13 Cumulative and Transboundary Impacts and Accidental Events

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13.1 Introduction

This Chapter of the Shah Deniz Stage 2 (SD2) Project Environmental and Socio-economic Impact Assessment (ESIA) discusses:

- Cumulative and Transboundary Impacts; and
- Accidental Events that could potentially occur during SD2 Project works 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 project-related residual impacts; and
- Interactions between project-related residual impacts in combination with impacts from other projects and their associated activities.

As outlined in Chapter 1 of this ESIA, the SD2 Project comprises the next stage of development of the SD Contract Area. The existing EOP, ACG Phase 1, 2 and 3 and SD1 Project facilities at the Sangachal Terminal have been operational since 1997. The effects of these projects on the environmental and socio-economic environments are therefore incorporated into the existing baseline as presented in Chapters 6 and 7 (except where noted in the assessments below). The potential for cumulative impacts with other projects have been determined, based on a review of available information relating to projects in the vicinity of the Sangachal Terminal, which are of a scale that has the potential to result in cumulative impacts.

13.2.1 Cumulative Impact Between Separate Project Impacts

A detailed assessment of environmental and socio-economic project impacts, based on expected activities and events, is presented in Chapters 9, 10 and 11 of the ESIA. The assessment takes into account each activity and the existing controls and additional mitigation identified to minimise and manage impacts.

13.2.2 Cumulative Impact With Other Projects

Based on a review of available information it is understood that the following projects, which have the potential to interact with the impacts of the SD2 Project based on their location and scale, are planned or under construction in the vicinity of the Sangachal Terminal (refer to Figure 13.1):

- **Qizildas Cement Plant** – new cement plant to be located approximately 4km north of the Sangachal Terminal. The project incorporates dry kiln technology and will be designed to produce up to 2,000,000 tonnes of cement per annum from raw materials supplied from local quarries in the Garadagh and Absheron regions, at a distance of 2 to 40km from the plant. A new road to enable construction and operational vehicles to access the plant from the Baku-Salyan Highway is planned and the project also includes a railway spur from the railway line between the Sangachal Terminal and Umid. The numbers of jobs generated by the construction and operational phases of the plant is not known. Construction works are expected to be completed by 2014. Impacts associated with the operational phase of Qizildas Cement Plant have been assessed within an ESIA completed in 2009[1];
- **SD1 Flare Project** – replacement of an existing ground flare and surrounding enclosure located within the existing Sangachal Terminal boundary. Construction works are due to be completed by 2015. The new elevated flare package comprises the following: a HP/LP (High Pressure/Low Pressure) Main Flare A with a stack height of

[1] Qizildas Cement Factory ESIA, 2009.

50m; a HP/LP Main Flare B (50m stack height); and a HP Emergency Flare (100m stack height);

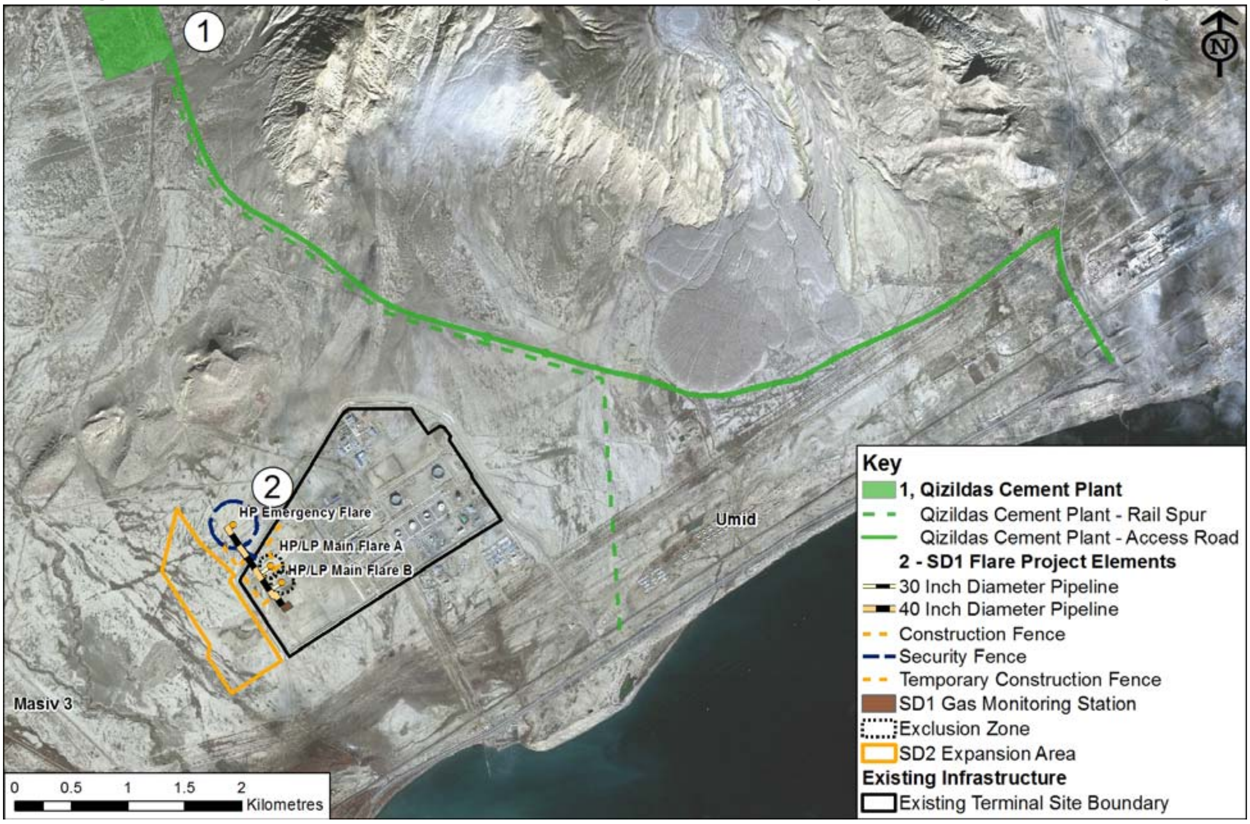
- **Garadagh District Umbaki (Jeyildagh) Jailhouse** – a new jailhouse prison that has a maximum capacity of 1,500 people. Construction works commenced in 2007 and are expected to be complete by December 2013;
- **New Baku Port** – the new port is located close to Alyat settlement, 25km to the south of the Sangachal Terminal and is being undertaken by the Ministry of Transport. The port covers an area of 400 hectares and includes the construction of two bridges for ferry boat movements; three freight bridges for container vessels; road networks for the movement of roll-on and roll-off cargo; and a dry cargo storage area. Construction works started in November 2012 and are expected to be complete by 2015;
- **State Oil Company of Azerbaijan Republic (SOCAR) Petrochemical Complex** – to be located approximately 3-4km to the north of the Sangachal Terminal and is expected to comprise a gas processing plant, oil refinery and petrochemical plant. The actual location of this development is not currently known and may overlap, or lie adjacent to, the land already identified for the Qizildas Cement Plant. Construction works are expected to commence during 2013-2014 with the facility being operational by 2020. According to press reports[2] the facility will employ a maximum of 15,000 over the construction and operation phase;
- **Baku Shipyard Company** – a modern shipyard facility located 23km from the Sangachal Terminal adjacent to an existing deep water plant. This project is being implemented by SOCAR in partnership with Keppel Offshore and Marine (a Singaporean company). Construction works started in 2011 and the facility is due to be completed by 2013; and
- **Navy and Military Camp for Navy Officers** – located close to Sahil settlement, this development aims to provide residential housing for officer's families and is being undertaken by the Ministry of Defence. Construction works are underway and some housing units have already been built. The development is expected to be complete by 2014.

Traffic flow along the Baku- Salyan Highway has increased in recent years[3] and is expected to continue to increase in the future due to development of these projects. To provide capacity for increased traffic flows, a requirement has been recognised to widen the Baku-Salyan Highway to four lanes in each direction. Additional information, such as the schedule and physical extent of the infrastructure upgrade works, are not available.

[2] http://www.usacc.org/news-publications/investment-news/construction-on-energy-refining-and-petrochemicals-complex-to-begin-in-2013-socar-president-says.html.

[3] Per comms, Head of the Technical Division, Azerbaijan Highway Authority, 2010.

Figure 13.1 Location of Planned or Under Construction Projects in the Terminal Vicinity



13.3 Approach to the Cumulative Assessment

Key assumptions made for the cumulative assessment with other projects are:

- The Qizildas Cement Plant is expected to be operational from 2015 and it has been assumed that the construction phase will overlap with the SD2 Project construction activities in the vicinity of the Sangachal Terminal; and
- The SOCAR Petrochemical Complex is expected to be operational from 2020 and it has been assumed that the construction phase will overlap with the construction phase of the SD2 Project.

For non greenhouse (GHG) emissions (refer to Section 13.7) the assessment of cumulative impacts between the SD2 Project and other planned or under construction projects includes the operational onshore and offshore SD and ACG facilities such that the combined impact of all Terminal operations can be assessed.

The approach taken to assessing cumulative impact between SD2 Project impacts focuses on assessing the potential temporal and geographic overlap between environmental impacts based on the current project schedule (refer to Chapter 5 Figure 5.3) and the results of modelling assessments demonstrating the expected geographic extent of the impacts (refer to Chapters 9, 10 and 11).

13.4 Terrestrial Environment: Cumulative Impacts

13.4.1 Cumulative Impact Between Separate Project Impacts

Construction activities associated with the SD2 Project will occur in the vicinity of the Sangachal Terminal (within the SD2 Expansion Area, the pipeline landfall area and along the onshore SD2 export pipeline route) and at the construction yards. While yet to be selected, the anticipated construction yards where the SDB platform complex topsides, jackets and bridge will be constructed are located more than 10km from the Sangachal Terminal. There is therefore no potential for overlap between separate project impacts in these locations in terms of environmental impacts (e.g. noise).

The assessments of noise and emissions associated with the onshore construction activities within the vicinity of the Sangachal Terminal are presented in Chapter 10. These assessments take into account the cumulative impact to receptors of all construction activities during construction works at the Terminal, onshore and nearshore pipeline installation works, pipeline pre-commissioning activities and Terminal commissioning. The assessments concluded that, following the application of existing and additional mitigation (which includes the development and implementation of a Community Engagement and Nuisance Management and Monitoring Plan) impacts are considered to be no more than Moderate Negative.

13.4.2 Cumulative Impact With Other Projects

13.4.2.1 Changes to Hydrology

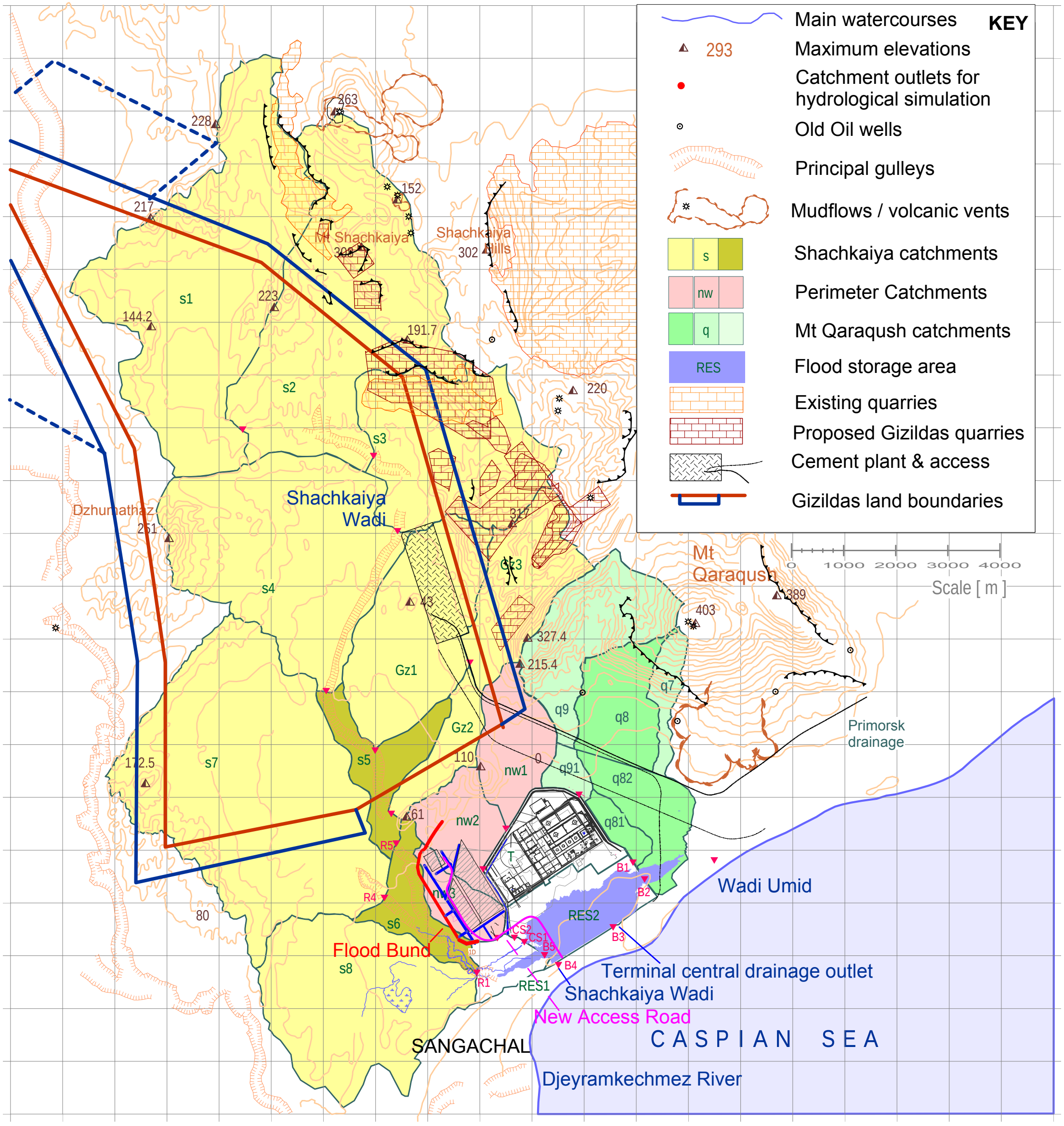
Any alteration to local hydrological conditions may change the existing flood risk to sensitive receptors located in the vicinity of the Sangachal Terminal.

The Qizildas Cement Plant and SOCAR Petrochemical Complex developments are expected to use land which is currently unoccupied, is located to the north and north east of the Sangachal Terminal and lies within the upper Shachkaiya Wadi catchment area (refer to Figure 13.2). The existing level of flood risk to downstream receptors may be modified through:

- An increase in the volume of water discharged directly into the Shachkaiya Wadi and its tributaries from the discharge of industrial wastewater associated with operation of the Qizildas Cement Plant and SOCAR Petrochemical Complex developments: and
- The rapid diversion of rainwater falling within areas covered with impermeable cover associated with the construction of roads, buildings and industrial areas that feature bunding and hardstanding materials. Rain and runoff water falling within impermeable areas will be rapidly diverted into drainage systems and discharged into the Shachkaiya Wadi and its tributaries, rather than falling onto natural soil and slowly infiltrating vertically.

The hydrological changes described above will act to reduce the amount of time taken for surface water levels within the Shachkaiya Wadi and its tributaries to increase. This may result in higher surface water volumes within the Shachkaiya Wadi and its tributaries which, during heavy precipitation events, may increase the overall level of flood risk to downstream receptors.

Figure 13.2 Main Drainage Catchment Areas in the Vicinity of the Sangachal Terminal and Qizildas Cement Plant



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

The hydrological model constructed for the SD2 Early Infrastructure Works (EIW) was used, with assumptions that the Qizildas Cement Plant and SOCAR Petrochemical Complex would alter surface water infiltration rates within the Gizilidas land boundary shown in Figure 13.2, to assess changes in flood level at:

- Sangachal Town; and
- The Caravanserai.

Table 13.1 Flood Levels at Key Receptors from the Qizildas Cement Plant and SOCAR Petrochemical Complex

Receptor	1 in 100-year flood levels in mAOD			
	Undeveloped Upper Catchment Area	Development of the Qizildas Cement Plant Only	Development of the SOCAR Petrochemical Complex Only	SOCAR Petrochemical Complex and Qizildas Cement Plant
Sangachal Town	-12.93	-12.47	-12.49	-12.47
Caravanserai	-20.95	-20.21	-20.36	-20.21

The results of the flood modelling in Table 13.1 indicate that the Qizildas Cement Plant will increase water volumes within the Shachkaiya Wadi during a 1 in 100 year flood event, from $61m^3/s$ to $80m^3/s$, leading to an increase in the flood level of Sangachal Town by 0.46m and 0.71m at the Caravanserai. The change in flood levels from the SOCAR Petrochemical Complex Plant is expected to increase by 0.44m at Sangachal Town and 0.59m at the Caravanserai. When the development of the Qizildas Cement Plant and SOCAR Petrochemical Complex is combined, flood levels increase by 0.46m at Sangachal Town and 0.74m at the Caravanserai.

In isolation, the SD2 Project is not expected to have a significant impact to flood levels at any sensitive receptors. The hydrological modelling has indicated that the future development of the Qizildas Cement Plant and SOCAR Petrochemical Complex has the potential to slightly increase flood risk to some downstream receptors.

13.4.2.2 Noise

The SOCAR Petrochemical Complex is likely to include a number of significant operational noise sources. While the internal layout of the complex is not known it is understood it will be sited within 2-3km of Azim Kend to the north of the existing Sangachal Terminal. A screening assessment was completed, taking into account the noise budgets at each of the receptors surrounding the Sangachal Terminal. These were derived from the nightime noise limit of 45dB(A) minus the existing Sangachal Terminal plant noise from the SD and ACG facilities and the predicted noise from the SD2 plant (refer to Appendix 11D for further details). Based on the assumed location of the site it was calculated that, in order for the nightime limit to be met, the noise from the operational SOCAR facility will need to be less than LAeq 35dB.

Specific details of the plant and operation of the facility are not known and as such a detailed analysis of the operational noise is not possible. To assess the likely cumulative impact a sound power level at the SOCAR Petrochemical Complex site boundary of LWA 120dB was assumed based on data for a similar petrochemical complex in the UK. The screening assessment indicated that, based on this assumption, the 45dB(A) nighttime noise limit would be met at Sangachal and Umid but exceeded at Azim Kend and Masiv 3 by up to 1dB(A). However detailed modelling would need to be completed for the facility once the location and layout has been finalised.

An assessment was also undertaken considering potential cumulative impacts associated with SD1 and SD2 non routine flaring, based on the flaring scenarios and associated noise levels anticipated for the new SD1 elevated flare and for the SD2 elevated flare.

The assessment for each flare system took the same approach as described within Chapter 11 Section 11.5.2.1 whereby the estimated noise levels at each receptor for each flaring scenario and the % duration of the year that the scenario was expected to occur was calculated. The results therefore indicated for what proportion of a year the most stringent noise limit (45dB(A) would be exceeded and this was compared against the requirement for noise limits to be met for 95% of the year. While the assessment for the SD2 Project flare as presented in Chapter 11 showed that compliance with the noise limit was expected for at least 99.3% of the year, with the addition of the SD1 flare, it was predicted that the noise limit would be exceeded for 12.1% of the year. This exceedance was found to be due to the frequency and duration of the SD1 compressor trip. The SD1 Flare Project have committed to implement a flaring policy to reduce the frequency and duration of this scenario.

13.5 Marine Environment: Cumulative Impacts

13.5.1 Cumulative Impact Between Separate Project Impacts

Environmental interactions will arise from the following activities and operations:

- Pipeline and flowline installation (physical disturbance);
- Pipeline commissioning (treated seawater discharges including preservation chemicals);
- Drilling (drill cuttings and drilling fluid discharges);
- Subsea cluster infrastructure installation (physical disturbance);
- Platform installation (physical disturbance);
- Platform operations;
- Routine subsea operations (control fluid discharge); and
- Non-routine subsea interventions (MEG, condensate, water and control fluid discharges).

Physical disturbance associated with pipelaying and subsea and platform installation is restricted largely to the footprint of the infrastructure. Disturbance arising from anchor handling during pipelaying will be transient. Physical disturbance is not considered to have a cumulative impact, or a cumulative interaction with other impacts.

Discharges of treated seawater discharges (including preservation chemicals) associated with the commissioning of pipelines and flowlines will involve more than 90 transient events of varying size, over a period of several years. The impact of most of these events is minimal (refer to Chapter 10 Section 10.8.3). The larger events are distributed in time and space, and the impacts will not overlap. It is considered that there will be no cumulative interaction between these discharges, and no cumulative interaction with other impacts.

The deposition of drill cuttings deposition has been modelled for both shallow-water and deep-water subsea clusters and for discharges from a single well and discharges from six wells at two separate drill centres (refer to Chapter 9 Section 9.4.2). Within each cluster, the progress of the drilling programme will lead to a cumulative interaction between the deposits arising from successive wells; however in both shallow and deep locations, the cuttings deposits (assuming deposition to 1mm thickness) will be confined to within a radius of 100-400m of the cluster centre, with maximum depth of accumulation being 1.2m within a radius of 200m range (depending on water depth at the drilling location). The subsea clusters are widely separated, and there will be no cumulative interaction between clusters. Once all wells at a cluster are completed, there will be no further drilling and accumulations of cuttings and cement that could interfere with the installation of the subsea production facilities will be dispersed by mechanical means or water jet.

During routine subsea operations, the only environmental interaction will arise from the discharge of subsea control fluids. This will take two forms; continuous discharge at a very low rate (0.03cm^3 per minute per valve) from directional control valves on the manifolds and trees, and intermittent discharge of larger volumes (litres per event) when actuator valves are operated. These releases have been modelled, and it has been demonstrated that no impact will occur more than 20m from the point of release, and that the potential duration of impact is less than one hour (refer to Chapter 11 Section 11.6.3). It is considered that there will be no cumulative impact from these discharges, and that there is no potential for cumulative interaction with other impacts.

During routine platform operations, the principal discharges will be cooling water, black water, grey water, and open drains water. Cooling water discharge has been modelled to assess the potential for thermal impact[4]. The modelling indicated that the discharge would meet the required 3ºC temperature gradient between the discharge plume and ambient sea

[4] CORMIX 8.0GT (i.e. the latest version) was used for thermal discharge modelling

temperature within 11m from the point of discharge. Other routine discharges are small in volume, and have no persistent or cumulative effect.

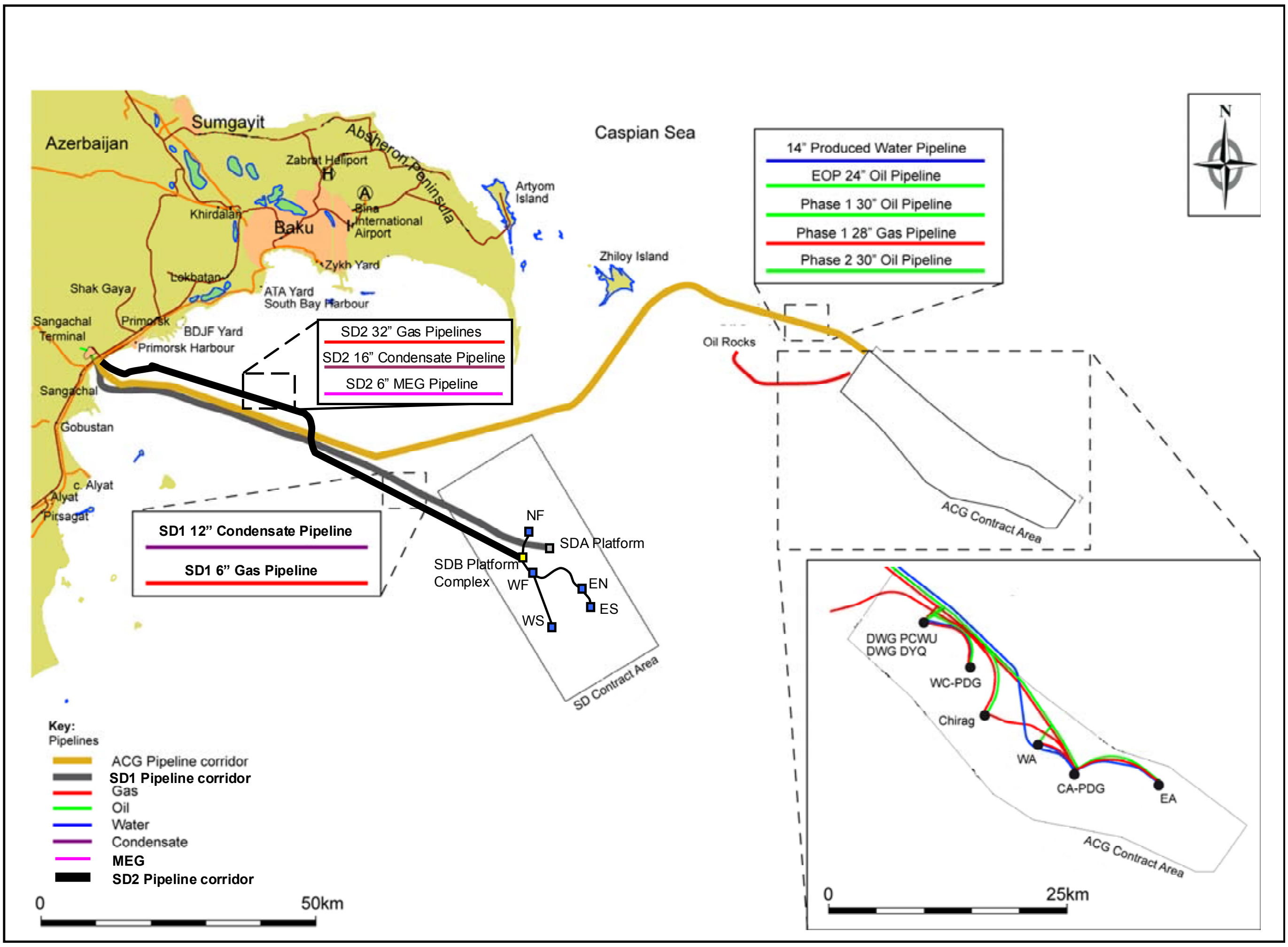
The MEG discharges associated with foreseeable subsea interventions are small in volume ($1.3m^3$), and will occur infrequently i.e. once per production tree across the PSA period. The impact has been assessed as no more than minor negative (refer to Chapter 11 Section 11.6.4).

Overall, with the exception of highly localised cumulative consequences arising from successive drilling activities within clusters, no events or activities will have cumulative impacts either in themselves or in combination with other project impacts.

13.5.2 Cumulative Impact With Other Projects

The location of the SD2 offshore and subsea facilities in the context of the existing SD and ACG offshore facilities is shown in Figure 13.3. As discussed in Section 13.5.1 above it is anticipated that treated seawater discharges from pipeline and flowline pre-commissioning, drilling discharges and control fluid discharges will impact a small area (no more than 400m in radius) within the locality of the discharge location. There is therefore no potential for cumulative impacts between SD2 Project discharges and discharges from the operational platforms within the ACG Contract Area (over 60km to the north east) and SD-Alpha platform (approximately 7km from the SDB platform complex and approximately 3-4 km from the nearest SD2 wells).

Figure 13.3 Location of Existing SD and ACG Offshore Facilities and Proposed SD2 Offshore and Subsea Facilities



13.5.3 Mitigation and Monitoring

Control measures to mitigate impacts to the marine environment from routine and non routine discharges associated with the SD2 Project 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 SD2 Project phase are included within BP Azerbaijan's Health, Safety, Security and Environment (HSSE) Policy (Refer to Chapter 14). Once operational, SD2 will become a component of the AGT Region 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 SD and ACG platforms.

13.6 Socio-Economic Environment: Cumulative Impacts

13.6.1 Cumulative Impact Between Separate Project Impacts

A detailed assessment of individual socio-economic project impacts, based on expected activities and events, is presented in Chapter 12 of the ESIA. The assessment takes into account each activity and the existing controls in place to manage the impact. No requirement for additional mitigation was identified and all impacts were considered to be minimised as far as practicable.

The expected activities and events that may result in a cumulative socio-economic impact from different components of the SD2 Project are:

- An rise in employment opportunities during the construction phase;
- An rise in economic flows from the use of major construction and installation contractors and their associated supply chain network of companies; and
- An increase in road traffic on the Baku-Salyan Highway.

13.6.1.1 Economic Flows

The SD2 Project is expected to increase economic flows at a regional (Garadagh District) and national level through increased employment and the procurement of goods and services. This is expected to occur from the use of different construction and installation contractors at the same time during the construction phase. The increase in economic flows is expected to contribute at a regional level, to socio-economic development and lead to improvements in the current status of health, education and other social infrastructure.

13.6.1.2 Employment

Employment levels during the SD2 Project construction phase are estimated as:

- 4,800 positions associated with the onshore construction works at the Sangachal Terminal which is expected to peak during 2016;
- 1,500 positions at the onshore construction yard used to fabricate the jacket which is expected to peak during 2015;
- 2,260 positions at the topsides onshore construction yard which is expected to peak during 2015; and
- 2,000 positions associated with marine subsea works, which are expected to peak during 2015 and 2016.

Whilst almost all of the jobs associated with the SD2 Project will be temporary, workers will be provided with an opportunity to develop their skills and experience during their employment. This will be achieved through implementation of the Employee Relations Management Plan and formal training activities.

Given the existing control measures in place and the positive impacts associated with employment, it is considered that the appropriate measures are in place to appropriately maximise the cumulative impacts associated with employment.

13.6.1.3 Increased Traffic on the Baku-Salyan Highway - Congestion

The Baku-Salyan Highway is the main traffic route in the local area and is expected to be used by traffic associated with the main construction and installation contractors working at and in the vicinity of the Sangachal Terminal. There is the potential for increased traffic on the Baku-Salyan Highway to cause disruption to other road users from increased congestion.

Off-site vehicle movements during Terminal Construction and Commissioning Activities are expected to peak during Phase 3 and Phase 4 to 1,310 a day, which reflects an increase of 13.1% of the total on the Baku-Salyan Highway traffic flow.

There are a number of improvements to the Baku-Salyan highway that are underway that will reduce congestion. All of the main construction and installation contractors will implement a Traffic and Transportation Management Plan, one of the aims of which will be to minimise impacts to road users and ensure that adherence to BP’s strict procedures associated with vehicles and safe driving are enforced. The Traffic and Transportation Management Plan will be subject to regular review and update and will take into account any changes in traffic flows or routing issues during the project duration.

Considering the planned future improvements to the Baku-Salyan Highway and use of the Traffic and Transportation Management Plan, the SD2 Project’s contribution to potential traffic impacts are minimised as far as possible.

13.6.2 Cumulative Impact With Other Projects

13.6.2.1 Visual Impacts

There is a potential for cumulative visual impacts at receptors in the Sangachal Terminal vicinity from the operation of the SD1 and SD2 flares.

A viewshed analysis was undertaken (refer to Appendix 12B) to determine the potential for cumulative visual impacts to occur between the SD2 Project and SD1 Flare Project. The viewshed analysis was based on a number of anticipated non-routine flaring scenarios to reflect conditions when the height of the flames above the elevated flare stacks, will be at their highest and are therefore, expected to be visible to residents from the local communities.

The analysis, which is based on the topography of the area and does not take into account features such as buildings and structures, demonstrated that SD2 flare was calculated to be visible to approximately 75% of the area surrounding the Terminal as a minimum. The additional of the SD1 flare increased the visibility to a maximum of 80% at Sangachal. This indicates that the additional visibility of an elevated feature at Sangachal Town is relatively low at 5%, resulting in a relatively minor cumulative impact.

The results of the viewshed analysis indicate that the extent of visibility for the residents of Umid, Azim Kend and Masiv 3 from an elevated feature associated with either the SD2 Project or SD1 Flare Project is similar, and that elevated features from both projects can be seen by local residents. This indicates that almost all residents of Umid, Azim Kend and Masiv 3 are predicted to see features associated with both the SD2 Project and SD1 Flare Project. Consequently, the cumulative impact associated with the SD1 Flare Project to these receptors is negligible.

The assessment of cumulative visual impacts from elevated features associated with the SD2 Project and SD1 Project are expected to be limited and no additional mitigation is required.

13.6.2.2 Increased Traffic on the Baku-Salyan Highway - Congestion

The Baku-Salyan Highway is expected to be used by traffic associated with the other projects described in Section 13.2.2. There is the potential for increased traffic on the Baku-Salyan Highway from the other projects to cause disruption to other road users from increased congestion, particularly during the construction phase of the SD2 Project where off-site vehicle movements will be greatest.

From all of the other projects described in Section 13.2.2, the potential to result in the highest contribution to traffic flows is expected to be the New Baku Port during operation from the road transport of cargo which lies 25km to the south of the Sangachal Terminal from 2015, and traffic associated with construction works at the SOCAR Petrochemical Complex (the actual timeframe for this project is not known).

The Qizildas Cement Plant project is also expected to result in additional traffic flows on the Highway however construction works are currently expected to be complete in 2014[5]. There is therefore a limited a period when construction would overlap with the SD2 Project works. Off-site construction vehicle movements associated with the construction phase of the SD1 Flare Project is expected peak at 26 off-site vehicles per day during 2014/2015.

Considering the scale of these other projects, it is expected that throughout the SD2 Project, there will be gradual increase in the volumes of traffic using the Baku-Salyan Highway. However, the overall cumulative contribution to traffic flows, particularly during the operation phase, is expected to be small, particularly if expansion of the Baku-Salyan Highway is implemented during the SD2 Project construction phase.

13.6.2.3 Employment

The increase in employment opportunities associated with the SD2 Project and the other projects described in Section 13.2.2, will benefit the individuals and households employed at a local, regional and national level. It is expected that the workforce required for the construction phase of the other projects will be similar to those needed at the Sangachal Terminal and onshore construction yards used by the SD2 Project. Where construction works overlap in time between the other projects, there may be increased competition between developers to secure the services of highly skilled and experienced construction workers, leading to increase in wage inflation. The rate of in-migration from job seekers based elsewhere in Azerbaijan into the regional area could also increase from the overlap when large numbers of construction workers are required.

13.6.2.4 Economic Flows

The contribution of the SD2 Project to the other projects described in Section 13.2.2 will lead to increased economic flows at a local, regional and national level. The increase in economic flows cannot be quantified as the expected economic benefits from the other projects are not stated. However, given the economic scale of the other projects, particularly the SOCAR Petrochemical Complex which represents a major oil and gas development, it is likely that economic flows created will be far greater than those attributed to the SD2 Project. This may increase the overall level of industrialisation and socio-economic development within the Garadagh District, attract additional ‘follow-on’ projects, and result in improved transport and communications infrastructure which will continue to enhance the region.

[5] Qizildas Cement Factory ESIA, 2009.

13.6.2.5 Community Development Initiatives

There is little information associated with community initiatives that will be designed and implemented by the other projects described in Section 13.2.2. BP's own community investment programme is described in Chapter 7, Section 7.12. BP is currently involved in educational programmes which provides support to people from a young age and continues to a university research level. BP also supports the development of local suppliers through training and financing programmes, building skills and sharing BP's internal standards and practices as appropriate. Such activities enable a greater number of local businesses to participate in their supply chain.

Cumulative impacts from the implementation of BP's community investment programmes with similar initiatives from the other projects are expected to be complimentary and have a positive impact upon local communities.

13.6.2.6 Conclusion

The assessment of socio-economic cumulative impacts demonstrates that negative cumulative impacts associated with the SD2 Project and other projects in the vicinity of the Sangachal Terminal, are expected to be limited. Positive cumulative impacts are expected to occur from employment, increased economic flows and the implementation of community development initiatives. These positive impacts will occur in parallel with increasing industrialisation across the Garadagh region which may lead to improvements in transport, communications, utility connections and social infrastructure.

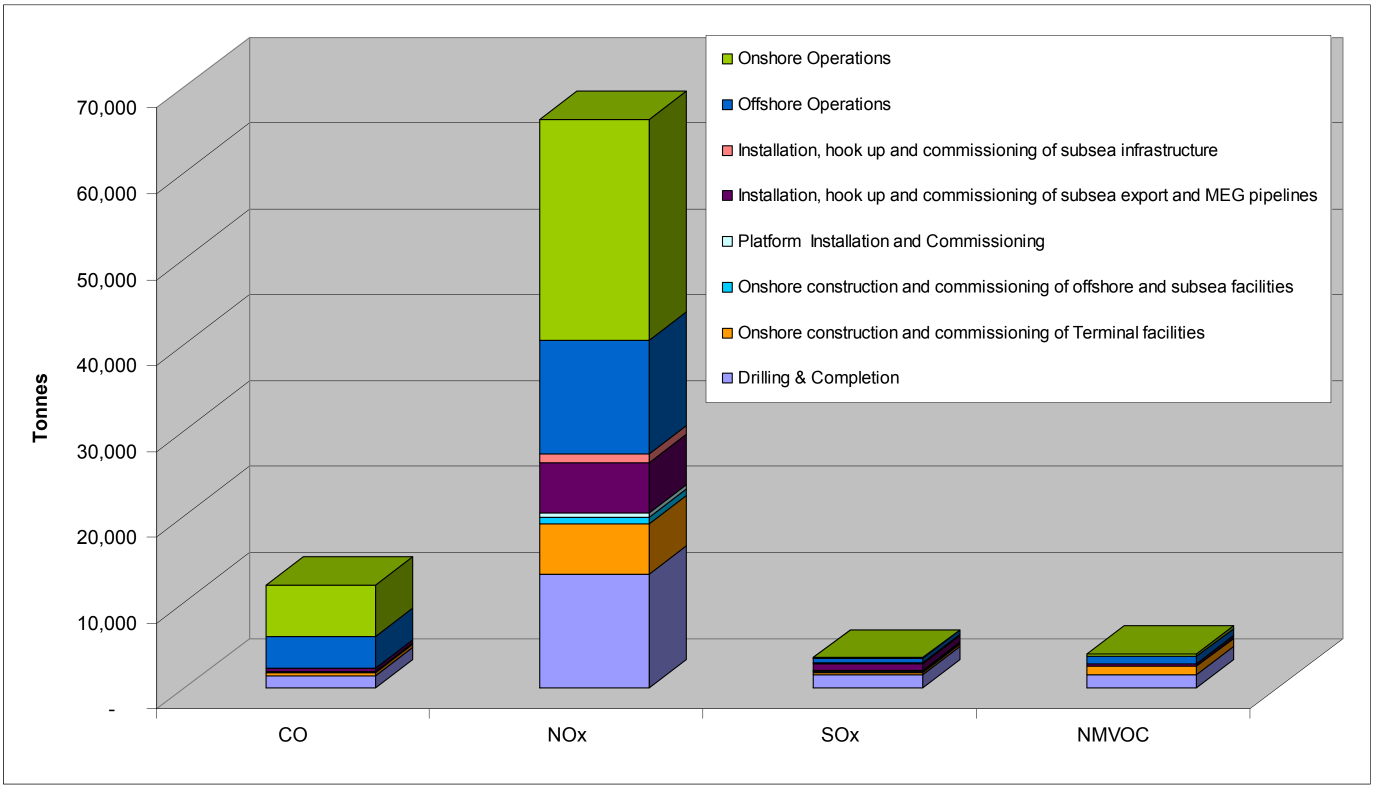
13.7 Non-Greenhouse Gas Atmospheric Emissions: Cumulative Impacts

Atmospheric emissions will be generated from the each SD2 Project phase due to:

- Operation of construction and operational plant;
- Operation of mobile drilling rigs and vessels;
- Flaring (during drilling and operations); and
- Fugitive emissions.

Figure 13.4 presents the volumes of the non-greenhouse gas (non-GHG) emissions nitrous oxides, sulphur oxides, carbon monoxide and non methane hydrocarbons, for each phase of the SD2 Project.

Figure 13.4 SD2 Non-GHG Emissions Per Project Phase



13.7.1 Cumulative Impact Between Separate Project Impacts

Air dispersion modelling (focused on NO_2) has been completed for emissions to atmosphere during SD2 drilling, SD2 construction activities at the construction yards and in the vicinity of the Sangachal Terminal and during onshore and offshore operations. Based on a review of the project schedule and the results of the modelling as presented in Chapters 9, 10 and 11 it is not expected there will be a cumulative impact associated with SD2 Project emissions to atmosphere. While the project will require a number of vessels operating within the SD2 Contract Area and along the SD2 Pipeline Route during drilling, pipeline and subsea infrastructure installation it is anticipated that vessel emissions will rapidly disperse and no impact to onshore receptors is predicted.

13.7.2 Cumulative Impact With Other Projects

13.7.2.1 Onshore Non-Greenhouse Gas Atmospheric Emissions

Modelling has been undertaken to assess the cumulative impact of the following on air quality at receptors in the vicinity of the Sangachal Terminal (refer to Appendix 11B):

- SD2 Project onshore facilities (routine operation);
- Existing SD and ACG facilities (routine operation);
- Proposed SD1 elevated flare (pilot flaring);
- Proposed Gizildash cement plant; and
- Proposed power plant associated with the SOCAR Petrochemical Complex (assumed to be the main source of emissions within the complex).

As no detailed plans or data is currently available for the SOCAR Petrochemical Complex, it was assumed, based on similar petrochemical plants of this size, that a 250MW power station would be required. Model input data was based on relevant emission factors for petroleum refining using natural gas as fuel and reasonable worst case assumptions regarding stack height and diameter.

Table 13.2 presents the long term annual average NO_2 concentrations predicted by the modelling for Azim Kend, Masiv 3, Sangachal and Umid in the context of the annual average air quality standard of 40 µg/m^3 and the background concentration of 6 µg/m^3.

Table 13.2 Predicted Annual Average NO_2 Concentrations at Receptors in the Sangachal Terminal Vicinity (Cumulative Scenario)

Receptor Name	NO_2 Annual Average (µg/m^3)		
	Modelled Contribution (µg/m^3)	Percentage of Limit Value (%)	Predicted Concentration (µg/m^3)
Azim Kend	3.8	9.4%	9.8
Masiv 3	6.0	15.0%	12.0
Sangachal	14.5	36.1%	20.5
Umid	4.2	10.5%	10.2

The results indicate that for the cumulative scenario modelled the annual average air quality standard will be met at all receptors. Comparing the results to those obtained for the SD2 Project alone (routine operations) the additional projects are anticipated to contribute between 3.9µg/m^3 and 12.6µg/m^3 to NO_2 concentration at receptors. Cumulative impacts to air quality are not considered significant and no additional mitigation measures are required.

13.7.2.2 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, COP, SD1 and the SD2 offshore facilities on NO_2 concentrations onshore (refer to Appendix 11C).

NO_2 emissions from both the existing platforms and proposed SD2 platform complex were modelled to determine the future contribution of emissions to the air quality onshore. Concentrations taking into account existing background levels[6] were compared against relevant long term (annual average) and short term (1 hour peak) air quality standards for the protection of human health[7].

The modelling demonstrated that during routine operations, NO_2 emissions disperse rapidly and the increase in long term and short term NO_2 concentrations due to all ACG, SD1 and COP offshore operations are likely to be indiscernible from background levels. Table 13.3 presents the NO_2 long term concentrations predicted for the routine modelling scenario relative to background concentrations and the relevant long term air quality standard of 40 µg/m^3.

Table 13.3 Predicted NO_2 Concentrations at the Absheron Peninsula and Sangachal During Routine Operation of all ACG and SD Offshore Facilities

Receptor Name	NO_2 Annual Average (µg/m^3)		
	Modelled Contribution (µg/m^3)	Percentage of Limit Value (%)	Predicted Concentration (µg/m^3)
Absheron Penisula (Shadili Spit)	0.15	0.4%	6.15
Sangachal	0.02	0.05%	6.02

6 Refer to Chapter 6: Environmental Description for background levels

7 Applicable 1 hour average (short term) and annual average (long term) standards for NO_2 are 200µg/m^3 and 40µg/m^3 respectively

13.8 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.

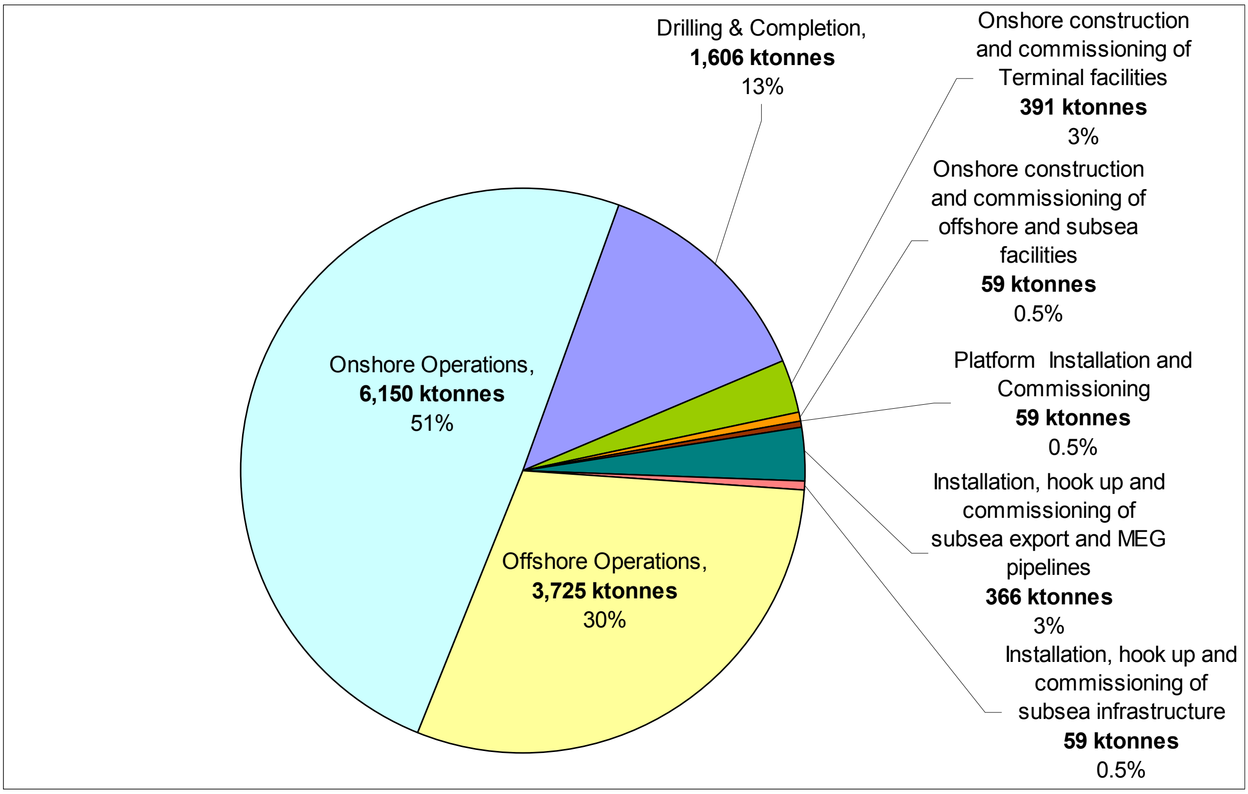
The most significant pollutant in terms of health impacts is NO_2. It has been demonstrated that emissions associated with SD2 Project activities alone and emissions from worst-case cumulative ACG and SD onshore activities are not expected to result any discernable changes in onshore NO_2 concentrations at the nearest onshore receptors in Azerbaijan. 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.

For both onshore and offshore activities, the volumes of emissions released (including visible particulates) due to the SD2 Project 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 the low H_2S content in the fuel gas used on the platform under routine conditions and at the SD2 Terminal facilities onshore, and are expected to disperse rapidly due to appropriate equipment design. Contribution of SD2 project SO_2 emissions to acid rain generation is therefore expected to be insignificant.

13.9 Greenhouse Gas Atmospheric Emissions: Cumulative and Transboundary Impacts

Expected greenhouse gas (GHG) emissions from SD2 activities (including carbon dioxide and methane) are presented in Chapter 5 of this ESIA for all phases of the project. Figure 13.5 shows the predicted contribution per phase.

Figure 13.5 SD2 Greenhouse Gas Emissions Generated for Each SD2 Project Phase



The majority (79.8%) of GHG is predicted to result from onshore and offshore activities during the SD2 Project operations phase. Activities associated with drilling and completion of SD2 wells is predicted to contribute 13.0% of the total volume of GHG emissions produced by the SD2 Project.

Figure 13.6 presents the volume of SD2 average annual GHG emissions during the operations phase, compared with the annual GHG emission volumes that have been recorded during operation of the ACG Phases 1, 2 and 3 and SD1 projects during 2012.

Figure 13.6 ACG & SD1 GHG Emissions (2012) and Average Annual Forecast SD2 GHG Emissions

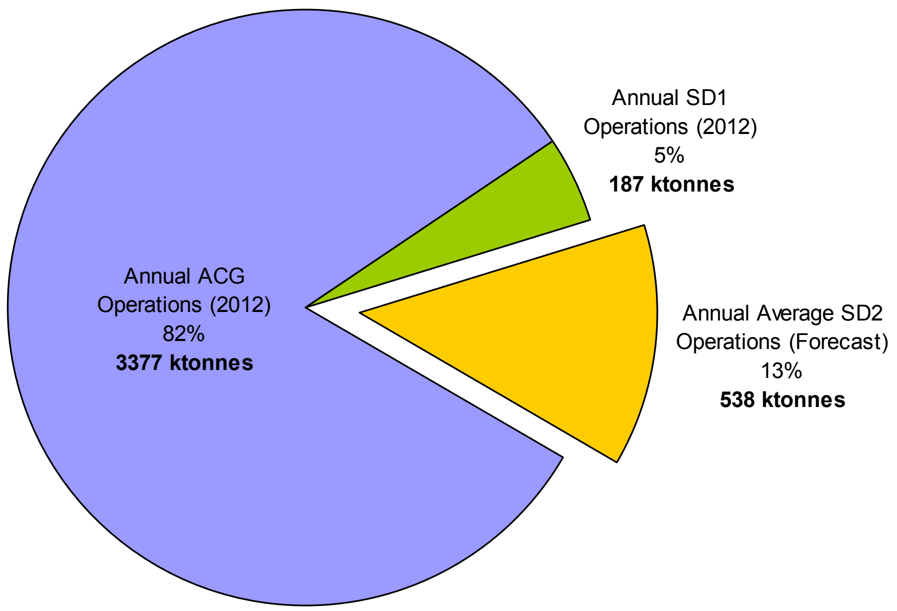


Figure 13.6 demonstrates that the SD2 will contribute approximately 13% of the annual operational GHG emissions from BP's upstream activities in Azerbaijan.

The most recent forecast of GHG emissions in Azerbaijan[8] 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 the SD2 Project forecast GHG emissions for 2020 are expected to contribute approximately 0.36% 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, H.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 has already identified development priorities as part of national development strategies, poverty reduction strategies and sector policies. These strategies are reflected in long-term State Programmes such as "State Programme on Renewable and Alternative Sources of Energy (2008–2015)", "State Programme for the Development of Fuel

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

Energy Complex (2005–2015)", "State Programme on Reliable Provision of Population of Azerbaijan Republic with Food Products (2008-2015)" and so on[9].

13.9.1 Conclusion

The principal sources of GHG emissions from the SD2 Project are associated with power generation, process heating at the Sangachal Terminal and non-routine flaring of gas which is required to maintain the safety of the facilities, operational workforce and surrounding communities. BP 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;
- Challenge and justify well testing requirements;
- Minimise combustion and fugitive emissions; and
- Avoid venting.

Design measures across the ACG and Shah Deniz 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 Projects 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.

As described within Chapter 4: Options Assessed, energy efficiency and GHG reduction was a key aspect taken into account during the development of the SD2 Project design, contributing to the selection of the following:

- Offshore compression vs onshore compression;
- Offshore flare vs vent;
- Direct Drive Gas Turbines onshore vs electric drives;
- Waste Heat Recovery on onshore compression gas turbines; and
- Onshore Flare Gas Recovery.

These resulted in a saving of approximately 103,700 ktonnes of CO_2 emissions across the SD PSA period.

As for non-GHG emissions, GHG monitoring and reporting procedures and documentation requirements for each ACG and SD project are included within BP Azerbaijan's Health, Safety, Security and Environment (HSSE) Policy (see Chapter 14). Once operational, SD2 will implement a set of specific GHG monitoring, management and reporting procedures based on and consistent with the procedures already in use on existing ACG platforms.

[9] Ministry of Ecology and Natural Resources, Technology Needs Assessment Report - Adaptation (July 2012)

13.10 Accidental Events

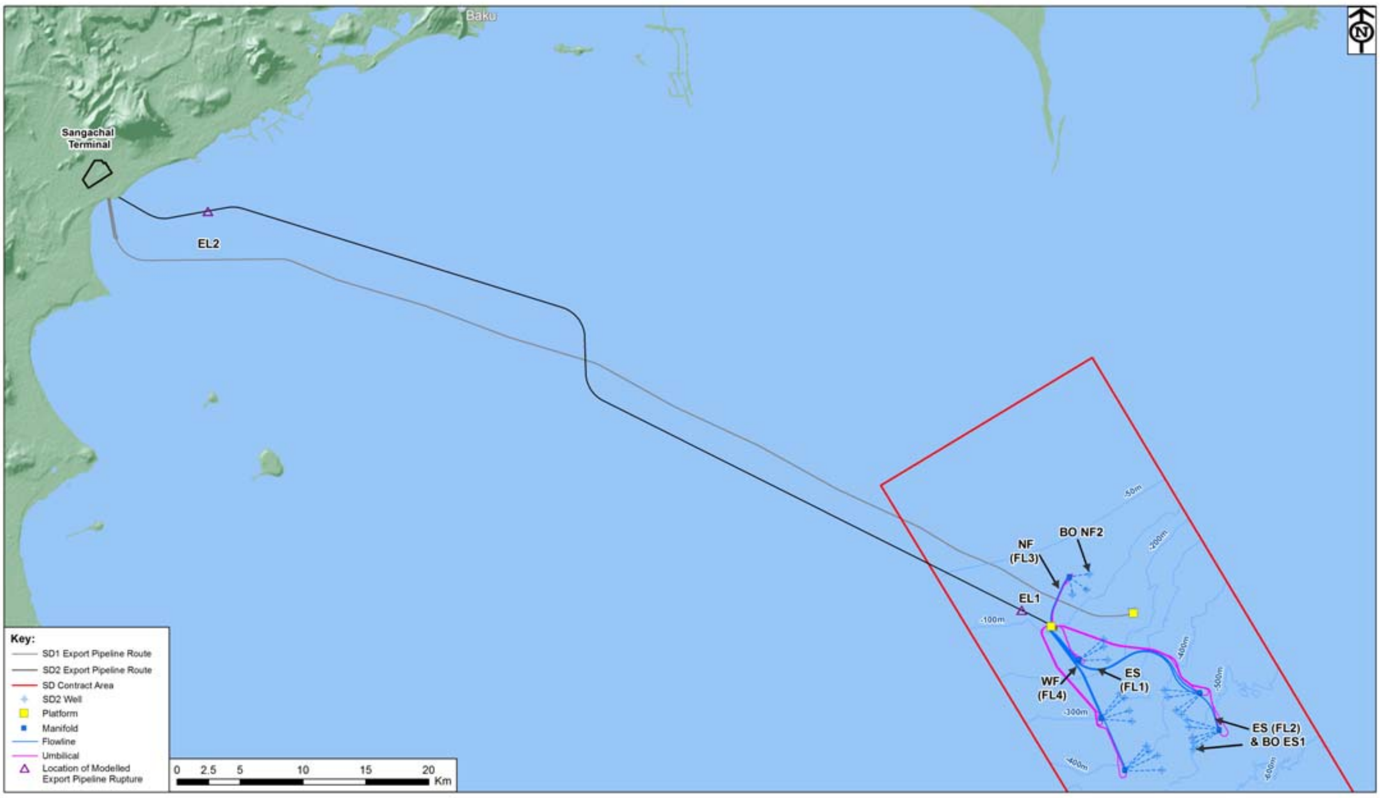
Accidental Events are considered separately from routine and non-routine activities as they only arise as a result of a technical failure, human error or as a result of natural phenomena such as a seismic event.

This section addresses the probable consequences of offshore releases of condensate and diesel fuel, taking into account aspects such as persistence of the spilled material and the prevailing environmental conditions.

13.10.1 Overview

A range of accidental events that could result in the release of condensate have been considered and modelled. The locations of the events considered, which include blowouts, flowline ruptures, condensate export pipeline ruptures and platform diesel inventory loss, are shown in Figure 13.7. Appendix 13A contains a summary of the spill modelling assessment report.

Figure 13.7 Locations of Accidental Events Resulting in Release of Condensate Considered Within Spill Modelling Assessment



13.10.2 Blowout Condensate Release Scenarios

Condensate will be present in the SD2 wells in association with the other reservoir fluids (gas and produced water). A blowout, as a consequence of loss of well control, would result in large quantities of all fluids (gas, produced water and condensate) being released simultaneously, with the condensate being entrained in the flow of released gas. A proportion of the liquid condensate would be mechanically dispersed into the water column as small droplets by the intense turbulence created by the high-pressure, high-velocity gas stream entering the water. The small condensate droplets would have little inherent buoyancy due to their small size, but would initially be propelled upwards through the water column with the rapidly rising plume of gas. Larger condensate droplets would have sufficient buoyancy to float to the sea surface.

Two blowout scenarios, BO ES 1 and BO NF 2 (refer to Figure 13.7) have been modelled. The common inputs used in both scenarios are presented in Table 13.4.

Table 13.4 Blowout Scenarios – Common Modelling Input Data

Scenario	Liquid flow rate (excluding gas)		Gas to Oil Ratio m^3/m^3	Orifice release diameter (ID) m	Time to shut in well
	Condensate m^3/hr	Water m^3/hr			
BO ES 1 and BO NF 2	165.4	56.3	1900	0.219	224 days

The input flow rate of 165.4m^3/hr (3969.6m^3/day) is equivalent to 25,000 bbls/day. With the blowout continuing for 224 days before a relief well would divert the flow, the total amount of condensate released into the water would be 889,190 m^3 or 4.928 million barrels.

The inputs specific to each of the two scenarios modelled, namely well location, water depth at these locations and discharge temperatures, are shown in Table 13.5.

Table 13.5 Blowout Scenarios –Key Input Data Specific to Each Modelling Scenario

Scenario	Release location	Water depth at release (m)	Discharge temperature (°C)
BO ES 1	ES C well location	530	72.2
BO NF 2	NF 1 / SD-X 6 well locations	70	74

The ES1 well is approximately 45km from the nearest shore and in deep water while the NF2 well is closer to shore (approximately 31km) and in relatively shallow water.

13.10.3 Flowline Rupture Condensate Scenarios

The SD2 Project Base Case includes 10 infield flowlines carrying gas, condensate and produced water from the wells and subsea manifolds to the fixed SDB-PR processing platform. Rupture of any of these flowlines would result in a high-pressure release of gas, condensate and produced water into the water column. The gas released into the sea would rapidly expand as it rose up towards the sea surface as a plume of gas bubbles. Depending on release depth, a proportion of the gas would dissolve into the water and some gas would rapidly rise as bubbles to the sea surface and then disperse into the air. A large proportion of the total amount of liquid condensate contained within the ruptured flowline would be ejected into the water along with the gas and would enter the water as droplets of various sizes. The smaller droplets would be mechanically dispersed into the water column. The flowline would continue to depressurise after the flow had been shut off and eventually would start to fill with seawater, to the extent that the geometry of the flowline would allow.

Three flowline rupture scenarios, ES FL1, ES FL2 and WF FL4, have been modelled (refer to Figure 13.7 for rupture locations). The common inputs used in all three scenarios are shown in Table 13.6. Two liquid flow rates have been used; the same for scenarios ES FL1 and 2, but lower for WF FL4 in accordance with the Base Case design.

Table 13.6 Flowline Rupture Scenarios – Common Modeling Input Data

Scenario	Liquid flow rate (excluding gas)		Gas to Oil Ratio (m^3/m^3)	Orifice release diameter (ID) m	Time to shut off flowline
	Condensate (m^3/hr)	Water (m^3/hr)			
ES FL 1	122.1	29.2	1900	0.314	5 minutes
ES FL 2					
WF FL 4	84.4	20.9			

The input specific to each of the three scenarios modelled, namely flowline length & volume, release locations, water depth at release location and discharge temperatures, are shown in Table 13.7.

Table 13.7 Flowline Rupture Scenarios– Key Input Data Specific to Each Modelling Scenario

Scenario	Flowline length (km)	Flowline volume (m^3)	Release location	Water depth at release (m)	Discharge temperature (°C)
ES FL1	18.3	1,425	Close to escarpment	185	26
ES FL2	18.3	1,425	ES C well upstream	530	62
WF FL4	3.3	258	WF wells upstream	164	50

13.10.4 Condensate Export Pipeline Rupture Scenarios

The gas is separated from the condensate and produced water on the SDB-PR processing platform. The condensate is sent to the Sangachal Terminal via a new dedicated 16” diameter subsea pipeline, 89 km in length.

Rupture of the condensate export would result in an initial release of condensate before the flow was stopped, followed by a slower condensate release during depressurisation due to the pressure drop and expansion of the vapour and residual gas in the pipeline. The pressure in the pipeline would rapidly drop to that of the water pressure at the depth of rupture locations. A further, much slower, release of condensate would occur as the ruptured pipeline partly filled with seawater, to the extent that the geometry of the pipeline would allow.

Two condensate export pipeline rupture scenarios, EL 1 and EL 2, have been modelled (refer to Figure 13.7 for rupture locations). The common inputs are shown in Table 13.8.

Table 13.8 Condensate Export Pipeline Rupture Scenarios – Common Modelling Input Data

Scenario	Condensate (mbd) maximum	Gas to Oil Ratio (m^3/m^3)	Orifice release diameter (ID) (m)	Time to export pumps being stopped (minutes)
EL1 and EL 2	122	13.4	0.314	4

The inputs specific to each of the two scenarios modelled, namely release location, water depth at release location and discharge temperatures, are shown in Table 13.9.

Table 13.9 Condensate Export Pipeline Rupture Scenarios – Key Input Data Specific to Each Modelling Scenario

Scenario	Release location	Water depth at release (m)	Discharge temperature (°C)
EL 1	Upstream of NRV	85	39.4
EL 2	Nearshore	12	Winter 6 Summer 25

13.10.5 Platform Diesel Inventory Loss

A single platform inventory loss of 123 m^3 of diesel fuel from the SDB-PR platform has been modelled. The inputs are shown in Table 13.10.

Table 13.10 Diesel Inventory Loss Scenario – Input Data

Scenario	Release location	Liquid flow rate (m^3/hr)	Duration (hours)	Water depth at release (m)	Discharge temperature (°C)
SD2 PR	SDB-PR platform	123	1	Surface	Winter 10 Summer 25

13.10.6 Modelling Results

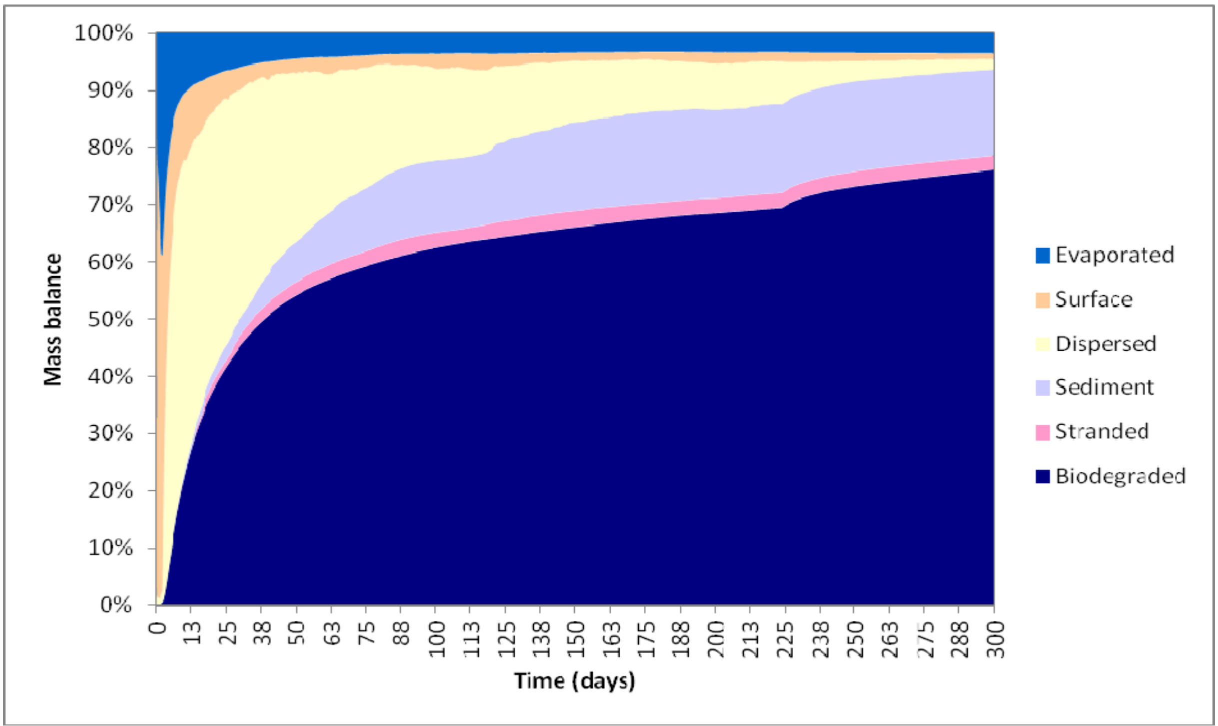
13.10.6.1 Results from Blowout Release Scenarios

The modelling[10] that has been undertaken indicates that the released condensate would undergo the following processes.

- **Dispersed into the sea and subsequently biodegraded**
  A proportion of the condensate released subsea would be mechanically and permanently dispersed as small droplets into the water column by the intense turbulence associated with the simultaneous release of gas, condensate and produced water. A proportion of the condensate that reached the sea surface would be naturally dispersed by the prevailing wave action. A large proportion of the dispersed condensate would eventually be biodegraded while in the water column.
- **Dissolved into the sea**
  Some of the small proportion of partially water-soluble chemical compounds in the condensate would be dissolved into the water column. Although this would only account for a very small proportion of the volume of the released condensate it has implications for the potential for negative effects to be caused to marine organisms.
- **Sedimentation**
  Some of the dispersed condensate would become associated with sediment in the water column and would be eventually deposited over a wide area of the seabed.
- **Lost to the air by evaporation**
  Volatile components in the condensate residue would evaporate from the condensate residue that reached the sea surface.

The relative proportions of the condensate that would undergo these processes depend on prevailing conditions and are illustrated in Figure 13.8 for the BO ES1 in summer blowout scenario.

Figure 13.8 Fate of Condensate Released from BO ES 1 (Summer Blowout Scenario)



[10] Both stochastic (multiple scenario) and deterministic (single scenario) modelling was undertaken. Stochastic modelling was used to allow the selection of appropriate weather periods to run all the scenarios as deterministic under worst case summer and winter conditions. Results for the deterministic cases are presented in the ESIA Chapter 13 to provide a summary of the worst case scenarios. Appendix 13A includes the both the stochastic and deterministic modelling results.

A small proportion of the total volume of condensate that had been released would remain on the sea surface in the form of a waxy residue. This waxy residue would drift under the influence of the prevailing currents and winds and some condensate residue would eventually come ashore.

The sources of ecological concern, as discussed in Section 13.10.7.2 below, are:

i. The transfer of partially water-soluble and potentially toxic chemical compounds, such as the BTEX (Benzene, Toluene, Ethylbenzenes and Xylenes) compounds, from the condensate and into the water column during the release and subsequently as the condensate is naturally dispersed. The concentration of these chemical compounds in the water column and the duration for which these concentrations persist is therefore of interest.

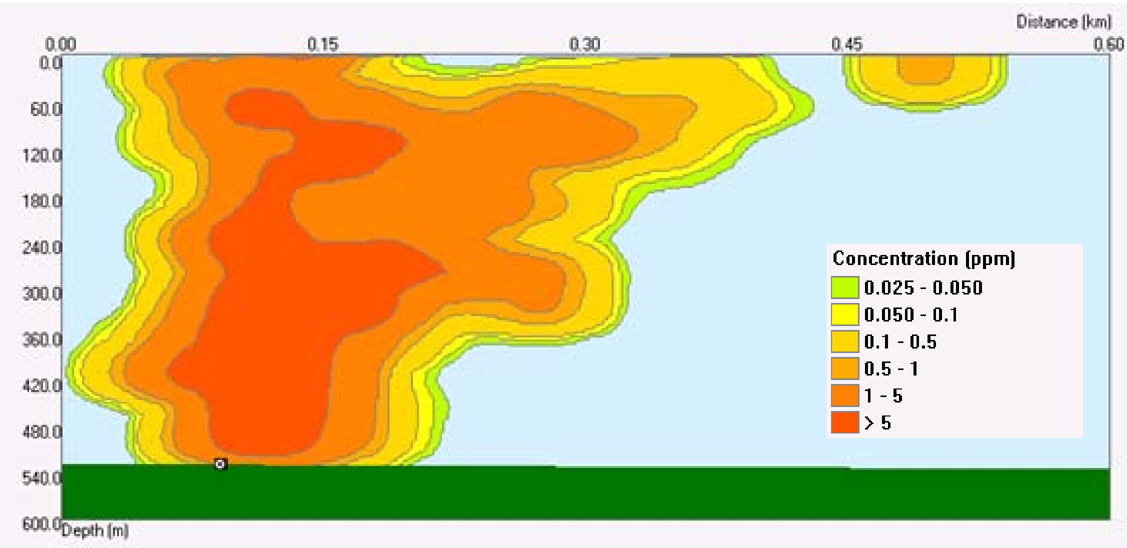
ii. Condensate residue persisting at sea for long enough to eventually drift ashore. Unlike most crude oils, the condensate does not form high-viscosity water-in-oil emulsions that contaminate seabirds' plumage and smother small coastal animals. Compared to crude oils, the condensate residue will contain only very low levels of potentially toxic chemical compounds. The BTEX type compounds will be depleted because they will have already been transferred into the water column.

The modelled consequences of these aspects of the behaviour of the condensate released from the blowout scenarios are summarised in Table 13.11.

Concentrations of Hydrocarbons and Potentially Toxic Compounds In The Water Column

Figure 13.9 shows a cross-section of the plume of condensate (dissolved fraction) produced at a blowout under winter conditions.

Figure 13.9 Fate of Condensate Released from BO ES1 Blowout Scenario – Vertical Cross Section through Plume



Very small condensate droplets produced during the blowout release will have very low buoyancy due to their small size and will only float slowly towards the sea surface. However, the condensate droplets will be propelled upwards through the water by the buoyant gas plume.

As the gas dissolves into the water, the buoyancy of the gas plume will decrease. The condensate droplets will float upwards towards the sea surface at a velocity proportional to their buoyancy; the smaller condensate droplets will be permanently dispersed in the water column and the larger droplets will rise to the sea surface.

Partially water-soluble chemical compounds in the condensate will dissolve out of the condensate and into the water. Concentrations of hydrocarbons in the water column, including both condensate droplets and dissolved chemical compounds, will rise rapidly to high concentrations of many ppm (parts per million) close to the blowout. The maximum concentration of hydrocarbons in the vicinity of the blowouts is shown in Table 13.11 for both the relatively shallow water BO NF2 scenario and the deeper water BO ES1 scenario.

Table 13.11 Summary of Modelled Blowout Outputs

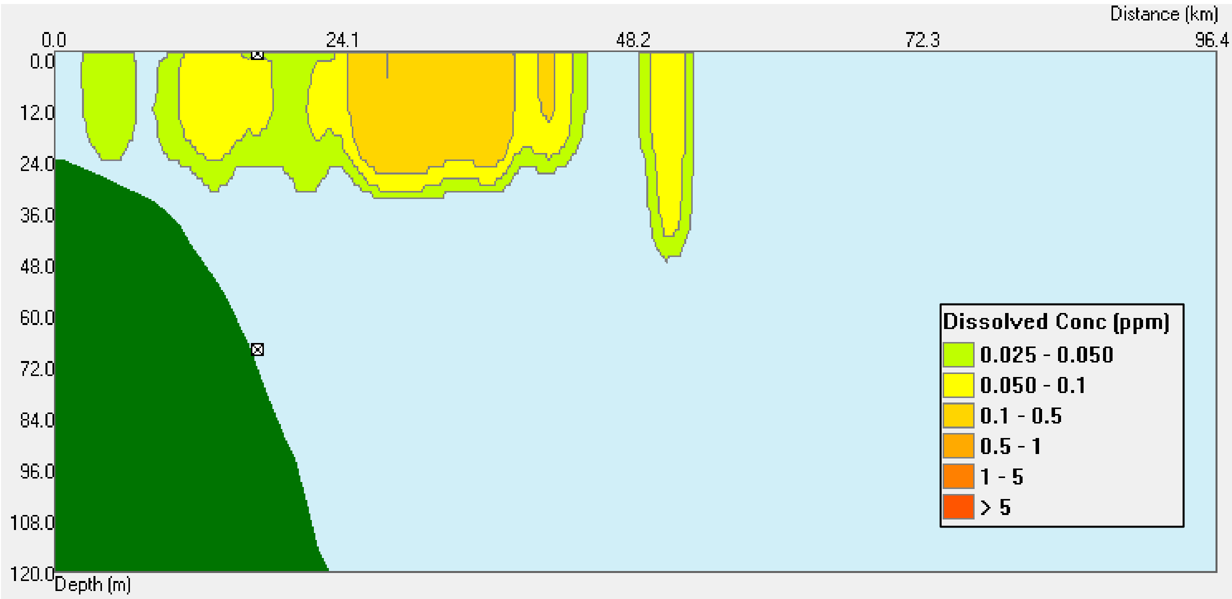
Scenario	Release location	Maximum total water column concentrations[1] (ppm)		Duration of exposure to elevated hydrocarbon concentrations	Minimum time to beaching (days)		Maximum mass onshore (tonnes)	
		Summer	Winter		Summer	Winter	Summer	Winter
BO ES 1	ES C well location	4.9	2.5	Approximately 240 days	13	13	18,960	20,570
BO NF 2	NF1/ SD-X 6 well location	8.5	10.0	Approximately 240 days	9.5	8.5	2,426	3,103

Note 1: Water column concentrations include both hydrocarbon droplets/solids and dissolved hydrocarbons

The blowout in the shallower water produces higher peak hydrocarbon concentrations in water, around 10 ppm, that the blowout in deeper water where the peak concentrations are less than half this concentration.

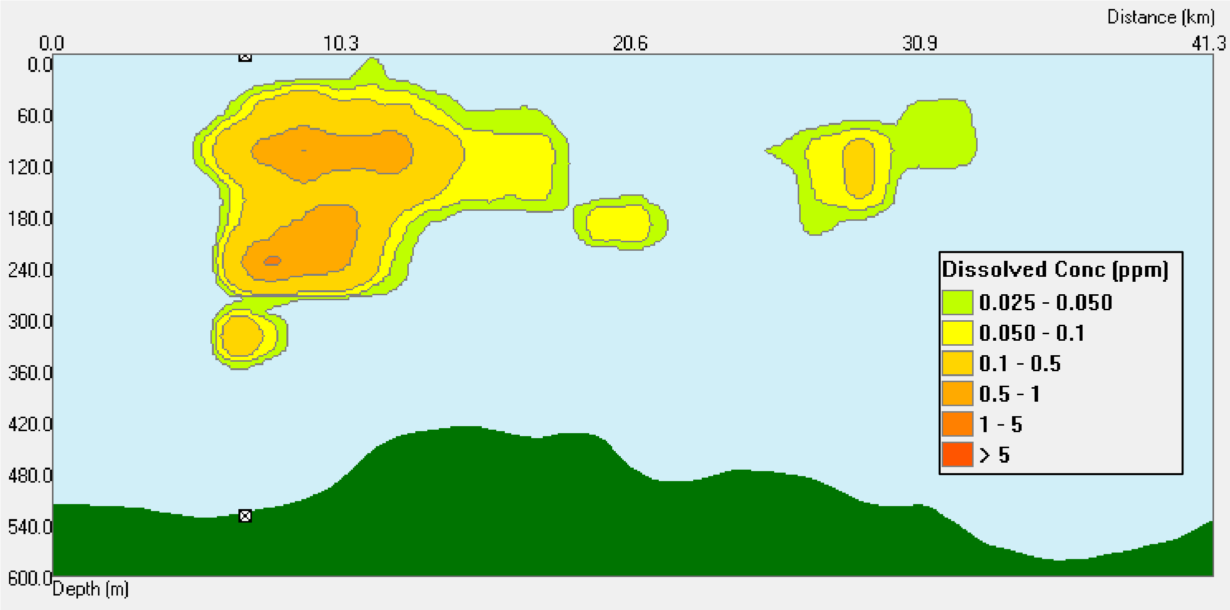
In the case of the relatively shallow water BO NF2 blowout scenario, the elevated dissolved hydrocarbon concentrations will be in the upper water layers and spread out by the rising and spreading plume of gas (Figure 13.10).

Figure 13.10 Dissolved Hydrocarbon Concentrations in the Water for Day 15 of the BO NF2 Blowout Scenario



For the deeper water BO ES 1 scenario, the elevated dissolved hydrocarbon concentrations will be in deeper water, but above the release source as the condensate droplets are carried upwards by the buoyant gas plume (Figure 13.11)

Figure 13.11 Dissolved Hydrocarbon Concentrations in the Water for Day 15 of the BO ES1 Blowout Scenario



These hydrocarbon-in-water concentrations will be maintained in the volume of water in the vicinity of the blowout for the entire blowout duration. Hydrocarbon concentrations in the water column will subside relatively quickly when the blowout ceases, taking from 6 to 12 days to fall to below 25 ppb (parts per billion).

Amounts of Condensate Coming Ashore, Time To Come Ashore and Probable Locations

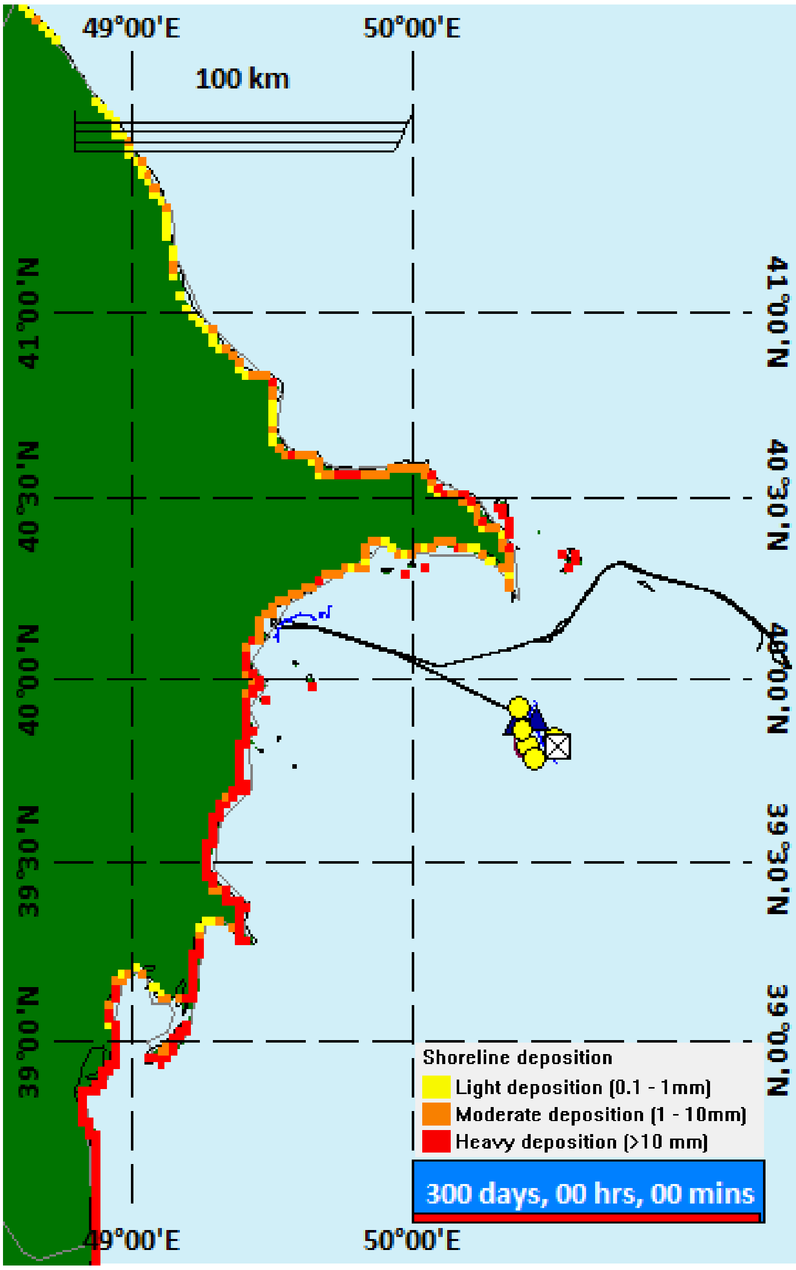
The amount of condensate residue that would come ashore at any particular location after a blowout will depend on the location of the blowout (distances from shores), the persistence of the condensate residue on the sea surface and the prevailing currents and winds.

The modelling results presented in Table 13.11 indicate that the condensate residue would start to come ashore after approximately 9 days from the shallow water BO NF2 blowout and after 13 days from the more distant deeper water BO ES1 blowout.

More condensate residue would come ashore from the deeper water BO ES1 blowout scenario, around 20,000 tonnes, than would come ashore from the relatively shallow water BO NF 2 blowout scenario, around 3,000 tonnes, even though the shallow water blowout is closer to shore. The difference in condensate beaching relates to the fate of the dispersed wax particles. In deeper water these disperse over a wide area and many reach currents that bring them onshore. For the shallower release scenario they tend to encounter different currents that keep the wax particles at sea for longer, thus resulting in reduced beaching. Although these may seem to be relatively large quantities of condensate that are predicted to be washed onshore, they represent only a small fraction of the total amount of condensate released (3.6% in the case of the BO ES 1 scenario and 0.5 % in the case of the BO NF 2 scenario).

The location of shoreline deposition will depend on the prevailing winds, prevailing currents and the water depth at the release. Figure 13.12 shows the predicted shoreline deposition under worst case winter conditions.

Figure 13.12 Shoreline Deposition Resulting from the BO ES1 Blowout Scenario in Winter



13.10.6.2 Results from Flowline Rupture Release Scenarios

The release of condensate from a ruptured flowline occurs in two stages:

1. Condense release during depressurisation;
   a) Depressurisation release: a fast phase taking place over 1 or 2 minutes, and
   b) Displacement release: a slower phase taking 4 to 9 minutes, until pipeline pressure drops to ambient hydrostatic pressure;
2. Condensate release due to subsequent seawater ingress displacing some of the remaining condensate over a period of hours until water-accessible lengths of the pipeline are filled.

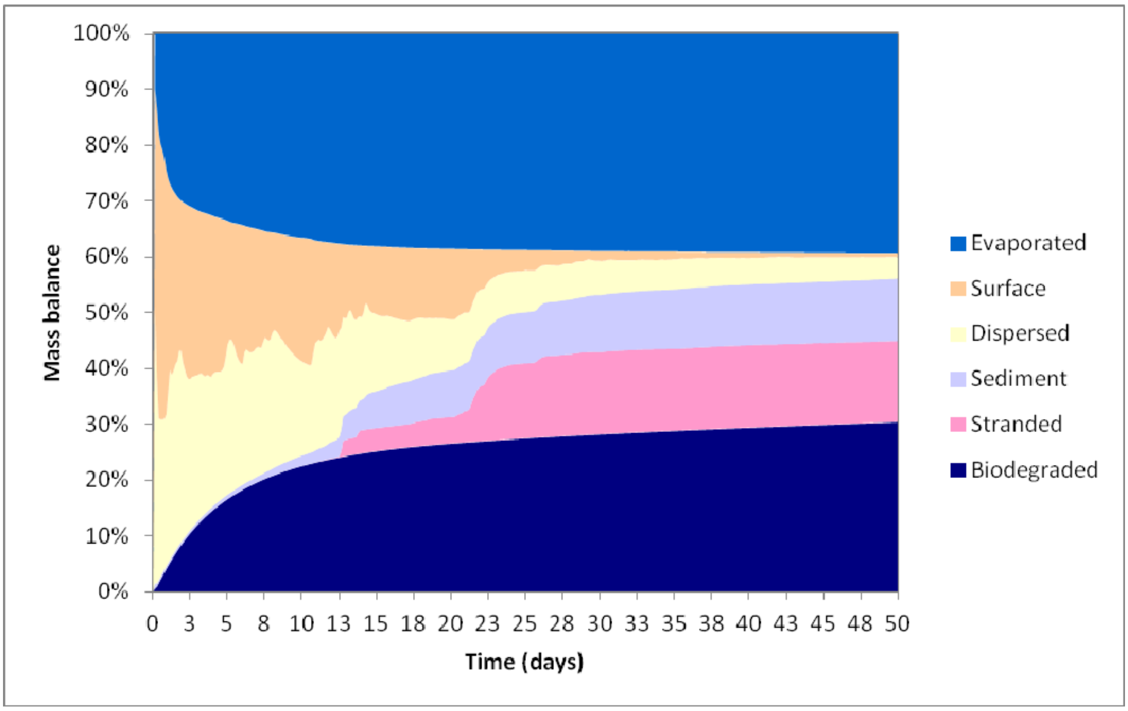
These processes were modelled using the pipeline spill quantification software POSVCM (Pipeline Oil Spill Volume Estimation Model), developed by SINTEF for the US Minerals Management Service. The amount of condensate released from a ruptured flowline depends on the scenario and is shown in Table 13.12.

Table 13.12 Amounts of Condensate Released from Ruptured Flowlines

Scenario	Release location	Water depth at release (m)	Depressurisation release (m^3)	Displacement release (m^3)	Total release (m^3)
ES FL1	Close to escarpment	185	209.5	901.8	1111.3
ES FL2	Deep water near well location	530	153.3	0.0	153.3
WF FL4	WF wells upstream	164	65.4	0.0	65.4

Condensate released from a ruptured flowline would undergo the same processes of dispersion, biodegradation, sedimentation and evaporation as described in Section 13.10.6.1 for condensate released from a blowout. Figure 13.13 illustrates the fate of the relative proportions of the condensate for the ES FL1 in winter scenario.

Figure 13.13 Fate of Condensate Released from ES FL1 in Winter (Flowline Rupture Scenario)



Concentrations of Hydrocarbons And Potentially Toxic Compounds in the Water Column

The maximum concentrations of total hydrocarbons in the vicinity of the flowline ruptures are shown in Table 13.13 for all three flowline rupture scenarios. The concentrations range from 2.9 to 4.9 ppm in summer and are lower in winter.

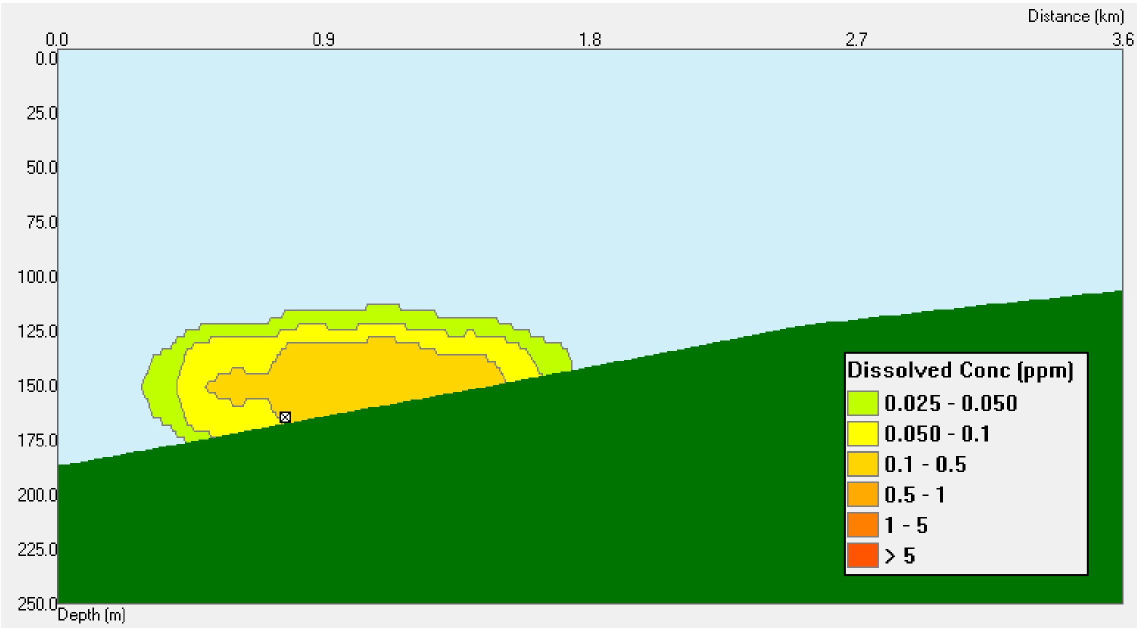
Table 13.13 Summary of Modelled Flowline Rupture Outputs

Scenario	Release location	Maximum total water column concentrations[1] (ppm)		Duration of exposure to elevated hydrocarbon concentration	Minimum time to beaching (days)		Maximum mass onshore (tonnes)	
		Summer	Winter		Summer	Winter	Summer	Winter
ES FL 1	Close to escarpment	4.9	2.5	1 or 2 days	20	11.5	44	152
ES FL 2	ES C well flowline upstream	2.1	2.6	1 or 2 days	n/a	n/a	Negligible	Negligible
WF FL 4	WF wells flowline upstream	2.9	0.3	1 or 2 days	n/a	n/a	Negligible	Negligible

Note 1: Water column concentrations include both hydrocarbon droplets/solids and dissolved hydrocarbons

The distribution of dissolved hydrocarbon concentrations for day 1 of the WF FL4 flowline rupture scenario at 164m water depth is shown in Figure 13.14. The elevated dissolved hydrocarbon concentrations are close to the rupture location. The concentrations of total hydrocarbons in the water and the concentrations of dissolved hydrocarbons in the water will rapidly decrease when the initial phase of the release has ended and will be below 25 ppb in 2 to 4 days.

Figure 13.14 Dissolved Hydrocarbon Concentrations in the Water for Day 1 of the WF FL4 Flowline Rupture Scenario



Amounts of Condensate Coming Ashore, Time to Come Ashore and Probable Locations

The modelling results presented in Table 13.13 show that only a relatively small amount of condensate residue from the ES FL1 scenario will persist at sea for long enough to drift ashore. In the cases of the ES FL2 and WF FL4 scenarios the amount coming ashore will be negligible.

13.10.6.3 Results from Condensate Export Line Rupture Scenarios

The release of condensate from a ruptured condensate export pipeline occurs in two stages in a similar way to that described for a ruptured flowline in Section 13.10.6.2. The processes were modelled using the pipeline spill quantification software POSVCM and the results are shown in Table 13.14.

Table 13.14 Amounts of Condensate Released from Ruptured Condensate Export Pipeline

Scenario	Release location	Water depth at release (m)	Depressurisation release (m^3)	Displacement release (m^3)	Total release (m^3)
EL 1	Upstream of NRV	85	541.9	239.0	780.9
EL 2	Near-shore	12	744.9	1078.8	1823.7

More condensate is released from the ruptured export pipeline at the 12m water depth because of the greater hydrostatic pressure at 85m water depth that counters the outflow. The geometry of the pipeline, being uphill from the platform to the shore, also allows for a greater volume of condensate to be displaced by the ingress of seawater.

A summary of the modelling outputs is presented in Table 13.15.

Table 13.15 Summary of Modelled Condensate Export Pipeline Rupture Outputs

Scenario	Release location	Maximum total water column concentrations[1] (ppm)		Duration of exposure to elevated hydrocarbon concentration	Minimum time to beaching (days)		Maximum mass onshore (tonnes)	
		Summer	Winter		Summer	Winter	Summer	Winter
EL 1	Upstream of NRV	7.6	8.6	6 or 7 days	8.5	11.5	117	73
EL 2	Near-shore	68	93	6 or 7 days	1.1	1.9	356	367

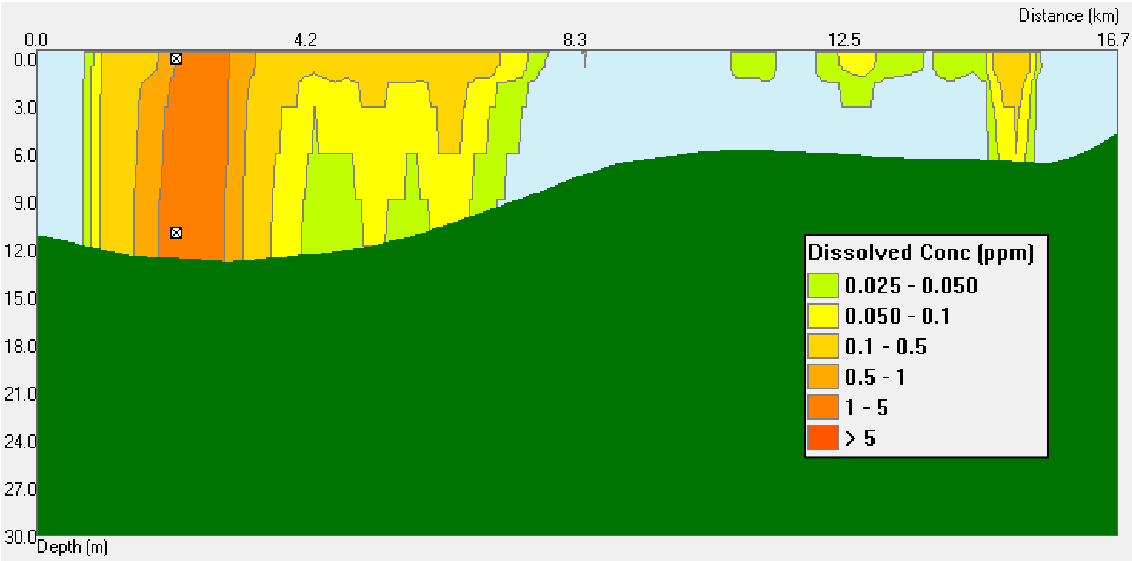
Note 1: Water column concentrations include both hydrocarbon droplets/solids and dissolved hydrocarbons

Concentrations of Hydrocarbons and Potentially Toxic Compounds in the Water Column

The shallow water, near-shore condensate release (EL2 scenario) causes very high maximum total hydrocarbon concentrations of 68 to 93 ppm in the water near the release.

These high concentrations of total hydrocarbons are accompanied by high concentrations of dissolved hydrocarbons as is illustrated in Figure 13.15. These high concentrations of dissolved hydrocarbons would persist for several days after the release, eventually being reduced to 25 ppb after 6 or 7 days.

Figure 13.15 Dissolved Hydrocarbon Concentrations in the Water for Day 1 of the EL2 Condensate Export Pipeline Rupture Scenario

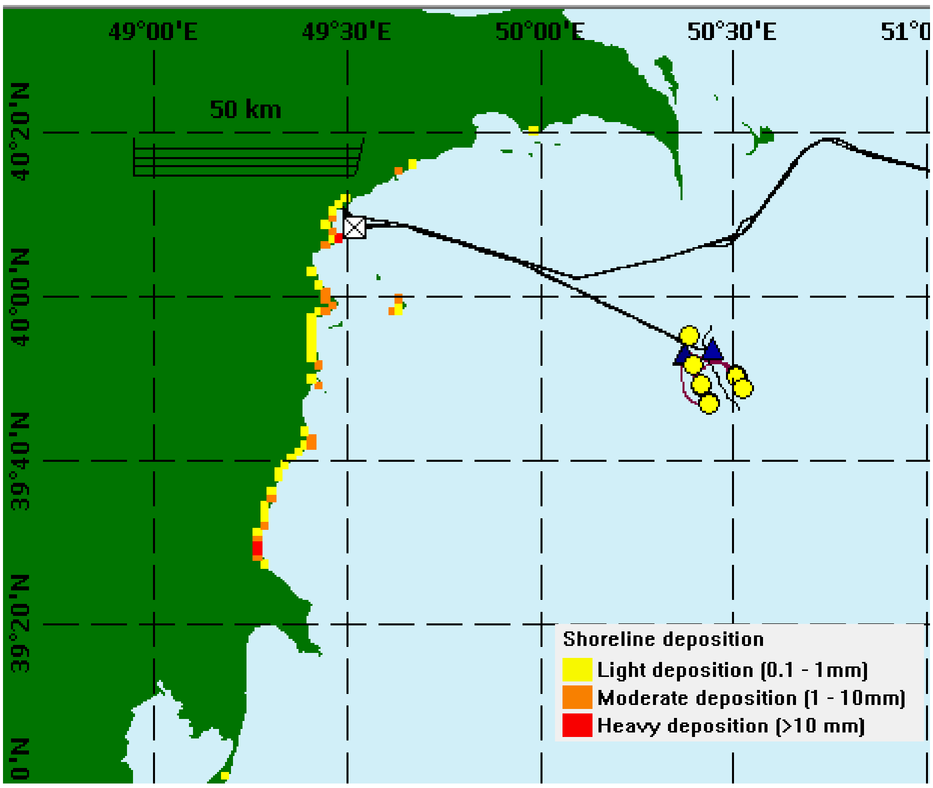


Amounts of Condensate Coming Ashore, Time to Come Ashore and Probable Locations

The model results predict that approximately 360 tonnes of condensate residue will come ashore from the near-shore EL2 scenario, while less will come ashore from the EL1 scenario that is further offshore.

The shoreline deposition from the near-shore EL2 scenario would be heaviest close to the release location, although some deposition would also occur to the north and to the south (Figure 13.16).

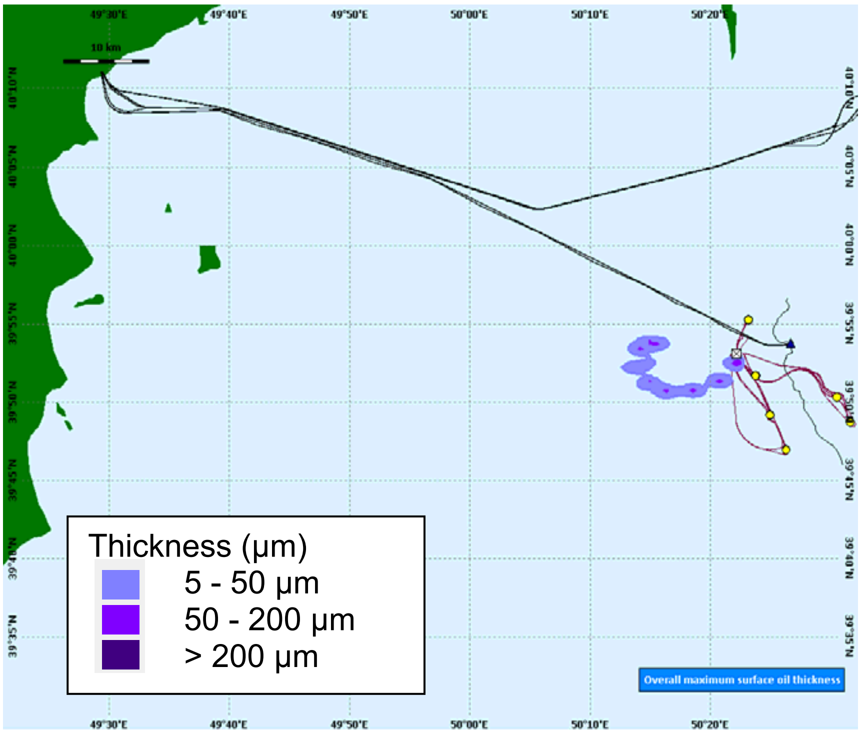
Figure 13.16 Shoreline Deposition Resulting from the EL2 Condensate Export Pipeline Rupture Scenario In Winter



13.10.6.4 Results from Platform Diesel Inventory Loss Scenario

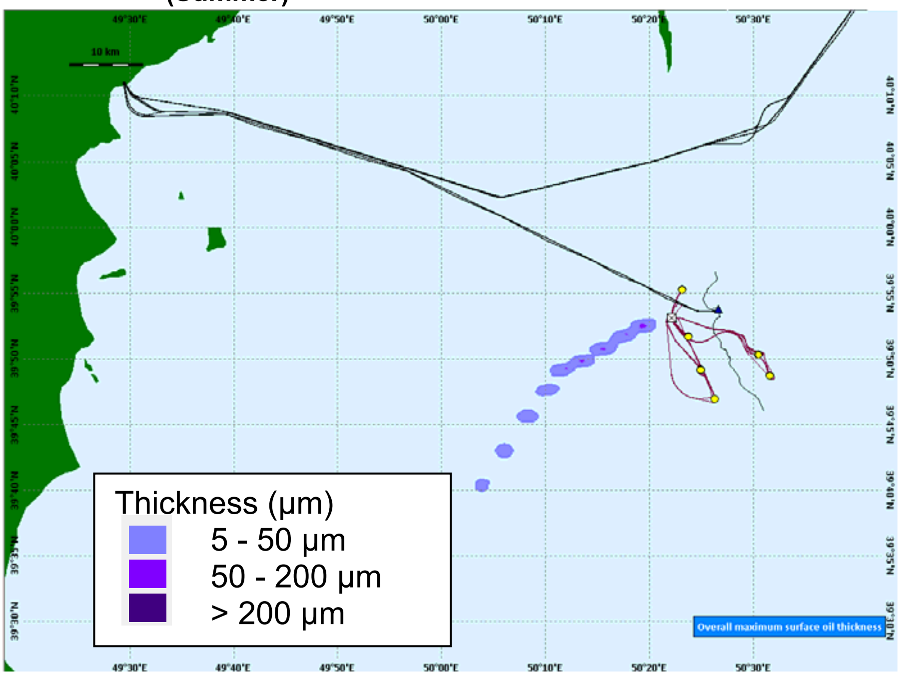
The 123m^3 of diesel fuel released from the SDB-PR platform would rapidly spread out to form a thin sheen on the sea surface. Modelling indicated that the area of sea surface covered by a film of diesel of 5µm or thicker from this spill would be approximately 42km^2 in summer and 13km^2 in winter. Figures 13.16a and 13.16b present the modeling results for winter and summer, suggesting that the film on the sea surface would be visible up to 13km and 42km from the SDB complex respectively.

Figure 13.16a Maximum Time-averaged Thickness of Diesel on the Sea Surface (Winter)



Note: This does not represent the size of the slick, but is the maximum thickness that occurs at any point during the simulation i.e. not a snapshot

Figure 13.16b Maximum Time-averaged Thickness of Diesel on the Sea Surface (Summer)



Figures 13.16c and 13.16d shows the modelled thickness and water column concentrations of the diesel spill 24 and 48 hours after release during winter respectively.

Figure 13.16c Thickness of Diesel Spill i) 24 hours and ii) 48 hours Post-Release (Winter)

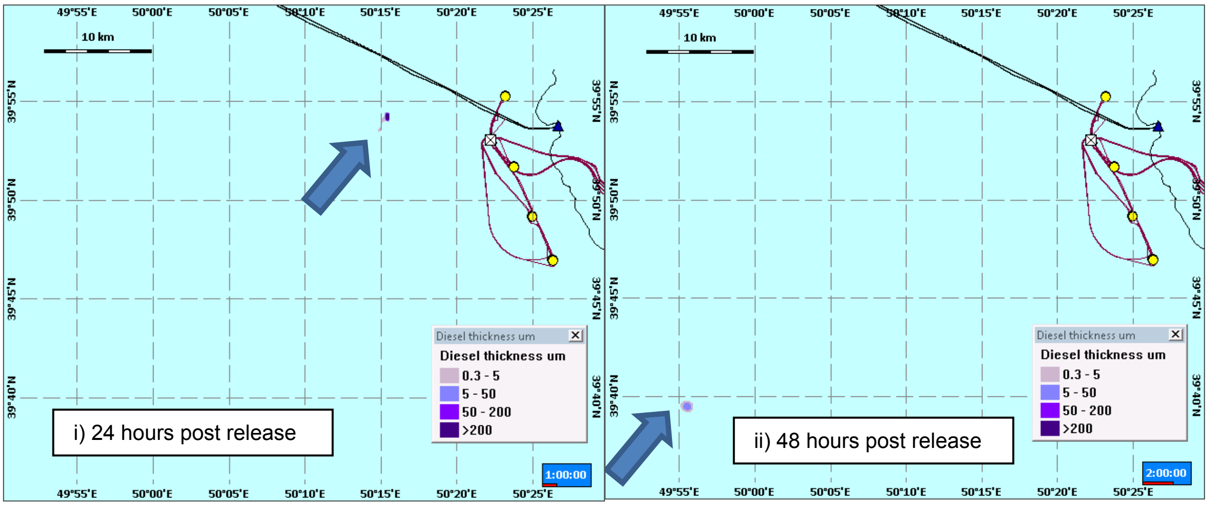
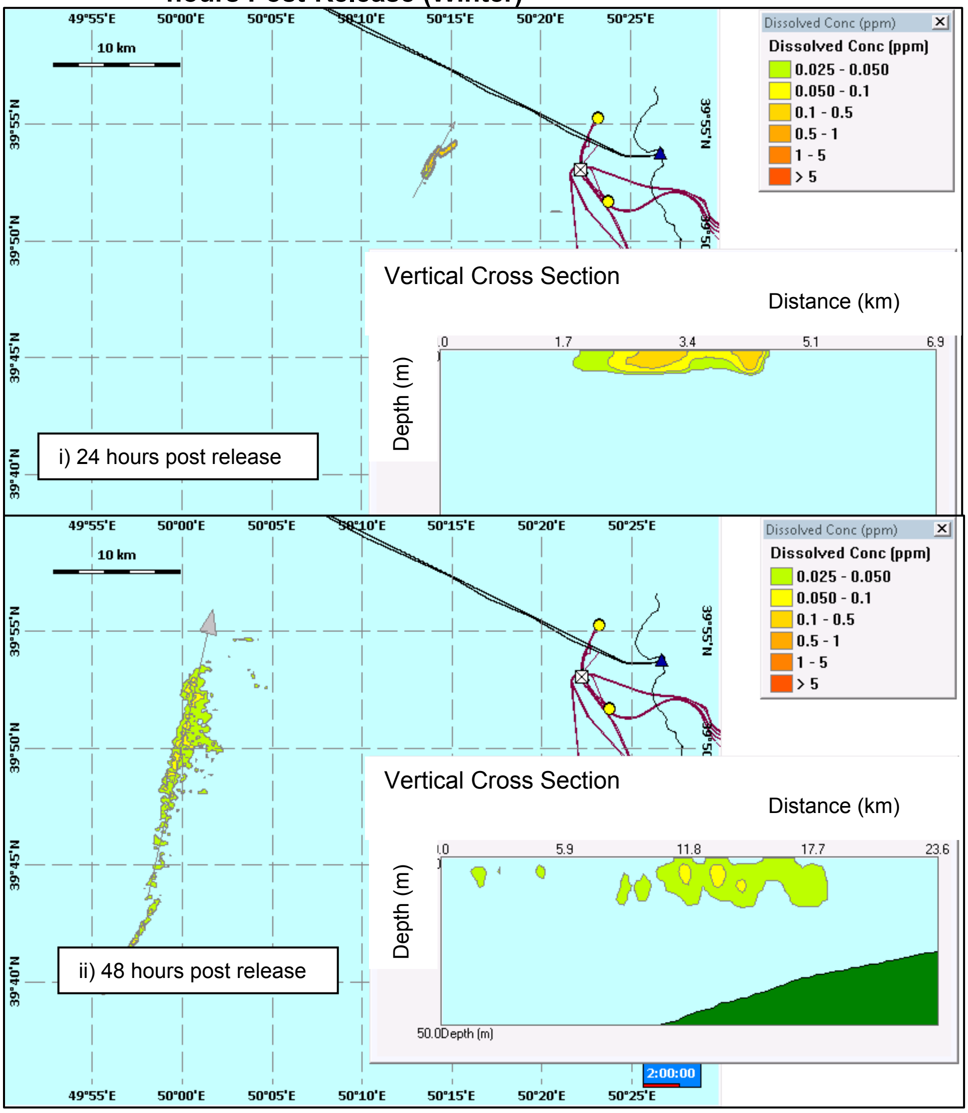
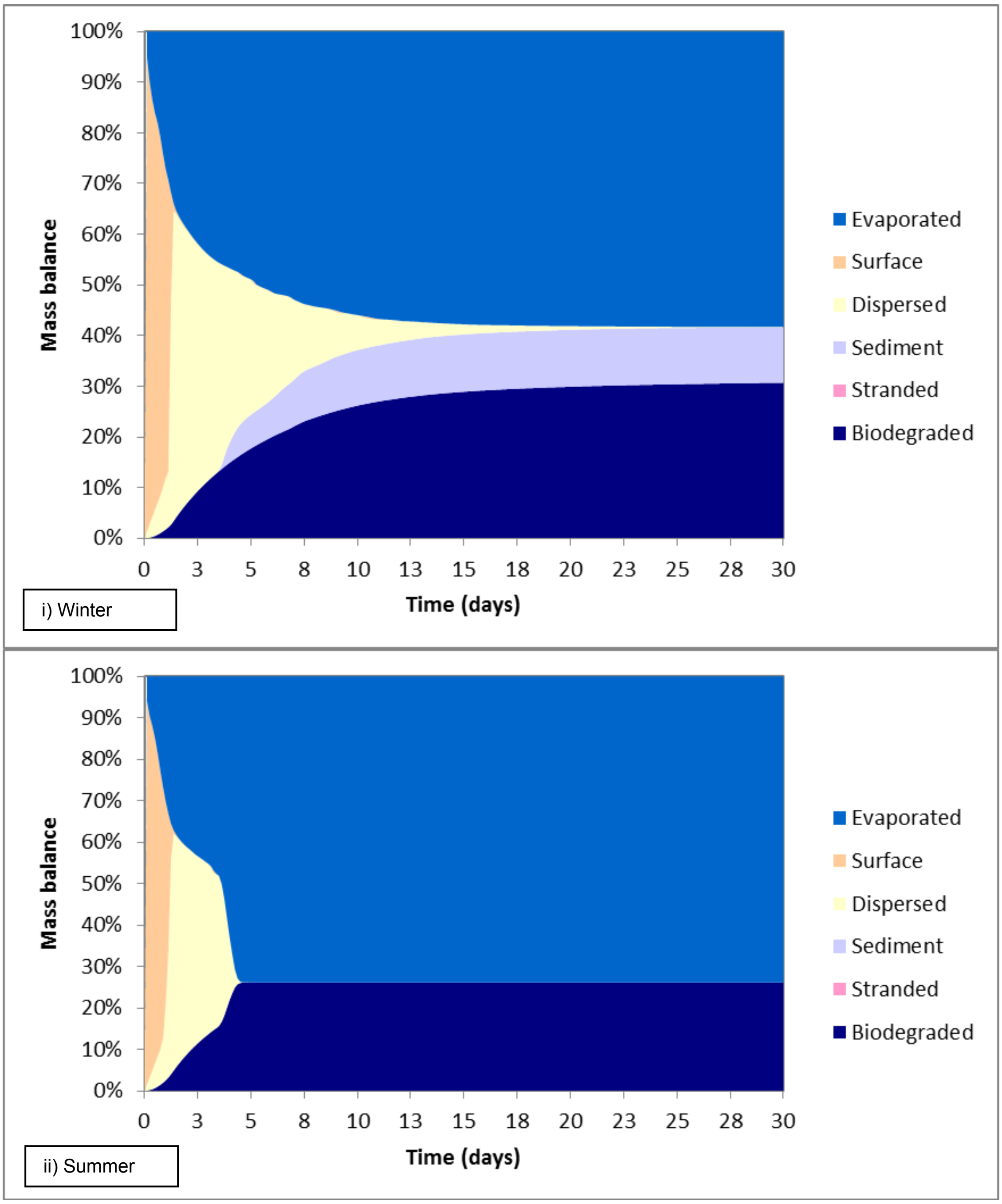


Figure 13.16d Concentration of Diesel Within the Water Column i) 24 hours and ii) 48 hours Post-Release (Winter)



Over time following the release diesel would be lost from the sea surface by evaporation into the air and by natural dispersion into the water column. Figure 13.16e presents the fate of the relative proportions of the diesel for the winter and summer conditions.

Figure 13.16e Fate of Diesel Released for i) Winter and ii) Summer Conditions



As Figure 13.16e shows, the majority of the volume of the released diesel is rapidly lost to the air by evaporation or naturally dispersed into the water column and then biodegraded. The modelling completed showed that all of the diesel released would be removed from the sea surface by these processes within approximately 2 days in winter and 11/2 days in summer.

The concentrations of naturally dispersed diesel in the water column were shown to reach a maximum of around 1 ppm, which will decline to less than 25 ppb dissolved in the water column within 48 hours under both summer and winter conditions.

13.10.7 Impact of Condensate and Diesel Releases

13.10.7.1 Physical State of SD2 Condensate and Residues Remaining After Weathering

The condensates to be produced from the various reservoirs at Shah Deniz 2 have relatively high wax contents and Pour Points, ranging from +3°C to +12°C. Precipitated wax can be seen in the samples of various condensates at room temperature (Figure 13.17).

Figure 13.17 Appearance of Various Condensates to be Produced at SD2

SINTEF conducted a laboratory weathering study on a condensate sample from well SDX-05Y. The condensate sample has a Pour Point of +9°C. Distillation residues were prepared to simulate different degrees of evaporative loss from the condensate. The 150°C+, 200°C+ and 250°C+ distillation residues, representing 19%, 34% and 50% volume loss from the condensate had Pour Points of +21°C, +30°C and +33°C, respectively.

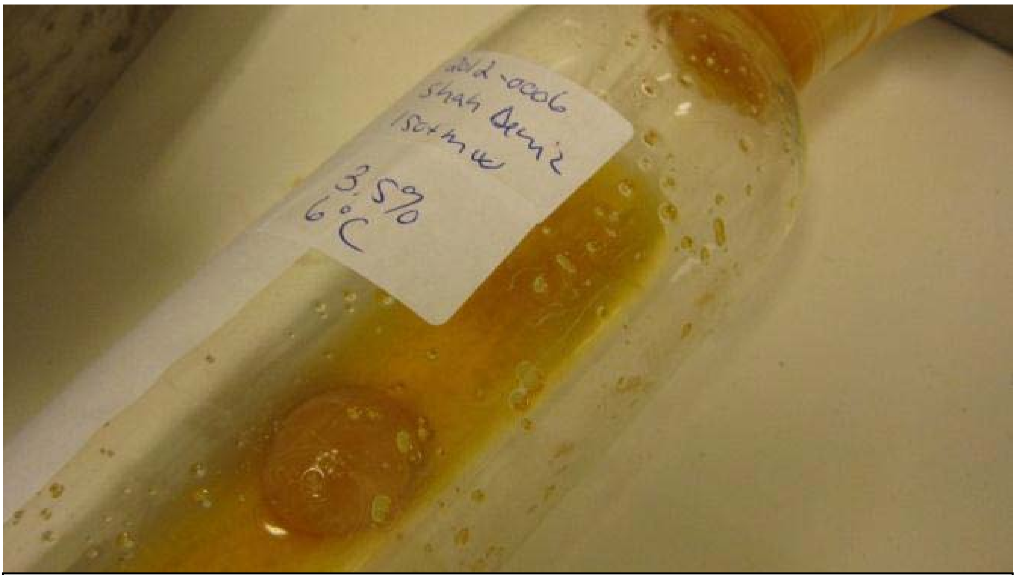
The 200°C+ distillation residue, representing the evaporative loss after 0.5 to 1 day on the sea surface, was totally solid at room temperature of approximately 24°C (the inverted bottle in Figure 13.18).

Figure 13.18 Physical State of the Distillation Residues at a Room Temperature Of 24°C

Photograph from SINTEF Report Shah Deniz Condensate – Weathering properties, WAF and Toxicity

When the 250°C+ distillation residue was mixed with seawater at 6°C for 24 hours to investigate the possibility of water-in-oil emulsion formation the condensate separated into two phases; a wax-depleted, liquid oily phase and a wax-enriched, solid waxy phase. The wax agglomerated into a single large lump in the flask (Figure 13.19).

Figure 13.19 Lump of Wax Produced on Mixing the 250°C+ Distillation Residue With Seawater at 6°C



Photograph from SINTEF Report Shah Deniz Condensate – Weathering properties, WAF and Toxicity

Spills and releases of high Pour Points condensate have previously occurred. A relatively recent example was the Montara incident in the Timor Sea, off northern Australia in August 2009. The released condensate had a Pour Point of +27°C and the sea surface temperature was also 27°C, although the air temperature at times was over 40°C. The condensate released during the Montara incident weathered at sea and the Pour Point increased. The spilled condensate was present on the sea surface in the form of wax in thick layers when contained by booms (Figure 13.20), but as scattered particles when uncontained (Figure 13.21).

Figure 13.20 Weathered Condensate at Montara Incident Contained in a Boom

Photograph from MONTARA WELL RELEASE, TIMOR SEA . Monitoring Study O2 Monitoring of Oil Character, Fate and Effects Report 01. AMSA (Australian Maritime Safety Authority) 24th September 2009

Figure 13.21 Weathered Condensate at Montara Incident on Sea Surface

Photograph from MONTARA WELL RELEASE, TIMOR SEA . Monitoring Study O2 Monitoring of Oil Character, Fate and Effects Report 01. AMSA (Australian Maritime Safety Authority) 24th September 2009

The precise behaviour of the SD2 condensate released into the sea will depend on the release conditions. Condensate released simultaneously into the sea at depth with large amounts of gas and some produced water from the blowout and flowline release scenarios will initially be in the form of very small droplets of liquid condensate. Large globules of condensate will be released from the less intense turbulence associated with an export pipeline rupture. The droplets or globules will rise up through the water column, losing water-soluble components into the water as they rise. On arriving at the sea surface, the more volatile components will be rapidly lost by evaporation. This is most likely to lead to a waxy residue being left on the sea surface in some release circumstances.

13.10.7.2 Ecological Impacts from Accidental Releases of Condensate.

There are two potential sources of environmental impacts resulting from accidental releases of condensate.

Ecological Impacts in the Water Column

The accidental release of condensate into the water column could cause negative effects to marine organisms in the locality of the release because of an increased level of potentially toxic compounds being released from the condensate into the water column.

There are several classes of chemical compounds that are present in crude oils that have the potential to exert toxic effects on marine organisms (Table 13.16). Condensates contain some, but not all, of these compounds. The extent to which these different classes of compound partition in to the water column or evaporate into the air will be the primary factors in determining their potential impact.

Table 13.16 Chemical Compounds in Crude Oils and Condensates That Have the Potential to Exert Toxic Effects on Marine Organisms

Chemical Compounds	Includes	Potential Effects	Exposure Route	Fate
Low molecular weight alkanes	Pentane, Hexane, Heptane	Narcosis (often reversible)	Slightly soluble in water	Evaporate from slick into air
BTEX	Benzene, Toluene, Ethylbenzenes and Xylenes	Acute toxicity	Moderately soluble in water	Evaporate from slick into air, or biodegraded in the water column
SVOC (Semi-Volatile Organic Compounds)	Substituted (alkylated) naphthalenes	Acute toxicity	Transfer from dispersed condensate droplets into water column	Biodegraded
PAHs (Polycyclic Aromatic Hydrocarbons)	3, 4 or 5 (or more) fused aromatic rings and include anthracene, chrysene, benzo-a-pyrene (and many others).	Chronic toxicity	Ingestion of condensate and subsequent metabolisation	Persistent

The severity of negative effects that could be caused to marine organisms by these chemical compounds will be a function of their exposure to them. Exposure is a function of the concentration of these chemical compounds in water and the duration for which the organisms are exposed.

Blowout Scenarios

The maximum concentrations of total hydrocarbons (both dissolved and in the form of condensate droplets) in water generated in the blowout scenarios (Section 13.10.6.1) are predicted by the modelling to be from 3 to 10 ppm (Table 13.11). The concentrations of dissolved hydrocarbons are lower (Figures 13.10 and 13.11), but are high enough to cause negative effects to exposed marine organisms, particularly as they will be maintained at these levels for the entire blowout duration and take several days longer to subside to low levels. The duration of exposure is very likely to cause severe negative effects to affected marine organisms.

Flowline Rupture Release Scenarios

The maximum concentrations of total hydrocarbons in water generated in the flowline rupture scenarios (Section 13.10.6.2) are predicted to be between 0.3 and 4.9 ppm (Table 13.13), but the exposure duration will be for only 1 to 2 days. The volumes of water with elevated dissolved hydrocarbons (as in the example illustrated in Figure 13.14) will be small and localised to the vicinity of the flowline rupture. The relatively short exposure in confined water volumes is likely to cause only very localised and temporary effects to affected populations of marine organisms.

Condensate Export Pipeline Rupture Scenarios

The condensate release from the ruptured pipeline in near-shore, shallow water (Scenario EL2 in Section 13.10.6.3) will generate extremely high maximum concentrations of total hydrocarbons in water of 68 or 93 ppm (Table 13.15). The dissolved hydrocarbon concentrations will also be very high, over 5 ppm (Figure 13.15) in the water volume near the pipeline rupture location. These high concentrations will be maintained for 6 or 7 days and could have a severe impact on the affected marine organisms.

Ecological Impacts on The Sea Surface And Shore

The waxy residue of condensate that would remain at sea for a relatively long time would have been depleted in the most potentially toxic chemical compounds that could cause negative effects by chronic exposure. Almost all of the BTEX and SVOCs would have been previously lost by dissolution and evaporation. The condensate does not contain significant levels of Polycyclic Aromatic Hydrocarbons (PAHs) that can cause negative effects by chronic exposure. Unlike most crude oils, the condensate does not form stable water-in-oil emulsions that could smother small coastal animals and contaminate the plumage of seabirds.

The waxy residue that comes ashore after condensate releases will be in the form of wax particles, or granules, widely scattered along the shoreline, although there may be localised concentrations. These wax particles may melt in the sun during the day and soak into sandy shoreline substrates.

The ecological effects of waxy condensate residue coming ashore are therefore likely to be minimal, certainly much less severe than would be the case for emulsified crude oil coming ashore.

13.10.7.3 Ecological Impacts from Accidental Releases of Diesel

Potential Ecological Effect of Diesel on the Sea Surface

The water depth under the spilled diesel on the sea surface will always be greater than approximately 70 metres. The upper layers of this water will be well-oxygenated. The duration of time that there will be a layer of diesel on the sea surface will be a maximum of 2 days. During this time, the diesel will not be present as a coherent, stationary layer capable of preventing oxygen transfer into the water. Instead, it will be present as an oil slick that drifts across the sea surface and is continually being exposed to wave action that disrupts, and eventually disperse it. There will be little, if any, oxygen depletion in the upper water column and no significant effects on marine organisms.

Potential Ecological Effect of Diesel in the Water Column

The diesel-in-water concentration will rise up to a maximum of 1 ppm (parts per million) in localised areas under the drifting oil slick and then rapidly decline to less than 25 ppb (parts per billion) within 48 hours. Experience and laboratory studies have shown that exposure to these diesel concentrations for this duration are too low and too brief to cause any significant effects on any marine organisms.

13.10.8 Spill Prevention and Response Planning

13.10.8.1 Oil Spill Contingency Planning - Azerbaijan Offshore

An Oil Spill Response Plan has been developed, which provides guidance and actions to be taken during a hydrocarbon spill incident associated with all Shah Deniz offshore operations, which include mobile offshore drilling units, platforms, subsea pipelines and marine vessels. It is valid for spills that may occur during the commissioning, operation, and decommissioning of the systems.

The Oil Spill Response Plan is designed to:

- Establish procedures to control a release or the threat of a release, that may arise during offshore operations and associated facilities;
- Establish procedures to facilitate transition of response operations from a Tier 1 incident to a Tier 2/3 release or threat of release;
- Minimise the movement of the hydrocarbon spill from the source by timely containment;
- Minimise the environmental impact of the oil spill by timely response;
- Maximise the effectiveness of the recovery response through the selection of both the appropriate equipment and techniques to be employed; and
- Maximise the effectiveness of the response through trained and competent operational teams.

BP’s response strategy is based on: an in-depth risk assessment of drilling and platforms operations and subsea pipelines; analysis of potential spill movement; environmental sensitivities and; the optimum type and location of response resources. BP supplements its dedicated resources with specialist spill response contractors.

BP has contracted an independent oil spill response contractor in Azerbaijan to provide a response to a Tier 2 oil spill incident originating from BP's offshore operations and these resources may be accessed for larger spills in Azerbaijan. Oil Spill Response (Ltd) (OSRL) is a Tier 3 responder who has bases in both the UK and Singapore and will provide Tier 3 services to BP in the event of a major release and/or highly sensitive Tier 2 incident. In addition to the supply of equipment, they can also provide response technicians and supervisors.

BP will also coordinate with local emergency services and government agencies in Azerbaijan, both prior to, and during oil spill incidents, and additional resources are available from the Ministry of Emergency Situations. The OSRP describes how BP will utilise these resources to protect the environment in which it resides.

13.10.8.2 BP Capping Resources - Azerbaijan Offshore

In addition to oil spill response capability, BP also has a well capping stack, dispersant, debris removal and ROV tooling system designed to be transported by air to any location around the world where BP operates. In addition, BP is a subscriber to the Subsea Well Response Project (SWRP) through which it will have access (from 2013 and subject to availability) to four capping stacks and two subsea dispersant systems. OSRL will own, store and maintain the four capping stacks and the two dispersant systems at bases in Stavanger, near Rio de Janeiro, near Cape Town and in Singapore. The systems are available for deployment to any global location (excluding the US). Both the BP and the SWRP capping stack systems are capable of being transported to Azerbaijan but are subject to deployment limitations in the Caspian as described below.

The Caspian region is limited in the number of response vessels and vessels with suitable ROV and subsea crane capabilities to deploy a capping stack system. There is also a concern that the high flow-rate wells in the Caspian in combination with shallow water will limit vertical access to a failed BOP. This is due to high VOCs (Volatile Organic Compound) at surface and challenging vessel surface operating conditions.

At present, there are significant challenges to an operator's ability to deploy a capping stack on Caspian wells. Work is ongoing through SWRP and BP, however, to understand capping stack landing limitations on a failed BOP, assess deployment requirements and develop vertical offset installation methods to respond to an incident in the Caspian.

13.10.9 Reporting

All non-approved releases (liquids, gases or solids) including releases exceeding approved limits or specified conditions during all phases of the SD2 Project will be internally reported and investigated. Existing external notification requirements agreed with the MENR will be adopted during the operation phase of the SD2 Project are:

- For liquid releases to the environment exceeding a volume of 50L, notification will be made to the MENR within 24 hours after the incident verbally and within 72 hours in the written form; and
- If the release to the environment is less than 50L, then information about the release will be included into the BP AGT Region Report on Unplanned Releases and sent to the MENR on a monthly basis.

Spills that occur at the main construction and installation contractors sites and from vessels they operate will be reported to the MENR by the contractors.

A Protocol "On Agreeing the Main Principles of Cooperation for Regulation of Unplanned Material Releases" signed between BP and MENR in December 2012 defines an approved release as "a release that is permitted by applicable PSA, MENR permitted and/or approved documents including ESIA, EIA, Technical Note, Technical Letter, individual discharge request letters to MENR or any other written agreement with the MENR". Unapproved releases are those that do not fall into this definition.