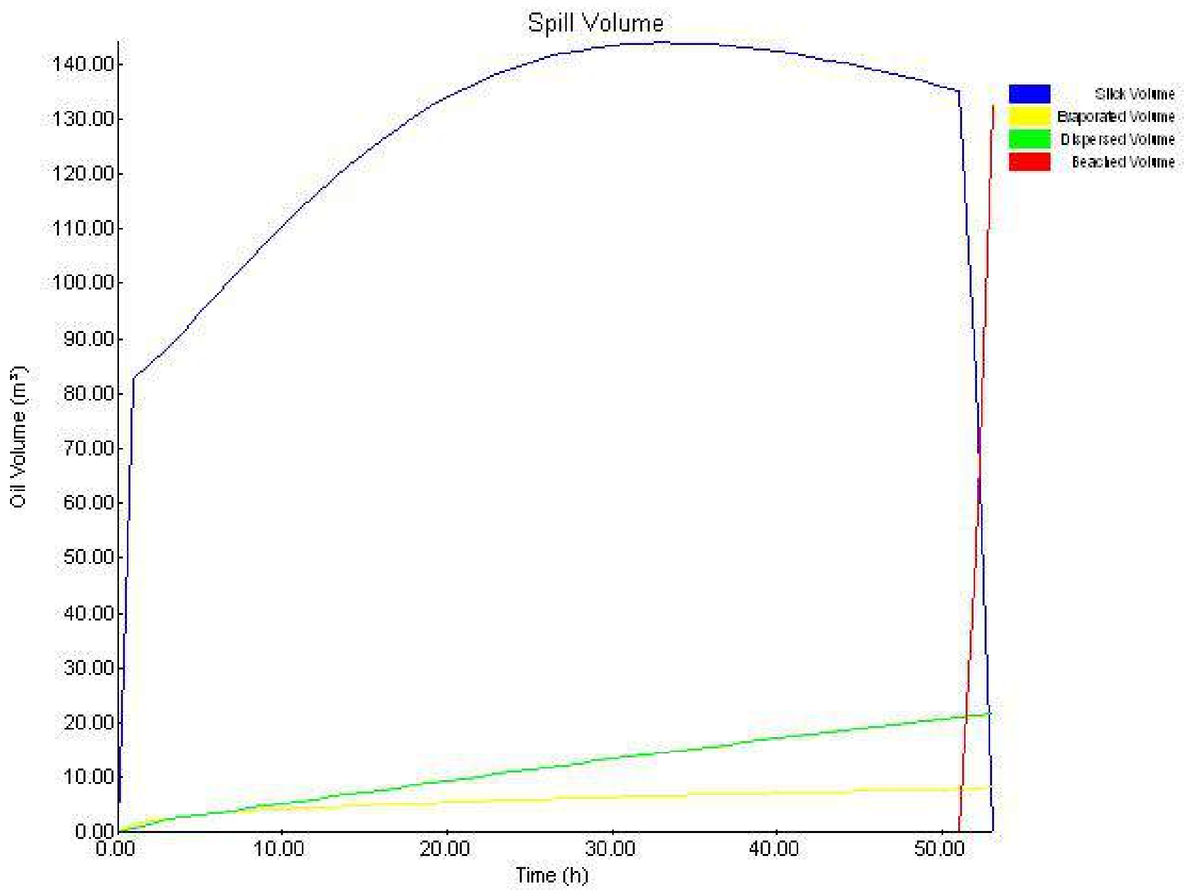

Figure 25 The volumes of oil in different phases over time for Scenario 1B.1.

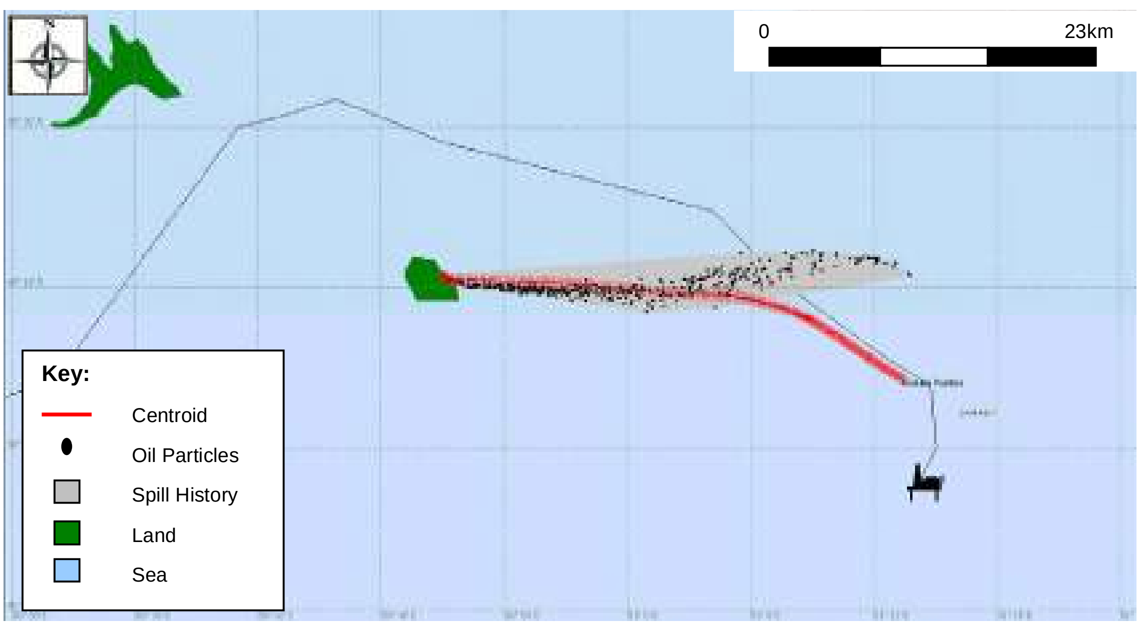

Figure 26 Spill history for Scenario 1B.1 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

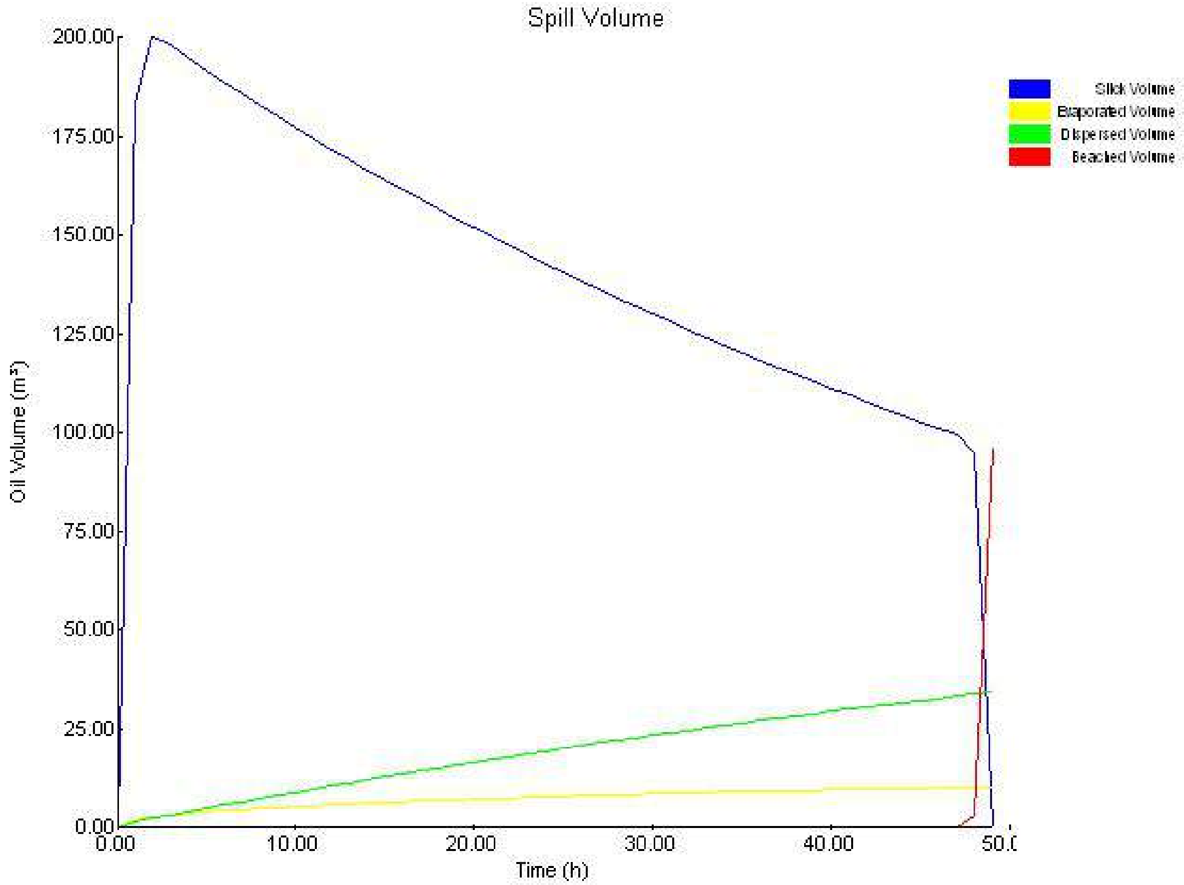

Figure 27 The volumes of oil in different phases over time for Scenario 1B.2.

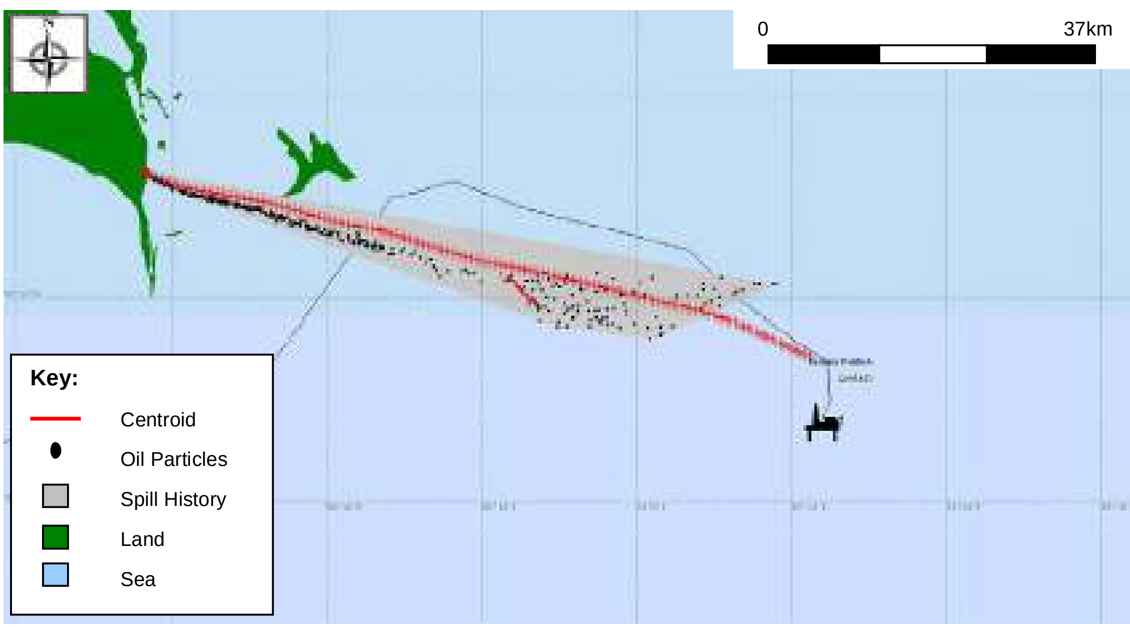

Figure 28 Spill history for Scenario 1B.2 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

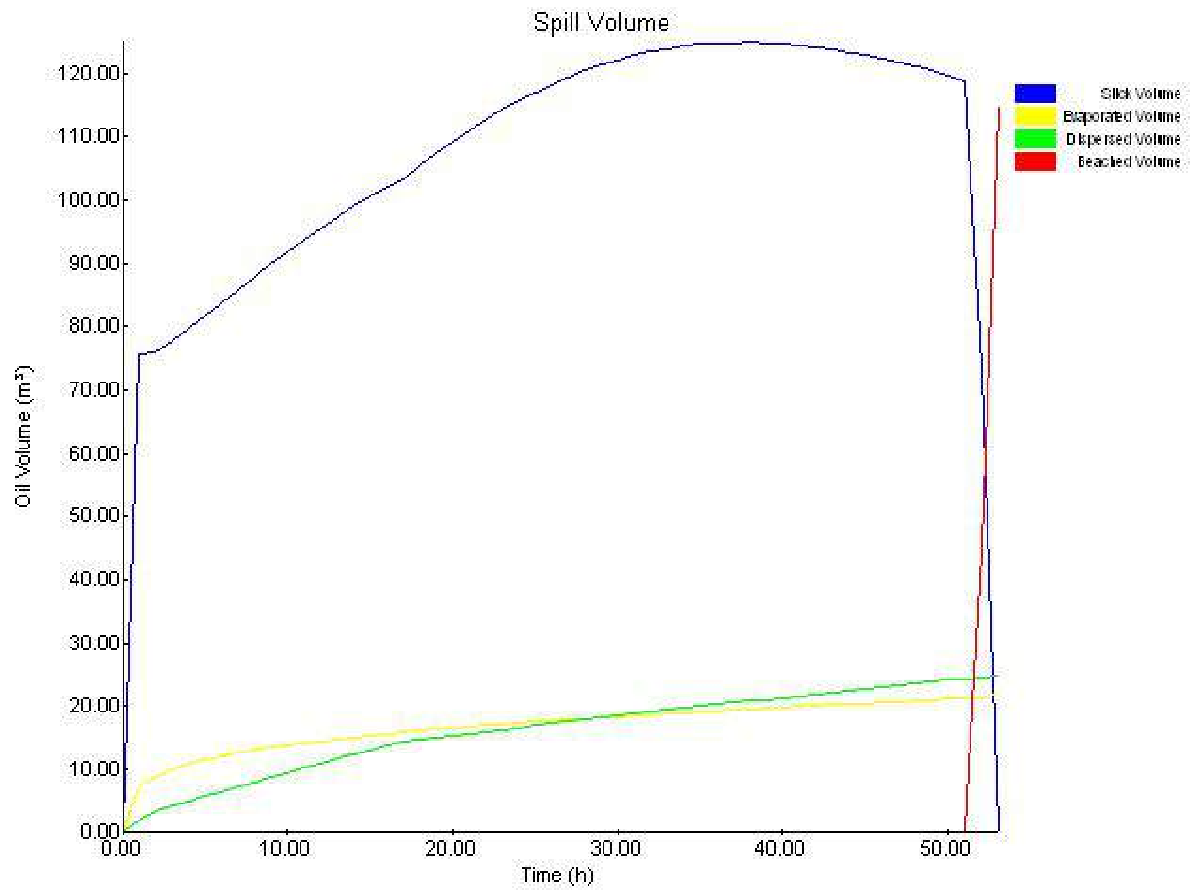

Figure 29 The volumes of oil in different phases over time for Scenario 1B.3.

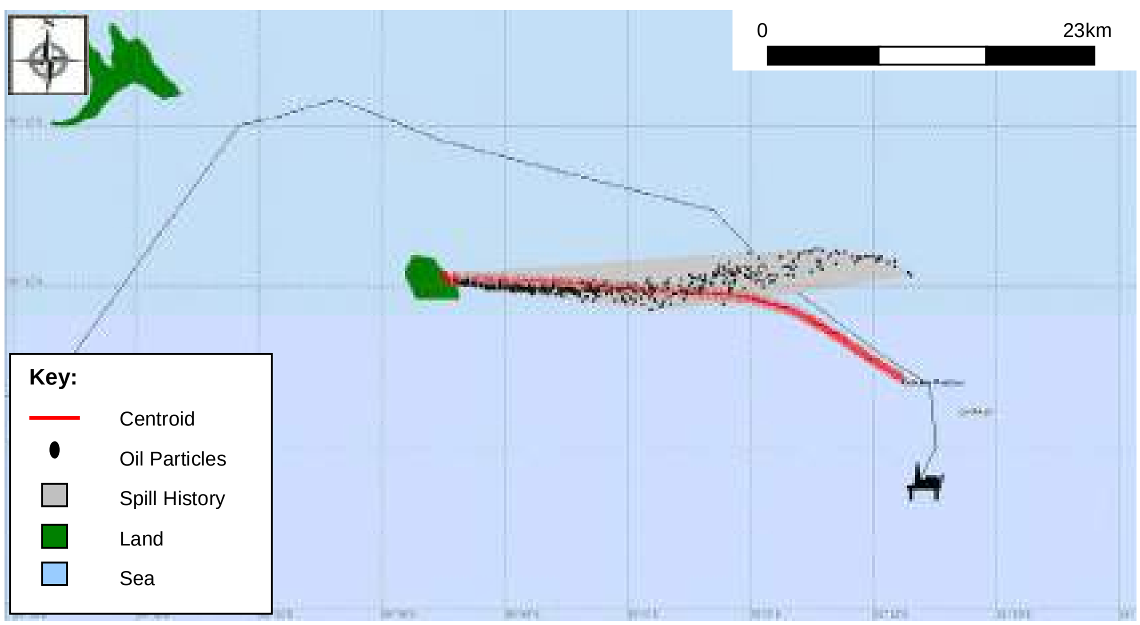

Figure 30 Spill history for Scenario 1B.3 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

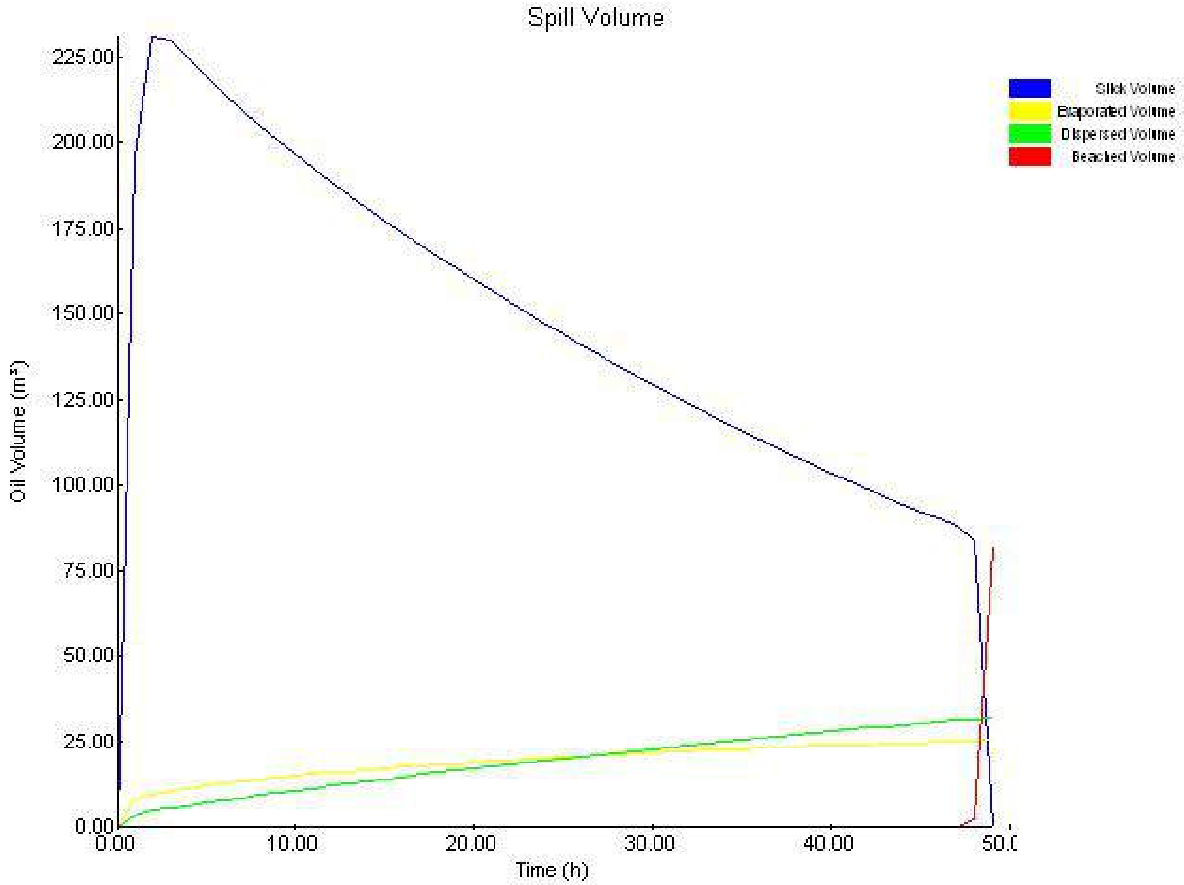

Figure 31 The volumes of oil in different phases over time for Scenario 1B.4.

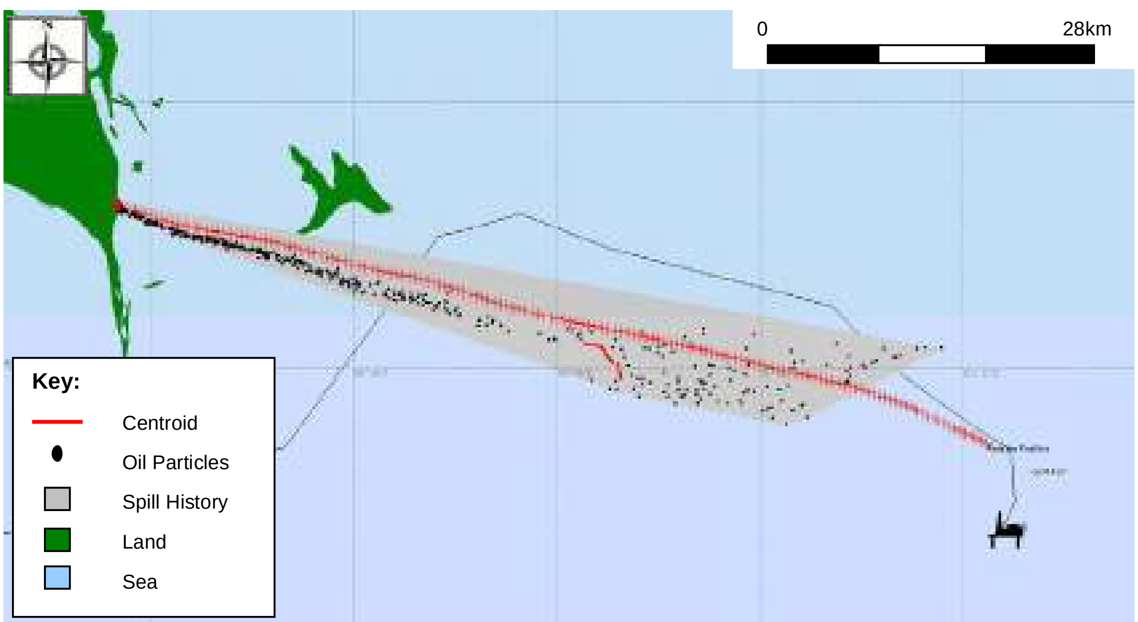

Figure 32 Spill history for Scenario 1B.4 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

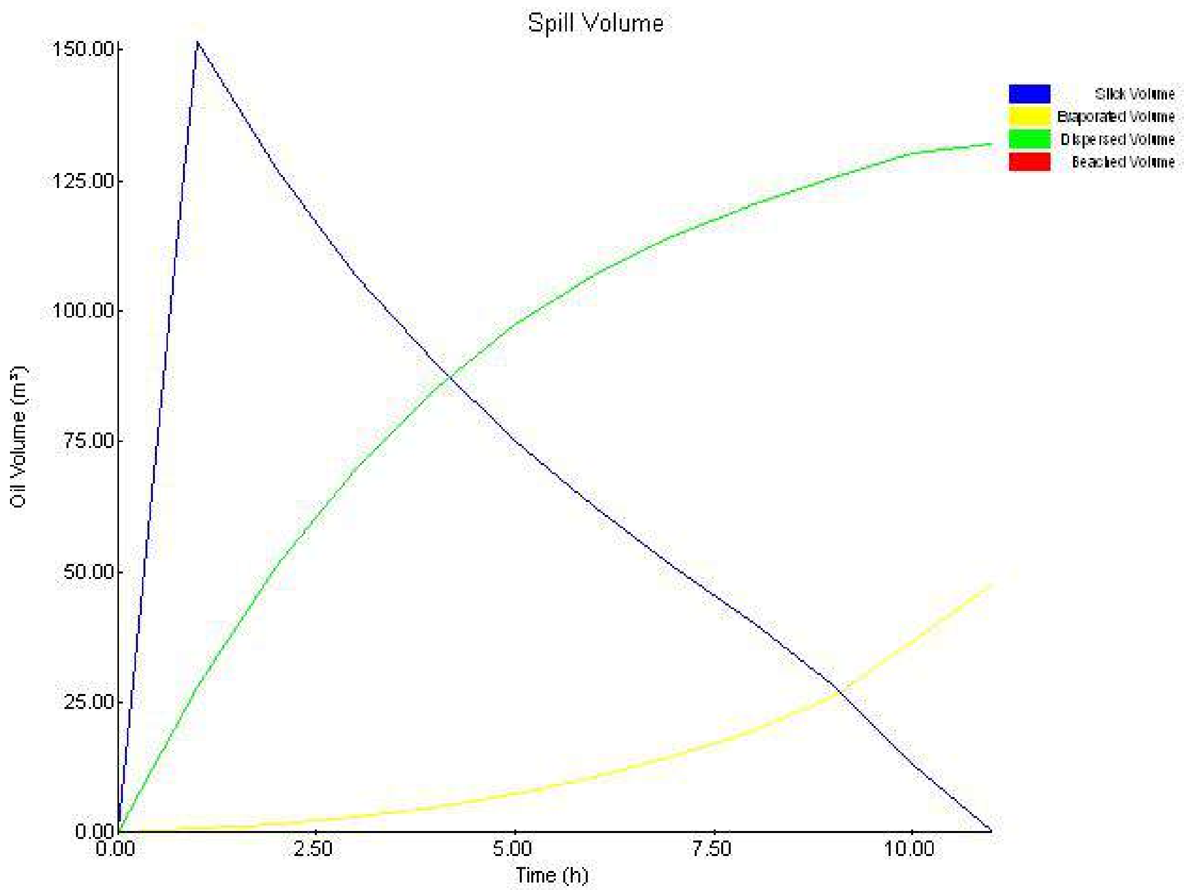

Figure 33 The volumes of oil in different phases over time for Scenario 1C.1.

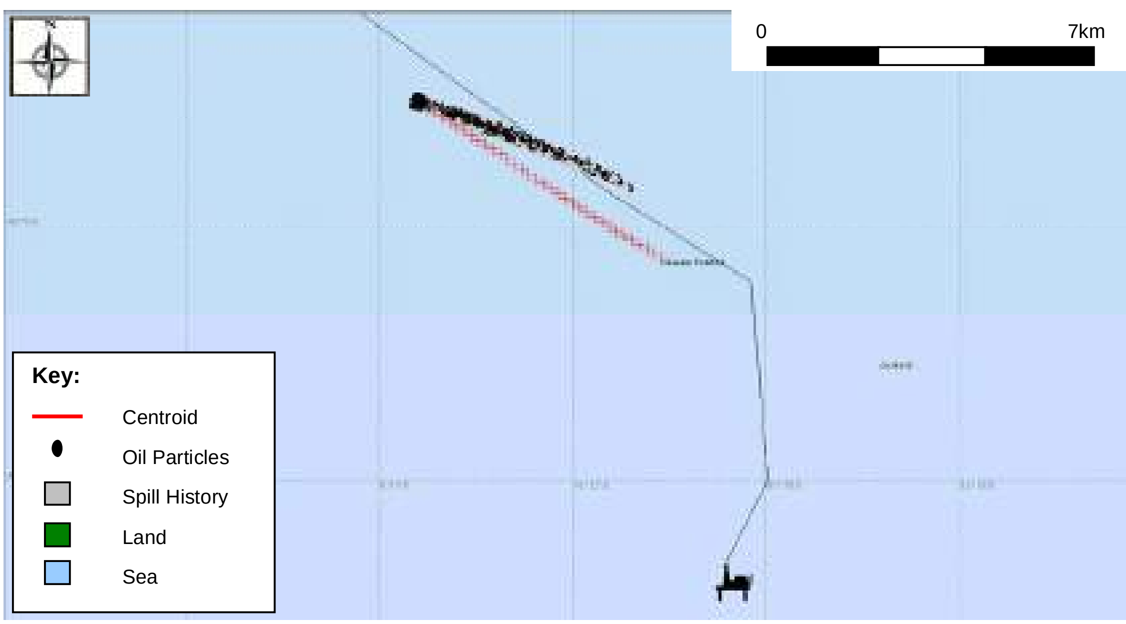

Figure 34 Spill history for Scenario 1C.1 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

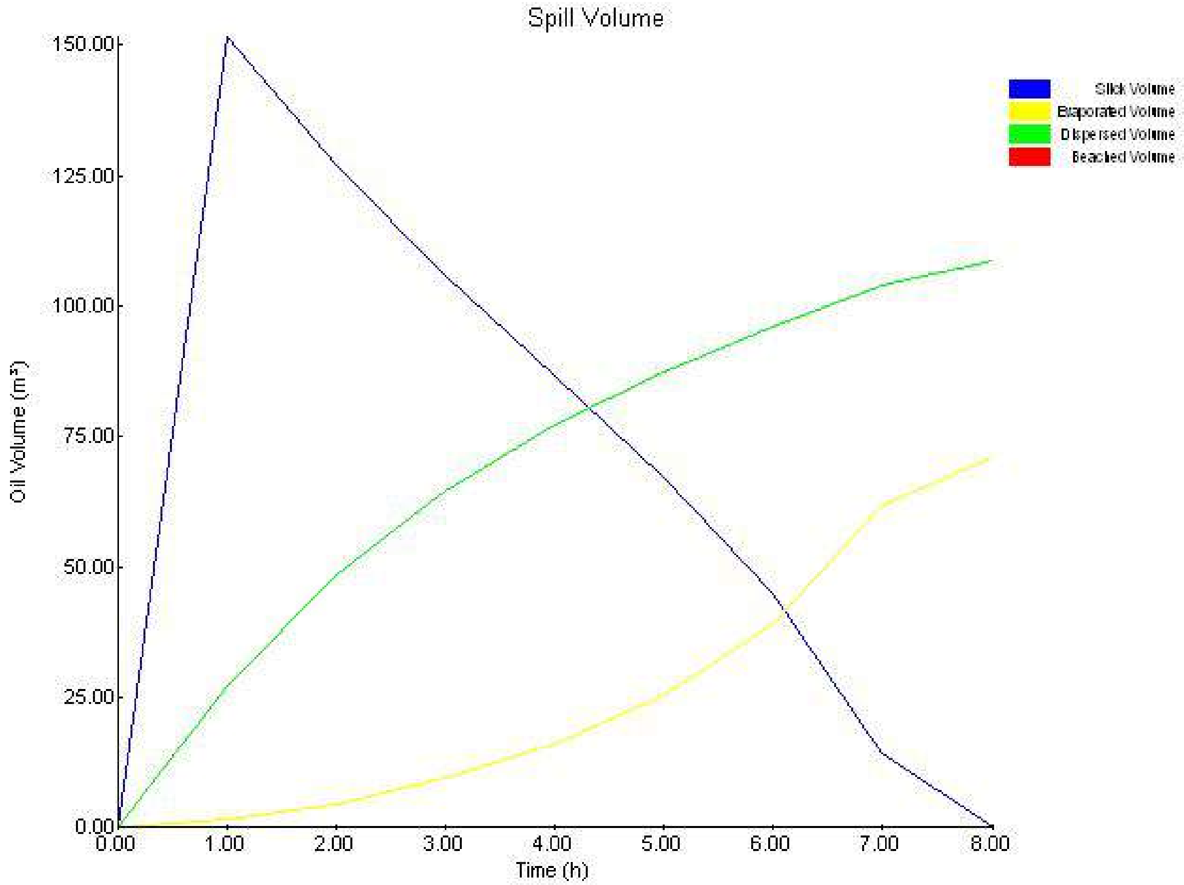

Figure 35 The volumes of oil in different phases over time for Scenario 1C.2.

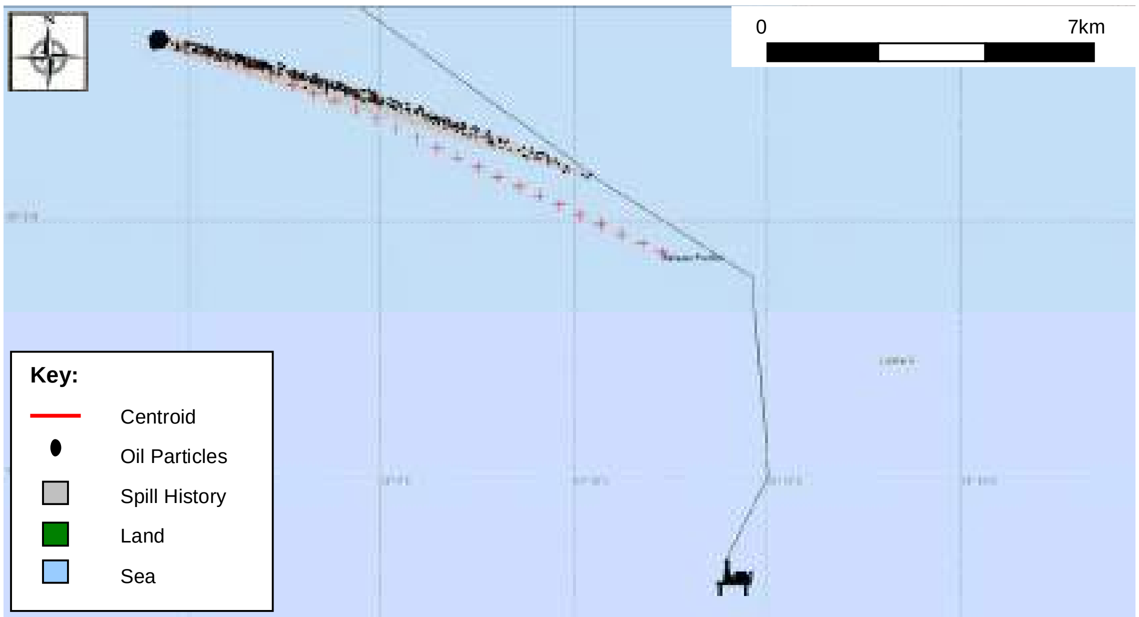

Figure 36 Spill history for Scenario 1C.2 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

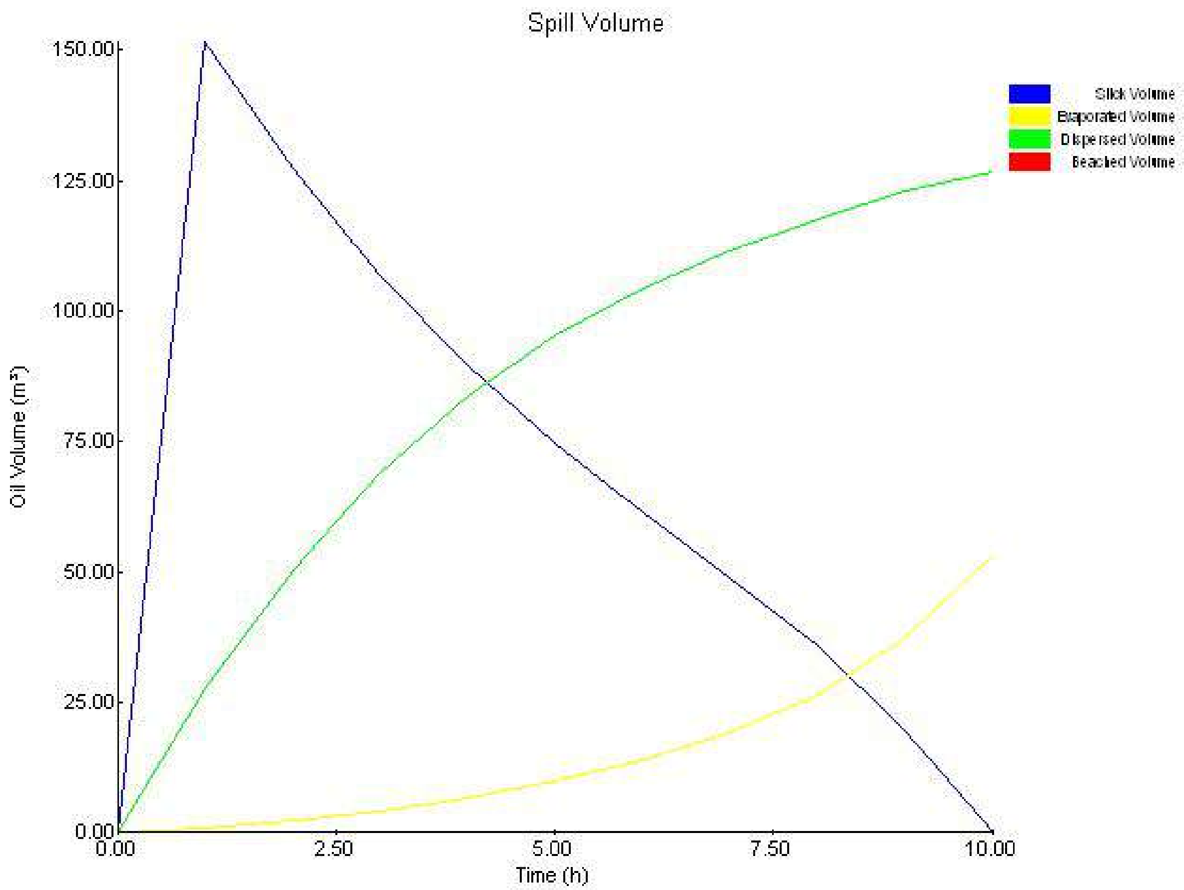

Figure 37 The volumes of oil in different phases over time for Scenario 1C.3.

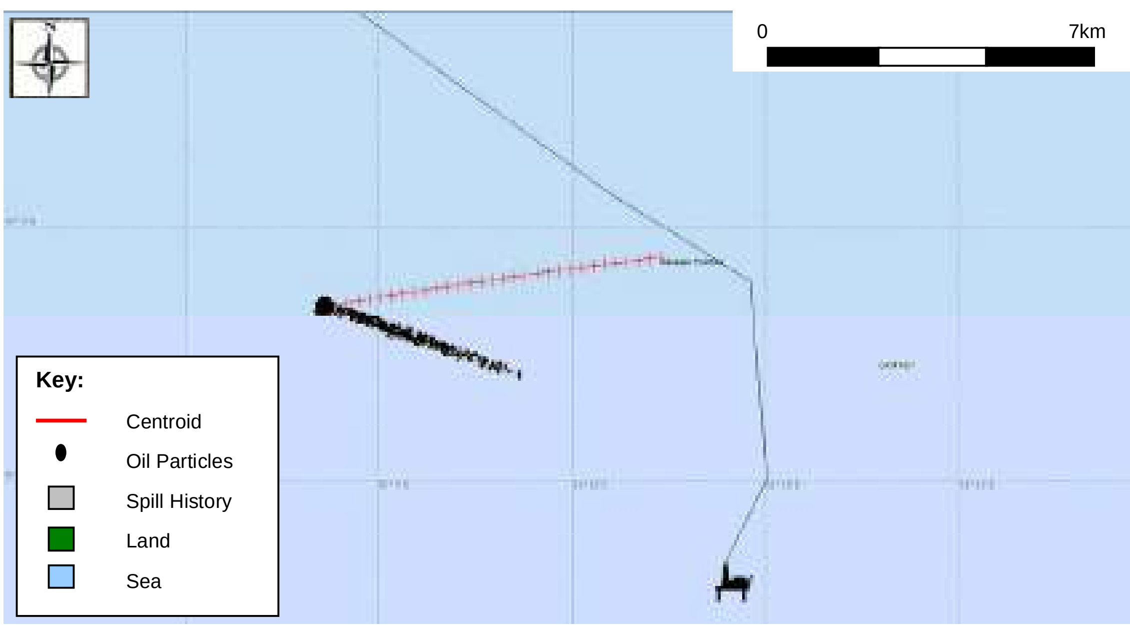

Figure 38 Spill history for Scenario 1C.3 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

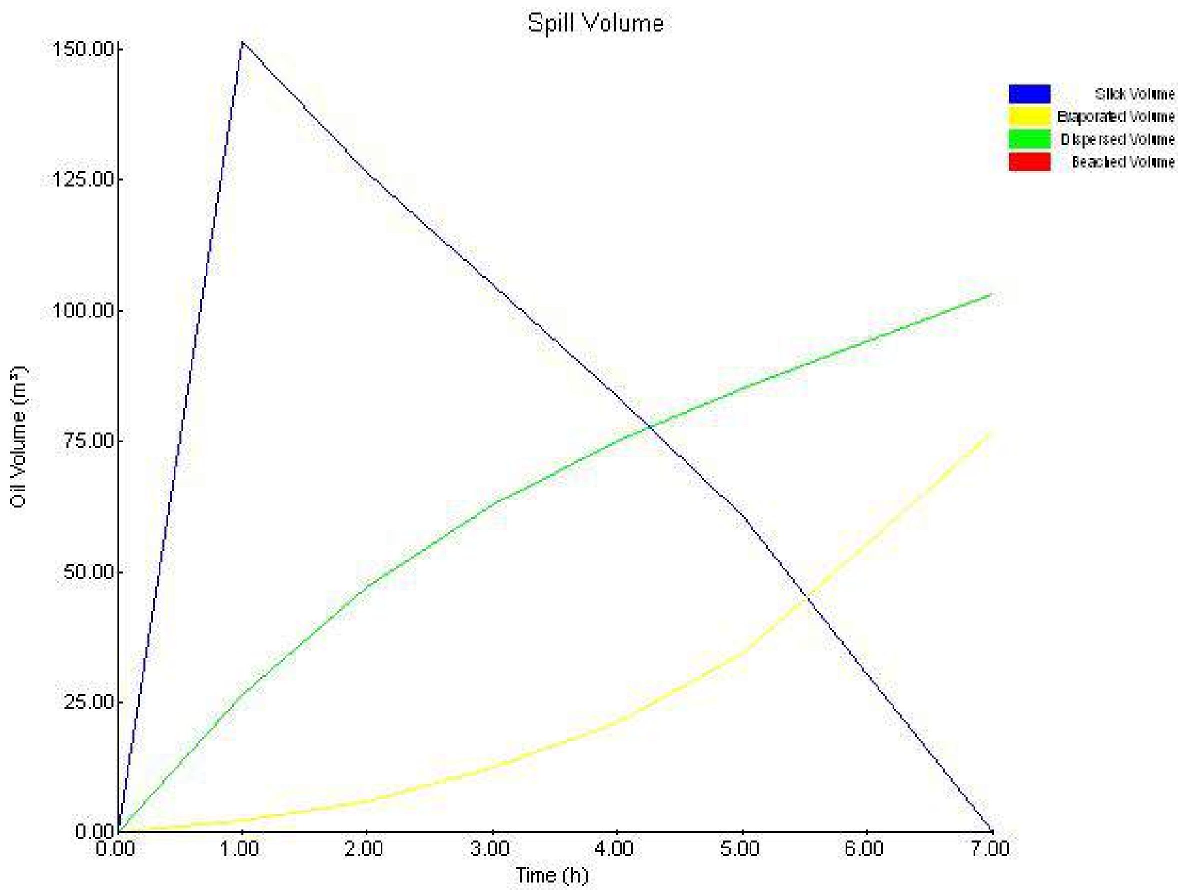

Figure 39 The volumes of oil in different phases over time for Scenario 1C.4.

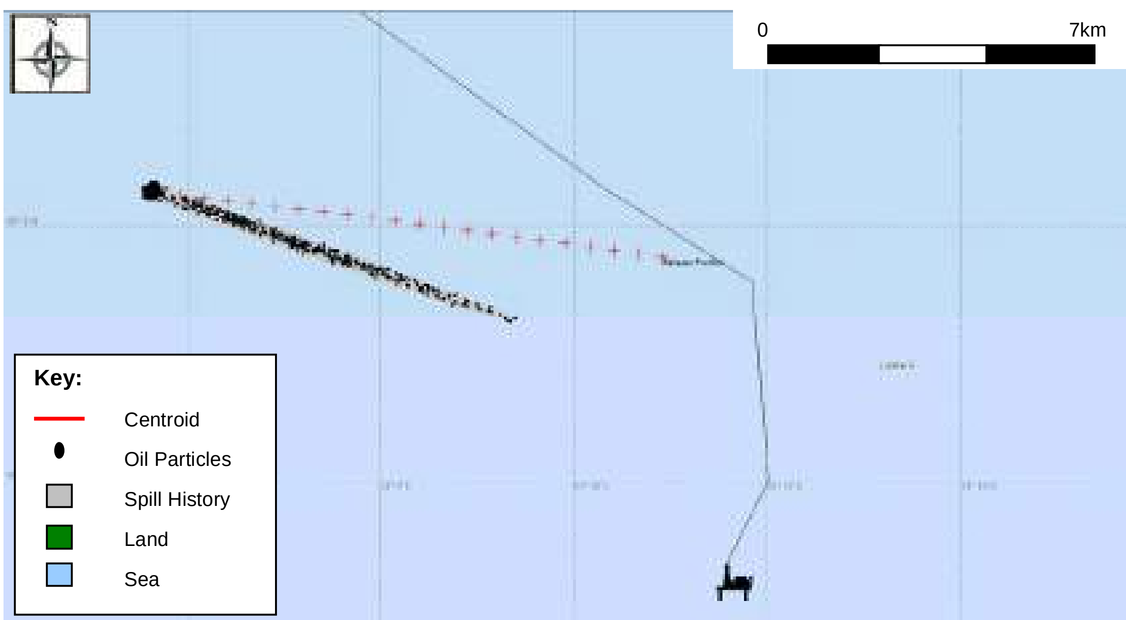

Figure 40 Spill history for Scenario 1C.4 showing the trajectory of the 24 hour oil spill. The grey area indicates the area most likely to be affected by oil sheening.

Annex A: OSIS Model Suitability and Verification

OSIS Version 4.2.2 is the latest release of the long-established oil spill modelling system jointly developed by BMT Cordah and AEA Technology. The system provides a total capability to predict the movement, spreading, weathering and coastal impact of oil spilt in the marine environment. Most importantly, the model has been extensively validated during scientific sea trials (through a licence exclusively held in the UK by AEA Technology) and real incidents (e.g. Braer, Sea Empress). 18 sea trials have been conducted, up to 3 days in duration and using 10 different oil types.

The system has been the primary oil spill modelling system in the UK for many years and is used by the UK Government's Maritime and Coastguard Agency, other governments including all 9 Arabian Gulf states, major spill response companies such as Oil Spill Response Ltd. and Briggs Marine Environmental Services, and most of the UK-based oil companies. It is also used internationally in areas such as SE Asia, Mediterranean, Pacific Asia and the Caspian by many of the world's largest oil companies.

Annex B: Additional scenarios

Two additional runs were undertaken for the COP blowout scenario (Scenario 1A) and are listed in Table 1 below:

Run no	Location (La t/ Long WGS84 datum)	Start Date / Time	Oil Type	Sea Temp (oC)	Air Temp (oC)	Wind		Spill Characteristics	
						Speed (m/s)	Direction (o)	Release Rate (m3/hr)	Release Duration (hrs)
13	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	5	105	132.5	24 (42 days)
14	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	Chirag	6	6	5	115	132.5	24 (42 days)
15	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	5	105	132.5	24 (42 days)
16	Easting: 519,004m Northing: 4,443,785m	1/02/2010 00:00	DWG	6	6	5	115	132.5	24 (42 days)

Table 1 Run descriptions for Scenario 1A COP blowout

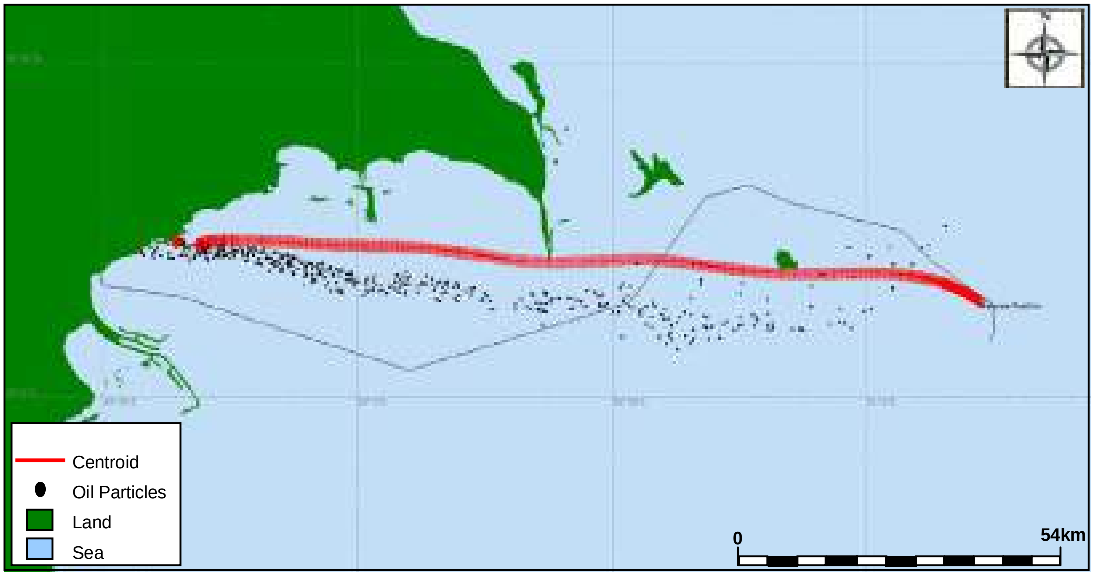

Figure 1 Spill history for Scenario 1A.13 showing the trajectory of the 24 hour oil spill

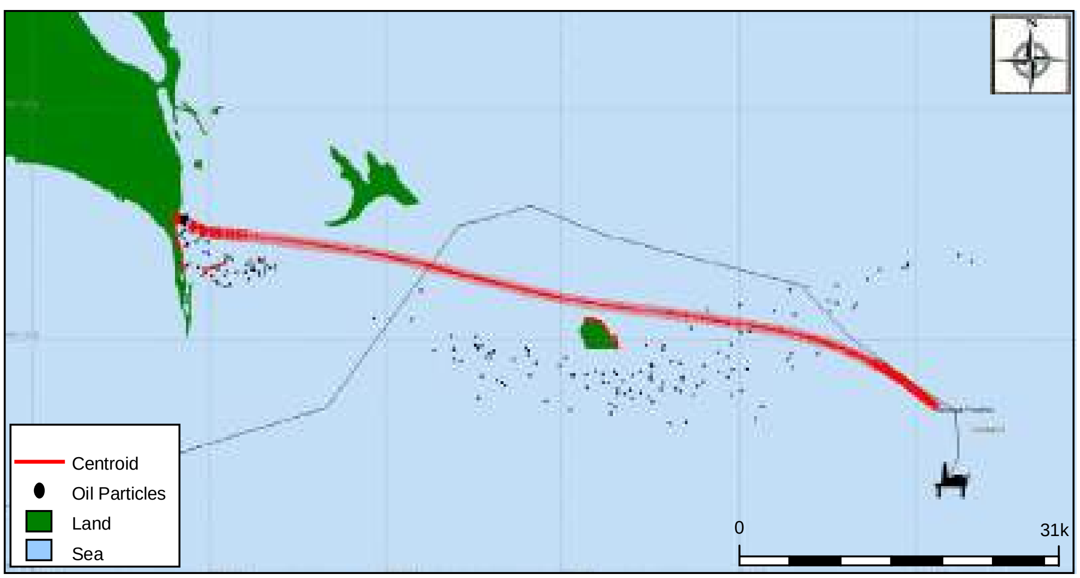

Figure 2 Spill history for Scenario 1A.14 showing the trajectory of the 24 hour oil spill

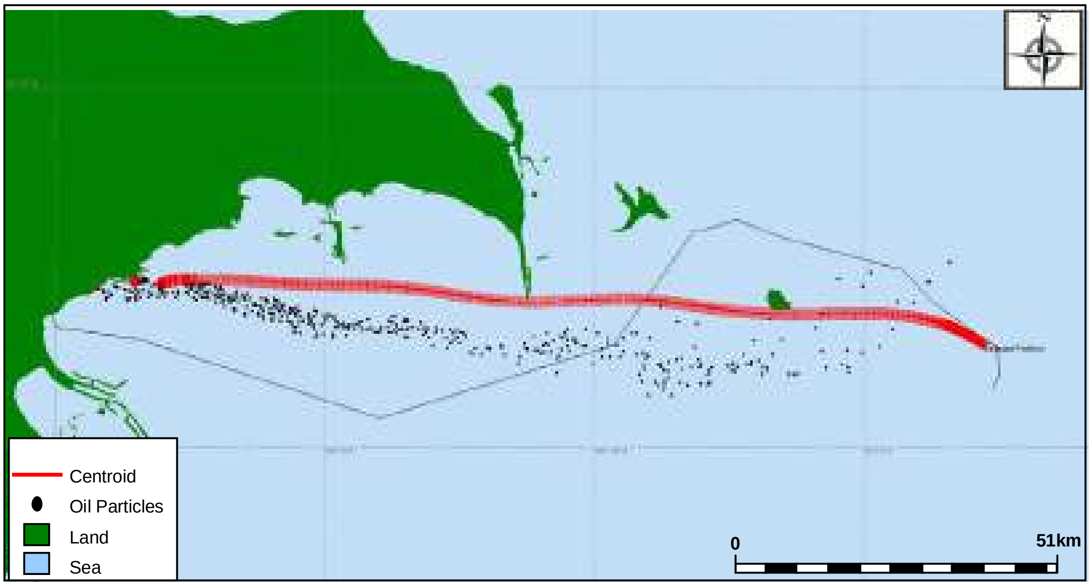

Figure 3 Spill history for Scenario 1A.15 showing the trajectory of the 24 hour oil spill

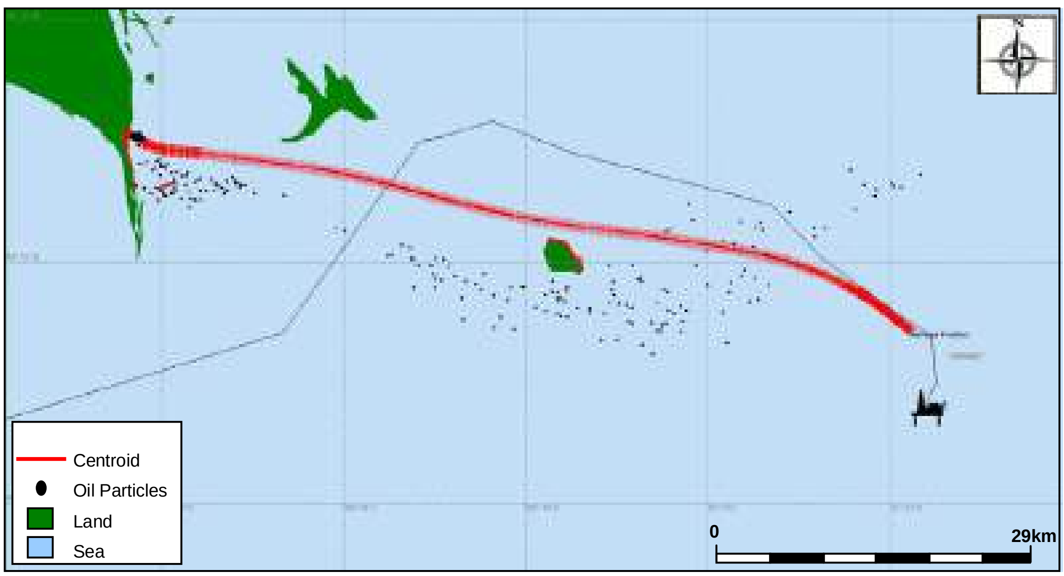

Figure 4 Spill history for Scenario 1A.16 showing the trajectory of the 24 hour oil spill.