Shallow Water Absheron Peninsula (SWAP) Exploration Drilling Project

Environmental and Socio-Economic Impact Assessment

Addendum: Bibiheybat (BHEX01) Exploration Well

June 2021

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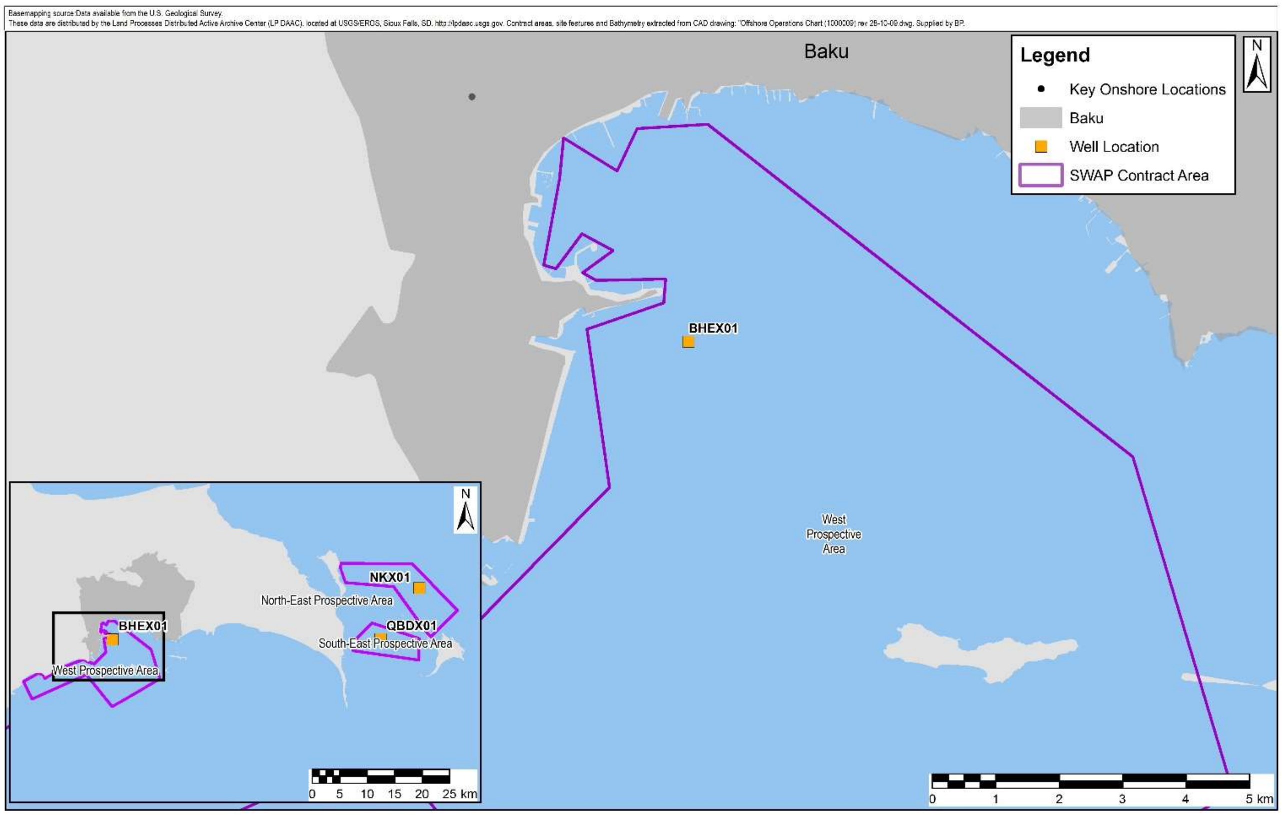
1 Introduction

This document has been prepared to describe and assess the potential impacts associated with the drilling activities for the proposed Bibiheybat (BHEX01) exploration well to be located within the West Prospective Area of the Shallow Water Absheron Peninsula (SWAP) Contract Area. This represents the next phase of activity under the SWAP Exploration Drilling Project, where the activities associated with the drilling of first of three wells (NKX01) were described and assessed within the SWAP Exploration Drilling Project Environmental and Socio-Economic Impact Assessment (ESIA) (Ref.1), which was submitted to the Ministry of Ecology and Natural Resources (MENR) in August 2020.

This document therefore represents an Addendum to the original SWAP Exploration Drilling Project ESIA. The location of the West Prospective Area and the indicative location of the BHEX01 exploration well are shown in Figure 1.1.

Figure 1.1: BHEX01 Exploration Well Location



Exploration drilling activities at the proposed QBDX01 well location located within South-East Prospective Area will be covered in a separate addendum.

The planned BHEX01 exploration well is located approximately 1.5km from the Azerbaijani coastline near Baku Bay in water approximately 7m deep. The well will be drilled using the same jack up-rig that will be used for the NKX01 well. Drilling is planned to commence in November 2021, however the timing will depend on the completion of NKX01 well drilling programme, which is planned to commence in August 2021. Drilling of the third well (QBDX01) is planned to commence once BHEX01 drilling programme is completed.

The BHEX01 exploration well is planned to target hydrocarbons approximately 4,000m below the seabed surface and drilling activities are expected to take up to 90 days to complete. During this period, support vessels will provide assistance to the jack-up rig. Drilling of the exploration well will be carried out, taking into account applicable national and international legal requirements and in accordance with the requirements of the SWAP PSA. The key objective of drilling the exploration well is to confirm the presence of hydrocarbons prior to the potential future development of the Contract Area.

The purpose of this ESIA Addendum, prepared for submission to the MENR, is to:

- Describe the proposed BHEX01 exploration well drilling activities (Chapter 2);
- Describe the environmental and socio-economic baseline conditions relevant to the BHEX01 location (Chapter 3);
- Identify and assess the potential environmental and socio-economic impacts associated with the drilling activities and the measures to be adopted to minimise the potential impacts[1] (Chapter 4);
- Provide an assessment of the potential cumulative and transboundary impacts and those arising from possible accidental events associated with the BHEX01 drilling programme (Chapter 5); and
- Summarise the environmental and social management system associated with the BHEX01 drilling programme (Section 6).

As described in the SWAP Exploration Drilling Project ESIA, Section 1.1.1, the location of BHEX01 has been determined based on seismic, geohazard and geotechnical surveys.

[1] Impacts will be assessed with reference to the legislative and policy framework and assessment methodology as set out within Chapters 2 and 3 of the SWAP Exploration Drilling Project ESIA (Ref.1) respectively.

2 Summary of BHEX01 Drilling Activities

2.1 Introduction

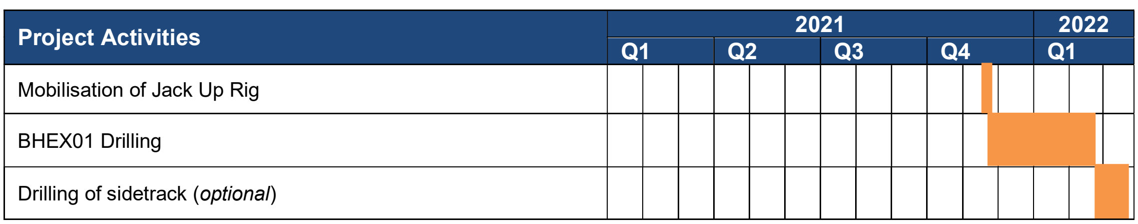
The drilling activities associated with the SWAP NKX01 exploration well drilling using a jack up rig are described within Chapter 4 of the SWAP Exploration Drilling Project ESIA (Ref.1). While the majority of the general drilling activities including the vessel and jack-up rig specifications will be consistent with those presented in the SWAP Exploration Drilling Project ESIA for the planned BHEX01 well, there are a number of differences such as the drilling programme, well design, drilling and cement chemicals to be used. Those aspects for the BHEX01 well that differ from those described in the SWAP Exploration Drilling Project ESIA are discussed in further detail below.

2.2 BHEX01 Drilling Programme

As shown in Figure 2.1, drilling of the BHEX01 exploration well, planned to commence in Q4 2021, is expected to be completed over a duration of approximately 3 months. An additional 1 month is scheduled for the drilling of an appraisal sidetrack well, which will be drilled if certain objectives are met following the successful completion of the drilling of the BHEX01 well. The base case assumes that drilling activities will commence in November 2021 however, for contingency, should there be any delay for logistical or operational reasons, and based on prior experience and best estimates, a delay of up to 2 months may occur.

In the event that problems are encountered while drilling the surface hole the well may be re-drilled within 500m of the original seabed location.

Figure 2.1 BHEX01 Exploration Well Drilling Schedule (Base Case)



2.3 Logistics, Supply and Equipment

Supply of materials, equipment and supplies associated with the drilling of the BHEX01 well will remain as described within Chapter 4 Section 4.5 of the SWAP Exploration Drilling Project ESIA. Similarly the positioning and function of the jack up rig and the number, function, specification and frequency of use of the vessels to be used to support the drilling programme remains the same with the exception on the average fuel consumption of the following:

Table 2.1 BHEX01 Jack-Up Rig and Support Vessels

Vessel	#	Duration/ Frequency of Use	Function	Maximum Persons on Board	Average Fuel Consumption (tonnes/day)
Jack-up rig	1	120 days	Drill BHEX01 (90 days) and the appraisal sidetrack (30 days) (assuming this is completed)	120	16
Helicopter	1	3 trips per week	Personnel transfer	21	0.6 per flight
Towing Vessel	3	4 days	Tow out and position the Jack-up Rig	15 (vessel crew)	11 (1 x main tug) 6 (2 x auxiliary tug)
		4 days	Demobilise the Jack-up Rig		
Cargo Supply Vessel	2	Every other day for the entire drilling operation duration.	Supply Jack-up Rig with dry and liquid bulk cargo, containerised deck cargo, pipes and other consumables to support drilling operations.	18 (vessel crew)	10 (per vessel)
			Ship solid and liquid waste (including drill cuttings) to shore facilities for treatment/disposal.		
Standby Vessel	2	120 days	Standby coverage during the drilling programme.	18 (vessel crew)	5 (per vessel in standby mode)

The jack-up rig and vessels utilities are the same as described in Chapter 4, Table 4.2 and 4.3 of the SWAP Exploration Drilling Project ESIA.

As described within Section 4.5.1 of the SWAP Exploration Drilling Project ESIA once the rig is in position and the legs are stable, the hull will be jacked up out of the water until the base is elevated approximately 10m above the sea surface. The legs of the rig will extended to a height of approximately 110m above sea surface. A mandatory 500m exclusion zone will be established around the rig while drilling is in progress. Figure 2.2 shows a typical jack up rig**.**

Figure 2.2 Typical Jack-Up Rig

2.4 Drilling Operations and Discharges

As stated in Section 2.1 above, the overall drilling operations will remain as described within Section 4.6 of the SWAP Exploration Drilling Project ESIA, namely the drilling muds will be prepared and supplied as described in Section 4.6.3 of the ESIA, with muds and cuttings returned to the rig using a closed loop system. The returned mud and cuttings will be separated and recovered cuttings will be collected in small drill cutting boxes. The cuttings boxes will be offloaded to vessels when full with used and separated mud also returned to shore backloaded to supply vessels.

As described in Section 4.6.3 of the ESIA, the well will comprise conductor and lower hole sections, and a sidetrack may also be drilled. The design for the BHEX01 well and the chemicals planned to be used throughout the drilling programme are similar to those of the NKX01 exploration well, however, differ in quantities. Further details are provided below.

2.4.1 Well Design

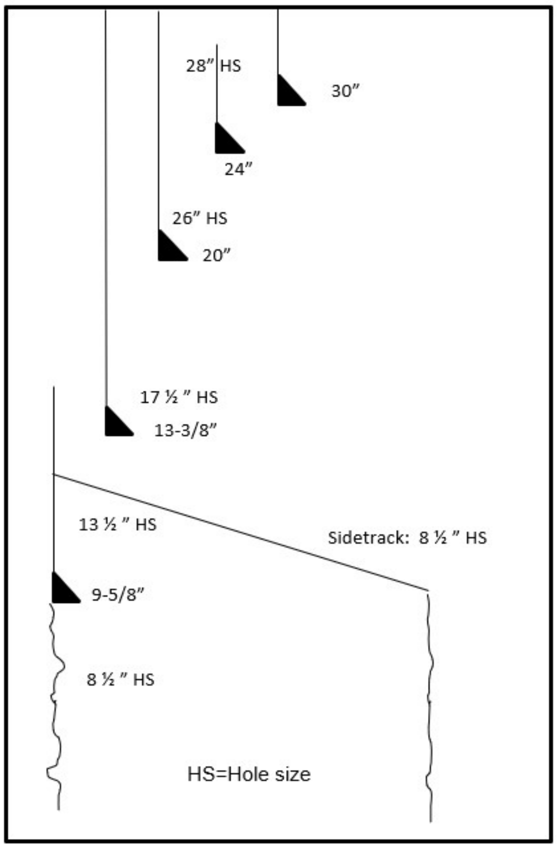
The proposed design for the BHEX01 well is presented in Table 2.2 and illustrated in Figure 2.3.

Table 2.2: BHEX01 Exploration Well Design

Hole Size (in)	Casing Size (in)	Section Length (MD) (m)	Drilling Mud System	Disposal Route of Drilling Muds/Cuttings
BHEX01 Exploration Well				
30	30	118	WBM	

Hole Size (in)	Casing Size (in)	Section Length (MD) (m)	Drilling Mud System	Disposal Route of Drilling Muds/Cuttings
28	24	62		Mud and cuttings will be returned to the jack-up rig. Muds will be separated from the cuttings on-board of the rig. Recovered muds and cuttings will be contained and shipped to shore for disposal in accordance with the existing BP AGT Region waste management plans and procedures.
26	20	812	SOBM/LTMOBM	
17 1/2	13 3/8	2397		
13 1/2	9 5/8	565		
8 1/2	N/A	486		
BHEX01 – Appraisal Sidetrack (if required)				
8 1/2	N/A	1141	SOBM/LTMOBM	

Figure 2.3 Generic BHEX01 Well Casing Design



2.4.1.1 Conductor and Upper Hole Section

Installation of the 30" conductor will be carried out using a drive and drill system as described within Section 4.6.3.1 of the ESIA. The well driving operations will be intermittent with approximately 10 hrs of hammering operations in total, with each driving event lasting 60min.

The composition and volumes of the water based mud (WBM) to be used during drilling of the BHEX01 well 30" conductor section will differ for the NKX01 well. The expected chemical composition of the 30" conductor section drilling chemicals to be used is presented in Table 2.3.

Table 2.3: Estimated Use of WBM Drilling Chemicals – 30" Conductor Section of BHEX01 Well

Chemical	Trade Name	Function	Estimated Use (tonnes)[1]	Hazard Category[2]
Barite	Barite	Weighting Agent	50	E
Bentonite	Bentonite	Viscosifier	25	E
Soda Ash	Soda Ash	Alkalinity Control	1	E
Xanthan Gum	Duovis	Viscosfier	1	E

Chemical	Trade Name	Function	Estimated Use (tonnes)[1]	Hazard Category[2]
Nut Shells	Nut Plug	Loss Control Materials (LCM)/Pipe scouring	0.7	E

Notes:
1. Volumes will depend on the actual subsurface conditions encountered as such these volumes are best estimates based on previous experience.
2. 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 May 2021.

Following 30” conductor drill and drive operation, a 28” hole section will be drilled using WBM and 24” casing will be installed. The composition of WBM for the 28” hole section is outlined in Table 2.4 below.

Table 2.4: Estimated Use of WBM Drilling Chemicals – 28” Hole Section

Chemical	Trade Name	Function	Estimated Use per Hole (tonnes)[1] 28”	Hazard Category[2]
Barite	Barite	Weighting Agent	100	E
Soda Ash	Soda Ash	Alkalinity Control	1	E
Poly Anionic Cellulose	Polypac UL	Water soluble polymer designed to control fluid loss	7	E
Poly Ether Amine / Poly Ether Amine Acetate Blend	Ultrahib	Stabiliser / shale inhibitor	36	Gold
Aliphatic Terpolymer	Ultracap	Anti-acretion additive	6	Gold
Ester / Alkenes C15-C18 Blend	Ultrafree	Shale Encapsulator	36	N/A
Flo-Trol	Cellulose polymer / modified starch	Fluid loss control and reduces the risk of drill string sticking	2.2	E
Xanthan Gum	Duovis	Viscosfier	1	E
Nut Shells	Nut Plug	Loss Control Materials (LCM)/Pipe scouring	1.5	E

Notes:
1. Volumes will depend on the actual subsurface conditions encountered as such these volumes are best estimates based on previous experience.
2. 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 May 2021.

2.4.1.2 Lower Hole Sections

As for the NKX01 well, the lower hole sections will be drilled using a synthetic oil based mud (SOBM) or a low toxicity mineral oil based mud (LTMOBM). Muds and cuttings from the lower hole sections will be returned to the jack-up rig, separated as described in Section 2.6.3 of the ESIA, contained and shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures. Table 2.5 presents the expected composition of the lower hole section drilling chemicals and the estimated use for the BHEX01 well.

Table 2.5: Estimated Use of SOBM/LTMOBM Drilling Chemicals - Lower Hole Sections of BHEX01 Well

Chemical	Trade Name	Function	Estimated Use (tonnes)[1]	Hazard Category[2]
Barite	Barium sulphate ore	Weighting agent	1000	E
Calcium Chloride	Calcium chloride	Borehole stabiliser	75	E
Ecotrol	Polymer	Fluid loss control and reduces the risk of drill string sticking	2.5	E
Lime	Calcium hydroxide	Alkalinity, calcium ion treatment	12	E
Suremul EH	Emulsifier	Emulsifier	35	C
Surewet	Surfactant	Wetting agent for drill solids and barite	8	D

Chemical	Trade Name	Function	Estimated Use (tonnes)[1]	Hazard Category[2]
Rheflat Plus	Alkenes/Fatty Acid	Rheology modifier	1.5	D
Rhethik	Oxybisethanol/ Diethylenetriamine	Viscosifier	4	*
Rhebuild	Propylene arbonate	Temporary viscosity agent	0.1	C
Escaid 110 base oil	Base Oil	Mineral Oil base fluid	2000	D
Versatrol M	Gilsonite/Lignite	Fluid Loss Additive	18	D
VG Plus/VG Supreme	Organophyllic Clay	Viscosifier/ removal of cuttings	22	E
G-Seal Plus	Graphite	Lost circulation/ seepage control	16	E
Durcal-130	Calcium Carbonate	Lost circulation/ seepage control	16	E
Walnut	Nut Shells	Lost circulation/ seepage control	5	E
Safe-Carb	Calcium Carbonate	Lost circulation/ seepage control	20	E

Notes as per Table 2.4. * Not currently listed into UK Offshore Chemical Notification Scheme (OCNS) Ranked Lists of Notified

2.4.2 Summary of Mud and Cuttings

Table 2.6 presents the estimated quantities of waste drilling fluids and cuttings for each well hole section (based on the experience of the project engineers and the diameter and length of each well section) and the planned disposal route.

Table 2.6: Estimated Well Cuttings and Mud Volumes Per Hole Section

Hole Size (Drill Bit Diameter)	Description	Estimated Quantity of Cuttings (tonnes)	Estimated Quantity of Waste Drilling Fluids (tonnes)[1]	Drilling Fluid/ Mud System	Cuttings and Mud Disposal
BHEX01 Exploration Well					Muds and cuttings will be returned to the jack-up rig. Muds will be separated from the cuttings on-board of the rig. Recovered muds and cuttings will be contained and shipped to shore for disposal in accordance with the existing BP AGT Region waste management plans and procedures.
30”	30" conductor	130	47	WBM	
28”	24” Liner	80	27		
26”	20" casing	830	153	SOBM /LTMOBM	
17 ½”	13 3/8” casing	1013	223		
13 1/2"	9 5/8" Liner	116	43		
8 1/2"	N/A	48	31		
BHEX01 Appraisal Sidetrack					
8 1/2"	N/A	100	38	SOBM/ LTMOBM	

Notes:
1. The WBM chemical usage includes water. Currently WBM is not stored for reuse. Untreated WBM is not stable over extended periods without additions of viscosifier and biocide.
2. Note that estimates of WBM waste is not equivalent to the estimated volumes of chemical used. This is because allowance is made for mud volumes left behind in casings.
3. Estimated volume of SOBM/ LTMOBM shipped to shore is conservative as it excludes mud volumes left behind in the well following casing, attached to the cuttings shipped to shore and the SOBM/ LTMOBM returned to shore for reuse on subsequent wells.
4. 8½ in hole section will not be cased (the well is for data gathering purposes only), section length will be 486m

2.4.3 Casing and Cementing

Installation of the casing strings and subsequent cementing for the BHEX01 well will be undertaken as described within Section 4.6.5 of the SWAP Exploration Drilling Project ESIA.

Any excess cement generated during the cementing activities will be circulated out from the well and returned to the jack-up rig and contained in the Drill Cutting Boxes (DCB) for transportation to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures. Excess cement remaining in the jack-up rig cement unit at the end of cementing of each casing string mixed with seawater, contained within barriers around the unit and transferred to the DCBs on-board the jack-up rig for transportation to shore.

There will be no planned discharge to the marine environment associated with cement or cement unit wash out. The estimated volumes of each cement chemical, and the associated hazard categories, used for the BHEX01 well cementing activities are presented in Appendix **2A** along with volumes associated with a potential cement system equipment commissioning mix trial and abandonment plugs as described in Section 4.10 of the SWAP Exploration Drilling Project ESIA.

2.4.4 Drilling Hazards and Contingency Chemicals

As described within Section 4.6.6 of the SWAP Exploration Drilling Project ESIA, a number of contingency chemicals will be retained for use in the event that hazards predominantly associated with downhole mud losses are encountered during drilling. Table 2.7 lists the estimated chemicals intended to be stored on the jack-up rig and used for the BHEX01 well in the event of contingencies when drilling with SOBM/LTMOBM. By definition, the use of contingency chemicals cannot be predicted with accuracy, however, their use will be minimised to the lowest practicable extent in accordance with operational needs. Along with SOBM/LTOBM and cuttings, unused contingency chemicals remaining in the mud system will be returned to the jack-up rig and shipped to shore for disposal in accordance with the existing BP AGT Region waste management plans and procedures. There will be no planned discharges of contingency chemicals to the marine environment.

Table 2.7: Estimated Usage of Drilling Contingency Chemicals for BHEX01 Well

Chemical	Function	Estimated use (tonnes)[1]	Hazard Category[2]
G-Seal Plus	Stress cage application	13	E
Durcal 130	Stress cage application	13	E
Safecarb	Stress cage application	28	E
Walnut	Stress cage application	5	E
Sand-Seal	LCM	2	E
NutSHELL	LCM /Cement scouring pill	2	E
M-I-X II	LCM FIBER	4	E
Notes as per Table 2.4			

2.5 Well Displacement

The chemicals and fluids planned to be stored on the rig and used for displacement of the BHEX01 well ,are provided in Table 2.8.

Table 2.8: Estimated Well Displacement Chemicals for BHEX01 Well

Chemical/Fluid	Function	Estimated Use (tonnes)[1]	Hazard Category[2]
Brine	Weighted circulation fluid	12.5	N/A
SAFE-VIS LE (@7ppb)	Viscosifier	0.2	E
Deepcelan	Surfactant	5	GOLD
Transition Pill			
Brine	Weighted circulation fluid	35	N/A
Drill water	Circulation fluid	6	N/A
SAFE-VIS LE (@7ppb)	Viscosifier	0.8	E
FLOVIS PLUS	Viscosifier	0.1	GOLD
Wash Pill			
Brine	Weighted circulation fluid	22	N/A
Deepclean	Detergent	4	D
Tail Spacer			
Brine	Weighted circulation fluid	7	N/A
Drill water	Circulation fluid	4	N/A
FLOVIS PLUS	Viscosifier	0.05	GOLD
Notes as per Table 2.4			

As stated in Section 4.7 of the SWAP Exploration Drilling Project ESIA it is planned that displacement chemicals will be circulated back to the jack-up rig with the drilling fluids and will be reused/recycled. It is not planned to discharge displacement chemicals or fluids to the marine environment under routine conditions. Solids collected within the jack-up rig separator during well displacement will be collected and shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.

2.6 Blow Out Preventor (BOP)

A Surface Blow Out Preventer (Dry BOP) will be located on the jack-up rig and will be installed on the well after the 20" casing has been cemented into place to control pressure in the well. The BOP control system will use hydraulic fluids in a closed loop system to actuate the BOP valves and, therefore, no planned discharges to sea from the operation of the BOP valves are anticipated.

2.7 Well Logging and Abandonment

A number of well logging activities will be undertaken during the drilling of the exploration well, including:

- Mud logging;
- Monitoring of well bore parameters;
- Wireline logging to obtain information on the physical properties of the formations, pressures and fluids by means of sensors deployed on logging tools;
- Logging while drilling (LWD) to obtain information on the physical properties of the rock formations and fluids by means of sensor gauges on specially adapted drill collars; and
- VSP (Vertical Seismic Profile) logging for correlation with surface seismic data. VSP measurements will be done using geophones inside the wellbore and a source (air gun) at the surface near the well.

With regard to VSP the following is anticipated for the BHEX01 well, conventional VSP to be undertaken following the completion of all drilling activities to provide seismic well data for potential future field development.

Conventional VSP will be undertaken only in the event the well Is successful and would be undertaken towards the end of the drilling schedule.

It is anticipated that the VSP will comprise one source with four guns (likely to be 2,000 psi pressure airguns) with a total cluster volume of up to 500 cubic inches and zero to peak amplitude of 1.01 MPa. The sources will be hung over the side of the jack-up rig and suspended from one of the cranes in a single position below the surface of the water. The airguns will be fired simultaneously. The total duration of the VSP survey is anticipated to last up to a maximum of 16 hours, however data acquisition is likely to be over a period of 6–8 hours. As soon as the VSP survey is complete the sound source will cease operating.

2.8 Emissions, Discharges and Waste Summary

2.8.1 Summary of Emissions to Atmosphere

Table 2.9 summarises the GHG (i.e. CO_2 and CH_4) and non GHG emissions associated with the Project.

Table 2.9: Estimated GHG and Non GHG Emissions Associated with BHEX01 Drilling Activities

Tonnes	Total Emissions Estimates for Rig Transfer and Drilling Activities
CO_2 (k tonnes)	15
CO (tonnes)	51
NO_x (tonnes)	267
SO_2 (tonnes)	0
CH_4 (tonnes)	1
NMVOC (tonnes)	10
GHG (k tonnes)	15

Basis of estimate:
1. Total duration of the BHEX01 well drilling programme expected to be 4 months (3 months for BHEX01 well drilling and 1 month for appraisal sidetrack drilling);
2. Rig, vessel and helicopter anticipated use and fuel consumption assumed as SWAP ESIA and Table 2.1

3. Emissions factors for rig engines from E&P Forum - Report No. 2.59/197. CO_2 - 3.2; CO - 0.0157; NO_x; 0.0594; CH_4 – 0.000018; VOC – 0.002;
4. Emissions factors for vessels and helicopters from EEMS Atmospheric Emission Calculations Issue 1.8 UKOOA 2004:
   Vessels: CO_2 - 3.2; CO - 0.008; NO_x; 0.059; CH_4 – 0.00027; VOC – 0.0024;
   Helicopters: CO_2 - 3.2; CO - 0.0052; NO_x; 0.0125; CH_4 – 0.000087; VOC – 0.0008;
5. Sulphur Dioxide Emission Factor = 2 x weight fraction of sulphur in diesel (0.05wt%)
6. GHG = CO_2 + 25 * CH_4

2.8.2 Summary of Discharges to Sea

Discharges to the marine environment will be limited to discharges from the support vessel utilities as described within Table 4.3 of the SWAP Exploration Drilling Project ESIA and non oily drainage (deck drainage and wash water) and cooling water from the jack-up rig as described within Table 4.2 of the ESIA.

There will be no planned discharges to sea of drilling muds and cuttings, BOP fluids, chemicals (including pipe dope) or cement during drilling of the BHEX01 exploration well.

2.8.3 Summary of Hazardous and Non-Hazardous Waste

The estimated quantities of non-hazardous and hazardous waste expected to be generated during the BHEX01 exploration well drilling programme are provided in Table 2.10.

Waste quantities have been estimated based on operational data from the drilling of the wells within the SD Contract Area using the Istiglal MODU and the estimated duration of the BHEX01 drilling programme.

All waste generated during the drilling activities will be shipped to shore and managed in accordance with the existing BP AGT Region Waste Management Procedures. Further details of the waste management procedures, including storage and handling are outlined in Chapter 4, Table 4.3 of the SWAP Exploration Drilling Project ESIA. The planned destination of each key waste stream is provided within Table 2.10.

Table 2.10: Total Estimated Hazardous and Non Hazardous Waste Associated With the BHEX01 Exploration Well Drilling Programme

Classification	Physical Form	Key Waste Stream	Estimated Volume (tonnes)	Destination
Non-hazardous	Solid Waste	Metals - scrap	36	Non-hazardous landfill dedicated for BP operations – current facility has been designed and constructed to EU standards.
		Paper and cardboard	<1	
		Wood	25	
		Cement	105	
		Domestic/office wastes	50	
	Total Non-hazardous Waste		**209**	
Hazardous	Solid Waste	Batteries - dry cell	<1	Treatment/disposal by State licensed and BP approved contractor or storage pending availability of appropriate contractor
		Batteries - wet cell	<1	
		Clinical waste	<1	
		Oily rags	9	
		Container - plastic	<1	
		Filter bodies	<1	
		Toner or printer cartridges	<1	
		Container - metal	15	
		Lamps/tubes – mercury vapour	<1	
		Explosives	<1	
	Liquid Wastes	Sewage - untreated	4	Treatment/disposal by State licensed and BP approved contractor or storage pending availability of appropriate contractor.
		Well suspension fluids	4	
		Drilling muds SOBM/LTMOBM	1289	
		Drilling cuttings - SOBM/LTMOBM		
		Paints and coatings	<1	
		Water - oily	500	

Classification	Physical Form	Key Waste Stream	Estimated Volume (tonnes)	Destination
		Solvents, degreasers and thinners	1	
		Oils - lubricating oil	40	
		Bentonite	24	
		Drilling muds WBM - contaminated	2310	
		Drilling cuttings WBM - contaminated		
		Laboratory chemicals and testing reagents	3	
		Drilling chemicals	79	
	Total Hazardous Waste		**4184**	

2.9 Management of Change Process

During the detailed planning and execution stages of the Project programme, there may be a need to change a design element or a process. A formal process will be implemented 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.

Further details on the ESIA Management of Change process are provided in Section 4.12 of SWAP Exploration Drilling Project ESIA. The assessment of any changes to the drilling activities for the BHEX01 well described in this BHEX01 Addendum will follow the Management of Change process described in the ESIA.

3 Environmental and Socio-Economic Description

3.1 Introduction

This Chapter describes the environmental and socio-economic baseline conditions relevant to the SWAP Exploration Drilling Project BHEX01 exploration well. The purpose of this Chapter is to provide sufficient information to allow the potential impacts related to drilling of the proposed BHEX01 exploration well, to be assessed in accordance with the assessment methodology as set out in Chapter 3 of the SWAP Exploration Drilling Project ESIA (Ref.1).

This Chapter provides relevant information, additional to the SWAP Exploration Drilling Project ESIA, particularly on the following:

- Coastal setting and environment specific to the Project location;
- Physical setting of the the Project location and its immediate vicinity; and
- Marine environment including the Prospective Area where the BHEX01 exploration well will be located and a summary of the seabed and water column physical, chemical and biological/ecological conditions in this location, including an overview of pre-existing contamination within Baku Bay, and potential areas known to be of importance for fish.

With regard to socio-economic baseline conditions, information is provided relating to:

- A summary of local facilities and management companies;
- A summary of small-scale coastal fishing, tourism and recreational activities currently undertaken within Azerbaijani nearshore waters and specifically within the vicinity of the Project location;
- A description of regional shipping routes located within the vicinity of the Project location, associated port infrastructure and any known location of subsea obstructions; and
- Cultural heritage comprising a summary of the marine archaeological and cultural heritage sites known to be present in the waters in and around Baku Bay.

The geographic scope of the data presented is based on the data available for the Project location, with local, national and regional information provided, where relevant, to provide a basis for the assessment of impacts. Where no further baseline information is available, the findings of the previous ESIA Report is not reproduced in this Addendum, but the previous ESIA report is referenced where appropriate.

3.2 Data Sources

This Chapter has been prepared based on the following:

- Review of available bp and third party ESIAs completed for projects in the Absheron region and in the Azerbaijan sector of the Caspian Sea, specifically within or in close proximity to the Project location. Key documents include:
  - SWAP Exploration Drilling Project ESIA (2020) (Ref.1). The ESIA was prepared to obtain permission to undertake drilling activities associated with the NKX01 well;
  - SWAP 3D Seismic Survey ESIA (2015) (Ref.2). The ESIA was prepared to obtain permission to undertake a 3D seismic survey across and in the vicinity of the SWAP Contract Area (onshore and offshore). A number of specific surveys were undertaken to gather additional environmental data, including offshore shallow water environmental surveys, terrestrial ecology surveys, noise surveys and terrestrial cultural heritage surveys. A socio-economic study was also undertaken in November 2015 within the onshore areas of the 3D Seismic Survey Area. The survey included the identification of residential areas located within, or immediately adjacent to, the 3D Seismic Survey Area, the physical presence of coastal facilities where users of the sea access the water via ports and jetties, coastal recreational facilities and fishing areas used for commercial and coastal fishing activities located adjacent to and within the 3D Seismic Survey Area;
  - 3D SWAP Seismic Survey Environmental Risk Assessment (ERA) (2016) (Ref.3). This document was prepared for submission to the MENR to assess a number of changes made

to the SWAP 3D Seismic Survey design including changes to the 3D Seismic Survey Area and the schedule; and
    - Azeri Chirag Gunashli (ACG) ESIAs and Environmental Technical Notes (ETNs) (Refs.4-11) and Shah Deniz (SD) ESIAs prepared for the phased developments within the ACG and SD Contract Areas, including the associated subsea export pipelines to the onshore Sangachal Terminal.

- Primary data held by bp associated with the studies and surveys undertaken to support the bp ESIAs listed above and ongoing operational monitoring data collected as part of the Environmental Monitoring Programme (EMP). These include satellite imagery remote sensing data and geophysical/ geotechnical surveys and seabed hazard surveys that were carried out at the proposed BHEX01 well location to assess soil stability and identify subsurface hazards to allow the selection of potential locations for exploration drilling.

- Primary data relating to a baseline survey completed for Baku Bay in 2012 for the Ministry of Emergency Situations (MES). The Environmental Baseline Study (EBS) report prepared by Royal Haskoning DHV (Ref.12) included the results of a comprehensive sediment and water quality survey completed in the Bay and its immediate surroundings.

- Socio-economic surveys undertaken in March 2021 covering the coastline area from Baku Boulevard to Bibiheybat to consult with local businesses and management companies, local recreational clubs/groups and the port authority. Engagement was carried out with the following key stakeholders:

    - Port (Authority) and Harbour Master;
    - Baku Yacht Club;
    - Tourist Boat Operators;
    - Crystal Hall;
    - Yarat Contemporary Art Centre;
    - Stone Chronicle Museum;
    - Aquatic Palace ;
    - European Games Park;
    - Boulevard Management;
    - Carpet Museum;
    - Baku Sports Hall;
    - Caspian Waterfront Mall;
    - Baku Scuba Diving and Freediving Center; and
    - Institute of Archaeology and Ethnography.

- Secondary data collected through consultation with local governmental and other organisations including:

    - The Ministry of Ecology and Natural Resources (MENR);
    - Caspian Shipping Company;
    - The Ministry of Culture (MoC);
    - Azerbaijan Fisheries Research Institute; and
    - The State Oil Company of Azerbaijan Republic (SOCAR).

- Secondary data and literature publicly available on the internet including reports published by Azerbaijan State Committee of Land and Mapping, United Nations Educational, Scientific and Cultural Organization (UNESCO), International Union for Conservation of Nature (IUCN); United Nations Environment Programme Global International Waters Assessment (UNEP / GIWA) and the World Bank. In addition, data was obtained from a study of the effects of contaminated sediment on fish health in Baku Bay (Ref.13).

A number of specific surveys for the BHEX01 Addendum have been undertaken to gather additional environmental data. These surveys, included:

- **Offshore Environmental Baseline Survey (EBS):** this survey undertaken in October 2019 involved water column and sediment sampling around the proposed BHEX01 well site in water depths ranging from approximately 4 to 8 metres (m). In total 4 water column and 38 sediment samples were taken, and physical, chemical and biological analysis was undertaken. In addition, a drop down video survey was conducted at each sediment sample location and video footage was collected to allow analysis of the seabed conditions; and
- **Noise:** Noise surveys were undertaken in February 2021 at five locations around Baku Bay to allow the baseline noise environment to be characterised.

The results of the surveys are incorporated into the relevant sections below.

3.3 Coastal and Terrestrial Environment

3.3.1 Setting

The coastal setting is established from a combination of desk based studies, reviews of secondary data and ground verification surveys undertaken in March 2021.

The Project is located offshore as shown in Figure 1.1. In terms of landscape, the views of the Project will be limited by the flat topography at the coastline, while in the higher locations (>100m) in the eastern parts of Baku, there are some areas with a vista overlooking the entirety of Baku Bay and beyond. At night, much of the landscape is heavily lit, creating bright illumination and is reflected by the sea.

In 2015 a land use classification exercise was commissioned by bp to understand the land use types in the area around Baku Bay. The exercise involved the analysis of Landsat imagery which is a moderate resolution (multispectral 30 m) remote sensing data source. The remote sensing exercise indicates the area around Baku is predominantly categorised as urban (includes areas that are low in density and are characterised by low rise buildings) and commercial / industrial (includes areas of tower blocks and areas of mixed industrial / commercial). In addition particularly along the coastal fringes of Baku Bay there are areas categorised as bare ground (land that does not have any vegetation cover) and sparse / stressed vegetation (vegetation that is dense / healthier than scrub land vegetation).

The areas around Baku Bay whereby the Project will be potentially visible is characterised as an urban landscape dominated by commercial, residential and recreational areas.

The results of the remote sensing exercise were verified through ground truthing surveys as described below.

Commercial / Industrial: Commercial use is associated with the operation of industrial facilities including port and harbour infrastructure and oil and gas infrastructure, which is either in use, or abandoned. Industrial land use was observed as being particularly dense on the coastal area west of Bibiheybat. Construction of new buildings was observed in locations along the boulevard during the ground truthing surveys (see Figure 3.1).

Figure 3.1 Examples of Commercial Land Use within Baku Bay

(i) Construction site known as “Crescent Bay” located in Baku and (ii) oil and gas infrastructure in Bibiheybat

Residential and Recreational: The main residential areas closest to the Project location comprise the two communities of Bayil and Bibiheybat as well as coastal residential premises spread along the coastline of Baku Bay. Figure 3.2 shows some of the typical type of apartment buildings and developments, mainly located towards the centre of Baku and Bayil.

Recreational land use along the coastline of Baku Bay includes a number of restaurants, hotels, museums and cultural landmarks, particularly along the boulevard. Cafes, restaurants and hotels are reported to be active throughout the year and are spread along the boulevard at various locations.

3.3.1.1 Visual Amenity

The planned BHEX01 exploration well is located approximately 1.5km from the Azerbaijani mainland at the entrance to Baku Bay. Due to the urban nature of the landscape in Baku Bay the number of potential visual receptor groups to the Project is quite high and a number of these receptors have clear unobstructed views of Baku Bay. Residential receptors include people living, working or staying in close vicinity of Baku Bay or those located in more elevated parts of Baku with views across Baku Bay (refer to Figure 3.2). Recreational receptors comprise visitors to the seashore, including the boulevard (refer to Figure 3.3), Crystal Hall and Carpet Museum, and recreational and tourist boats operating with Baku Bay. Numbers of visual receptors is likely to vary dependent upon the seasons, and tourists visiting during summer months will experience a shorter duration of exposure to views than permanent residents.

Figure 3.2 Examples of Residential and Recreational Land Use around Baku Bay

(i) Urban setting in background towards Baku city centre with recreational boulevard area and Casipan Waterfront Mall in foreground.

(ii) Baku Eye, Bayil Castle, Crystal Hall, Flag Square and Residental buildings.

(iii) Example of residential developments located in Bayil

Figure 3.3 Examples of Recreational Areas

(i) Baku boulevard and waterfront

3.3.2 Air Quality

At a national level, air quality varies across Azerbaijan with higher pollutant concentrations recorded in cities (such as Baku) due to increased industry and transport emissions than in rural areas. Monitoring of pollution of ambient air in Azerbaijan is undertaken by the Department of National Environmental Monitoring and reported on an annual basis since 2005 at 26 stations in cities across the country, including nine locations within Baku city (Ref.15). Outside of Baku it is understood that air quality in coastal areas of the Absheron region is not routinely monitored except in the vicinity of the Sangachal Terminal located approximately 40 km south west of Baku.

From the survey data available, air quality along the coastline of the Absheron region is known to be variable. In the vicinity of Bibiheybat, concentrations of NO_2 recorded between 2005 and 2013 have varied between approximately 25µg/m^3 and 50µg/m^3 with a concentration of approximately 38g/m^3 recorded in 2013; significantly higher NO_2 concentrations (up to 120µg/m^3) have been recorded within Baku itself (Ref.16).

Monitoring of dust and particulate levels around the Sangachal Terminal and within Baku indicate average particulate concentrations (as PM_{10}[2]) of 24.3 and 240µg/m^3 which is 6 times more than the annual average EU limit value of 40µg/m^3. Windblown dust is a known nuisance issue across the region and within Baku, and considered typical of such an environment.

3.3.3 Terrestrial Noise

An ambient noise monitoring survey was undertaken at five locations around Baku Bay on the 27th February 2021 to establish existing levels of ambient noise. The monitoring locations were selected in areas around the bay to represent urban, recreational and residential land use types. The survey locations are shown in Table 3.1 and illustrated in Figure 3.4 below. Three 5-minute duration measurements were undertaken at each location to determine the typical ambient noise conditions during the daytime.

Table 3.1 Coordinates of Noise Monitoring Locations

ID	Location	Co-ordinates	
		X	Y
1	Bibiheybat	400655.6948	4464035.8755
2	Crystal Hall	402363.1751	4468312.7072

[2] Atmospheric air containing dust having particulates with <10 um diameter aerodynamic size distribution.

ID	Location	Co-ordinates	
		X	Y
3	Baku Boulevard	401387.4721	4470703.1797
4	Ağ Şəhər Bulvarı	404753.6476	4471890.285
5	Həzi Aslanov Park	411551.0455	4467694.7619

Figure 3.4 Noise Monitoring Locations

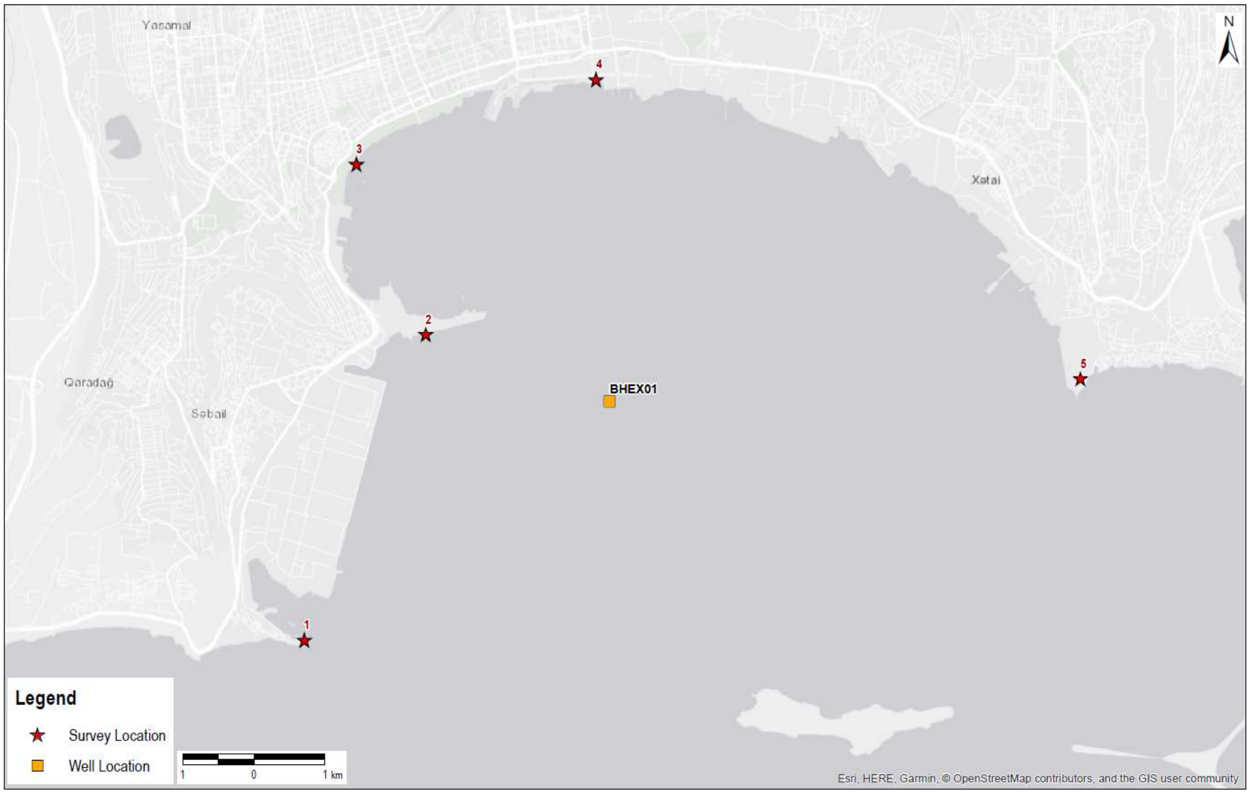


Table 3.2 presents the noise levels recorded (as $L_{Aeq,5min}$[3]) during daytime periods at the monitoring locations. During each survey, weather conditions were fair with no precipitation and wind speeds generally less than 5 m/s. Observations were made throughout the surveys to record the noise sources and identify dominant sources in each location.

Table 3.2 Summary of Noise Levels Recorded

Monitoring location	Location	Land Use Type	Range of Measured Levels dB $L_{Aeq,5min}$	Notes – main sources of noise
1	Bibiheybat	Industrial/Coastal	59-63	Noise from ship yard, alarms, Light good vehicles (LGVs), people and birds
2	Crystal Hall	Recreational/Coastal	51-54	LGV, birds, airplane
3	Baku Boulevard	Recreational/Urban/Coastal	56-58	People, birds, traffic from Neftchilar Avenue
4	Ağ Şəhər Bulvarı	Recreational/Urban	50-51	LGVs, birds, people
5	Həzi Aslanov Park	Industrial/Coastal	64-65	LGVs, birds

[3] The equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation that is usually composed of sound from many sources near and far (e.g. road traffic, construction works, animals), within a time interval of 5 minutes.

The survey results showed that the main noise sources were from traffic and birds. Noise levels were generally consistent with minor variations of measured $L_{Aeq,5min}$ values at each survey location with the exception of location 5 which had a low of 26LA_{min}. The highest recorded noise levels were found at location 1 and can be attributed to the activities at the nearby ship yard. Locations 2, 3 and 4 are urban survey locations and were all very similar in terms of results with the main sources of noise coming from people, traffic and birds. Road traffic on Neftchilar Avenue was found to be a contributing source for the urban locations.

Traffic counts were undertaken at the locations indicated in Table 3.1 during the period of the noise survey. The highest traffic numbers (during the period of the noise survey (LGVs)) were recorded at location 5 in an industrial area, where approximately 26 LGVs were counted during a five minute period (16:21 – 16:26) during off peak traffic flow.

3.4 Marine Environment

3.4.1 Marine Environment Survey Data

To establish the anticipated physical, chemical and biological characteristics of the seabed environment and the water column within the vicinity of the proposed Project location, the data sources as listed within Section 3.2 were reviewed. This included:

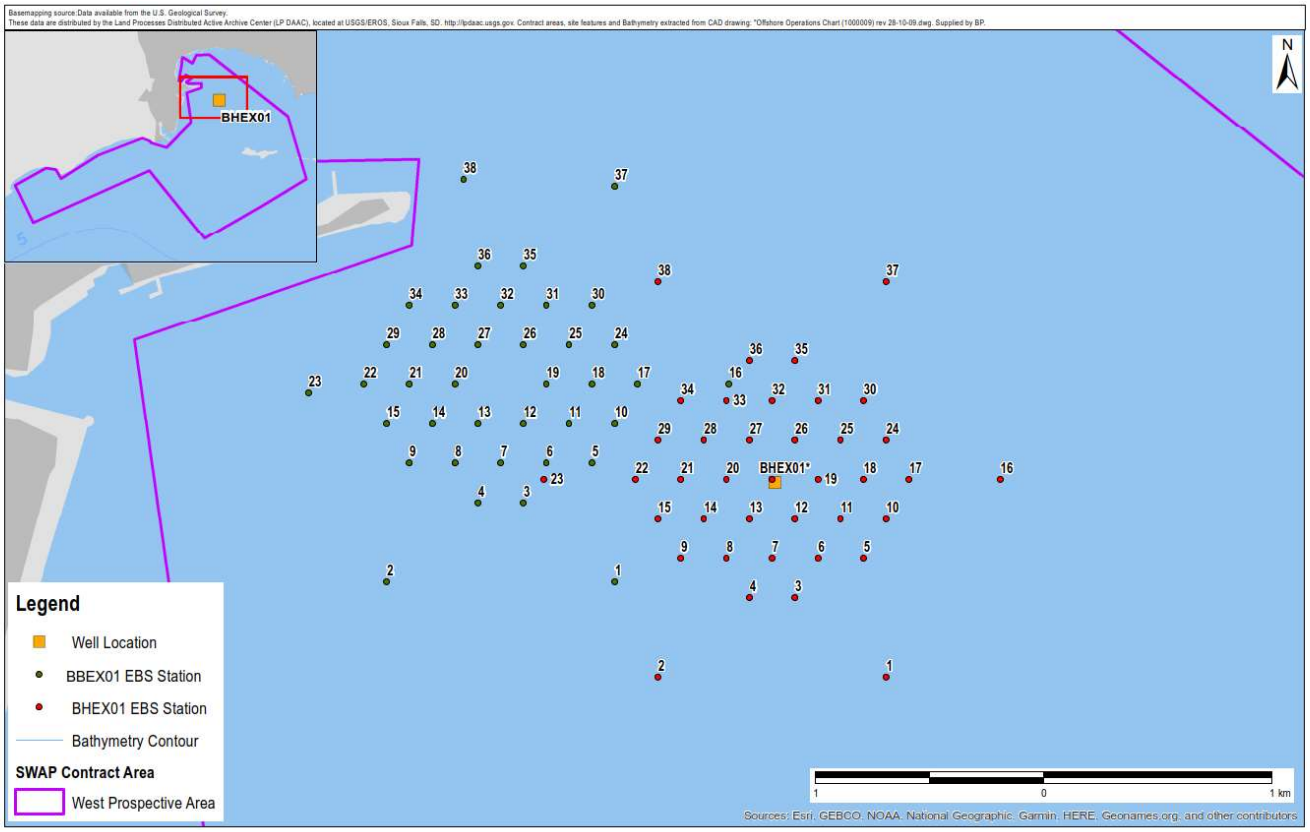
- 2018 EBS at the BBEX01 location;
- 2018 and 2019 West Prospective Area (WPA) seabed hazard surveys; and
- 2019 EBS at the BHEX01 location.

An EBS was conducted in 2018 at a preliminary well site in Baku Bay denoted as BBEX01, however the position of the well was re-located to a new site and re-named as BHEX01. The BBEX01 position is located approximately 1,260m west-northwest of the BHEX01 location.

Figure 3.5 shows the locations of the sampling stations for the BBEX01 and BHEX01 EBSs. In addition, the results of the BBEX01 and BHEX01 EBSs have been compared with the results of two other EBSs conducted by bp (2004 Dredge Sediment Disposal Site Assessment Survey (located approximately 8km southeast of the BHEX01 survey area) and 2018 Sangachal Bay EBS). The comparison to the Sangachal Bay EBS provides a comparison between the results from within the formerly industrialised Baku Bay location (BHEX01 and BBEX01) and a coastal location which has been exposed to fewer anthropogenic stresses.

In addition to the results of the bp commissioned surveys noted above, which are described in Sections 3.4.2 – 3.4.5, an overview of the results of an extensive Environmental Baseline Study of Baku Bay carried out by Royal Haskoing DHV in 2012 (Ref.12) is provided in Section 3.4.1.1. This provides an overview of the environmental conditions across Baku Bay as a whole, including the effects of historic pollution of the Bay.

Figure 3.5 Location of 2019 BHEX01 EBS and 2018 BBEX01 EBS Site Sampling Stations



3.4.1.1 Baku Bay Environmental Quality and Contamination Status

An Environmental Baseline Study of Baku Bay was commissioned by the Ministry of Emergency Situations (MES) in 2012. The purpose of the study included the identification of historic and current pollution sources both onshore and offshore that impact on the quality of seawater and sediment in Baku Bay and establish the quality of water and sediment in the study area according to international standards. The study (Ref.12) identified a number of major historic sources of pollution around the Bay, including Bibiheybat oil field; various wastewater outfalls; abandoned industrial sites; offshore oil derricks and ship wrecks and discharge of oil wastes from ships. It is recognised that a number of these pollution sources have been removed or have ceased operating in the years 1999 – 2012.

Results, which included samples taken from three sediment depths at 300 sample locations, indicated that sediments throughout the Bay were substantially contaminated with mineral oil (Total Petroleum Hydrocarbons (TPH)) and Polycyclic Aromatic Hydrocarbons (PAH). Contamination was predominantly found near the shores, particularly in the city centre and industrial areas, and generally decreased significantly with depth. Sediment contamination at the east shore was limited to the superficial layers (within the top 0.5m of sediment) while contamination towards the west shore (near an existing refinery) was observed in much deeper layers (up to 2.5m depth).

The survey found that biota was limited or non-existent in the seabed sediments in large parts of the Bay with benthic life identified at one sampling location only. The report noted the high availability of oil related compounds has the potential to cause high environmental risks for organisms. The report authors predicted that some mineral oil present in the sediments could be expected to seep into the water over time due to agitation (i.e. due to wind action, currents, ship movements, etc.); however, a substantial decrease of the contamination levels in the sediment over time is considered to be unlikely as the sediment layer in the Bay is believed to be mostly anoxic (no life), meaning that biodegradation of the contaminants in the Bay from natural processes is unlikely.

Results from the 2012 Baku Bay EBS indicate that water quality showed high concentrations of heavy metals and hydrocarbon contamination in localised points although mostly samples did not exceed the detection limit within the Bay. The main source of pollution affecting water quality is attributed to the discharge of residential/industrial waste water into Baku Bay, which was estimated to be in the region of 550,000 m^3/day at the time the report was prepared. Locally high concentrations of coliform, suspended solids, BOD (Biological oxygen demand) and chemical oxygen demand (COD) were recorded; predominantly in locations close to waste water outfalls.

The findings of this study in terms of contamination of sediments by mineral oil are consistent with the results of earlier studies which examined the environmental condition within Baku Bay undertaken in the 1990s. A study examining the impact of acute and genotoxic effects of Baku Bay sediment on Russian Sturgeon (*Acipenser guildensteidti*) found contamination of the sediments with PAHs was very high (Ref.13) while other studies have which showed the heavily contaminated bottom sediments have caused the complete extirpation of the benthic flora and fauna (Ref.17) and in some areas, oil pollution is estimated to be present as much as 2m deep on the the bottom of Baku Bay (Ref.18).

3.4.2 Seabed Physical and Chemical Environment

3.4.2.1 Physical Properties of Sediment

Table 3.3 presents a summary of the physical properties of the sediments at and within the vicinity of the proposed BHEX01 location.

Table 3.3: Physical Sediment Properties Recorded in Environmental Surveys in the Vicinity of the BHEX01 Location

	2019 BHEX01 EBS			2018 BBEX01 EBS			2018 Sangachal Bay			2004 Dredge Site		
Parameter	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Mean diameter (µm)	8	573	45	15	636	195	7	615	183	20	1019	355
Sampling Station	25	38	-									
Carbonate (% w/w)	13	80	42	29	81	52	21	80	42	14	68	50
Sampling Station	25	38	-			-						
Organic(% w/w)	1.61	30.4	8.97	0.42	21.8	3.64	0.91	6.6	3.03	1.16	13.5	5.63
Sampling Station	38	25	-									
Silt/Clay (% w/w)	3	95	69	1	77	26	4	98	39	7	71	31
Sampling Station	38	25	-									

At the Project location, samples from stations 25 and 38 were distinct in their characteristics. The sample from station 25 was composed of 95% silt/clay, and contained no fractions greater than 1mm in diameter, while the sample from station 38 exhibited a more heterogeneous structure with higher proportions of the mid-range sand fractions and a very low silt and clay content. Excluding stations 25 and 38, the physical composition of sediments were very similar at the majority of BHEX01 sample stations. Sediments were characterised as being dominated by the silt/clay fractions over the coarsest gravel fractions (which were mainly composed of broken down shell fragments), and very low proportions of the mid-range sand fractions. Although the BHEX01 and BBEX01 survey areas within Baku Bay were separated by only approximately 1200m, the sediment structure within the two survey areas was noticeably different. While both locations had similar proportions of gravel, the sediments at the BHEX01 location were dominated by the silt/clay fraction, whereas sediments at the BBEX01 location were dominated by the mid-range sand fractions. Data obtained in 2019 as part of the WPA seabed hazard survey (Ref.26) indicates the shallow geology at the proposed BHEX01 well location comprises: approximately 1m thick very soft clay/very loose sand with gassy or oily infills on the surface; firm to hard sediments of clay/silt/sand from approximately 1- 5.7m below seabed and below this layer the survey data is interpreted as possible bedrock that comprises layers of clay/silt/sand. No faults were detected within the vicinity of the BHEX01 well location during the seabed hazard survey.

Organic content was present at a greater range in the three survey areas within Baku Bay. The proportion of organic content was greatest within the BHEX01 survey area, with a mean of 8.97% compared to 3.64% at BBEX01, and 5.63% at the 2004 Dredge Site Assessment Survey.

Results of the carbonate content samples in BHEX01 were slightly lower than those proportions within BBEX01 and 2004 Dredge Site Assessment Survey with a mean of 42% compared to 52% and 50% respectively. Proportions of carbonate content is often related to sediment type, and the higher carbonate results from Sangachal Bay are correlated to much coarser gravel fraction derived from broken down shell material.

Overall, sediments from the 2004 Dredge Site Assessment Survey, on average, exhibited a greater similarity to those from the BBEX01 location, with a higher mean particle size, slightly higher carbonate content and a lower silt/clay content than those recorded in the BHEX01 survey.

3.4.2.2 Chemical Properties of Sediment

Hydrocarbon Concentrations

Table 3.4 summarises the sediment hydrocarbon concentrations recorded in the 2019 BHEX01 EBS and 2018 BBEX01 EBS sediment samples.

Table 3.4: Minimum, Maximum and Mean Total Hydrocarbon Concentrations at the Project Location

	THC (μg/g)		UCM (μg/g)		%UCM		Total 2-6 ring PAH (ng/g)	
	2018 BBEX01	2019 BHEX01	2018 BBEX01	2019 BHEX01	2018 BBEX01	2019 BHEX01	2018 BBEX01	2019 BHEX01
Min	127	594	122	565	94	86	167	2,214
Max	82,400	123,800	77,963	106,200	98	97	1,683,000	1,740,000
Mean	7,250	17,660	6,888	16,530	95	94	84,480	188,400
	NPD (ng/g)		**%NPD**		**USEPA 16 PAH (ng/g)**			
	2018 BBEX01	**2019 BHEX01**	**2018 BBEX01**	**2019 BHEX01**	**2018 BBEX01**	**2019 BHEX01**		
Min	65	783	16	10	33	276		
Max	393,781	1,181,000	40	68	423,800	243,000		
Mean	19,051	75,260	28	23	19,770	28,190		

The survey results indicate that total hydrocarbon concentrations (THC) were very high across all the sample locations, ranging from 594 micrograms per gram (μg/g) to 123,800 μg/g; the average and median values were 17,660 and 7,287 μg/g respectively. The lowest concentration of 594 μg/g, recorded at station 38, was approximately six times lower than the next lowest concentration of 3,188 μg/g recorded at station 2. Station 38 was identified as having a distinctive sediment structure, which is dominated by the mid-range sand fractions and a very low proportion of silt/clay, which was high throughout the rest of the survey area. It is possible that some form of physical disturbance has occurred at station 38 prior to the survey, which has removed the more contaminated surface layer of sediments from this location. The highest concentrations were recorded at stations 35, 25 and 11.

There was some variation in the hydrocarbon profile between stations. Most of the samples exhibit a profile similar to sediments found further offshore and suggests that a major source of the hydrocarbons present is the weathered crude oil hydrocarbons found in the Azerbaijan coastal area.

Percent unresolved complex mixture (UCM) values were high (in excess of 86%) at most stations, indicating that the hydrocarbons were heavily weathered. Concentrations of 2-6 ring Polycyclic Aromatic Hydrocarbons (PAH) ranged from 2,214 to 1,740,000 ng/g, with average and median values of 3-.480, and 188,400 ng/g respectively. Concentrations of naphthalenes, phenanthrenes and dibenzothiophenes (NPD) ranged from 783 to 1,181,000 ng/g and represented between 10 to 68% of the total PAH.

The proportions of UCM and NPD in all samples were indicative of heavily weathered material being present throughout the survey area. The only exception was station 11 where the highest concentrations of THC and PAH were recorded; the NPD proportion at this location was relatively high, indicating the presence of less weathered PAH compounds. Additionally, the PAH throughout the survey area is considered high, meaning PAHs are not absorbed onto sediment particles and are therefore available for uptake by marine organisms, mainly filter feeders (Ref.12).

Comparison of results from BHEX01 and BBEX01 indicate that the sediments within the wider Baku Bay area contains high concentrations of heavily weathered hydrocarbons, although the concentrations present within the BHEX01 survey area were notably higher than those recorded at the BBEX01 location. It is expected that the generally higher hydrocarbon concentrations at the BHEX01 location are a consequence of the higher adsorption capacity of the dominant fine silt/clay sediments compared to the coarser mid-range sand fractions that dominate the BBEX01 location.

The variation in hydrocarbon profiles within and between the two survey areas, and the different physical and chemical features identified at individual stations, suggest that sediments within the survey area were influenced by inputs from a number of different sources. Potential inputs include both recent and historic discharges and run-off from the nearby urbanised area, and from industrial sources such as shipping activity and oil production. These results are supported by the previous studies examining the environmental conditions in Baku Bay as discussed in Section 3.4.1.1. Previous studies have shown the sediments throughout Baku Bay are seriously contaminated with mineral oil and related compounds with highest concentrations found in the top of the seabed near shore, especially near the city centre and industrial areas (Ref.12).

Heavy Metal Concentrations

Table 3.5 provides a statistical summary of the concentration of heavy metals recorded in the 2019 BHEX01 EBS, 2018 BBEX01 EBS, 2018 Sangachal Bay EBS and 2004 Dredge Site sediment samples.

Table 3.5: Minimum, Maximum and Mean Heavy Metal Concentrations Recorded in Environmental Surveys in the Vicinity of the Project Location

Parameter		2019 BHEX01 EBS		2018 BBEX01 EBS	2018 Sangachal Bay	2004 Dredge Site
		Value	Station	Value	Value	Value
Arsenic (µg/g)	Min	7	13	5	9	4
	Max	17	38	19	29	13
	Mean	10	-	14	14	6
Barium (µg/g)	Min	365	38	134	526	412
	Max	904	24	580	1,231	629
	Mean	620	-	368	587	412
Cadmium (µg/g)	Min	0.175	38	0.116	0.205	0.110
	Max	0.928	27	0.9	0.443	0.490
	Mean	0.395	-	0.256	0.317	0.253
Chromium (µg/g)	Min	12	38	8	11	10
	Max	122	27	105	76	94
	Mean	75	-	31	39	45
Copper (µg/g)	Min	7	38	4	8	8
	Max	254	18	82	41	47
	Mean	46	-	21	22	23
Iron (µg/g)	Min	8614	38	6,288	9,813	6,661
	Max	33237	9	27,108	34,012	26,373
	Mean	27759	-	13,577	22,649	16,332
Mercury (µg/g)	Min	432	35	391	403	Not measured
	Max	644	23	1,991	932	
	Mean	542	-	676	566	
Lead (µg/g)	Min	9	38	8	12	5
	Max	47	23	74	25	31
	Mean	30	-	23	18	20
Zinc (µg/g)	Min	20	38	13	28	19
	Max	154	24	125	96	104
	Mean	105	-	52	65	63

The results of the 2019 BHEX01 EBS showed that, with the exception of a small number of outliers, the variability in sediment metal concentrations across the survey area was low. All metals were intercorrelated and were associated with sediment silt content; the only exception was mercury, which was not correlated to any other metal.

With the exception of Arsenic and Manganese, the lowest concentrations of all metals were recorded in the sample from station 38. The distinctive metal composition at station 38 is likely related to the dominance of the coarser particle size fractions, and the near absence of the finer silt/clay sediments which were present at all other stations.

Comparing to previous surveys, the concentrations of metals cadmium, chromium, copper, iron, lead, and zinc recorded in the 2019 BHEX01 survey were higher than those recorded in both the 2018 BBEX01 and 2018 Sangachal Bay surveys. Whereas the concentrations of barium and mercury were comparable to those recorded within Sangachal Bay, and arsenic was comparable to the results recorded in the 2018 BBEX01 survey.

The difference between the metal concentrations present in the BHEX01 and BBEX01 surveys is likely to be a consequence of the different sediment structure present within the two survey areas; in particular, the higher silt/clay content in BHEX01 samples.

The concentrations of metals in samples from the 2004 Dredge Site survey were generally similar to those recorded at the BBEX01 location; this is likely due to the similar physical characteristics of sediments in both surveys.

3.4.3 Seabed Biological Environment

The biological benthic environment comprises marine flora (seagrass and algae) and benthic invertebrates as described below.

3.4.3.1 Marine Flora

Marine flora is a key component of the ecosystem, providing refuge for invertebrates and juvenile fish, stabilising sediments and reducing wave energy in shallow water environments and providing a food source for water and wading birds. Seagrass, *Zostera noltii*[4] typically grows in shallow water where light can penetrate and is sensitive to changes in nutrient levels and turbidity, both of which can affect primary productivity for some species.

Analysis of the drop down video survey conducted at the BHEX01 well location showed no signs of seagrass within the survey area. Footage of the area showed the seabed is largely covered in shell fragments, clay sediments, and patches of macrophyte algae present on the sediment surface.

3.4.3.2 Benthic Invertebrates

The abundance and species richness for each benthic taxonomic group recorded at each station associated with the 2019 BHEX01 EBS, 2018 BBEX01 EBS, 2018 Sangachal Bay EBS and 2004 Dredge Site EBS are presented within Table 3.6.

Table 3.6: Number of Invertebrate Species (S) and Percentage (%) of Total Abundance Recorded in Benthic Surveys Within and in the Vicinity of the BHEX01 Location

Taxon Group	2019 BHEX01 EBS		2018 BBEX01 EBS		2018 Sangachal Bay		2004 Dredge Site EBS	
	S	N (%)	S	N (%)	S	N (%)	S	N (%)
Polychaete	3	22	4	49	4	21	4	64
Oligochaete	1	1	1	6	3	2	3	1
Cumacea	1	<1	0	0	0	0	0	0
Amphipoda	1	<1	11	<1	140	4	0	0
Decapod	0	0	0	0	0	0	0	0
Bivalve	4	77	4	45	3	73	5	36
Gastropoda	2	<1	2	<1	2	<1	0	0
Insecta	0	0	0	0	<1	<1	0	0

[4] *Zostera noltii* is the only species of seagrass present in the Caspian Sea.

Taxon Group	2019 BHEX01 EBS		2018 BBEX01 EBS		2018 Sangachal Bay		2004 Dredge Site EBS	
	S	N (%)	S	N (%)	S	N (%)	S	N (%)
Bryozoa	0	0	0	0	0	0	0	0
Total species per survey	12		13		28		12	
Average abundance/m^2	4588		8087		3859		2297	
Notes: S = number of species observed; N (%) = percentage abundance.								

The number of invertebrate species recorded within each survey ranged between 12 and 28. At the Project location the taxa recorded comprised 3 polychaete (two invasive and one native), 4 bivalve (3 invasive and 1 native), 2 gastropods (both native) and 1 oligochaete (native). One species of cumacean and one species of amphipod (native) was recorded in a sample collected at station 1 and station 38 respectively but these species were not present in any other stations. The variety of species recorded during the BHEX01 survey was comparable to BBEX01 and the 2004 Dredge Site. The highest variety of species was greatest at the 2018 Sangachal location however the lowest abundance was recorded at the 2004 Dredge Site. Tables 3.7 present the species recorded per survey and the species per taxa and Table 3.8 presents the abundance per 2019 BHEX01 EBS station.

Table 3.7: Benthic Species Presence in Surveys Conducted within and in the Vicinity of the BHEX01 Location

Species	2019 BHEX01 EBS	2018 BBEX01 EBS	2018 Sangachal Bay	2004 Dredge Site
Oligochaetes				
Isochaetides michaelseni				✓
Psammoryctides deserticola			✓	✓
Stylodrilus cernosvitovi			✓	✓
Stylodrilus parvus	✓	✓	✓	✓
Polychaetes				
Nereis diversicolor	✓		✓	✓
Nereis succinea	✓	✓	✓	
Hypaniola kowalewskii				✓
Manayunkia caspica	✓	✓	✓	
Fabricia sabella ssp. Caspica				✓
Crustaceans - Cumaceans				
Stenocuma diastyloides	✓			
Crustaceans - Amphipoda				
Amathillina affinis			✓	
Dikerogammarus caspius			✓	
Dikerogammarus haemobaphes			✓	
Gammarus spp			✓	
Gammarus ischnus		✓	✓	
Gammarus pauxillus			✓	
Niphargoides carausui			✓	
Gmelina pusilla	✓	✓	✓	
Gmelina brachyura			✓	
Corophium spp.		✓	✓	
Corophium curvispinum			✓	
Corophium mucronatum			✓	
Corophium nobile		✓	✓	
Corophium monodon		✓	✓	
Corophium volutator			✓	
Mollusca - Gastropoda				
Caspia gmelini	✓	✓	✓	

Species	2019 BHEX01 EBS	2018 BBEX01 EBS	2018 Sangachal Bay	2004 Dredge Site
✓*Caspiohydrobia gemmata*	✓	✓	✓	
Mollusca - Bivalva				
Dreissena rostriformis distincta				✓
Dreissena caspia	✓	✓		✓
Mytilaster lineatus	✓	✓	✓	✓
Cerastoderma lamarcki	✓	✓	✓	✓
Abra ovata	✓	✓	✓	✓

The communities in the BHEX01 and BBEX01 survey areas exhibited a high degree of similarity (~81%) and the only notable difference was the presence and relatively high abundance of the polychaete *Fabricia*, and a higher abundance of the polychaete *Manayunkia caspica* and the oligochaete *Stylodrilus parvus* in the BBEX01 survey.

The main differences between the 2004 Dredge Site community and the communities present in the BHEX01 and BBEX01 surveys were: the presence and numerical dominance of the polychaete *Hypaniola caspica*; the very low abundance of the polychaete *Manyunkia Caspica*; the low abundance of the oligochaete *Stylodrilus*; and the absence of gastropods in the 2004 Dredge Site survey community. It should be noted that, while present, gastropod abundance was very low in both the BHEX01 and BBEX01 surveys.

The bivalve community structure in BHEX01, BBEX01 and 2004 Dredge Site surveys were very similar; notably the bivalve *Dreissena caspia* was also present in the 2004 Dredge Site survey macrobenthic community. The presence of *D. caspia* in all three Baku Bay surveys suggests that this species may be a common component of the macrobenthic community across the wider Baku Bay area. It should be noted, however, that the abundance of *D. caspia* was low in all three surveys, with an average abundance of 50, 21 and 17 n/m^2 being recorded in the BHEX01, BBEX01 and 2004 Dredge Site surveys respectively.

Within the 2019 BHEX01 EBS, the macrofaunal community comprised 12 taxa and was numerically dominated by bivalve molluscs which accounted for 77% of the total abundance. The bivalve *Mytilaster lineatus* was present at all sample stations, and was the most abundant taxa within the survey, accounting for 61% of the total abundance. The next most abundant taxonomic group were polychaetes which accounted for 22% of individuals present, with 18% being represented by *Manayunkia caspica*; *Manayunkia* and the less abundant polychaete genus *Nereis* were present at all sample stations. The abundance of all other taxa were very low, individually accounting for ≤1% of the total abundance.

Although the distribution was relatively patchy, total abundance was generally higher at stations within the northern third of the survey area. The lowest abundances were generally observed at stations within the centre of the survey area where taxonomic richness was at the lower end of the recorded range. Overall there was very little variability in the macrobenthic community between stations.

The presence of the bivalve *D. caspia* within the BHEX01 community is a significant feature as it is an International Union for Conservation of Nature (IUCN) Red List critically endangered species. Although *D. caspia* was present at 33 of 38 BHEX01 stations it only accounted for ~2% of total abundance. Notably, *D. caspia* was also recorded in the 2018 BBEX01 survey: present at 15 of the 38 stations at a similarly low abundance. The only previous recording of this species in bp monitoring surveys of the Caspian Sea was in the 2004 Dredged Sediment Disposal Site Assessment survey, also within Baku Bay, where the species was present at a similarly low abundance (5 of the 10 sample stations). The abundance of *D. caspia* was low in all three Baku Bay surveys: the average abundance ranged from 17 to 50 n/m^2.

Table 3.8: Number of Benthic Taxa and Abundance (number per square metre (n/m²)) of Main Taxonomic Groups – 2019 BHEX01 EBS

Station	Polychaete		Oligochaete		Cirripede		Cumacea		Amphipod		Decapoda		Insect		Bivalve		Gastropod		Bryozoan	
	Taxa	n/m²	Taxa	n/m²	Taxa	n/m²	Taxa	n/m²	Taxa	n/m²	Taxa	n/m²	Taxa	n/m²	Taxa	n/m²	Taxa	n/m²	Taxa	n/m²
1	3	1160	0	0	-	-	1	10	0	0	-	-	-	-	4	1640	0	0	-	-
2	3	1050	1	30	-	-	0	0	0	0	-	-	-	-	3	2060	0	0	-	-
3	3	1090	1	50	-	-	0	0	0	0	-	-	-	-	3	3000	0	0	-	-
4	3	160	0	0	-	-	0	0	0	0	-	-	-	-	3	2980	0	0	-	-
5	3	1200	1	100	-	-	0	0	0	0	-	-	-	-	2	1570	0	0	-	-
6	3	530	0	0	-	-	0	0	0	0	-	-	-	-	3	1190	0	0	-	-
7	3	620	0	0	-	-	0	0	0	0	-	-	-	-	3	2100	0	0	-	-
8	3	190	0	0	-	-	0	0	0	0	-	-	-	-	4	2230	0	0	-	-
9	3	490	1	40	-	-	0	0	0	0	-	-	-	-	3	1580	0	0	-	-
10	3	880	1	40	-	-	0	0	0	0	-	-	-	-	2	1910	0	0	-	-
11	3	1030	1	20	-	-	0	0	0	0	-	-	-	-	3	3290	0	0	-	-
12	2	1050	0	0	-	-	0	0	0	0	-	-	-	-	4	1170	0	0	-	-
13	2	390	0	0	-	-	0	0	0	0	-	-	-	-	4	4270	0	0	-	-
14	3	930	0	0	-	-	0	0	0	0	-	-	-	-	4	3280	2	20	-	-
15	3	1540	1	40	-	-	0	0	0	0	-	-	-	-	4	3940	0	0	-	-
16	3	3610	1	20	-	-	0	0	0	0	-	-	-	-	4	950	0	0	-	-
17	3	1200	1	20	-	-	0	0	0	0	-	-	-	-	4	2370	0	0	-	-
18	3	230	0	0	-	-	0	0	0	0	-	-	-	-	4	510	0	0	-	-
19	3	770	1	20	-	-	0	0	0	0	-	-	-	-	4	4650	0	0	-	-
20	1	300	0	0	-	-	0	0	0	0	-	-	-	-	4	360	0	0	-	-
21	2	670	0	0	-	-	0	0	0	0	-	-	-	-	3	4180	0	0	-	-
22	2	470	0	0	-	-	0	0	0	0	-	-	-	-	4	5540	0	0	-	-
23	2	900	1	10	-	-	0	0	0	0	-	-	-	-	3	7330	2	20	-	-
24	3	470	0	0	-	-	0	0	0	0	-	-	-	-	3	2330	0	0	-	-
25	2	190	0	0	-	-	0	0	0	0	-	-	-	-	2	600	2	110	-	-
26	2	120	0	0	-	-	0	0	0	0	-	-	-	-	1	820	0	0	-	-
27	3	1550	0	0	-	-	0	0	0	0	-	-	-	-	2	5720	2	20	-	-
28	2	850	1	40	-	-	0	0	0	0	-	-	-	-	3	1440	1	10	-	-
29	2	490	0	0	-	-	0	0	0	0	-	-	-	-	1	5720	1	10	-	-
30	3	2010	1	60	-	-	0	0	0	0	-	-	-	-	2	5420	0	0	-	-
31	3	980	0	0	-	-	0	0	0	0	-	-	-	-	2	4540	0	0	-	-
32	2	1700	0	0	-	-	0	0	0	0	-	-	-	-	2	5580	0	0	-	-
33	2	1950	1	20	-	-	0	0	0	0	-	-	-	-	2	6170	0	0	-	-
34	3	860	1	20	-	-	0	0	0	0	-	-	-	-	3	10920	0	0	-	-
35	3	4290	1	40	-	-	0	0	0	0	-	-	-	-	4	2050	0	0	-	-
36	3	730	0	0	-	-	0	0	0	0	-	-	-	-	3	8030	1	10	-	-
37	3	1340	0	0	-	-	0	0	0	0	-	-	-	-	3	7720	1	10	-	-
38	2	1020	1	920	-	-	0	0	1	30	-	-	-	-	4	4420	0	0	-	-

3.4.4 Water Column Physical and Chemical Environment

The shallow water within the survey area means there is no lasting thermal stratification of the water column. Clockwise surface currents are typically weak throughout the year in direction and speed. The system is mainly wind driven due to the geographical nature of this sheltered bay and the water column in the bay is effectively a single, mixed water mass.

Water samples were collected at four 2019 BHEX01 EBS monitoring stations (6, 8, 31 and 33). One sample was collected from surface waters (~0-2m depth) at each station.

The recorded results (mean values) for dissolved oxygen (6.57mg/l), pH (8.38) and salinity(11.59 Practical Salinity Units (PSU) were similar to the results reported in previous coastal surveys while turbidity levels were similar to those recorded at BBEX01, and were lower than the results recorded in previous surveys conducted within Sangachal Bay.

Table 3.9 summarises the nutrient and organic and non-organic chemical levels recorded across the BHEX01 and BBEX01 surveys while a summary of the minimum, maximum and average heavy metal concentrations is presented in Table 3.10.

Table 3.9: Chemical Analysis & Nutrient Levels Recorded in Water Column Surveys within the BHEX01 and BBEX01 Locations

		2019 BHEX01 EBS		2018 BBEX01 EBS	
Parameter		**Value**	**Station**	**Value**	**Station**
TSS (in mg/l)	Min	<2	All Stations	<2	All Stations
	Mean	<2		<2	
	Max	<2		<2	
BOD-5 (mg/l)	Min	<0.5	All Stations	<1	05
	Mean	<0.5		1	-
	Max	<0.5		1	09, 17, 30
COD (mg/l)	Min	24.2	33	18.4	05
	Mean	26.6	-	21.9	-
	Max	30.6	8	23.8	17
Nitrites NO_2–N (µg/l)	Min	<0.2	6, 8	<0.2	All Stations
	Mean	2		<0.2	
	Max	2.2	33	<0.2	
Nitrates NO_{2+3} –N (µg/l)	Min	<10	6, 8, 33	<10	All Stations
	Mean	<10	-	<10	
	Max	10.5	31	<10	
Ammonium NH_4-N (µg/l)	Min	<10	All Stations	<10	All Stations
	Mean	<10		<10	
	Max	<10		<10	
Total N (µg/l)	Min	455	8	440	05
	Mean	509	-	551	-
	Max	572	33	634	30
Phosphates, PO_4 –P (µg/l)	Min	9.91	6	<1.6	All Stations
	Mean	16.5	-	<1.6	
	Max	21.9	33	<1.6	
Total P(µg/l)	Min	16.3	8	13.1	17
	Mean	19.3	-	14.6	-
	Max	22.1	31	16.4	09
Silicates SiO_2-Si (µg/l)	Min	291	33	134	17
	Mean	314	-	245	-
	Max	348	31	455	09

Table 3.10: Heavy Metal Concentrations Recorded in Water Column Surveys within the BHEX01 and BBEX01 Locations

Parameter		2019 BHEX01 EBS Value	2019 BHEX01 EBS Station	2018 BBEX01 EBS Value	2018 BBEX01 EBS Station
Cadmium	Min	<0.1	All Stations	<0.1	All Stations
	Mean	<0.1		<0.1	
	Max	<0.1		<0.1	
Cobalt	Min	0.03	6	0.067	09
	Mean	0.047	-	0.082	-
	Max	0.062	33	0.09	05
Copper	Min	1.24	33	2.89	17
	Mean	1.3	-	4.93	-
	Max	1.49	31	7.34	30
Iron	Min	26.7	6	21.0	05
	Mean	31.9	-	24.93	-
	Max	39.3	33	28.3	30
Lead	Min	0.36	31, 33	0.706	09
	Mean	0.39	-	1.25	-
	Max	0.42	6	1.91	30
Zinc	Min	7.8	31	1.47	09
	Mean	8.59	-	3.54	-
	Max	9.55	6	2.93	05

The results from the 2019 BHEX01 EBS indicate values for biological oxygen demand (BOD), chemical oxygen demand (COD) and total suspended solids (TSS) were low. These results appear to be consistent with the 2012 Baku Bay EBS (Ref.12) which generally recorded low concentrations throughout the Bay except in areas in the vicinity of waste water outfalls. Nitrite, nitrate and ammonium concentrations were close to, or below, the limits of detection. Total nitrogen and silicate concentrations were high, and reflective of samples collected in previous surveys (BBEX01 and Sangachal Bay); these values probably represent the cell contents of phytoplankton present in the samples.

Concentrations of THC, PAH and phenols recorded within the samples from the 2019 BHEX01 EBS were below the limits of detection in all samples. Higher THC concentrations, ranging from 23 to 65µg/l were recorded in the BBEX01 EBS. These findings correspond with the results of the 2012 Baku Bay EBS (Ref.12) which found that elevated hydrocarbon concentrations in the water column are found locally, typically near the coast in areas with waste water outfalls, although most sample locations within the Bay did not exceed the detection limit.

Cobalt concentrations recorded were also below the limit of detection in all samples and the concentrations were slightly lower than those recorded in the 2018 BBEX01 survey. The concentration of cobalt is not measured in Sangachal Bay surveys, however, the results recorded within the two Baku Bay surveys were comparable to those previously recorded at offshore Caspian monitoring locations. Copper, nickel, and lead concentrations were similar to those recorded in previous Sangachal Bay surveys while the concentrations of copper and lead were lower than the samples recorded in the BBEX01 survey. The concentrations of iron were similar to those recorded at BBEX01, and were slightly lower than the results recorded in previous surveys conducted within Sangachal Bay.

All results were within the respective maximum allowable concentration (MAC) for Azerbaijani fisheries waters, the exception was iron which exceeded the MAC in both the BHEX01 and BBEX01 surveys and all previous surveys conducted within Sangachal Bay.

3.4.5 Water Column Biological Environment

3.4.5.1 Plankton

Phytoplankton

The phytoplankton of the southern Caspian Sea is comprised of marine, euryhaline, and brackish water forms. The most numerous phytoplankton of the Southern Caspian, in terms of both numbers and taxa are diatoms, followed by dinoflagellates and cyanophytes (blue-green algae). Of the diatoms, the invasive species *Rhizosolenia calvaris* is often the most abundant and is now found to be generally present throughout the year. This species has an exceptionally large cell size, and combined with its abundance, can be responsible for up to 90% of the total phytoplankton biomass.

There are some broad spatial patterns in productivity evident in the Caspian Sea with higher levels of production (as measured by chlorophyll concentration) observed in some shallow water areas compared to open ocean, particularly where nutrient levels are high near urban coastal areas.

Table 3.11 presents a summary of phytoplankton community composition results recorded in the water column at the BHEX01 and BBEX01 survey locations shown in Figure 3.5 with the species recorded presented in Table 3.12.

Table 3.11: Summary of Phytoplankton Community Composition in the Vicinity of the BHEX01 and BBEX01 Survey Locations

Taxon Group	2019 BHEX01 EBS			2018 BBEX01 EBS		
	S	Net N (%)	Bottle N (%)	S	Net N (%)	Bottle N (%)
Diatoms	27	19	58	25	47	9
Dinoflagellates	8	2	38	8	10	44
Green algae	3	78	3	4	37	40
Blue-green algae	3	1	1	5	6	7
Total species observed	41	-	-	42	-	-
Notes: S = number of species observed; N (%) = percentage abundance.						

Table 3.12 Species of Phytoplankton Recorded During BHEX01 EBS

Species
CYANOPHYTA
Oscillatoria chalybea (Mert.)
Oscillatoria sp. №1
Gomphosphaeria f.aponina Kutz.
BACILLARIOPHYTA
Psevdosolenia calcar-avis M. Schultze
Cyclotella meneghiniana Kutz.
Tabellaria fenestrata v. intermedia Grun.
Thalassionema nitzschioides Grun.
Actinocyclus ehrenbergii Ralfs
Amphora ovalis Kütz.
Chaetoceros pendulus Karsten
Chaetoceros peruvianus Brightwell
Nitzschia sigmoidea (Ehr.) W. Sm.
Nitzschia sigma (Kütz.) W. Sm.
Nitzschia acicularis W. Sm
Nitzschia holsatica Hust.
Navicula hungarica Grun.
Navicula cryptocephala v. veneta (Kütz.)
Pleurosigma elongata w. Sm.
Coscinodiscus perforatus Ehr.
Coscinodiscus granii Gough.
Diatoma sp.
Cymbella affinis Kütz
Diploneis interrupta (Kütz) Cl.
Synedra ulna (Nitzch) Ehr
Coscinodiscus jonesianus (Grev.) Ostf.
Navicula placentula (Ehr). Grun
Nitzschia tenuirostris Mer.
Chaetoceros var. abnormis f. abnormis Pr.-Lavr.

Species
Chaetoceros subtilis Cl. var. subtilis f. subtilis
Chaetoceras rigidus
DINOPHYTA
Goniaulax polyedra Stein
Prorocentrum micans Ehr.
Prorocentrum cordatum (Ostf.) Dodge
Goniaulax sp
Glenodinium behningii (Lind.) I. Kissel.
Prorecentrum proximum Makar.
Gymnodinium variabile Herdm.
Glenodinium pilula (Ostf.) Schiller
CHLOROPHYTA
Ankistrodesmus longissimus var acicularis (Chod.) Brunnth
Binuclearia var. crassa Pr.-Lavr. et Makar.
Chlamydomonas sp.

The results show the phytoplankton community is typically composed of diatoms, dinoflagellates, chlorophyta (green algae) and cyanophyta (blue-green algae). A total of 41 species of phytoplankton were recorded in the BHEX01 survey. The phytoplankton diversity was similar to the diversity recorded in the 2018 BBEX01 survey, and slightly higher than the diversity recorded in the 2018 Sangachal Bay survey, where 42 and 33 phytoplankton species were recorded respectively.

In the 2019 BHEX01 survey diatoms were the most species rich taxonomic group with 27 species identified. They accounted for 19% and 58% of the total abundance in the net and bottle samples respectively. Of the 8 Dinophyta (dinoflagellate), abundance of the group was low in the net samples, accounting for 2% of the total abundance, while a higher abundance was recorded in the bottle samples, accounting for 38% of total abundance.

Three species of Cyanophyta (blue-green bacteria) and Chlorophyta (green algae) were identified in the survey. Cyanophyta abundance was low throughout, representing 1% of the total abundance in both the net and bottle samples.

Diatoms were the most taxonomically rich group in both the BHEX01 and BBEX01 surveys. The only notable difference between the net sample results from the two surveys was the high abundance of chlorophyta in the BHEX01 survey. With regard to the bottle samples, diatoms were numerically dominant in the 2019 BHEX01 while diatoms and chlorophyta were co-numerically dominant in the 2018 BBEX01 survey.

Biomass in net samples was dominated by diatoms, which accounted for 77% of the total biomass. Cyanophyta and Dynophyta accounted for 19% and 3% of the total biomass respectively.

Phytoplankton growth and composition follows a seasonal cycle with two ‘blooms’ of peak biomass in the Caspian Sea - a large bloom in the autumn and a smaller bloom in the spring. The seasonal cycle of production reflects seasonal changes in sunlight and water temperature and the availability of nutrients. During the winter phytoplankton production is low due to low water temperatures, low light levels and a mixed water column. Changes in light and temperature in the spring, and the resulting stratification of the water column trapping nutrients in the upper layers, results in a dramatic increase in growth, particularly by diatoms.

Growth remains high during the summer but there may be a successional shift from diatoms to dinoflagellates, typical of phytoplankton cycles in marine systems. Through the autumn the warm waters continue to be productive, often with a second higher peak in production levels, before phytoplankton biomass decreases again in winter (Ref.19).

Zooplankton

The southern region of the Southern Basin has been reported to support around 180 species of zooplankton comprising protists, rotifers, copepods, cladocera and pelagic crustaceans such as mysids and the larvae of a range of invertebrate organisms. The three main types of zooplankton found in the Caspian Sea are:

- **Copepods** - small, shrimp-like animals often no more than 1mm long, some native to the Caspian Sea and some introduced from other areas Copepods are generally the numerically dominant component of the zooplankton;
- **Cladocerans** - 'water fleas', often larger than copepods (1 - 5mm long), predominantly native to the Caspian; and
- **Ctenophore** – the 'comb jelly' *Mnemiopsis leidyi* is not native and was first recorded in the Caspian Sea in 1999. This species may have been transported into the Caspian Sea from the Black Sea.

Prior to 2000, the zooplankton present was largely dominated by naturalised and endemic species of copepods and cladocerans. Since 2003 however, native and endemic taxa have been rare or absent in bp-sponsored surveys, whilst the invasive copepod *Acartia* and the invasive ctenophore (comb jellyfish) *Mnemiopsis* are more prevalent. The latter is an effective predator on both zooplankton and on fish larvae and has had a marked effect on secondary productivity in the mid and south Caspian. The persistence of *Acartia* might, in part, be due to its reproductive behaviour; whilst most native copepods and Cladocera keep their embryos in egg sacs or brood pouches until the nauplii hatch, *Acartia* releases its eggs directly into the water column. Since embryos spend less time associated with females, they are less likely to be consumed when females are predated by *Memiopsis.*

A full list of the zooplankton species recorded during the 2019 BHEX01 EBS and 2018 BHEX01 EBS water column surveys are included in Table 3.13.

Table 3.13 Zooplankton Species Recorded from the 200µm and 53µm Net Samples in the Vicinity of the BHEX01 Location

Species	2019 BHEX01 EBS	2018 BHEX01 EBS
Rotatoria		
Testudinella patina (Hermann)	✓	✓
Cladocera		
Pleopis polyphemoides (Leuckart)	✓	✓
Copepoda		
Acartia tonsa Dana	✓	✓
Nauplii copepoda	✓	✓
Ostracoda		
Ostracoda spp	✓	✓
Cirripedia		
Nauplii balanus	✓	✓
Polychaete		
Larva polychaeta	✓	✓
Mollusces		
Larva bivalvia	✓	✓
Ctenophora		
Mnemiopsis leidyi (A.Agassiz)	✓	✓
Mnemiopsis leidyi egg.	✓	

Nine zooplankton taxa were recorded during the BHEX01 survey, with the community numerically dominated by the non-native species of copepod, *Acartia tonsa*, at all stations. Also present in all four samples were the invasive predatory ctenophore, *Mnemiopsis leidyi*, the Cladoceran *Pleopis polyphemoides*, and nauplii larvae of the barnacle genus *Balanus*. The invasive ctenophore Mnemiopsis was also present in low numbers.

Comparison with the BBEX01 EBS survey showed that the zooplankton community structure in all both surveys were similar, with *Acartia tonsa* being the numerically dominant taxa. The most notable differences between the surveys was the lower abundance of *Acartia* in the BBEX01 survey. The abundance of *Mnemiopsis leidyi* and diatoms recorded in the BHEX01 and BBEX01 net surveys were notably lower than the abundance recorded at Sangachal Bay in 2018 and Cladoceran *Evadne* which was recorded in the Sangachal Bay survey was absent in both the BHEX01 and BBEX01 surveys.

Seasonal abundance of zooplankton is closely related to that of phytoplankton with peaks in abundance usually observed in the spring and autumn (approximately one month after the phytoplankton peak).

3.4.5.2 Fish

A comprehensive overview of the fish (including presence, spawning and and migration) commonly found in the Central and Southern Caspian Sea is provided in Section 5.4.6.2 of the SWAP Exploration Drilling Project ESIA.

The shallow water coastal regions of the Azerbaijani sector of the Caspian Sea are important for non-migratory species as it provides breeding and nursery habitat for a number of species during spring, summer and autumn. A review of drop down video survey footage taken at the BHEX01 well location recorded the presence of individual sandsmelt, gobies and stickleback. The water depth and conditions are typical habitat for these species and while present in water depths of 20m or more year round, these species typically breed in waters of up to 10m deep, more commonly in shallow waters of up to 4m deep. Kilka were not observed in the drop down video, however they may be present during their spawning period. *Clupeonella delicatula caspia* typically spawn at depths of between 5-10m. Other species that may be found at the Project location, based on water depth, include pipefish and some shad species. Considering the existing contamination within Baku Bay, habitat type and location, it is not expected that sturgeon are present (Ref.13).

3.4.5.3 Caspian Seals

Information on the current status of the the Caspian seal (*Phoca caspica*), including data on population estimates, migration and scientific studies is provided in Section 5.4.6.4 of the SWAP Exploration Drilling Project ESIA. Based on the published scientific data as described in the ESIA, observations and knowledge from local National experts, it is considered highly unlikely that Caspian seals will be present within the vicinity of the Project location during the drilling operations. This is mainly due to lack of availability of food resources as their main prey are not abundant in this area. Furthermore, seals will tend to avoid the bay area due to anthropogenic disturbance.

3.5 Birds

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. Section 5.5 of the SWAP Exploration Drilling Project ESIA provides an overview of the distribution and abundance of birds based on published literature and coastal survey data for the period 2002 to 2017.

The Project location is not located within an Important Bird Area (IBA), with the nearest IBA (Red Lake) located over 10km from the BHEX01 well location. The Azerbaijani coastline, mainly along wetlands and lakes, is a major flyway for migrating waterfowl and coastal birds, which is most active during March and November. Birds are primarily migrating to the southern coast of the Caspian Sea, the Kur-Araz lowland, Turkmenistan, southwest Asia and Africa for the winter and then fly north along the same route during spring.

Although not a designated site of importance, the islands of Gum Zira, Dash Zira, Boyuk Zira, Tava and Khanlar island located near the entrance of Baku Bay (approximately 4.5km southeast of the proposed BHEX01 well location) are recognised as key areas for nesting/breeding birds. It is thought these islands support a regular population of up to 110 pairs of birds. The population mainly comprises common tern (Sterna hirundo) (110 pairs) but also includes small numbers of sandwich tern (*Thalasseus sandvicensis*), Caspian gull (*Larus cachinnans*) and slender billed gull (*Chroicocephalus genei*) (Ref.2). The breeding and nesting season along the Azerbaijan coastline begins at the end of April/beginning May and continues until mid-July. At the end of July and beginning of August, the birds leave their nesting places and disperse. Other species likely to be present in Baku Bay at times throughout the year include cormorants, black-headed gull (*Chroicocephalus ridibundus*), teal duck (*Anas crecca*), tufted duck (*Aythya fuligula*), great crested grebe (*Podiceps cristatus*), Eurasian coot (*Fulica atra*), and Greater Scaup (*Aythya marila*).

3.6 Socio-Economic Description

3.6.1 Introduction

This section describes the socio-economic baseline conditions relevant to the Project. The purpose of the section is to provide sufficient information to allow the potential socio-economic impacts of the

Project activities to be assessed. The scope and content of the section has been determined based on the anticipated socio-economic interactions identified during the scoping process. The section focusses on socio-economic conditions within and in the vicinity of the Project area.

National and regional level information on Azerbaijan's economy, health and education as well as data relating to population, demographic structure and ethnicity is presented in Section 5.6.1 and 5.6.2 of the SWAP Exploration Drilling Project ESIA.

3.6.2 Stakeholder Consultation

As part of the BHEX01 Addendum process, the local context has been reviewed and further information has been provided through engagement with key stakeholders. Key stakeholders were identified based on their location along the boulevard and proximity to the Project area of influence, particularly if there was potential for visual impacts. The identification of stakeholders was undertaken with input from Synergentics, a Baku based consultancy.

Interviews were held on 1st and 2nd of March 2021 with the aim of providing the stakeholder with key project information; gain an understanding of the use of facilities and to record any questions or concerns raised regarding the Project. The survey team conducted interviews with the following key Stakeholders:

- **Recreational Facilities:** The following recreational facilities were consulted with the aim of of providing basic project information, understand the use of facilities and to record any questions or concerns regarding the Project:

    - Baku Yacht Club;
    - Tourist Boat Operators (part of Boulevard Management);
    - Crystal Hall;
    - Yarat Contemporary Art Centre;
    - Stone Chronicle Museum;
    - Aquatic Palace;
    - European Games Park;
    - Boulevard Management;
    - Carpet Museum;
    - Baku Sports Hall; and
    - Caspian Waterfront Mall;

    Outcomes of the engagement are provided in Sections 3.6.2.1 to 3.6.2.5.

- **Port (Authority) and Harbour Master:** The port authority was consulted to understand the use of the Project Area by vessels, including a description of the types of large vessels going to / from port(s) and to identify whether recreational or small-scale fishing activity occurs within the area around the BHEX01 well location. Details are provided in Section 3.6.3.

- **Baku Scuba Diving and Freediving Center:** The club was consulted to identify diving activity in the Baku Bay area and Absheron Peninsula. Details are provided in Section 3.6.2.4.

- **Institute of Archaeology and Ethnography**: Engagement with the Institute of Archaeology and Ethnography (IoAE) was undertaken to understand the underwater archaeological sensitivities in Baku Bay as well as any concerns the IoAE may have with regards to the Project. Details on marine cultural heritage and outcomes of the meeting are provided in Section 3.6.4.

3.6.2.1 Tourism and Recreation

Recreational land use along Baku Bay includes hotels, restaurants, cafes and other facilities such as museums and parks. There are a number of museums, art centres and venues situated along the Boulevard, many of which are open all year round. Visitor numbers to these facilities vary depending on the season with peak periods typically in the summer months. The main boulevard, built in 1909, is an important feature within Baku and is popular throughout the year by local residents and tourists with a number of cafes, restaurants and culturally important landmarks spread along the Boulevard. The majority of the sites will have a line of sight to the Project location, with only the Carpet Museum having an obstructed view by other buildings and trees.

Overall, the majority key stakeholders listed in Section 3.6.2 did not raise any issues or concerns regarding Project activities and they consider it as an important national project. Baku Yacht Club, which also has hotel facilities, was concerned about the potential noise and vibration impacts from Project activities.

3.6.2.2 Recreational Vessels

To identify recreational vessel usage within Baku Bay, a representative of the Baku Yacht Club was interviewed as part of the socio-economic survey. As with many of the recreational facilities along the boulevard, the peak season occurs during the summer months. On average, between 5 and 10 vessels sail per month, depending on weather conditions. All departures and arrivals are managed by the State Maritime Administration. Currently, there are approximately 35 registered vessels in the Baku Yacht Club marina.

3.6.2.3 Tourist Boats

There are two tourist boat operators within Baku Bay, controlled by the Boulevard Management administration. During peak season, the frequency of tourist boats are determined by passenger demand and can operate numerous times per day without a set timetable. The route departs from the jetty on the boulevard and travels towards Sabayil Castle and Crystal Hall, returning to the boulevard after approximately 30 minutes. When consulted during the socio-economic survey, the boat operators did not have any concerns with the Project and confirmed that the boats do not pass within 500m of the Project area.

3.6.2.4 Diving

As part of the socio-economic survey, the Baku Scuba and Freediving Center were interviewed to identify diving activities in Baku Bay and it was confirmed that there are no recreational diving sites within Baku Bay. Dive sites within Azerbaijan are located in more rural parts of the country, in both freshwater and marine settings. Freshwater diving sites include the mountain lakes of Goy-Gel and Maral-Gel. Within the Caspian Sea, the more popular sites include the rocky archipelago of islands close to the Absheron Peninsula (Ref.20). This information aligns with previous data gathered for bp projects in the vicinity (Ref.2). Boyuk Zira Island, located approximately 4.5km from the BHEX01 well location, is the nearest diving location although it is visited less frequently than the sites to the east of the Absheron Peninsula.

3.6.2.5 Small Scale Coastal Fishing

Small scale and coastal fishing is predominantly undertaken using medium sized small tonnage vessels, with fishing taking place within to 2-3 nautical miles from the coastline. Typically, March to April and September to November are the peak seasons for small scale fishing with many of the fish caught being sold to local markets. Areas along the coastline between the Absheron Peninsula and Gobustan where the majority of licences have been issued for small-scale fishing include Zira, Hovsan, Shikh, Bayil, Zygh and Sangachal-Gobustan. Further details of small scale and coastal fishing is provided in Section 5.6.3.4 of the SWAP Exploration Drilling Project ESIA. From discussions with the Port Authority, there are no known fishing areas within the immediate vicinity of the BHEX well location.

Further information on small scale fishing as well as an overview of the current status of commercial fishing in Azerbaijan is presented in Section 5.6.3 of the SWAP Exploration Drilling Project ESIA.

3.6.3 Shipping, Ports and Existing Offshore Infrastructure

Discussions with the Port Authority confirmed that up until 2019, the marine passenger terminal within Baku Bay served passenger and cargo ships and ferry boats to and from Kazakhstan (Aktau), Turkmenistan (Turkmenbashi) and Russia (Olya). Since the opening of the new port, cargo ships and passenger ferry boats now operate from Alat, located approximately 70km south of Baku. Currently, the marine passenger terminal in Baku only serves six ships, used primarily for oil and gas purposes by bp and SOCAR. All vessels entering and leaving Baku Bay are regulated by the State Maritime Administration of the Republic of Azerbaijan (Ref.21) which operate a vessel traffic control system. As part of this regulation, vessels are required to obtain permission from the administration and undergo technical inspection. There are no main shipping routes within Baku Bay or within the vicinity of the Project location.

3.6.4 Marine Cultural Heritage

As described in Section 5.7 of the SWAP Exploration Drilling Project ESIA the Caspian has been subject to extensive fluctuation in sea levels, with recorded sequences of succession and regression (Ref.22). As a result, a number of ancient settlements and fortifications have been claimed by rising sea levels, resulting in submerged archaeological landscapes.

Baku and the Absheron Peninsula have a rich cultural heritage dating back to the late Stone Age. The coastal plains were vulnerable to attack from the sea and consequently a number of fortifications were built along the coastline primarily during the 13th to 15th centuries. No recent survey has been undertaken to identify potential marine cultural heritage in Baku Bay and the only known archaeological remains found in Baku Bay is Bayil Castle, located approximately 1km northwest of the BHEX01 well location. The castle was built on the Bayil Hills in the 13th century by Shirvanshah Fariburz III. As a result of an earthquake in 1306, the castle collapsed and subsequent sea level rises caused the complete submergence of the castle. Since 1306 the Caspian Sea level has fluctuated and in the 18th century the castle ruins were visible again due to a fall in the sea level. However, recent sea level rises have completely submerged the castle again. The site was investigated by the Institute of History, Academy of Science, between 1939 and 1969.

A number of medieval and early post-medieval shipwrecks in the vicinity of Absheron Peninsula were investigated by the History Museum of Azerbaijan between the 1960s and 1980s (Ref.23). There is a high potential for submerged marine archaeology, including shipwrecks and possibly buried former land surfaces throughout Baku Bay. As described in the SWAP Exploration Drilling Project ESIA it is understood the MENR have recently undertaken a study to identify and remove and/or salvage the shipwrecks of modern vessels around the Absheron Peninsula to clear navigational and environmental hazards (Ref.24). In total it is understood that 99 modern shipwrecks were identified in areas just outside of Baku Bay, offshore of Sahil and Bibiheybat. To date it is understood that 20 shipwrecks have been removed. Data identifying the locations of the modern wrecks is not currently available.

However, it should be noted that the footage from the drop down video survey conducted as part of the BHEX01 EBS did not show any features on the surface of the seabed which may indicate the presence of marine archaeology. Seabed hazard surveys undertaken in 2018 (Ref.25) and 2019 (Ref.26), which comprised side scan sonar, multibeam bathymetry, sub bottom profiler and magnetometer detected a number of unidentified metallic and non-metallic objects in the area, none were within the immediate vicinity of the BHEX01 well location. Furthermore, the Institute of Archaeology and Ethnography were consulted and confirmed there was no known archaeological or significant objects in the vicinity of the Project location.

4 Impact Assessment

4.1 Introduction

The activities and events associated with the Shallow Water Absheron Peninsula (SWAP) Bibiheybat exploration well (BHEX01), have been determined based on the activities described within Chapter 2 (Project Description) of this ESIA Addendum; and the potential for interactions with the environment identified.

In accordance with the impact assessment methodology as described in Chapter 3 of the SWAP Exploration Drilling Project ESIA (Ref.1), Scoping has been undertaken to identify selected activities that may be "scoped out" from the full environmental impact assessment process if the event magnitude is identified to be very low and the receptor interaction predicted to be highly unlikely; supported with established controls and mitigations, that may include existing operational procedures and design measures etc.

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 activities undertaken to confirm that these controls are implemented and effective, as well as additional mitigation and monitoring to further minimise impacts, where required, are provided. Assessments of cumulative and transboundary impacts and accidental (unplanned) events have also been undertaken and are provided in Chapter 5.

4.2 Scoping

The Project activities and associated Events that have been scoped out due to their limited potential to result in discernible environmental impacts are presented in Table 4.1. The scoping process has used judgement based on prior experience of similar Activities and Events. 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 4.1: Key "Scoped Out" Project Activities

ID	Activity/Event	Justification for "Scoping Out"
SW1	Disturbance to onshore receptors from the generation of airborne noise from the jack-up rig	• Airborne noise levels generated by jack-up drilling rigs are typically in the region of 75 to 80 dB LAeq at a distance of 10m from the jack-up rig. • The nearest residential receptors are in Bibiheybat and along Baku boulevard; both are located at a distance of approximately 2 km from the BHEX01 well location. • Using noise propagation calculations[5], airborne noise levels generated by the operation of the jack-up rig at the nearest receptors are estimated to be 30-35 dB. This is well below the current baseline noise levels (which were dominated by traffic and wind noise sources) recorded at the nearest location, namely Baku boulevard (56 -58 dB) located approximately 2 km to the northwest of the BHEX01 well location (refer to Chapter 3 Section 3.3.3.). • The estimated jack up rig noise level at receptors of 30-35 dB is below the World Health Organization (WHO) and International Finance Corporation (IFC) guideline (Ref.27) levels of 45 dB LAeq,8h that is the external night-time noise (22.00 – 07.00) threshold for sleep disturbance. **Conclusion:** Due to the distance of the nearest receptors located to the BHEX01 well location it is not anticipated that airborne noise associated with the Project drilling activities will be discernible from existing baseline noise sources at the nearest community receptors.
SW2	Disturbance to birds and communities from to increased light levels from the jack-up rig and support vessels	• Section 5.5.1 of the SWAP Exploration Drilling Project ESIA summarises the potential presence of migrating birds. The key autumn migratory period is from August to December with October to December expected to be the most active period. Baku Bay is located within the migratory route. Migratory birds are known to migrate overnight and are attracted to artificial lighting (Ref.28).

[5] Noise propagation calculations were prepared in accordance with ISO 9613:1996 'Acoustics - Attenuation of Sound during propagation outdoors Part 1 – Calculation of the absorption of sound by the atmosphere' and 'Part 2 – Attenuation of sound during propagation outdoors

ID	Activity/Event	Justification for "Scoping Out"
		• The nearest residential receptors are situated in Bibiheybat and along Baku boulevard; both at a distance of approximately 2 km from the BHEX01 well location. • The jack-up rig and support vessels will carry appropriate navigation lights for operating during night-time and periods of poor visibility. The jack-up rig will also require lighting to allow drilling operations to continue safely during the hours of darkness. The level of lighting will be commensurate with the activities being undertaken and will be in compliance with maritime safety regulations at sea. Appropriate lighting design during night-time works will be implemented, including use of directed illumination, screens, shades, timers, etc. as required. Skyward and seaward light projection will be eliminated as far as safe and practicable, by removing unnecessary illumination, reduction of light intensity and shielding of light sources during the night. **Conclusion:** Although lighting may present some localised and temporary disturbance to birds, it is necessary for human safety and sea navigation and it is considered that impacts are minimised as far as practicable. With the controls in place, and the existing light levels (Boulevard night lighting, Crystal Hall and lighthouses) within the bay, it is considered the impact of lighting on biological receptors will be indiscernible. Given the location of the Project is over 1.5km from the coastline, and the mitigation above will be employed, the lighting levels are not predicted to cause a disturbance.
SW3	Disturbance to birds from the generation of airborne noise from the jack-up rig	• The nearest Important Bird and Biodiversity Area (IBA) to the BHEX01 well location is the Red Lake IBA, located approximately 10km south of Baku and is an important breeding bird area. • There are a number of islands (Gum Zira, Dash Zira, Boyuk Zira, Tava and Khanlar), as summarised in Section 5.3 of this Addendum, which are recognised as key areas for nesting/breeding birds. The islands are located, at their closest point, approximately 4.5 km south east of the BHEX01 well location. • Typically, birds will not take flight until a disturbance is closer than 30-50 m although they may be aware of disturbances at distances of 200-300 m[6]. • It is recognised that various species of birds will periodically be present in Baku Bay including in the vicinity of the Project location. However, given the area of disturbance from noise generated by the jack-up rig will be limited in extent and duration, and the existing background noise levels in the area, it is expected that the birds using this area are likely to be habituated to the existing noise environment and will be able to avoid and adapt to the additional short term disturbance. • Jack-up rig and vessel personnel will be provided with environmental awareness training that includes measures designed to minimise sound and disturbance generated by offshore activities. **Conclusion:** Given that the BHEX01 well is located approximately 4.5 km from the nearest recognised nesting bird area and 10km from the nearest IBA it is not anticipated that drilling activities will cause any significant disturbance to birds.
SW4	Physical presence of the jack-up rig on visual amenity	• The drilling programme is expected to be three months in duration after which the jack-up rig will be moved. • The jack-up rig will be located approximately 1.5 km, at its nearest point, from the coastline of Baku, which includes recreational facilities such as the boulevard, Carpet Museum and the Crystal Hall. The nearest residential receptors are situated in Bibiheybat and along Baku boulevard; both at a distance of approximately 2 km from the BHEX01 well location. • The legs of the jack-up rig will extend up to 110 m above the sea surface and is expected to be visible from locations along the coastline with unimpeded views of the Bay. • There are a number of ports to the east of Baku Bay, as shown in Figure 5.3 of the SWAP Exploration Drilling Project ESIA, including the Zykh Yard, East Port and the SOCAR Refinery from where large vessels regularly travel across the Bay. There are defined shipping routes from these locations. **Conclusion:** Baku Bay includes several shipping routes and marine traffic is common place. The presence of such features within the seascape setting and the context of background views from visual receptors somewhat reduces the susceptibility to the change proposed from the presence of the jack-up rig. The introduction of the jack-up rig will be an obvious and distracting feature at 110 m high but will occupy a very small part of horizontal extent of seaward views. The temporary nature of the jack-up rig and three month drilling programme will further limit potential seascape and visual effects. The very-short duration in combination with limited physical extent of change is unlikely to result in any significant seascape and visual effects therefore scoped out from further landscape and visual assessment.

[6] These limits are derived from BS5228:2009 (Ref.28) and relate to noise associated with construction that has the potential to impact the local community. This guidance value differs from limit values associated with operational noise as construction noise is recognised as being temporary and has different characteristics to operational noise

ID	Activity/Event	Justification for "Scoping Out"
SW5	Physical presence of the jack-up rig on fisheries and recreational boats	• No commercial fishing vessels are known to use the waters within 5 km of the BHEX well location. The nearest commercial fishing area is understood to be near the Oil Rocks and Makarov Bank located over 30 and 50 km away, respectively. • As stated within Chapter 3: Section 3.6.3.4 coastal small-scale fishing is limited to 2-3 nautical miles (approximately 5 km) from the coastline[7]. No known small scale fishing takes place in the vicinity of the Project location and no interaction between the Project activities and small-scale coastal fishing is anticipated. • A recreational tour boat operator was consulted during the socio-economic survey as summarised in Section 3.6.2.3 of this ESIA Addendum. It was confirmed that the location of the BHEX01 well is not located within the tour route. While the jack-up rig will be visible from the boats, the duration will be limited to three months. • Maritime businesses (including diving companies) will be consulted and informed of the Project drilling activities and the planned schedule. **Conclusion:** Given no concerns or issues were raised during the stakeholder engagement and the expected unlikely presence of fishing or recreational boats in the vicinity of the BHEX01 well location, the risk of interactions and impacts is considered to be insignificant.
SW6	Physical presence of jack-up rig and support vessels on shipping and navigation	• The BHEX01 location and exclusion area is understood to be located outside of the main shipping routes and since the opening of the new Port of Baku at Alat the level of shipping traffic in and around Baku Bay has significantly decreased. There are still a number of reduced shipping routes across Baku Bay to transit supply/ crew vessels to offshore infrastructure. • Notifications regarding the drilling programme will be issued to the relevant maritime and port authorities, as well as directly communicated with sea users where necessary, in advance of the BHEX01 exploration drilling programme. • All vessels will operate in compliance with national and international maritime regulations for avoiding collisions at sea, including the use of signals and lights. **Conclusion:** Given that the Project location is not located within the main shipping routes and communication lines with the relevant maritime and port authorities, as well as other sea users will be maintained by the project team prior to and during the drilling programme the risk of interactions with maritime users is considered to be insignificant.
SW7	Underwater sound from drilling activities (conductor driving and VSP) on divers	• While diving for recreation is not known to be a popular recreational activity in the Azerbaijan sector of the Caspian Sea, three diving clubs are active in the Absheron Region. • The nearest known dive site is located adjacent to Boyuk Zira Island, approximately 4.5 km from the BHEX01 well location. This was reconfirmed during the socio-economic survey through consultation with the Baku Scuba and Freediving Center, as summarised in Section 3.6.2.4 of this ESIA Addendum, which confirmed that there is no diving within Baku Bay. • Maritime businesses (including diving companies) will be consulted and informed of the Project drilling activities and the planned schedule. **Conclusion:** Given the distance between the BHEX01 well location and the nearest dive site, impacts from Project activities on divers are not anticipated.
SW8	Generation of waste	• Estimated volumes of non-hazardous and hazardous waste that will be generated during the BHEX01 drilling programme are presented in Table 2.9 of this ESIA Addendum. • Waste onboard the jack-up rig and support/supply vessels will be segregated at source, stored and transported in fit for purpose containers. • State licensed and approved waste management facilities will be used for disposal of waste during the drilling programme. • Waste generated during the Project will be managed in accordance with the existing bp Azerbaijan Georgia Turkey (AGT) Region management plans and procedures. Waste management plans will be established for the jack-up rig and support/supply vessels (operated in accordance with the MARPOL 73/78 Annex IV: Prevention of Pollution requirements) in accordance with the existing bp AGT Region management plans and all waste transfers will be controlled and documented. **Conclusion**: Waste generated during the BHEX01 drilling activities is managed in accordance with the existing bp AGT Region management plans and procedures as described within Chapter 8 of the SWAP Exploration Drilling Project ESIA. No discernible impact to the terrestrial or marine environment is expected.
SW9	Fugitive emissions from dry bulk transfer	• During the transfer dry bulk (primarily cement and barite) from the vessels to the rig some losses to the atmosphere of dry bulk may occur through vent lines (the vent lines must be open as part of operational requirements). • Fugitive emissions resulting from dry bulk transfer are expected to be minimal.

[7] Order 073 issued by Ministry of Emergency Situations on 16 June 2007 & Ministry of Justice Certificate 3350 on 26 June 2007

ID	Activity/Event	Justification for "Scoping Out"
		Conclusion: No discernible impact to the marine environment is anticipated due to fugitive emissions resulting from dry bulk transfer.
Notes: As described within Chapter 2 Section 2.6, it is planned that all muds and cuttings generated during the drilling activities along with cement returns and cement unit washout will be recovered, contained on-board the jack-up rig and shipped to shore for disposal according to existing bp AGT Region waste management plan and procedures. As shown in Table 2.3 of Chapter 2, it is assumed all grey water, black water and galley waste generated onboard the jack-up rig will be contained and shipped to shore for disposal according to existing bp AGT Region waste management plan and procedures.		

Table 4.2 presents the Activities related to Project that have been assessed within this Chapter.

Table 4.2: "Assessed" BHEX01 Well Drilling Activities

ID	Activity	Event	Receptor
SW10	Jack-up rig power generation and support vessel engine emissions	Emissions to atmosphere (non GHG)	Atmosphere
SW11	Jack-up rig positioning / demobilisation	Underwater sound	Marine Environment
SW12	Drilling (excluding conductor driving)		
SW13	Use of Support Vessels		
SW14	Conductor driving		
SW15	VSP airgun operations		
SW16	Intake and discharge of cooling water	Water intake/ entrainment	
SW17	Discharge of treated black and grey water from support vessels and other discharges (drainage water and galley waste)	Discharge to sea	
SW18	Jack-up rig positioning	Seabed disturbance	

4.3 Impacts to the Atmosphere

4.3.1 Mitigation

Existing controls associated with non-greenhouse (GHG) emissions to atmosphere from jack-up rig power generation and support vessel operations include:

- Jack-up rig diesel generators and engines and support vessel engines will be maintained in accordance with written procedures based on the manufacturers' guidelines or applicable industry code or engineering standards to ensure efficient and reliable operation; and
- Planned use of good quality, low sulphur fuel.

4.3.2 Jack-up Rig Power Generation and Support Vessel Engine Emissions

Non GHG emissions to the atmosphere will arise from jack-up rig power generation and the use of support vessels. GHG emissions associated with the drilling of the BHEX01 well are discussed within Chapter 2 and Chapter 5 of this ESIA Addendum. This section focuses on the assessment of potential air quality impacts.

4.3.2.1 Event Magnitude

Description

As stated within Chapter 2, Section 2.2 of this ESIA Addendum, it is anticipated that the BHEX01 well will be drilled using a jack-up rig. A drilling programme of approximately three months is anticipated. The duration of the drilling programme may potentially be extended by one month if side-track drilling is required (refer to Chapter 2, Section 2.3 of this ESIA Addendum). Emissions will be generated through the use of the jack-up rig onboard engines and generators. In addition, as discussed in Chapter 2, Section 2.5.2 of this ESIA Addendum, emissions will result from the operation of support vessels required throughout the drilling programme.

Assessment

Jack-up Rig Power Generation

Air quality dispersion modelling undertaken for jack-up rig power generation is presented in Appendix 4A. The modelling focuses on NO_X (which comprises nitrogen 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 (sulphur oxides (SO_X), carbon monoxide (CO) and non-methane hydrocarbons) and its potential to impact upon human health and the environment.

Due to the short duration of the drilling programme, short term (1 hour) NO_2 concentrations were modelled to assess the contribution of the emissions associated with the rig in the context of the short term EU ambient air quality limit values for NO_2 of 200 micrograms per cubic metre (µg/m^3). 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.

As described in Chapter 4, Section 4.5.1 of the SWAP Exploration Drilling Project ESIA, once the jack-up rig is positioned at the drilling location, the hull will be raised out of the water. Based on the specifications of jack-up rigs with similar power output operating in the Caspian Sea, it was assumed the height of the emission stack will be approximately 28 m above the sea level (Ref.30).

The modelling results demonstrate that during routine drilling activities at the BHEX01 well location, the maximum contribution of NO_2 for the short-term 1 hour period at nearest onshore receptors (located in Bibiheybat and Baku City centre) are predicted to be less than 50 µg/m^3. With respect to PM_{10}[8] emissions; the maximum offshore contributions for the annual average and 24 hour averaging periods at receptors are predicted to be less than 0.01 µg/m^3 and 0.1 µg/m^3, respectively.

Considering the existing average short term background concentration of NO_2 in Baku is assumed to be 76 µg/m^3 (refer to Appendix 4A for further details), the modelling predicts that NO_2 air quality limit values will be met at all the modelled receptors (Bibiheybat and Baku city centre). For PM_{10}, the mean annual and short term background concentrations already exceed limit values. This can be attributed to the natural occurrence of particulate matter in the local environment reflecting the high particulate concentrations associated with dry arid region (for example soil particles becoming airborne through wind entrainment). The contribution of BHEX01 offshore drilling activities to increases in PM_{10} concentrations at onshore receptors is insignificant.

No discernible change in pollutant concentrations or exceedances of the short term air quality limit values relevant to human health are predicted at any distance from the jack-up rig due to the BHEX01 well drilling activities[9]. Based on efficient operation, regular maintenance, planned use of good quality, low sulphur fuel and previous experience, routine operation of the jack-up rig engines and generators will not result in plumes of visible particulates from the generator exhausts.

Support Vessel Engines

As stated within Chapter 2, Section 2.5.2 of this ESIA Addendum, vessels will be required throughout the drilling programme to supply consumables (e.g. drilling mud, diesel, chemicals, etc.) and return solid and liquid waste to shore for treatment and disposal. The number and type of vessels anticipated to be used are presented in Chapter 2: Table 2.1.

The total volume of emissions of the key pollutant species relevant to human health, NO_2, for all sources over the entire drilling programme is presented in Chapter 2: Table 2.8. For the period of drilling activities, it is predicted that NO_2 emissions from support vessels will total approximately 408 tonnes. This is approximately five times more than the NO_2 emissions associated with jack-up rig power

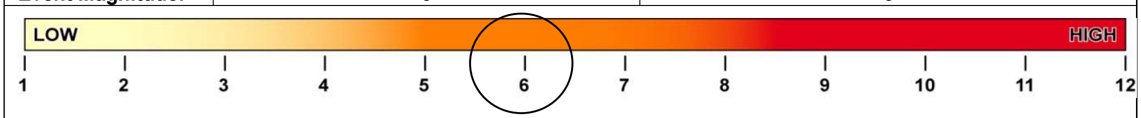
[8] Particulate matter (PM) particles, with diameters that are generally 10 micrometres and smaller.
[9] Historically in Azerbaijan ambient concentrations of NO_2, SO_2, CO and PM_{10} have also been assessed against specific 24 hour and 1 hour limit values. These limit values were not derived using the same health based criteria as the IFC, WHO and EU guideline values and the limit values derived are not widely recognised. However, Appendix 4A includes an assessment of expected air quality concentrations against these limit values for completeness. The modelling demonstrated that none of these limit values would be exceeded during BHEX01 well drilling activities.

generation during drilling activities; however, emissions from vessel movements will occur across a relatively large geographic area and over the entire drilling programme. They are therefore expected to disperse rapidly and are not expected to result in measurable increases in NO_2 concentrations at onshore receptors.

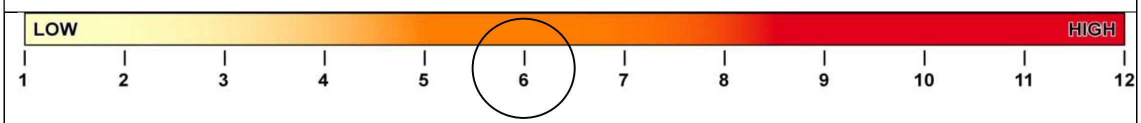
Based on efficient operation, regular maintenance, planned use of good quality, low sulphur fuel and previous experience, routine operation of the support vessels should not result in plumes of visible particulates from the vessel engine exhausts. Table 4.3 presents the justification for assigning a score of 6 for jack-up rig power generation and a score of 6 for support vessels emissions, which represents a Medium Event Magnitude.

Table 4.3: Event Magnitude

Event Parameter	Jack-up Rig Power Generation	Support Vessel Engines
Extent/Scale	1	1
Frequency	1	2
Duration	3	2
Intensity	1	1
Event Magnitude:	**6**	**6**



Jack-up Rig Power Generation



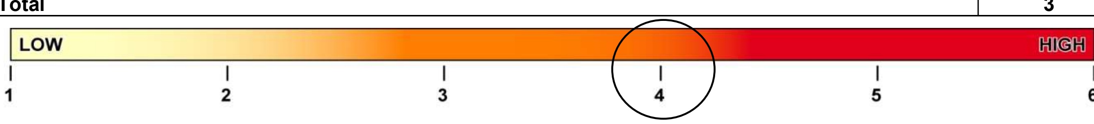
Support Vessel Engines

4.3.2.2 Receptor Sensitivity

Table 4.4 presents the justification for assigning a score of 3 to human receptors, which represents Medium Receptor Sensitivity.

Table 4.4: Receptor Sensitivity

Parameter	Explanation	Rating
Presence	There are a number of receptors located within 5 km of the BHEX01 well location.	3
Resilience	Changes in air quality onshore are expected to result in increases in short term concentrations which will be indiscernible at receptors. No exceedances of short term limits are anticipated.	1
Total		**3**



4.3.2.3 Impact Significance

Table 4.5 summarises impacts on air quality associated with the BHEX01 well drilling activities.

Table 4.5: Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Jack-up Power Generation	Medium	Medium	**Moderate Negative**
Support Vessel Engines	Medium	Medium	**Moderate Negative**

Monitoring and reporting requirements associated with emissions to the atmosphere during jack-up rig drilling activities include:

- Jack-up rig diesel usage will be recorded on a daily basis;
- Environmental management system inspections of drilling operations including jack-up rig drilling will be undertaken periodically; and
- The following will be provided to the MENR within the Environmental Report:
  - Volume of fuel used by the jack-up rig (recorded daily in tonnes and reported monthly); and
  - Estimated volumes of emissions generated as a result of fuel used (calculated using emission factors).

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.

4.4 Impacts to the Marine Environment

4.4.1 Mitigation

Existing control measures associated with underwater sound from jack-up rig drilling, conductor driving, vessels and from vertical seismic profiling (VSP) activities include:

- Vessels will not intentionally approach seals for the purposes of casual (recreational) marine mammal viewing which may result in disturbance; and
- Support vessels are subject to periodical performance review, which includes environmental performance. Corrective actions will be undertaken to address any performance gaps.

Existing controls related to discharges to sea from the jack-up rig include:

Rig Black and Grey Water:

- Grey and black water will be contained and shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.
- Sewage sludge will be shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.

Rig Galley Waste:

- Galley waste will be contained and shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.

Rig Deck Drainage:

- Non oily drainage (deck drainage and wash water) may be discharged to sea as long as no visible sheen is observable; and
- Rig floor runoff, including WBM spills, collected via rig floor drains will be recycled to the rig mud system with no planned discharge of drill cuttings or drilling fluids.

Existing controls related to support/supply vessels discharges include:

Vessel Black and Grey Water:

- Grey water will either be sent to the vessel sewage treatment plant with the black water or discharged directly to sea without treatment as long as no floating matter or visible sheen is observable.
- Under routine conditions black water will be treated within the vessel sewage treatment plant to MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards. No chlorination of the effluent will be required under routine conditions, however when chlorine is used for disinfectant purposes, it is planned to maintain the concentration of residual chlorine

in the effluent below 0.5mg/l and discharge to sea. In the event it is not practicable to achieve this concentration, the effluent will be contained and shipped to shore.
- When vessels' sewage treatment system is not available, black water will be contained and shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.
- Sewage sludge will be shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.

Vessel Galley Waste:

- Depending on the availability of the vessel system, galley food waste will either be:
    - Sent to 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 prior to discharge[10]; or
    - Contained and shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.

Vessel Deck Drainage:

- Oily and non-oily drainage and wash water will be segregated. Non oily drainage (deck drainage and wash water) may be discharged to sea as long as no visible sheen is observable.
- Oily water will be shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.

4.4.2 Underwater Sound

Chapter 6, Section 6.4.2 of the SWAP Exploration Drilling Project ESIA describes the potential impact from underwater sound associated with the following activities:

- Jack-up rig positioning;
- Support vessel movements;
- Drilling (excluding conductor driving);
- Conductor driving; and
- VSP airgun operations.

As described in the SWAP Exploration Drilling Project ESIA, Chapter 6, Section 6.4.2: the propagation of sound from the above activities was calculated using a simplified geometric spreading model to understand the magnitude of potential impacts of underwater sound to the biological receptors in the marine environment (seals and fish). The underwater sound modelling undertaken for the NKX01 well location presented in the SWAP Exploration Drilling Project ESIA is considered applicable to the BHEX01 well location given that both water depths are shallow, and the Project activities are very similar. As such this assessment relies on the magnitude of impacts described in the SWAP Exploration Drilling Project ESIA and following section presents the impact assessment with reference to the receptor sensitivity and baseline conditions specific to the BHEX01 well location.

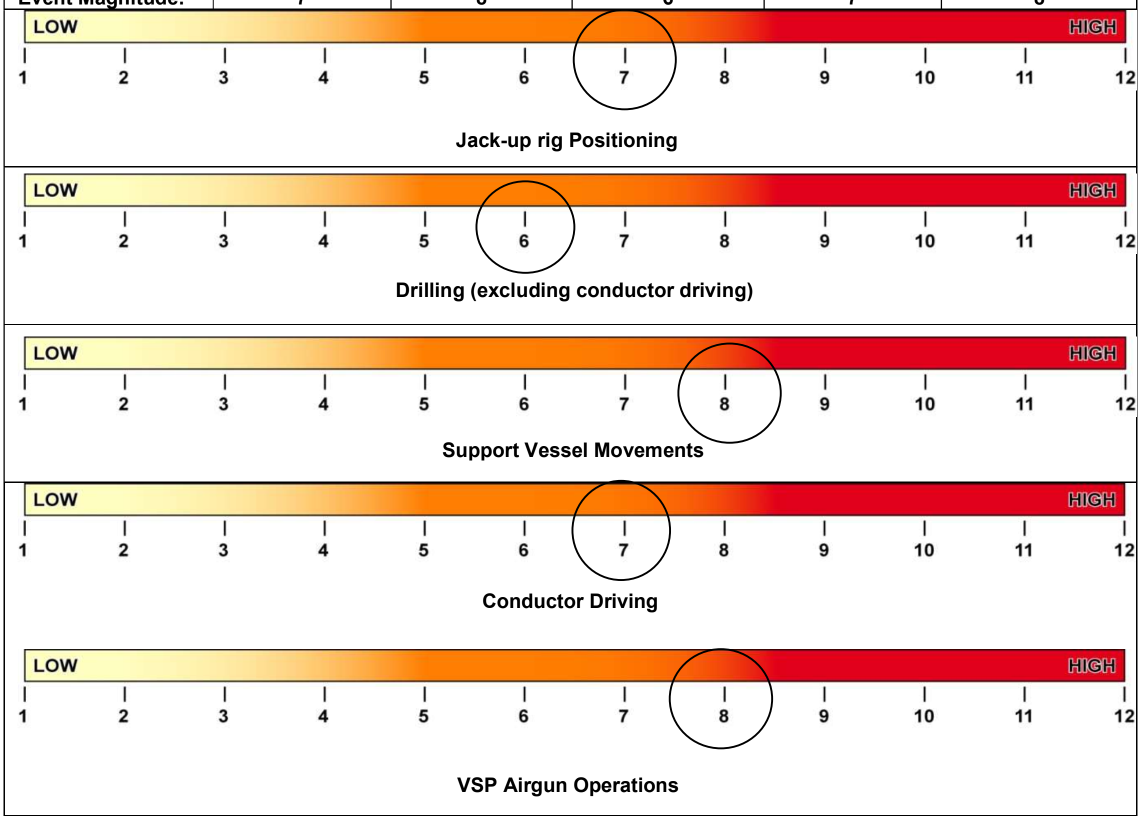
4.4.2.1 Event Magnitude

Chapter 6, Section 6.4.2.1 of the SWAP Exploration Drilling Project ESIA summarises the Event Magnitude for underwater sound; the information is replicated in Table 4.6.

[10] Designed to produce a slurry of food particles and water that washes easily through the required 25 mm screen

Table 4.6: Event Magnitude

Event Parameter	Jack-up Rig Positioning	Support Vessel Movements	Drilling (excluding conductor driving)	Conductor Driving	VSP Airgun Operations
Extent/Scale	3	3	1	3	3
Frequency	1	1	1	1	1
Duration	2	3	3	1	1
Intensity	1	1	1	2	3
Event Magnitude:	**7**	**8**	**6**	**7**	**8**



4.4.2.2 Receptor Sensitivity

Seals

Based on the published scientific data as described in the SWAP Exploration Drilling Project ESIA, observations and knowledge from local National experts, it is unlikely that the Caspian seal will be present in the vicinity of the BHEX01 well location. The migration routes and feeding grounds are located further offshore and in the region of the Absheron Peninsula. This is mainly due to lack of availability of food resources as their main prey are not abundant in Baku Bay area where the BHEX01 well is located. Furthermore, seals will tend to avoid the Baku Bay area due to anthropogenic disturbance.

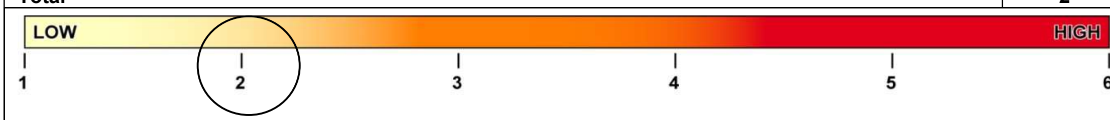
Fish

A review of drop down video survey footage taken at the BHEX01 well location recorded the presence of individual sandsmelt, gobies and stickleback. Other species that may be found at the BHEX01 well location, based on water depth include pipefish and some shad species. Considering the habitat type, quality and location, it is not expected that sturgeon are present. It is very unlikely that migratory species will be present in the waters surrounding the BHEX01 well location as these species usually migrate through deeper waters. Baku Bay does not have particular value for the fish present which occur widely across the Caspian Sea and none of the fish expected to be present are expected to be rare, unique or endangered species.

Based on data collected in country from observations/interviews, reported shipping activity data from vessels Automatic Identification System (AIS) and mapping of shipping lanes, fish will be habituated to existing underwater sound from vessels. Table 4.7 presents the justification for assigning a score of 2, which represents Low Receptor Sensitivity.

Table 4.7: Receptor Sensitivity (Seals and Fish)

Parameter	Explanation	Rating
Presence	**Fish:** It is unlikely that hearing specialist or endangered fish species will be present in the vicinity of the proposed BHEX01 well location during the drilling activities. Present species are expected to comprise resident species which are widely distributed and do not use this area exclusively. **Seals:** Due to the level of anthropogenic disturbance, seals are not expected to be present in the vicinity of the BHEX01 well location at any time of the year.	1
Resilience	**Fish:** Individual fish are at very low risk of injury or significant behavioural disturbance and therefore the risk to populations is considered to be even lower and ecological functionality will be maintained. **Seals:** Risk of injury or significant behavioural disturbance is expected to be very low or negligible given that seals are not expected to be present in the vicinity of the BHEX01 well location. The risk to the overall population is considered to be very low and ecological functionality is expected to be maintained.	1
Total		**2**



4.4.2.3 Impact Significance

Table 4.8 summarises underwater sound impacts to marine biological receptors (seals and fish) associated with jack-up rig positioning, conductor driving, drilling, vessel movements and VSP operations.

Table 4.8: Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Jack-up rig positioning	Medium	(Biological/Ecological) Low	**Minor Negative**
Drilling (excluding conductor driving)	Medium	(Biological/Ecological) Low	**Minor Negative**
Use of Support vessels	Medium	(Biological/Ecological) Low	**Minor Negative**
Conductor Driving	Medium	(Biological/Ecological) Low	**Minor Negative**
VSP airgun operations	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 and no additional mitigation is required.

4.4.3 Cooling Water Intake and Discharge

4.4.3.1 Event Magnitude

Description

The jack-up rig that will be used for the BHEX01 well will be designed to draw seawater for indirect cooling via an intake and discharge the seawater at a rate of up to 45 cubic metres per hour (m^3/hr) via a flexible hose located 5 m below sea level and at a maximum temperature of approximately 31°C (during summer) and 15°C (during winter).

It is anticipated that the seawater indirect cooling system will be protected by a standard anodic biofouling and corrosion control system. These systems typically result in very small concentrations of metal ions (e.g. copper, iron, aluminium) being introduced into the seawater at levels significantly below predicted no effect concentrations.

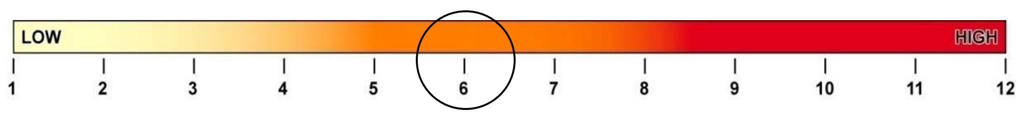
Assessment

The seawater intake depth is relatively shallow and as such it is anticipated that the lifted seawater will be at the same ambient temperature as the receiving water at all times of the year. The jack-up rig seawater intake velocity will be low and screens are installed to prevent fish entering the seawater system. Modelling of the cooling water discharge (refer to Appendix 4B) shows that the temperature difference between the discharge plume and ambient conditions returned to zero within 100 m of the discharge location with differences of only 0.2-0.5°C occurring within the first few metres of the discharge point for both summer and winter conditions. Therefore, it is concluded that the 3°C criterion is not exceeded at the edge of a scientifically established mixing zone under any conditions. The modelling results also indicates that cooling water discharge plume will not reach the sea surface, however due to the very shallow water and the depth of discharge the plume is predicted to reach the seabed and be in contact with the benthos for a very short period, although the change in temperature is very small.

Table 4.9 presents the justification for assigning a score of 6, which represents a Medium Event Magnitude.

Table 4.9: Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	Affects an area less than 1-2m from the source.	1
Frequency	Once.	1
Duration	Discharge will occur continuously through drilling activities.	3
Intensity	Low intensity.	1
Total		**6**



4.4.3.2 Receptor Sensitivity

While the intake will be fitted with a screen prevent fish entering the seawater system, plankton will, however, be entrained due to their small size. The area and volume of water within which any potentially harmful exposure might occur is limited to within the first few metres of the intake and hence impacts are expected to be insignificant to the water column. With regard to the cooling discharge, the modelling has indicated that 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 (although the probability of encounter with the plume is very low given the plume dimensions and the project activity).

For all plankton, interaction with the plume will depend on entrainment from the surrounding water and the process will ensure that individual plankton organisms do not remain in the discharge plume for more than a few tens of seconds. Any benthic invertebrates, including the bivalve *Dreissena caspia* which is considered to be a significant feature as it is an International Union for Conservation of Nature (IUCN) Red List critically endangered species, located in the immediate vicinity of the discharge (first few metres) may be in contact with the thermal plume. However, the change in temperature is very small and the benthos is unlikely to be affected.

Table 4.10 presents the justification for assigning a score of 2 for fish and plankton, which represents Low Receptor Sensitivity and Table 4.11 presents justification for assigning a score of 4 for benthic communities.

Table 4.10: Receptor Sensitivity (Fish and Plankton)

Parameter	Explanation	Rating
Presence	No significant presence of rare, unique or endangered species	1
Resilience	Exposure is negligible, so resilience is, in effect, high.	1
Total		**2**

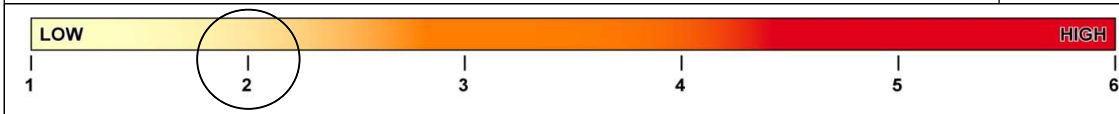
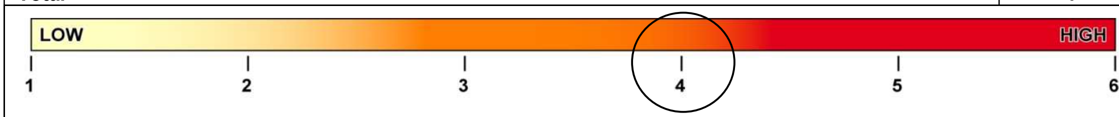


Table 4.11: Receptor Sensitivity (Benthic Communities)

Parameter	Explanation	Rating
Presence	Species present includes the critically endangered *Dreissena caspia,* which is in low abundance. Species are assessed at the community level only.	3
Resilience	Exposure is negligible, so resilience is, in effect, high.	1
Total		**4**



4.4.3.3 Impact Significance

Table 4.12 summarises the impact of cooling water discharges to sea on fish, zooplankton and phytoplankton and benthic communities.

Table 4.12: Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Jack-up Rig Cooling Water Intake and Discharge to Sea	Medium	Low (Fish)	**Minor Negative**
		Low (Phytoplankton)	**Minor Negative**
		Low (Zooplankton)	**Minor Negative**
		Medium (Benthic communities)	**Moderate Negative**

The assessment has demonstrated that Minor Negative impacts to fish and plankton and Moderate Negative impacts to the benthic communicates are predicted from cooling water intake and discharge. Although no studies have been undertaken on *Dreissena caspia* to understand their tolerance, *Dreissena* spp. have shown to tolerate extreme temperatures up to 39ºC for extended periods of time (Ref.31). Given the thermal plume from the cooling water discharge will not exceed a temperature increase of more than 0.5ºC, no additional mitigation beyond existing control measures is deemed to be necessary.

4.4.4 Other Discharges to Sea

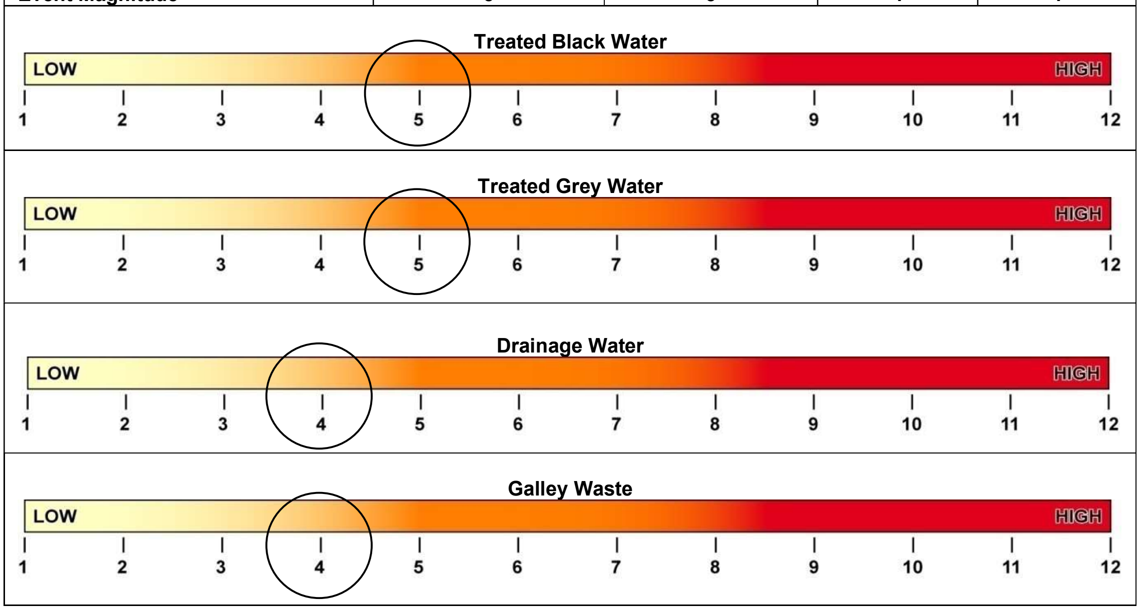
Chapter 6, Section 6.4.4 of the SWAP Exploration Drilling Project ESIA describes the potential impacts associated with the other discharges to sea. There is no change in the Event Magnitude described in the ESIA, however the following section presents the impact assessment with reference to the receptor sensitivity and baseline conditions at BHEX01 well location.

4.4.4.1 Event Magnitude

Chapter 6, Section 6.4.4.1 of the SWAP Exploration Drilling Project ESIA summarises the Event Magnitude for other marine discharges to sea; the information is replicated in Table 4.13.

Table 4.13: Event Magnitude

Event Parameter/Discharge	Treated Black Water	Treated Grey Water	Drainage	Galley Waste
Scale	1	1	1	1
Frequency	1	1	1	1
Duration	2	2	1	1
Intensity	1	1	1	1
Event Magnitude	**5**	**5**	**4**	**4**



4.4.4.2 Receptor Sensitivity

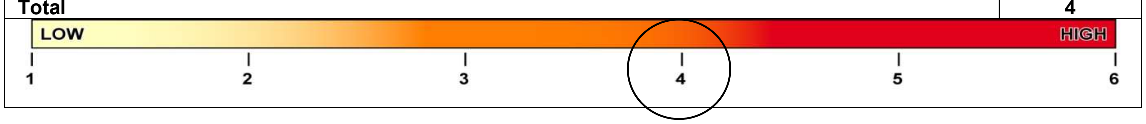
As described within Section 3.4.3.1 of this ESIA Addendum, the environmental baseline survey (EBS) conducted at the BHEX01 well location identified the presence of the bivalve *Dreissena caspia*. Although *Dreissena caspia* was present at 33 of 38 BHEX01 stations it only accounted for approximately 2% of total abundance.

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 4.15 present the justification for assigning a score of 4, which represents Medium Receptor Sensitivity.

Table 4.14: Receptor Sensitivity (All Receptors)

Parameter	Explanation	Rating
Presence	Species present includes the critically endangered *Dreissena caspia,* which is in low abundance.	3
Resilience	The extremely low level of exposure is equivalent to high resilience.	1
Total		**4**



4.4.4.3 Impact Significance

Table 4.15 summarises the impact of other discharges to sensitive present marine receptors including fish, zooplankton, phytoplankton and benthic invertebrates.

Table 4.15: Impact Significance

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Other Discharges to Sea: **Treated Black Water**	Medium	Medium	**Moderate Negative**
Other Discharges to Sea: **Grey Water**	Medium	Medium	**Moderate Negative**
Other Discharges to Sea: **Drainage Water**	Low	Medium	**Minor Negative**
Other Discharges to Sea: **Galley Waste**	Low	Medium	**Minor Negative**

Monitoring and reporting requirements associated with discharges from support vessels of black and grey water for the duration of the BHEX01 well will be undertaken as described in Section 6.4.4.3 of Chapter 6 of the SWAP Exploration Drilling Project ESIA.

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.

4.4.5 Seabed Disturbance

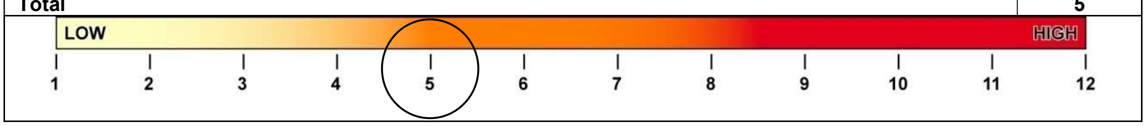
Chapter 6, Section 6.4.5 of the SWAP Exploration Drilling Project ESIA describes the potential impact associated with the positioning of the jack-up rig on the seabed. There is no change in the Event Magnitude described in the ESIA, however the following section presents the impact assessment with reference to the receptor sensitivity and baseline conditions specific to the BHEX01 well location.

4.4.5.1 Event Magnitude

Chapter 6, Section 6.4.5.1 of the SWAP Exploration Drilling Project ESIA summarises the Event Magnitude for seabed disturbance; the information is replicated in Table 4.16.

Table 4.16: Event Magnitude

Parameter	Explanation	Rating
Extent/Scale	The area affected by the disturbance is anticipated to be relatively small e.g. an area of less than 500m^2 around the Project location.	1
Frequency	Once.	1
Duration	The spud cans will be in position for a period of 3-4 months.	2
Intensity	There will be no discharges associated with these activities, the seabed disturbance is expected to be of low and very limited nature, therefore intensity is anticipated to be low.	1
Total		**5**



4.4.5.2 Receptor Sensitivity

The benthic community across the southern Caspian is dominated by native amphipod, gastropod, polychaete and oligochaete species, most of which have the potential to reproduce several times a year. In areas of high disturbance (with mobile sediments or elevated presence of contaminants for example), the benthic communities are dominated by species which are particularly resilient to local conditions, particularly polychaetes and oligochaetes. Given the known presence of contamination in the area, benthic invertebrates may take up toxicants from resuspended contaminated sediments released because of seabed disturbance. Sessile invertebrate species are expected to be more susceptible to temporary reductions in water / sediment quality than motile species as they are unable to relocate for the duration of any impact. These impacts are however expected to be only temporary and localised to the BHEX01 well location.

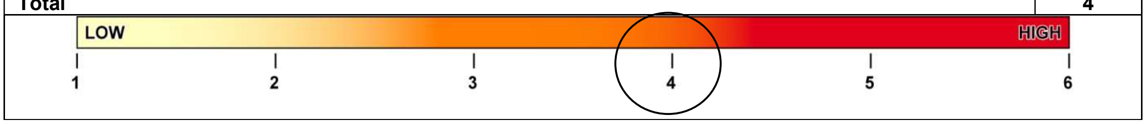
As stated in Section 4.4.5.1 above the 2019 EBS found that all species found in this area were native species except for the *Dreissena caspia*. Suspension-feeding bivalves, such as *D. caspia*, will have some capacity to adapt to changes in food quantity and quality, as these naturally vary seasonally and spatially in aquatic systems (Ref.32). In conditions of high turbidity inorganic particles will reduce food quality, foul gill surfaces, and interfere with filtration, ingestion, and gas exchange across gill membranes which will increase the bioenergetic cost of suspension feeding (Ref.33). However, these effects are only likely to result in changes to the health of animals when increased turbidity is persistent and long-term. For example, in natural turbidity experiments with the zebra and the quagga mussels (*Dreissena polymorpha* and *Dreissena rostriformis bugensis* respectively) an almost six month increase in turbidity had only a small negative influence on the shell growth of both species (Ref.34). Experiments with similar bivalve species, like the common mussel, also show high tolerance to increases in suspended sediment over days and weeks (Ref.35). Any increase in turbidity due to presence of vessels around the drilling area, particularly support vessels for the jack -up barge, will be very short term (less than 8 hours) and unlikely to much more significant than the periodic increases in turbidity caused by storm and wave action in such shallow waters. The effect of increased particulate matter is expected to minimal and recovery rapid.

While the effect may be that a small proportion of organisms within the benthic environment may be buried too deeply to recover to a position near the sediment surface, the majority of organisms will be able to re-establish themselves once the jack up rig has demobilised from the location.

Table 4.17 presents the justification for assigning a score of 4, which represents a Medium Receptor Sensitivity.

Table 4.17: Receptor Sensitivity

Parameter	Explanation	Rating
Resilience	The benthic environment is considered to be relatively tolerant to disturbance with evidence showing that invertebrates, which are generally short-lived, reproduce rapidly and re-establish following disturbance.	1
Presence	One critically endangered species present (*Dreissena caspia*) in low abundance. Species are assessed at the community level only.	3
Total		**4**



4.4.5.3 Impact Significance

Table 4.18 summarises impacts to benthic fauna associated with the temporary disturbance to seabed, based on the impact significance criteria presented in Chapter 3 of the SWAP Exploration Drilling Project ESIA.

Table 4.18: Impact Significance (Benthic Communities)

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Seabed disturbance	Medium	Benthic Communities (Medium)	**Moderate Negative**

As described above, the level of impact is predicted to be very limited in duration to benthic communities and *D. caspia* is expected to tolerate the level of seabed disturbance from positioning of the jack up rig. Therefore it is considered that impacts are minimised as far as practicable and no discernible impact to the marine environment due to seabed disturbance will occur.

4.5 Summary of the Project Activities Residual Environmental Impacts

With regard to the Project activities, it has been concluded that impacts are minimised as far as practicable and necessary through the implementation of the existing control measures. No additional mitigation measures are required.

Table 4.19 summaries the residual impacts associated with the Project.

Table 4.19: Summary of Residual Environmental Impacts Associated with the BHEX01 Well Drilling Activities

	Event/Activity	Significance Rating		
		Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Jack-up Power Generation	Medium	Medium	Moderate Negative
	Support Vessel Engines	Medium	Medium	Moderate Negative
Marine Environment	Jack-up Rig Positioning / Demobilisation	Medium	Low	Minor Negative
	Drilling (excluding conductor driving)	Medium	Low	Minor Negative
	Use of Support vessel	Medium	Low	Minor Negative
	Conductor Driving	Medium	Low	Minor Negative
	VSP Airgun Operations	Medium	Low	Minor Negative
	Jack-up Rig Cooling Water Intake and Discharge to Sea	Medium	Low	Minor Negative (fish and plankton)
	Jack-up Rig Cooling Water Intake and Discharge to Sea	Medium	Medium	Moderate Negative (benthic communities)
	Drainage Water Discharge	Low	Medium	Minor Negative
	Support Vessel Treated Black Water Discharge	Medium	Medium	Moderate Negative
	Support Vessel Grey Water Discharge	Medium	Medium	Moderate Negative
	Support Vessel Galley Waste Discharge	Low	Medium	Minor Negative
	Seabed Disturbance	Medium	Medium	Moderate Negative

5 Cumulative and Transboundary Impacts and Accidental Events

5.1 Introduction

This Chapter of the ESIA Addendum discusses:

- Cumulative and Transboundary Impacts; and
- Accidental Events that could potentially occur during the Project activities and the control, mitigation and response measures designed to minimise event likelihood and impact.

A detailed assessment of Project environmental and socio-economic impacts, based on expected activities and events, is presented in Chapter 4 of this Addendum.

5.2 Cumulative and Transboundary Impacts

Cumulative impacts are discussed in Chapter 3 of the SWAP Exploration Drilling Project ESIA (Ref.1) and can arise from:

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

Transboundary impacts are impacts that occur outside the jurisdictional borders of a project's host country.

5.2.1 Approach to the Cumulative Assessment

As described in Chapter 1: Introduction it is planned to drill three wells in the SWAP Contract Area; one well in each of the three Prospective Areas. The approach taken to assessing the cumulative impacts between the three wells focuses on assessing the potential temporal and geographic overlap between environmental impacts based on the current schedule (refer to Chapter 2: Section 2.2) and the results of modelling assessments demonstrating the expected geographic extent of the impacts (refer to Chapter 4).

The assessment takes into account each activity and the existing controls and additional mitigation measures identified to minimise and manage impacts. An analysis of the potential for these impacts to overlap and result in additive or synergistic effects within the marine environment and social environment is presented in Sections 5.2.3 below with potential cumulative and transboundary impacts associated with emissions to atmosphere discussed in Section 5.2.4.

The potential for cumulative impacts with other planned projects[11] has been determined based on a review of available information and taking into account geographic and temporal scope of the individual Project impacts and hence the potential to result in cumulative impacts in combination with the Project impacts.

5.2.2 Cumulative Impact between Separate Project Impacts

Due to the nature of the predicted residual impacts from the Project, the potential for individual Project activities to interact synergistically or in-combination and result in cumulative impacts on the receiving environment is considered very unlikely.

[11] The cumulative assessment does not take into projects or facilities that are currently operational as the effects of these projects are captured within the existing baseline against which the BHEX01 Project impacts have been assessed and is focused on other proposed bp projects within the vicinity of the proposed BHEX01 Project.

5.2.3 Cumulative Impact with Other Projects

In general, potential Project impacts are expected to be both of a short duration and concentrated to mostly within a few hundred metres to several kilometres of the BHEX01 well location. Due to the localised nature of the Project's impacts and the absence of other development projects in the area, no cumulative or synergistic impacts are expected.

5.2.4 Transboundary Impacts Associated with Greenhouse Gas Atmospheric Emissions

Transboundary impacts are those that may affect countries other than the country in which a project will be developed. The potential transboundary impacts associated with the Project activities are considered to be limited to greenhouse gas (GHG) emissions contributing to the global greenhouse effect.

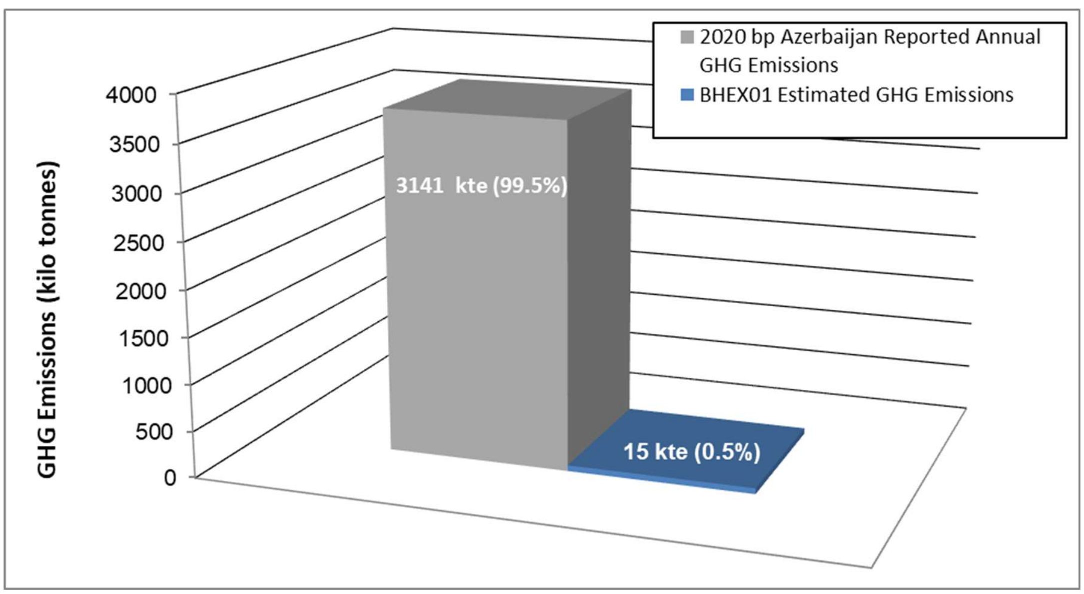
5.2.4.1 Greenhouse Gas Atmospheric Emissions

The estimated volume of GHG emissions (carbon dioxide, methane, nitrous oxide) generated by defined Project activities are presented in Chapter 2: Table 2.8 of this ESIA Addendum.

Figure 5.1 presents the estimated volume of Project activities total GHG emissions compared with the annual bp Azerbaijan operation's emissions volumes reported in 2020 (Ref.36). Figure 5.1 demonstrates that the estimated Project GHG emissions represent approximately 0.5% of the annual operational GHG emissions from bp's upstream activities in Azerbaijan based on GHG emissions data from 2020.

The most recently published (in 2018) GHG emissions data for Azerbaijan estimated a total of 61842 kilotonnes (ktonnes) of GHG emissions were emitted in 2013; 80% of which was estimated to be generated by the energy sector (Ref.37). As a proportion, the estimated GHG emissions for the Project activities are expected to contribute approximately 0.024% to the national total GHG emissions based on the 2013 data.

Figure 5.1: Estimated Project Exploration Drilling Total GHG Emissions Compared to Reported 2020 bp Azerbaijan Annual GHG Emissions



5.3 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. High operational performance and compliance with good industry practices will be maintained at all times by bp and their contractors. However, as with most projects of this nature, a low probability of an accidental event does exist.

The SWAP Exploration Drilling Project ESIA described and assessed the impacts associated with potential accidental events associated with drilling the NKX01 well. Potential accidental events that may result in potentially significant environmental impacts during drilling of the BHEX01 well have been identified and include:

- Vessel collision with other marine users;
- Release of chemicals/ waste from the Project vessels; and
- Hydrocarbon spills (e.g. small spills resulting from refuelling, large spill of marine diesel resulting from a vessel collision or well blowout of crude oil).

Drilling muds will be used throughout the drilling activities. The locations on the jack-up rig where the equipment and pipework associated with drilling muds are located are within areas equipped with appropriate containment. Prior to mobilisation, the jack-up rig will undergo a containment audit to document and confirm the control measures in place to prevent accidental spills from any potential equipment failure, tank overflows, etc. to sea. Any deficiencies will be identified and any additional measures required will be addressed and implemented prior to acceptance.

The likelihood of a spill associated with a riser failure is considered extremely unlikely. The rig to be used for drilling the BHEX01 well will be a stationary jack-up rig. This, along with the shallow water depth at the drilling location, limits the stress on the riser meaning failure is highly unlikely.

5.3.1 Vessel Collision

As described in Chapter 3: Section 3.6.3 of this ESIA Addendum the BHEX01 well is located at the entrance to Baku Bay. Currently, the marine passenger terminal in Baku only serves six ships, used primarily for oil and gas purposes by bp and SOCAR. All vessels entering and leaving Baku Bay are regulated by the State Maritime Administration of the Republic of Azerbaijan, which operate a vessel traffic control system. There are no main shipping routes within Baku Bay or within the vicinity of the Project location. A range of maritime and navigation safety measures outlined in Chapter 4: Table 4.1 of this ESIA Addendum are expected to minimise the risk of collision. The likelihood of a collision between vessels is considered to be very low given the preventative measures in place. However, in the event of a collision there is the potential for significant impacts on other marine users and infrastructure depending on the scale and nature of the collision.

5.3.2 Release of Chemicals / Waste

There will be chemicals and drilling fluids (e.g. drilling mud chemicals) prepared on shore and supplied to the jack-up rig via certified marine hose connections from the supply vessels to support the drilling operation. In addition, chemicals for cleaning and maintenance purposes, e.g. cleaning fluids, will be used on board the vessels throughout the drilling programme. All chemicals on the vessels will be labelled and stored appropriately in areas with secondary containment. Waste generated during the Project will be managed in accordance with the existing bp Azerbaijan Georgia Turkey (AGT) Region management plans and procedures.

The likelihood of an accidental release of chemicals or waste to the marine environment is considered to be very low given the control and mitigation measures are implemented as set out in Chapter 4. In the unlikely event of loss of containment and release of hazardous substances overboard, the bp AGT Region spill reporting procedures described within Section 5.3.4.3 of the SWAP Exploration Drilling Project ESIA will be followed.

5.3.3 Hydrocarbon Spills and Releases

Potential accidental discharges of hydrocarbons that may lead to pollution of the marine environment during the BHEX01 drilling programme include:

- Spills during vessel collision, fuel tank failure, fire or explosion; and
- Well blowout of crude oil following loss of well control.

The resulting potential discharges can be broadly categorised as follows:

- Spill of diesel from the jack-up rig or support vessels; and
- Major spill of crude oil from a well blowout.

Accidental release of drilling mud from the jack-up rig has not been modelled as well blow-out discharges and accidental diesel spills from vessels are considered the worst case scenario spills / discharges. Further to this, the accidental spill of mud is highly unlikely to occur given that the jack-up rig will undergo a containment audit prior to acceptance that will identify any higher risk areas and document the control measures in place to prevent accidental spills from equipment failure, tank overflows, etc.

5.3.3.1 Spill of Marine Diesel

As described in Section 5.3.1 of this ESIA Addendum the likelihood of a vessel collision occurring during the BHEX01 drilling programme is considered to be very low. Analysis of water transport accident statistics by the International Association of Oil & Gas Producers (IOGP) (Ref.38) shows that ship to ship collisions represent 12% of total ship losses and that the likelihood of this occurring is extremely low. The likelihood that such an incident would result in a loss of the vessel's fuel inventory is even lower, as a high-energy collision would be required to damage a vessel to such an extent that fuel tank integrity is compromised releasing its content into the sea.

Fuel on vessels is typically stored in a series of small tanks which are double bottomed and connected by valves and it is unlikely that contents of all the tanks would be lost simultaneously in the event of a collision. The jack-up rig will be equipped with diesel tanks to provide fuel for on board use. The largest volume of diesel stored on either the jack-up rig or support vessels used during the BHEX01 drilling programme will be $600m^3$. In the unlikely event of a release of the full diesel tank inventory the diesel will spill overboard. A description of the vessel diesel tank spill scenario and the modelling undertaken to predict the potential impact of the spill is presented in Section 5.3.3.6 of this ESIA Addendum.

5.3.3.2 Well Blowout Scenario

A well blowout, as a consequence of loss of well control, is an uncontrolled influx of liquids or gas from the formation into the wellbore which may result in an uncontrolled release into the environment. This influx can either be oil, gas, water or a combination of liquids and gas. Well blowout is considered to be the worst case scenario for oil spills.

Well blowouts are very low probability but high consequence events, which occur where all primary and secondary control failures occur together. A review of wells drilled in the period 2000-2015 in regulated countries across the world found that the probability of a well blowout that would result in a spill of 500 barrels or more of oil is 1 blowout per 3985 wells drilled (0.025% per well drilled) for exploration wells and 1 blowout per 14,444 wells drilled (0.007% per well drilled) for development wells, respectively (Ref.39). Similarly, a review conducted by the IOGP found a blowout occurs in approximately 1 out of every 4000 exploration wells operated at North Sea standards and 1 out of every 588 exploration wells operated at non-North Sea standards (Ref.40). A description of a potential blowout scenario of the Project exploration well and the modelling undertaken to predict the potential impacts of the blowout is presented in Section 5.3.3.6.

5.3.3.3 Fate of Hydrocarbons in the Marine Environment

The key processes that govern the fate of hydrocarbons at sea (e.g. evaporation, dissolution, dispersion, emulsification, sedimentation, photo-oxidation and bio-degradation) are described in detail in Section 7.3.3.3 of the SWAP Exploration Drilling Project ESIA and are not repeated in this Addendum.

5.3.3.4 BHEX01 Crude Oil Properties

Since oil has yet to be produced from the BHEX01 target reservoir location, no crude oil has been available for characterisation. Based on the anticipated physical-chemical properties of the oil targeted at the BHEX01 well an analogous oil (Norne Blend 2010) was selected from Stiftelsen for Industriell og Teknisk Forskning (SINTEF)'s Oil Spill Contingency and Response (OSCAR) modelling database to most closely represent the anticipated oil characteristics of the BHEX01 well. Table 5.1 below presents the predicted main oil properties of the BHEX01 well oil.

Table 5.1: Analogous Oil Properties for BHEX01 Well

Property	bp provided value (analogous oil selected from OSCAR database)	Notes
Name of oil type	Bibiheybat (Norne Blend 2010, 13°C)	Norne blend is a waxy oil analysed in 2010 by SINTEF for which good laboratory data is provided. 13°C means that many tests were conducted at 13°C conditions, which is close to ambient sea surface temperature.
Specific gravity	0.868 – 0.889 (0.868)	Norne blend is in the correct range.
Pour Point	20°C (12°C)	Pour point is reasonably close (i.e. relatively high for a crude oil) and will move between liquid and gel between summer and winter. The Norne blend may spread further, mix more and be less persistent on average.
Viscosity	14.8 – 15.1 centipoise (53 centipoise at 13°C)	It is possible that Bibiheybat oil is more viscous than Norne and therefore could disperse more slowly.
Asphaltene content	- (6%)	The Norne blend oil is likely to form an emulsion. Although Bibiheybat asphaltene content is unknown, most oils of this density will form emulsions.
Wax content	4.2% (11.7%)	Norne blend has a higher wax content and therefore is probably more persistent.

5.3.3.5 Oil Spill Modelling

To assess the potential impact of a hydrocarbon release during the BHEX01 drilling programme (i.e. diesel inventory loss from a vessel and a well blowout), modelling was undertaken using SINTEF's OSCAR modelling software (version 11.0). The locations of the spill events considered in the modelling study are shown in Figure 5.2. A summary of the diesel spill and crude oil blowout scenarios modelled is shown in Table 5.2.

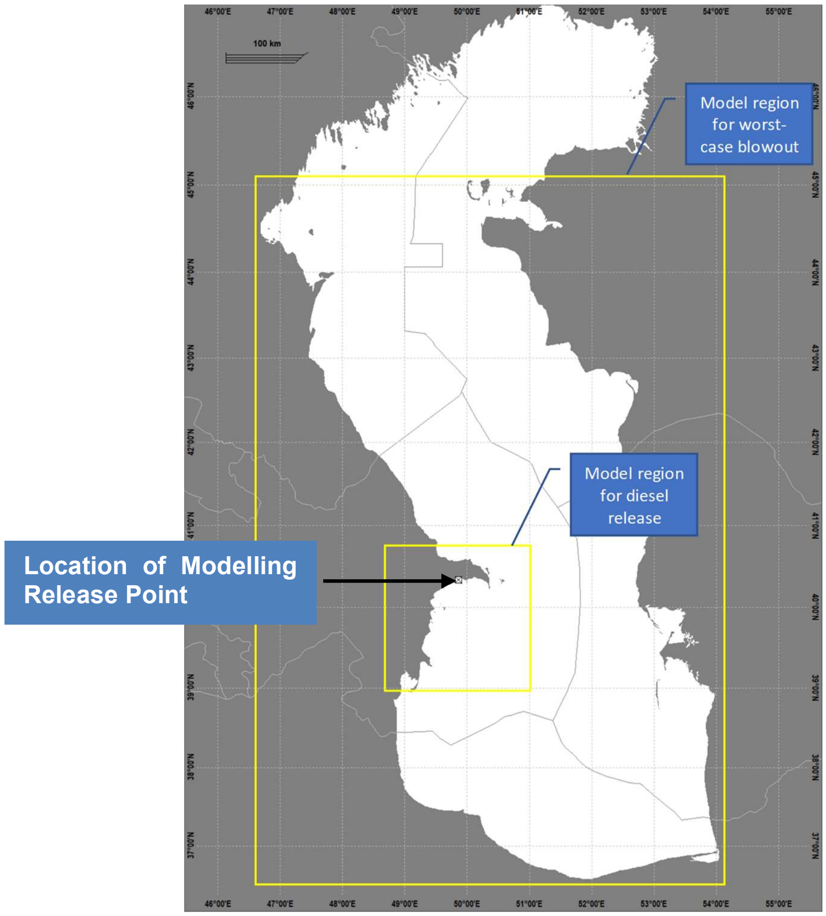
The following scenarios were modelled (refer to Appendix 4B for full details):

- Scenario 1: Drilling programme supply vessel inventory loss of 600m^3 of diesel; and
- Scenario 2: A surface blowout of crude oil (957,402m^3) over 81 days duration.

Table 5.2: Oil Spill Modelling Scenarios

<table>
<tr><th>Scenario ID</th><th>Spill Site</th><th>Spill Event</th><th>Oil Type</th><th colspan="2">Spill Rate</th><th>Spill Duration</th><th>Total Spilled Volume</th></tr>
<tr><td>1</td><td>BHEX01</td><td>Surface release of diesel fuel from diesel storage tank</td><td>Diesel</td><td colspan="2">3600 m^3/hr</td><td>10 minutes</td><td>600m^3</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">BHEX01</td><td rowspan="3">Surface blowout release - worst case, declining release rate</td><td rowspan="3">Norne Blend 2010</td><td rowspan="3">Oil[1]</td><td>Rate 1: 76,881 bbls/day</td><td rowspan="3">81 days (time to drill relief well)</td><td rowspan="3">957,402m^3</td></tr>
<tr><td>Rate 2: 73,945 bbls/day</td></tr>
<tr><td>Rate 3: 71,449 bbls/day</td></tr>
<tr><td colspan="8">Note 1: Rate 1 for 30 days, Rate 2 for 30 days, Rate 3 for 21 days</td></tr>
</table>

Figure 5.2: Extent of Regions Used Within Spill Modelling



Scenario 1 has been modelled assuming loss of 600m^3 of marine diesel from the vessel storage tank. It has been assumed that the diesel would be spilled directly onto the sea surface over a period of ten minutes at a rate of 3600m^3/hour.

Scenario 2 is the "worst case" estimate for a blowout of oil from the BHEX01 well and assumes the blowout would flow for 81 days, based on the anticipated time it would take to drill a relief well and therefore cease the blowout release. Scenario 2 has assumed a flowrate which declines over time ranging from 76,881 barrels per day (bbls/day) to 71,449 bbls/day, which is estimated to result in a total spill volume of 6,025,209 bbls (equivalent to 957,402m^3) of oil.

Spill scenarios were probabilistically (stochastic) analysed with time series weather and current data, demonstrating how the behaviour of the hydrocarbons change in variable metocean conditions. Stochastic outputs were generated as composites of all results obtained from 102 runs; and represent much larger areas than would be affected as a result of a single release scenario. Deterministic modelling (single scenario) was undertaken for the worst case scenario identified by stochastic modelling in both summer and winter conditions to predict the behaviour and fate of the plume over time in terms of surface accumulation, oil reaching the shore and water column concentrations.

Both stochastic and deterministic scenarios were run for the spill scenarios described above. From stochastic simulations the worse-case scenarios in terms of shoreline impact (greatest volume of hydrocarbon reaching shoreline) were identified and re-run as single deterministic simulations so that the fate of the release can be analysed in greater detail.

Section 5.3.3.6 of this ESIA Addendum provides a summary of the modelling undertaken while Appendix 4B provides a detailed overview of the fate of diesel and crude oil in the marine environment as a function of time, probabilities of surface and shoreline oiling and extent of the affected areas. It must be noted that modelling has not taken into account any spill response mitigation measures, meaning that the results should be only interpreted as indication of theoretical spill consequences without an implementation of the oil pollution prevention strategy. In reality, spill mitigation measures such as chemical dispersant application, containment, recovery and shoreline protection measures would be implemented to reduce adverse effects to marine and coastal resources. The same approach to spill prevention and response planning which is described in Section 7.3.4 of the SWAP Exploration Drilling Project ESIA will be implemented throughout the BHEX01 drilling programme.

5.3.3.6 Spill Modelling Results

Scenario 1 – Vessel Inventory Loss of Diesel

This section presents the modelling results for Scenario 1, which are summarised in Table 5.3.

Table 5.3: Summary of Vessel Diesel Inventory Loss Spill Modelling Results

Release location	Maximum surface extent of sheen above 0.04 µm (km)		Minimum time to beaching (days)[1]		Time until water column dissolved concentration <58 ppb (days)[1,2]		Maximum mass onshore (tonnes)	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
BHEX01 well	39	59	0.1	0.1	8	11	31	86
Notes: 1. Time from start of release. 2. Dissolved and dispersed oil in water column.								

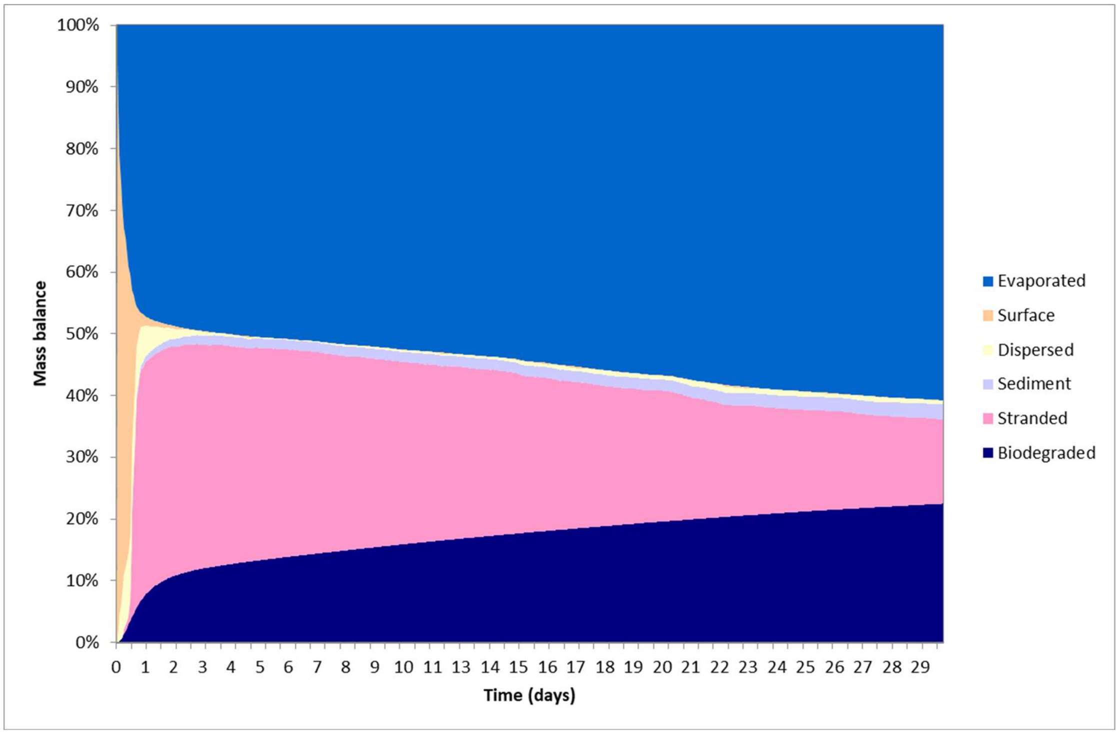
Under the worst case scenario (during winter conditions), diesel is predicted to reach the shoreline within approximately 2.25 hours after the initial release with up to 86 tonnes predicted to be on the shoreline, although the 50^{th} percentile value[12] is 13 tonnes.

As shown in Figure 5.3, initially the majority of the diesel is present on the sea surface, and over the first two days around 50% evaporates while in the second half of the first day following the release there is a rapid accumulation of diesel on shore. Dispersion and dissolution into the upper water column takes place close to the release point. Biodegradation also progresses relatively quickly, along with continuing evaporation, such that only a very small fraction of diesel on the water surface is left after 30 days (less than 0.1%). Ultimately, stochastic modelling analysis predicts 61% of the diesel evaporates, 22% is biodegraded, 1% is in the water column, 14% comes ashore and 2% is deposited in sediments.

The resultant slick is relatively small and short-lived. An important feature of the release location is that it is located in a relatively confined area with low currents and the presence of islands and obstructions protruding from the coast and in the nearby sea area. This means that shoreline oiling in Baku Bay is relatively limited by the capacity of the artificial surfaces to retain hydrocarbons, and it means that the diesel spends some time in Baku Bay in relatively warm water with little mixing, where a large fraction can evaporate. Figure 5.3 represents the spill during winter conditions, but the result is generally representative of the fate of diesel released at any point in the year.

Figure 5.3: Modelled Fate of Vessel Diesel Inventory Release (Winter)

[12] Means that in 50% of scenarios modelled, this value or less would result.



The spilled diesel on the sea surface is predicted to travel less than 60 km from the point of release in both summer and winter conditions before it drops below the lowest recognised visible thickness under ideal viewing conditions of 0.04 micrometres (µm). In both summer and winter, the breaks in surface sheen (as shown in Figures 5.4 and 5.5) are a result of changes in wind and wave conditions that disperse the diesel briefly and then allow it to re-emerge and form a new sheen separate to the first area. Thicker areas of diesel are restricted to a small radius around the spill location.

Figures 5.6 and 5.7 shows the maximum area of the water column where the diesel in water concentration is above the 58 parts per billion (ppb) threshold. The maximum extent of diesel in the water column is confined to 30 km from the release and tracks the path of the surface release. The area is affected for approximately 11 days in winter and 2 days in summer after the release before the diesel concentration disperses below the 58ppb threshold levels. In each figure, the output is the total area the diesel slick has covered as it has moved away from the release location. The cross section through the water column shows that for both summer and winter cases the release remains in the upper sections of the water column.

The probability of diesel reaching the shoreline (based on the results of stochastic modelling for summer and winter conditions) following the spill is presented in Figure 5.8 and the accumulation of diesel predicted on the shore following the spill under summer and winter conditions is shown in Figure 5.9. These represent the deposition of diesel on the shore at the end of the simulation when the maximum length of coastline is affected. The summer case shows a relatively localised spill, which relates to the confinement of the release near Baku Bay by coastal projections and islands. In winter, the diesel takes a different path and is slightly more persistent due to the temperature, resulting in shoreline deposition over a larger area. The vast majority of the coastline predicted to be impacted will experince very light (<0.1mm) deposition of spilled deisel while areas experiencing light (0.1-1mm) or moderate (1-10mm) deposition of diesel are small and are localised to within a few kilometres of the release location (refer to Figure 5.9).

Figure 5.4: Modelled (Deterministic) Cumulative Area Thickness of Diesel on the Sea Surface (Summer)

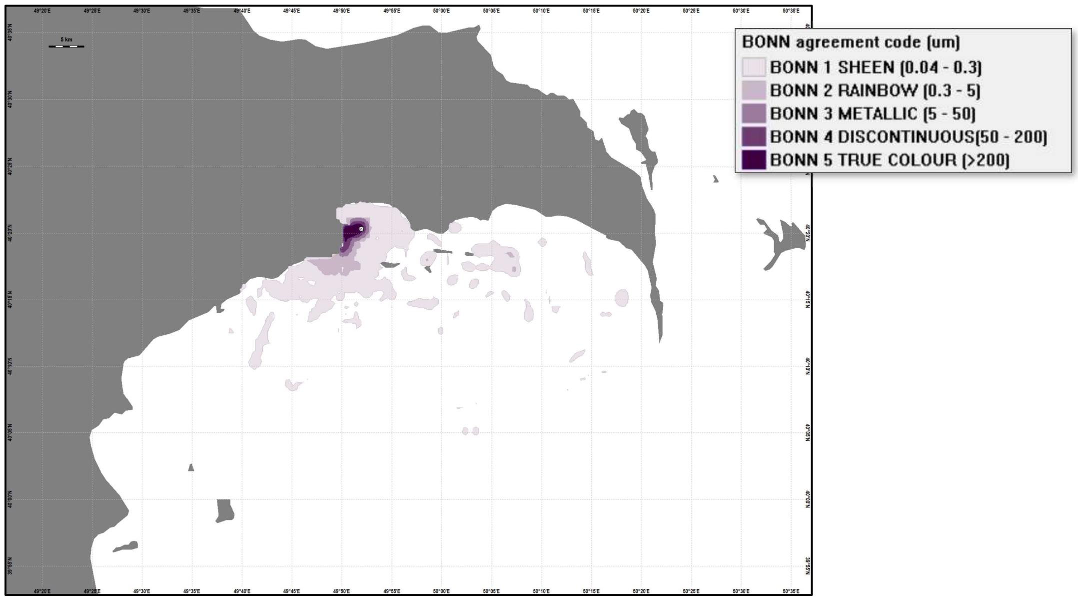


Figure 5.5: Modelled (Deterministic) Cumulative Area Thickness of Diesel on the Sea Surface (Winter)

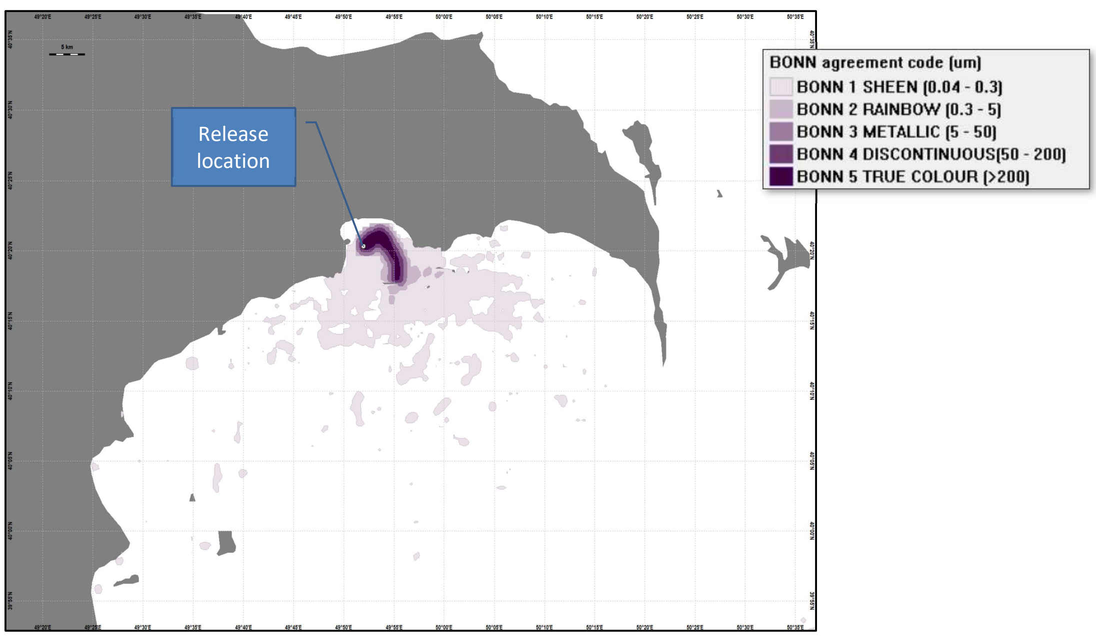


Figure 5.6: Modelled (Deterministic) Concentration Error! Bookmark not defined. of Diesel Within the Water Column (Summer)

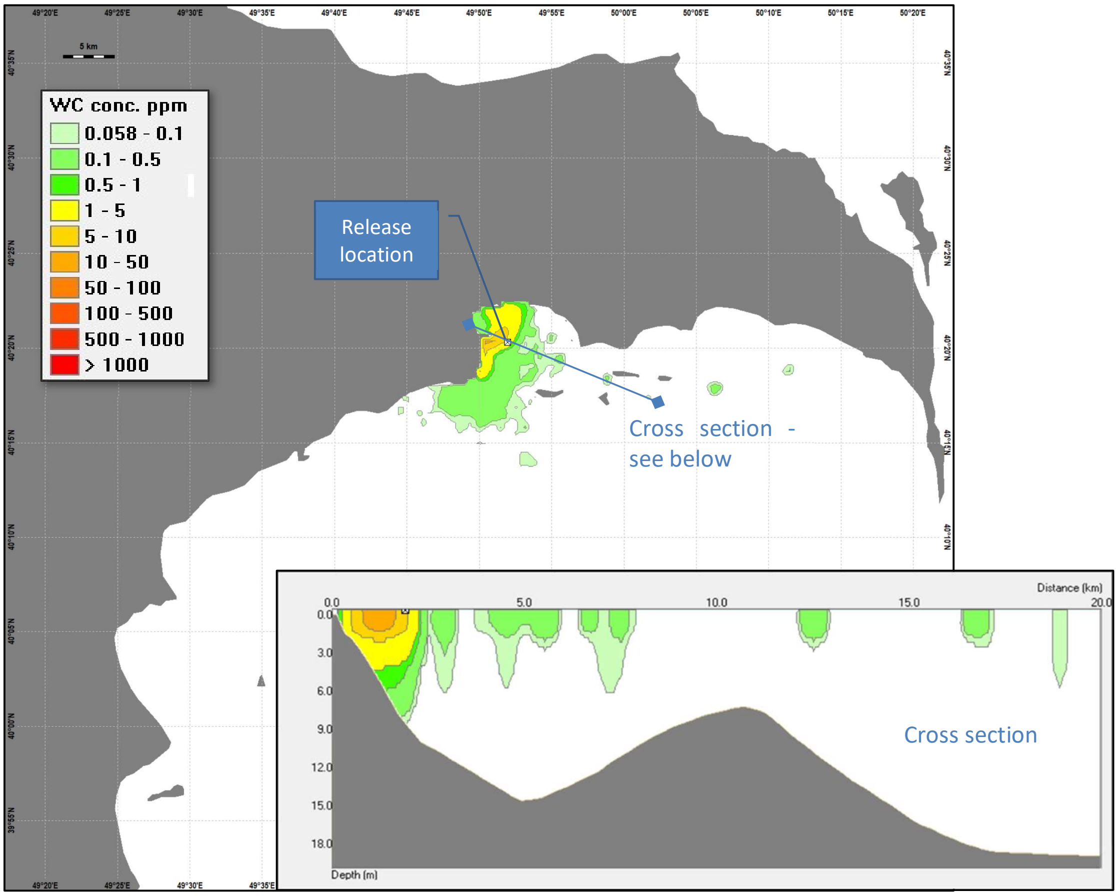


Figure 5.7: Modelled (Deterministic) Concentration Error! Bookmark not defined. of Diesel Within the Water Column (Winter)

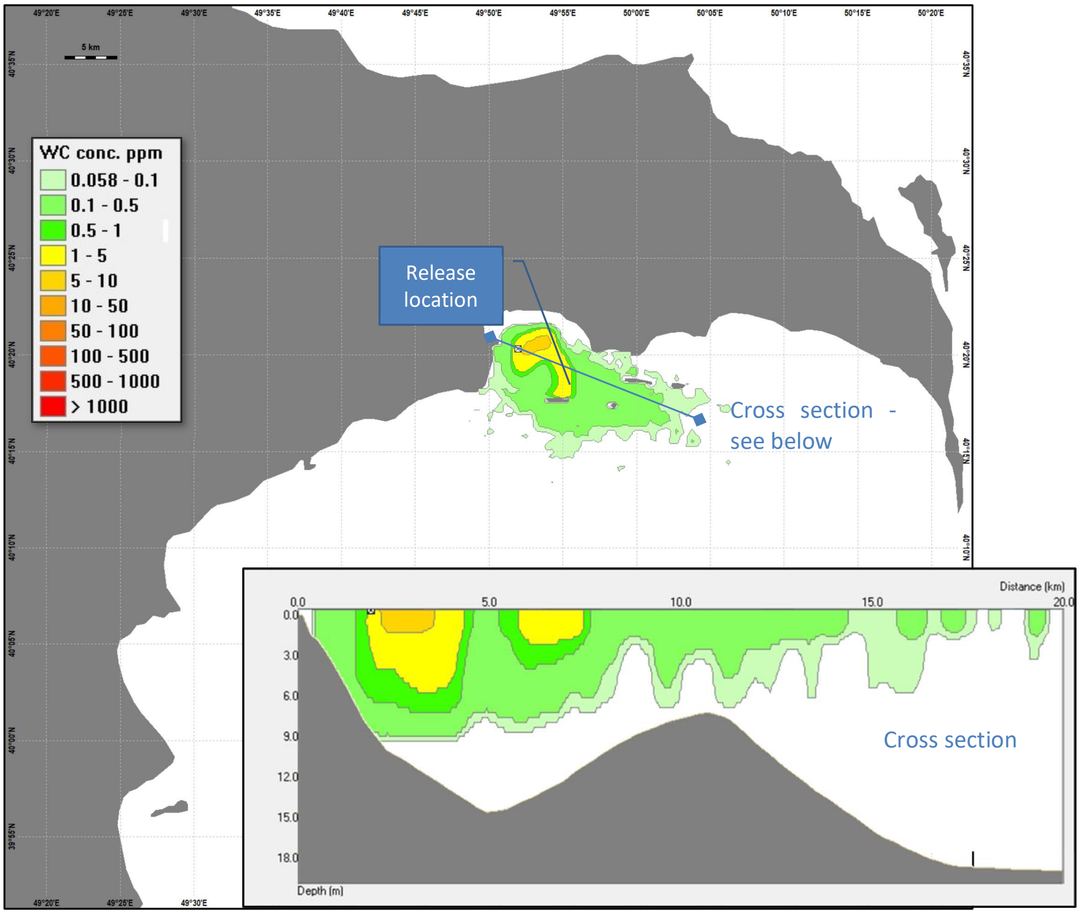


Figure 5.8: Modelled (Stochastic) Probability of Shoreline Oiling Above 0.1 litres/m^2 for Diesel Spill Scenario

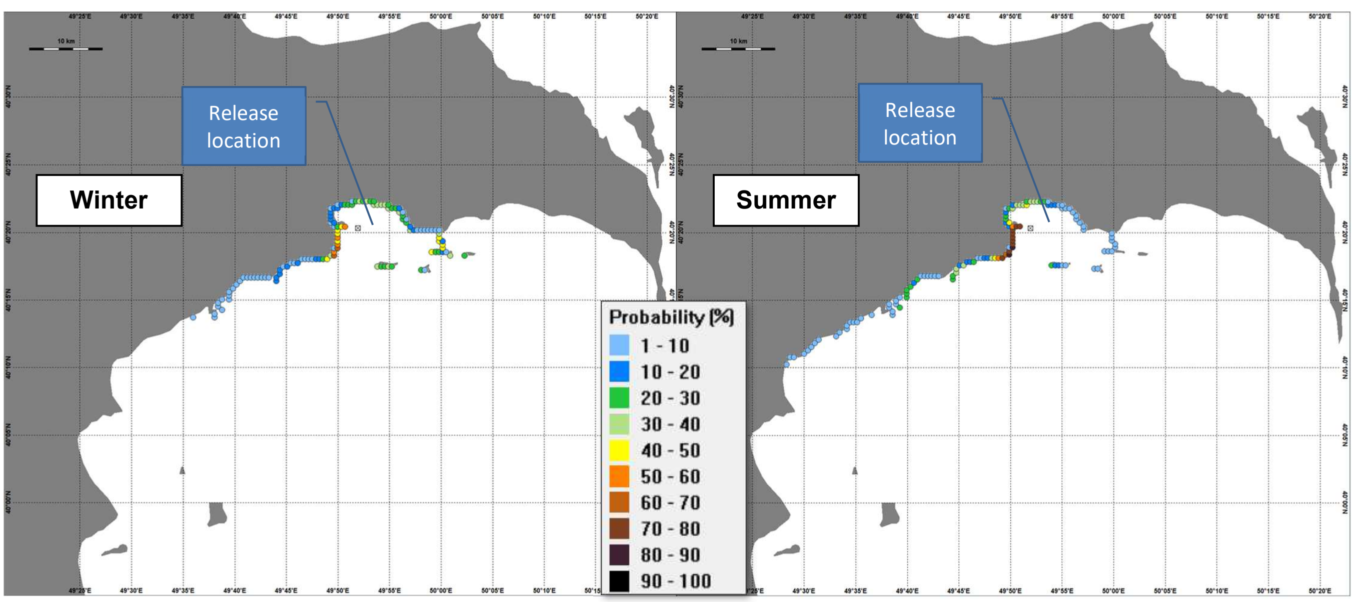
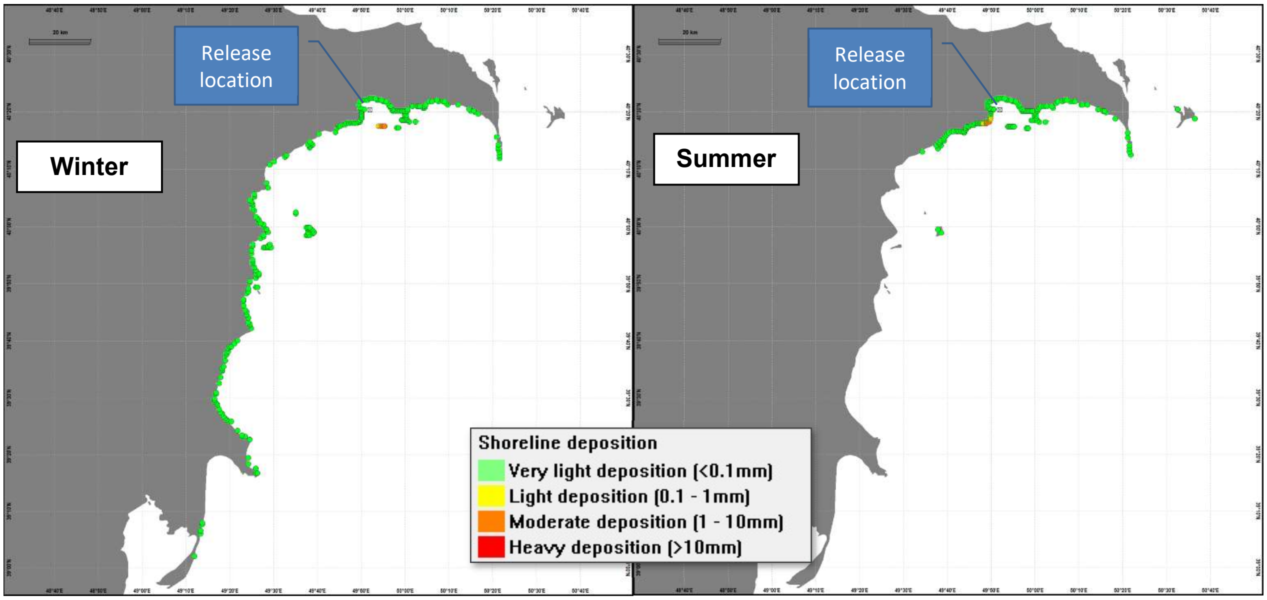


Figure 5.9: Modelled (Deterministic) Shoreline Deposition Resulting from Diesel Spill Scenario



Scenario 2 – Blowout of Crude Oil

This section presents the modelling results for Scenario 2, which are summarised in Table 5.4.

Table 5.4: Deterministic Results Summary for Hydrocarbon Release in Blowout Scenario

Release location	Maximum surface extent of sheen above 0.04 µm (km)		Minimum time to beaching (days)[1]		Time until water column dissolved concentration <58 ppb (days)[1,2]		Maximum mass onshore (tonnes)[3]	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
BHEX01	523	390	0.1	0.1	> 120	> 120	86,996	110,513

Notes:
1. Time from start of release.
2. Dissolved and dispersed oil in water column.
3. Mass of oil onshore excludes associated water. Crude oil is predicted to be present in an emulsion, and the mass of emulsion is expected to be around 2.5 times the mass of oil.

The results of the worst case deterministic modelling (Table 5.4) shows that oil is predicted to reach the shoreline within approximately 2.5 hours after the start of the release. A blowout during winter conditions is predicted to result in up to 110,513 tonnes of oil reaching the shoreline, although the 50th percentile value[12] is 62,425 tonnes.

As shown in Figure 5.10, during winter conditions, the majority of the oil is initially present on the sea surface following the release. The modelling simulation found that a significant fraction of the oil evaporated, reaching 46% of the total spilled oil volume by the end of the simulation period (120 days). This is due in part to the fact a large fraction of the shoreline in Baku Bay is artificial and is formed of marine walls and structures, which can retain less oil than a sandy shoreline which is common along many other parts of the Azerbaijan coastline. Furthermore, the projections from the nearby coastline and islands act to confine the oil, and since there are lower currents and winds at the shore, the oil is on the surface for a large fraction of the time allowing evaporatation to occur. During the blowout period of 81 days, oil is continually supplied to the surface, and oil on the surface remains significant until after the end of this period. Dependent on the wind and waves, oil can be mixed into the water column and some oil can subsequently re-surface during calmer periods. After approximately half a day, oil starts to deposit in sediments.Ultimately the modelling predicts 46% of the oil evaporates, 26% is biodegraded, <1% remains in the water column, 23% is deposited in sediments with approximately 4.6% reaching the shoreline. No oil is predicted to remain on the sea surface by the end of the modelling period (120 days).

The probability of surface oiling above 0.04μm threshold is shown in Figure 5.11 for summer and winter. Much of the oil behaviour is determined by prevailing winds, and when the wind is southerly, oil is pushed against the coastline and moves very little east or west of the release location since there are obstructions and bays along the coastline. Due to the confining effect of the Absheron peninsula, the sea and shores of Azerbaijan and northern Iran, i.e. to the south of the peninsula, are far more likely to be affected than those to the north.

The crude oil on the sea surface is predicted to travel around 400-500km before it drops below the lowest recognised visible thickness under ideal viewing conditions[13]. There is a distinct difference in oil movement between summer and winter with the oil more likely to remain closer to the coast in summer and travel north and south, while in the winter it is more likely to spread a further distance from the coast towards the east. The thickest areas of oil (>200 μm) are predicted to cover similar areas during winter and summer (refer to Figure 5.12).

The extent of oil in the water column above the 58ppb concentration threshold tracks the path of the surface release and can extend 390-530km from the source as shown in Figure 5.13 (summer and winter conditions). Figure 5.13 shows the total area the oil has covered as it has moved away from the release location[14]. The oil moves outwards and disperses via the action of circulation currents, winds and waves and its presence in the water column is dominated by the presence of the surface slick. Some of the surface oil dissolves into the upper water column and some disperses in droplet form during stronger wind and wave conditions and can then re-appear on the surface in calmer conditions. Wave mixing and diffusion of the dissolved components gives rise to appreciable concentrations in the upper 20m of the water column, and occasionally deeper to around 50m depth as shown in the cross sections, although the maximum concentrations remain immediately below the surface oil which is persistent.

The probability of oil reaching the shoreline (based on the results of stochastic modelling for summer and winter conditions) following the spill is presented in Figure 5.14 and the accumulation of oil predicted on the shore following the blowout under summer and winter conditions is shown in Figure 5.15. Figure 5.15 represents the deposition of oil on the shore at the end of the simulation when the maximum length of coastline is affected. Both summer and winter spill cases predict oil reaching southern Azerbaijan, northern Iran and the Absheron Peninsula. The summer case also predicts oil reaching the Russian coast. The eastern coastline of the Caspian is unaffected in the deterministic modelling although the stochastic analysis indicates that it is possible for oil to reach the eastern coastline of the Caspian in some metocean conditions (see Figure 5.14). A mixture of areas of very light (<0.1mm), light (0.1-1mm), moderate (1-10mm) and heavy (>10mm) oil deposition are predicted as can be seen in Figure 5.15. The maximum level of deposition on the artificial shorelines in Baku Bay is predicted to be moderate, as these shorelines are comprised of marine walls and structures which retain less oil than other shoreline types such as sand.

[13] The cumulative area illustrated in Figure 5.12 shows the maximum thickness or concentration of oil at any point at any time during the 120 day model duration, by merging together all of the model outputs and showing the greatest value in each grid cell. This helps to define the maximum extents of the oil trajectories and identifies which areas are at risk at some point during the release, and where the greatest effects can be expected. It does not however, show the extent of the release at any specific time, and the area or volume of oil at any time during the release is far smaller, being at worst 10-15% of the cumulative area shown.

[14] Figure 5.13 illustrates the total area the oil is predicted to cover as it moves away from the release location and does not represent how much oil may be present in the water column at a given point in time (i.e. the area of water shown in Figure 5.13 will not all be above the 58ppb threshold concentration at the same point in time). The instantaneous volume affected is around 10% of the cumulative volume presented in Figure 5.13.

Figure 5.10: Modelled Fate of Oil From Blowout Scenario (Winter)

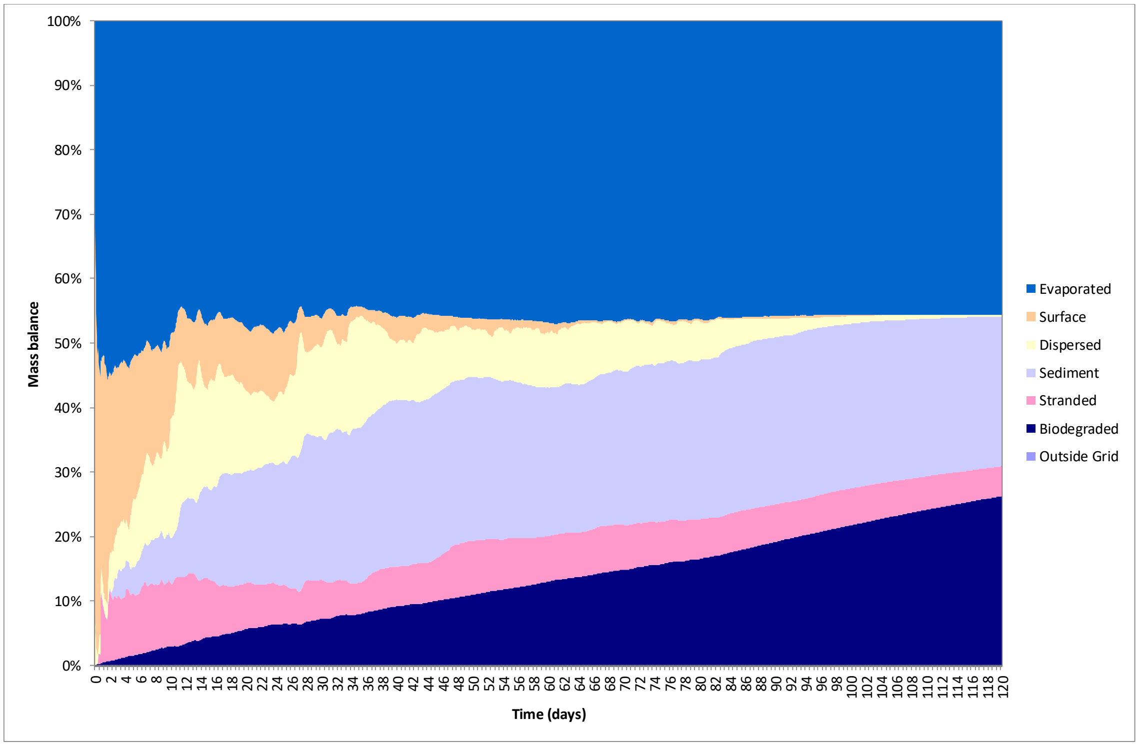


Figure 5.11: Modelled (Stochastic) Probability of Surface Oil Thickness Above 0.04µm Threshold for Blowout Scenario

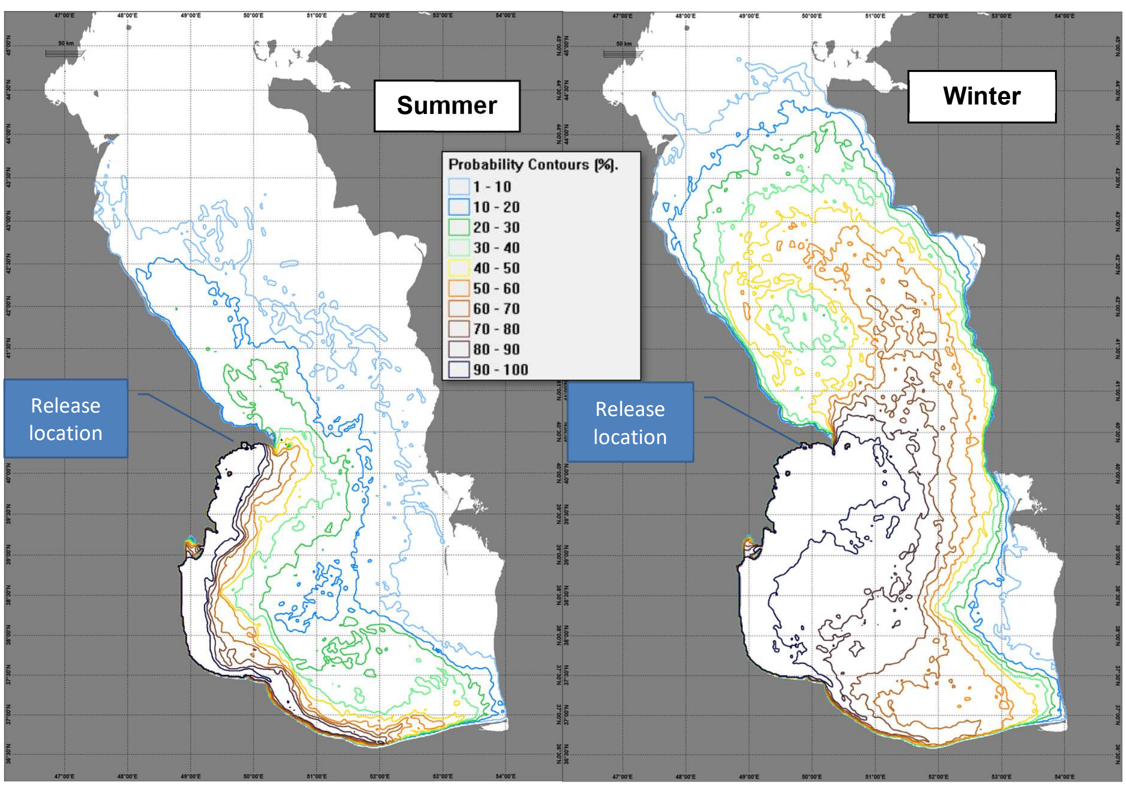


Figure 5.12: Modelled (Deterministic) Cumulative Area Thickness of Oil on the Sea Surface for Blowout Scenario

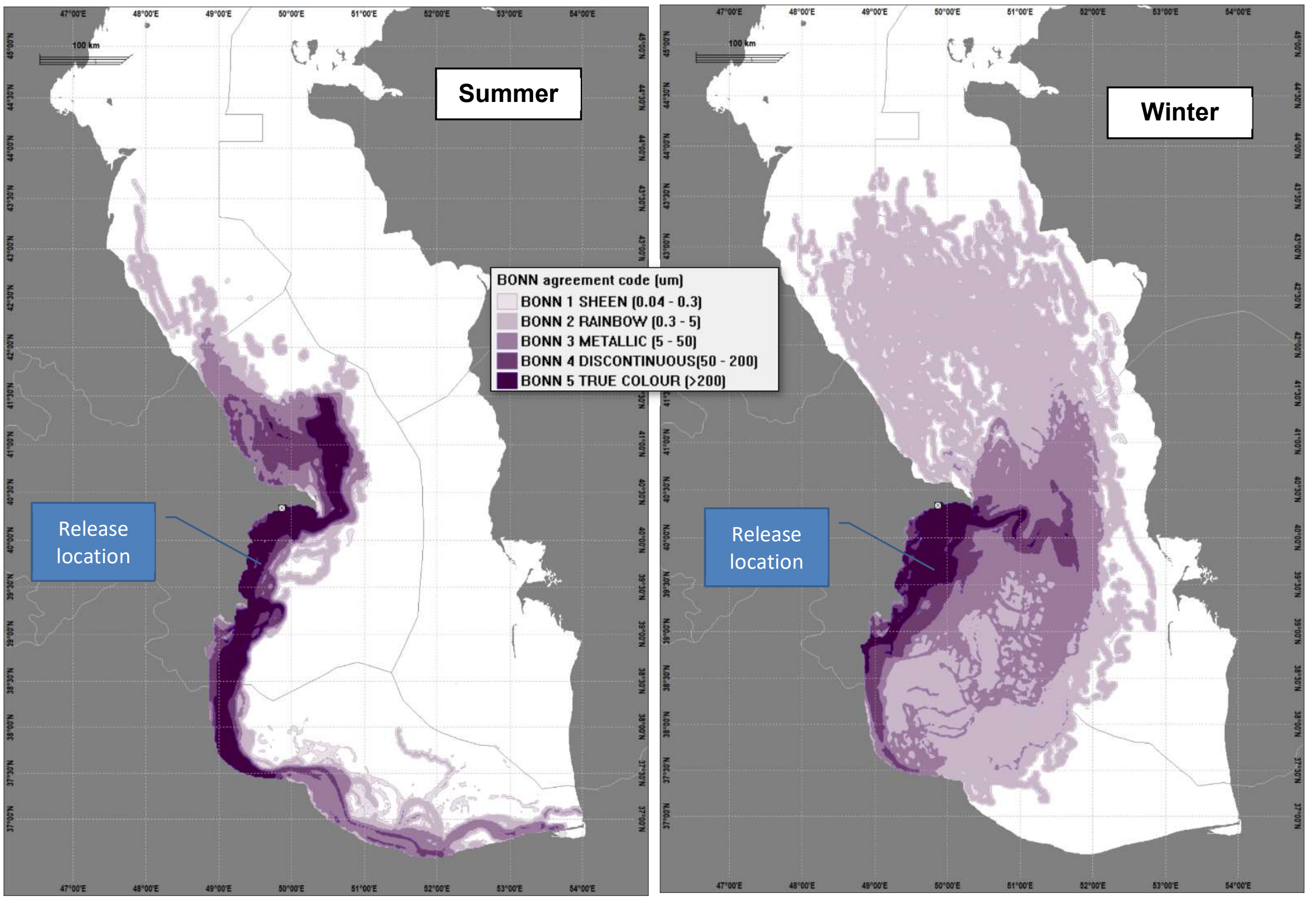


Figure 5.13: Modelled (Deterministic) Maximum Affected Area of Water Column Error! Bookmark not defined. **for Blowout Scenario**

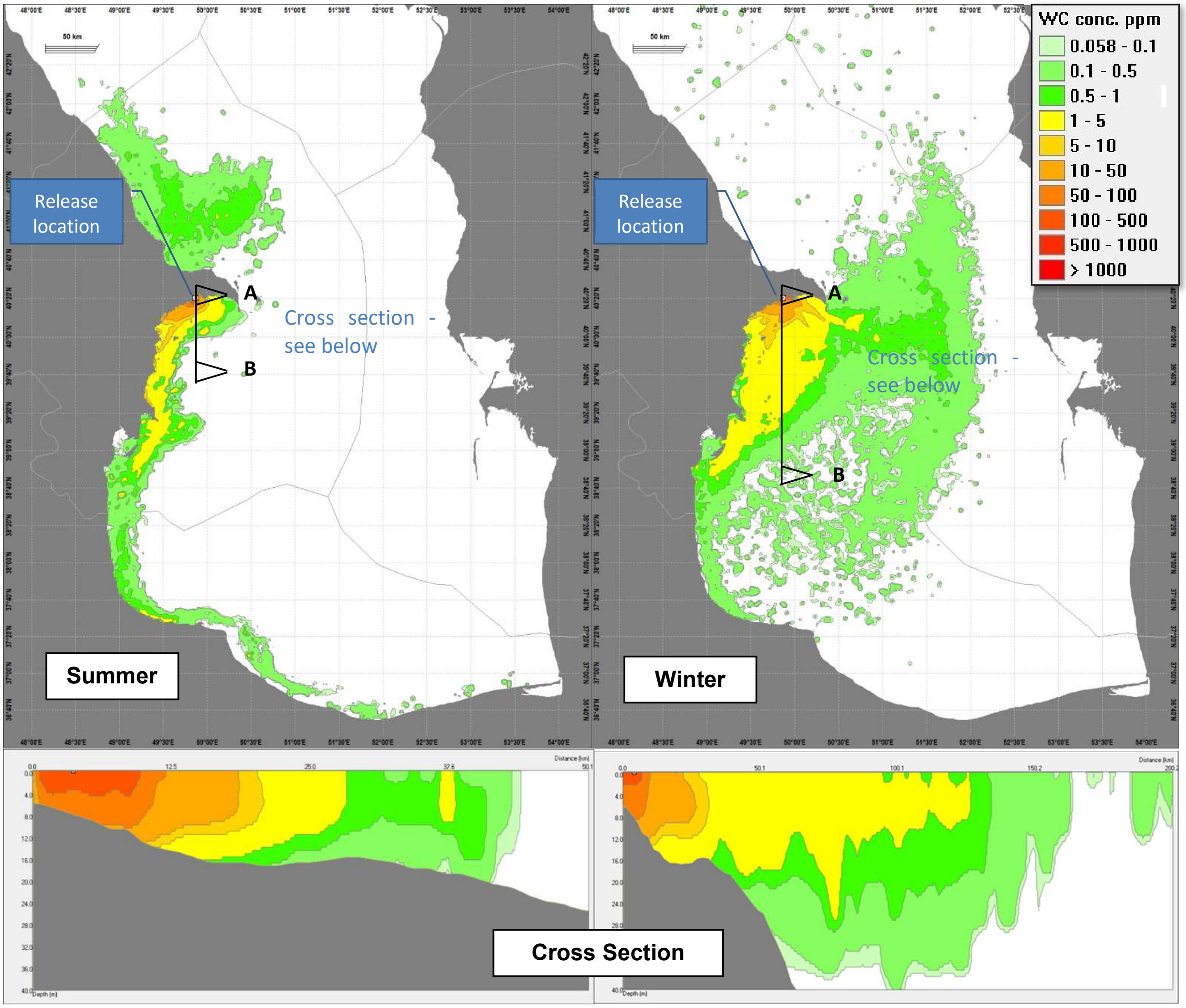


Figure 5.14: Modelled (Stochastic) Probability of Shoreline Oiling Above 0.1 litres/m² for Blowout Scenario

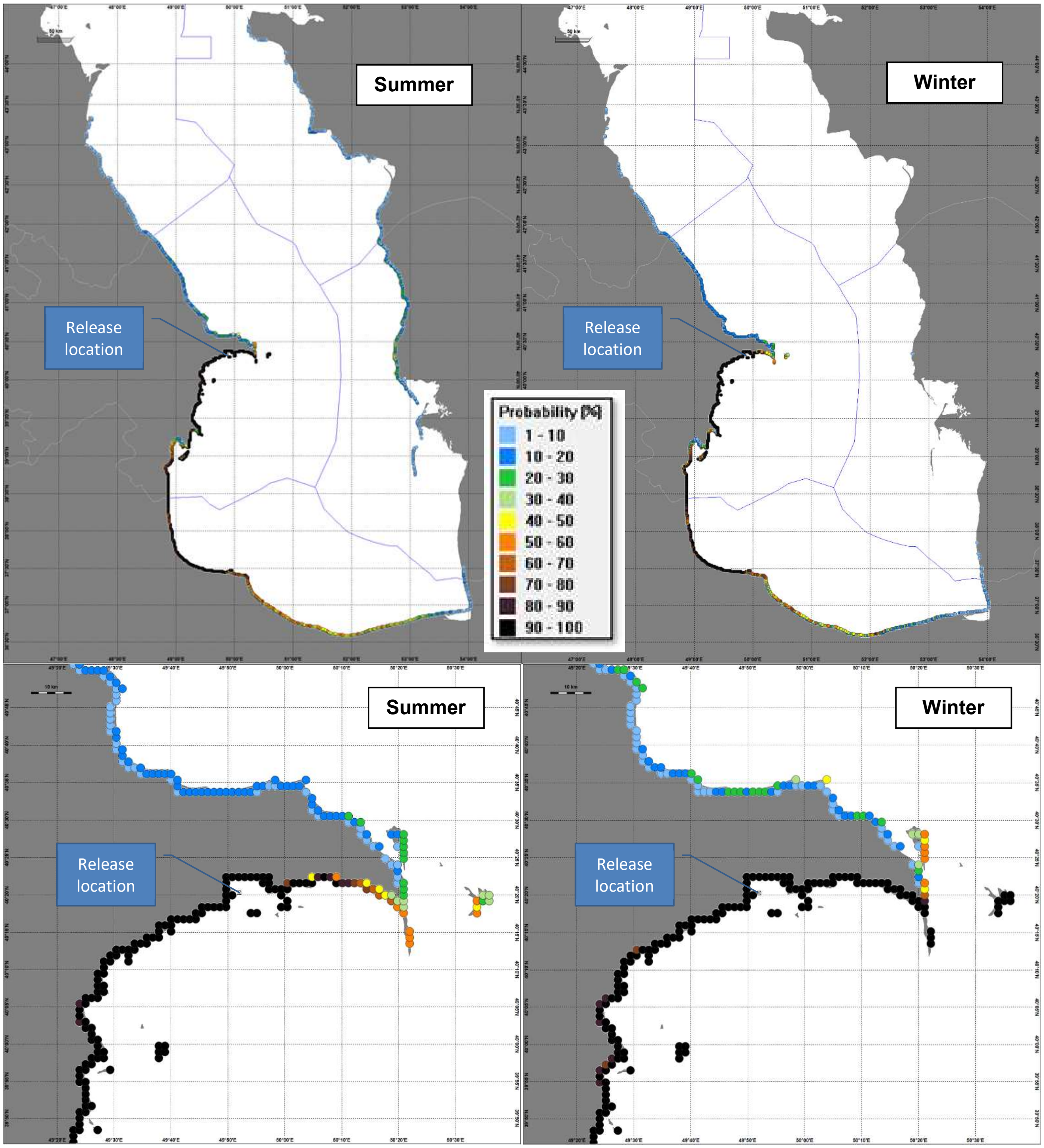
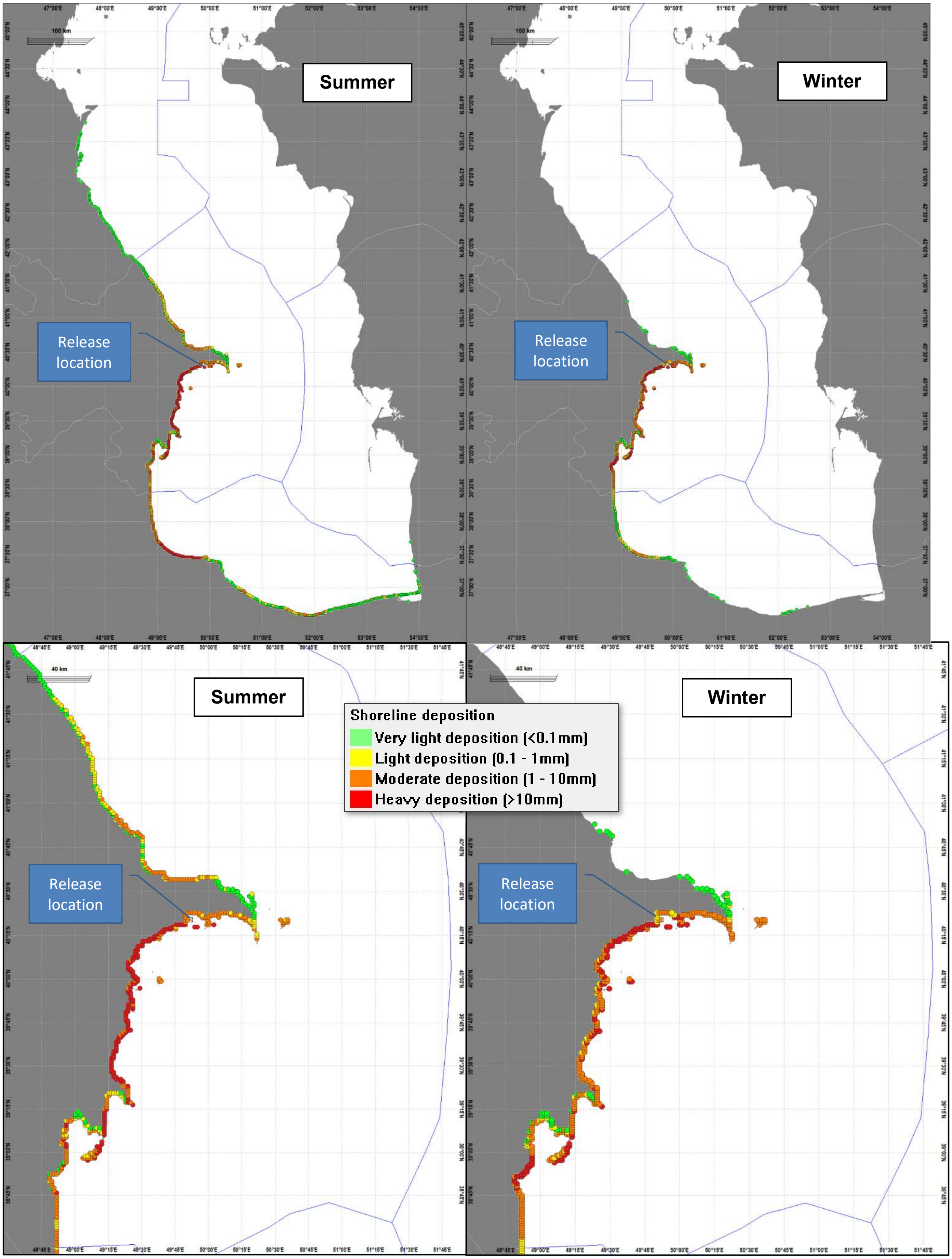


Figure 5.15: Modelled Shoreline Deposition Resulting from Blowout Scenario



5.3.3.7 Potential Impact of Hydrocarbon Release

Hydrocarbons have the potential to cause detrimental effects to water and sediment quality, marine and coastal flora and fauna, including plankton, benthic invertebrates, fish, birds and marine mammals that may come into contact with a spill. An impact on fisheries and an indirect impact on human health via the food chain is also possible, depending on the scale of the spill and its proximity to fishing grounds. A general overview of the vulnerability of marine and coastal receptors to hydrocarbon spills is provided in Table 7.5 of the SWAP Exploration Drilling Project ESIA and is not repeated here. A discussion of the potential impacts to marine and coastal receptors as a result of potential hydrocarbon spills (i.e. release of diesel or well blowout) specific to the BHEX01 well location is provided below.

Spilled hydrocarbons undergo a weathering process once they are released into the marine environment. The fate of diesel and crude oil in the marine environment is described in Section 7.3.3.3 of the SWAP Exploration Drilling Project ESIA and is dependent on the type and volume of oil spilled and the prevailing weather and sea conditions. The spill modelling results described in Section 5.3.3.6 above has estimated the trajectory of hydrocarbons in the marine environment for a range of scenarios including a loss of diesel inventory from a vessel at the proposed BHEX01 well location and a blowout of the BHEX01 well. A brief description of the potential impacts of the spills, taking into account the modelling results on marine and coastal receptors is presented below. Further details on the environmental and socio-economic receptors potentially impacted by a spill are provided in Chapter 3 of this Addendum.

Plankton

The spill modelling indicates that for a diesel release (Scenario 1) the concentrations of diesel in the water column above the 58ppb threshold are limited to 30km from the point of release and are not expected to persist for longer than 8 days (summer) and 11 days (winter), respectively. The exposure of plankton (excluding fish larvae) to toxic levels of hydrocarbons from this scenario is therefore expected to be short term and localised.

The modelling of the well blowout scenario (Scenario 2) estimates the maximum area of water column with a concentration of oil in the water column above the 58ppb threshold**Error! Bookmark not defined.** would be extensive and the concentration would remain above the 58ppb concentration threshold for greater than 120 days following the release. However, water column concentrations are predicted to be above the threshold of 58ppb for up to 30 days close to the release, and the majority of the affected area is predicted to be above the 58ppb threshold for less than 48 hours. The 58ppb is a 5th percentile LC_{50} threshold for toxic effects in the marine environment. This means that at 58ppb, 95% of species are not significantly affected. The most significant effects on plankton will occur in areas of much higher concentration and Patin (Ref.41) gives a range of 10-1,000ppb for sublethal effects in shallow, semi-closed marine areas.

The results of both the BHEX01 EBS and BBEX01 EBS described in Section 3.4.5.1 and 3.4.5.2 show that the plankton species present at the Project location are common throughout the Southern Caspian Sea. Plankton (particularly zooplankton, fish larvae and eggs) are likely to suffer high levels of mortality through exposure to hydrocarbons. However, plankton already experience very high levels of natural mortality, predominantly the result of predation. Plankton are generally short-lived, rapidly reproducing often releasing very high numbers of eggs and/or larvae and are also widely distributed, so that recovery, even from significantly detrimental impacts, can be relatively short (weeks or months) (Ref.42).

During the peak period of phytoplankton production (spring and autumn) the biomass exposed to a hydrocarbon spill would increase resulting in reduced growth levels and mortality. However, this is not expected to be significant in comparison to the total production level over the long term. Zooplankton may also suffer mortality as a result of a hydrocarbon spill, but the large number of early life stages produced and short reproductive cycles, will act as a buffer for recruitment from areas outside the spill affected region. It is recognised that a short term reduction in plankton communities will also impact on other marine species that predate on plankton species.

Thus, on the basis described in Section 5.3.3.6 above (i.e. the area of water shown in Figures 5.6, 5.7 and 5.13 will not all be above the 58ppb threshold at the same point in time), significant effects would be relatively localised and recovery in planktonic communities would then take place in a relatively short timescale, with recruitment from unaffected areas through natural circulation patterns. Patin (Ref.41) states that there is no evidence that oil spills have had irreversible long-term impacts on planktonic populations in open waters. As a result, the overall impact on the plankton communities is not considered to be significant.

Benthic Invertebrates

As detailed in Chapter 3: Sections 3.4.3, the (EBS conducted at BBEX01 (2018) and BHEX01 (2019) showed that the area is inhabited by both native and invasive species of invertebrate. Within the 2019 BHEX01 EBS, the macrofaunal community comprised 12 taxa and was numerically dominated by bivalve molluscs which accounted for 77% of the total abundance. The presence of the bivalve *Dreissena caspia* within the BHEX01 community is a significant feature as it is an International Union for Conservation of Nature (IUCN) Red List critically endangered species. Although *Dreissena caspia* was present at 33 of 38 BHEX01 stations it's abundance was low and only accounted for ~2% of total abundance. With the exception of *Dreissena caspia* the benthic invertebrate communities both within and in the vicinity of the Project location are very similar to those across the rest of the Azerbaijan sector of the southern Caspian.Benthic communities play an important role in supporting critical functions of the local ecosystem, particularly as prey items for other species, including fish such as sturgeon. There are a number of taxa that are important prey e.g. amphipod crustaceans, which are known to be sensitive to hydrocarbons.

As shown in Figure 5.3, it is predicted that a release of diesel from a vessel will result in approximately 2% of the spilled diesel ending up in sediments and thus benthic environments are less likely to suffer the impacts of a surface spill of diesel. The spilled diesel become mixed into the water column, subsequently combining with suspended sediments. This then sinks to the seabed where its toxic components can be lethal to benthic organisms (Ref.44). As shown in Figure 5.10, the spill modelling predicts that approximately 23% of the spilled oil from the blowout scenario (Scenario 2) will reach the seabed. A large proportion of the spilled oil ending up in the sediments is due to the shallow water depth at the well location meaning oil is deposited direct to the seabed rather than just through mixing with suspended sediments. The maximum amount of oil beached ashore is predicted to be 110,513 tonnes for the worst case blowout scenario.

A significant volume of oil is anticipated to reach the coastline and an estimated 23% of the released oil is predicted to deposit in sediments, predominantly in the shallow waters around the Absheron peninsula, by the end of the simulation period.

Potential impacts to the benthic invertebrates can include: (i) rapid mortality of sensitive species such as crustaceans, amphipods, and bivalves; (ii) a period of reduced species population and abundance and (iii) a period of altered community structure with increased abundance of opportunistic species. Based on experiences elsewhere in the world, effects on macrofauna are typically greatest amongst mollusc and crustacean communities due to their habitation of the benthos and their limited ability to metabolise oil components.

It should be noted that the sediments in Baku Bay have a long history of pollution and elevated levels of hydrocarbons (refer to Section 3.4.1.1) and high concentration levels of total hydrocarbons (THC) and Polycyclic Aromatic Hydrocarbons (PAH) were recorded during the 2018 BBEX01 EBS and 2019 BHEX01 EBS described in Section 3.4.2.2. Modelling of the predicted impacts of the oil released during the blowout on sediments (refer to Appendix 4B: Section 5.2.3.4) was undertaken and compared against recognised acute toxic effects thresholds[15]. Using these thresholds, significant effects would be unlikely below 10 mg/kg; between 10-100 mg/kg sub-lethal effects could be expected (such as narcosis and lower reproductive success); while above 1,000 mg/kg acute toxic effects would be expected in multiple species. This may take a period of months or years to decline substantially. Given the historic oil-producing nature of the area and pollution of Baku Bay in particular, background oil levels are already elevated or tolerated in many area; nevertheless acute toxic effects would be expected mainly within 42 km of the BHEX01 well based on these thresholds and sub-lethal effects potentially at a distance of

[15] Patin (Ref.41) recommends threshold of 10 milligrams of oil per kilogram of sediment (mg/kg) as a level that would be below the no effect concentration for most species; 10-100mg/kg where reversible effects would be expected; 100-1,000mg/kg where sublethal effects would be expected and above 1,000mg/kg as a level where acute toxic effects would begin to be observed.

120 km. As such, the potential impacts to benthic species in the areas sediment affected by the spilled oil from a blowout is likely to be significant in the short term to medium term.

The recovery times for benthos would vary depending on the environmental conditions and species affected. Although a large percentage of the spilled oil (23%) will be deposited within sediments, over time the oil will biodegrade and the effects of wave action and currents will naturally disperse the oil particularly along rocky and sandy shores. However, benthic species present in areas of fine sand or mud may suffer longer term effects as the oil that penetrates fine sediments can persist for many years and can often be released back into the water column if disturbed.

Modelling of the effect of the diesel release on sediments (Refer to Appendix 4B: Section 5.1.3.4) shows only small areas of sediments will experience deposition above the no effect concentration of 10mg/kg. This is likely to have a short term and localised impact on the benthic organisms present. Taking into account the limited area of sediments affected by stranded diesel and short term recovery rates, the overall impact to benthic invertebrates is expected to be low.

In summary, in terms of the worst case well blowout scenario, the potential for a large amount of oil to end up in sediments on the seabed and beach along a significant length of coastline is expected to lead to a potentially significant impact on benthic species present in areas impacted by the oil. There is potential for recovery to take a number of years and for changes to the community structure due to the increased abundance of opportunistic species.

Fish

As discussed in Chapter 3: Section 3.4.5.2, the shallow water coastal regions of the Azerbaijani sector of the Caspian Sea are important for non-migratory species as it provides breeding and nursery habitat for a number of species during spring, summer and autumn. Drop down video survey footage taken at the BHEX01 well location recorded the presence of individual sandsmelt, gobies and stickleback. The water depth and conditions are typical habitat for these species and while present in water depths of 20m or more year round, these species typically breed in waters of up to 10m deep, more commonly in shallow waters of up to 4m deep. Kilka were not observed in the drop down video, however they may be present during their spawning period. Common Kilka (*Clupeonella delicatula caspia)* typically spawn at depths of between 5-10m. Other species that may be found in the vicinity of the Project location, based on water depth, include pipefish and some shad species. Considering the existing contamination within Baku Bay, habitat type and location, it is not expected that sturgeon are present.

Further afield, the area south of the Absheron Peninsula is a known nursery area for the main commercial fish species. Pelagic species such as kilka are likely to be found in the waters of the Southern Caspian all year round (in depths of 20-40m), although in smaller numbers in winter, outside the main spawning and migration periods while migration of sturgeon and grey mullet takes place along the coast in water depths up to 100m.

The potential impacts of an diesel or oil spill on fish may include physical damage (e.g. through oiling of gills) and toxic effects (e.g. due to uptake of volatile toxic components of the diesl / crude oil) (Ref.43). Fish have the ability to detect hydrocarbons in water through olfactory (smell) or gustatory (taste) systems and tend to avoid contaminated areas (Ref.44). Different fish species have varying ability to metabolise oil and demersal fish species (i.e. fish that live on or just above the seabed) in particular could exhibit sub-lethal or toxic effects in the short term and taint in their flesh. A study examing the impact of acute and genotoxic effects of contaminated Baku Bay sediment on Russian Sturgeon (*Acipenser guildensteidti*), a bottom dwelling species, found this species to be very sensitive to the acute effects of exposure to sediments contaminated with high levels of PAHs (Ref.43). Depending on the time of year that a spill was to occur, different groups of fish species may be affected. It can be assumed therefore that the majority of adult fish would avoid the area of a spill, although in very shallow waters fish may be more restricted between the seabed and the hydrocarbons on the sea surface and the concentrations of dispersed oil in the water column may also be higher.

In the vicinity of the Project location, the risk to fish potentially increases as the BHEX well is located within shallow water (approximately 4m water depth) at the entrance to Baku Bay. More widely along the coast, spill avoidance behaviour can disrupt migration routes for some fish species, which has the potential to impact the migration of species of sturgeon and shad and semi-migratory species such kilka and mullet. Where mortalities linked to oil spills have been recorded they have generally been associated with high levels of surface oiling in storm conditions when mixing increases the presence of oil compounds in the water column. Juveniles and larvae are more vulnerable to oil spills as they have limited ability to move away from the contaminated zone, which may have implications for the reproduction of these species. It should be noted that protected sturgeon species do not spawn within Azerbaijani waters but will be migrating in spring and summer and may be feeding during summer in coastal waters up to 100m water depth.

Oil spill modelling for Scenario 1 indicates that diesel concentrations in the water column that have the potential to cause toxic effects on fish are non-persistent, with ~50% of the diesel evaporating within two days of the release and diesel concentrations within the water column dispersing below the 58ppb threshold levels within 11 days in winter and 8 days in summer.

In the event of a blowout (Scenario 2), a large proportion of the oil will evaporate, with the remaining oil expected to persist over a longer period compared to diesel (weeks and months compared to days for diesel). With the blowout scenario, the probability of the dispersed oil in water concentration exceeding the 58ppb threshold is 90-100% over an extensive area of the western side of the Southern Caspian from the Absheron Peninsula down to the Iran border and the modelling predicts it will take more than 120 days for the concentration to fall below 58ppb in impacted areas. However, as noted in Section 5.3.3.6 (footnote 5), Figure 5.13 illustrates the total area the oil has covered as it has moved away from the release location and does not represent how much oil may be present in the water column at a given point in time. Similalry, the areas with a 90-100% probability of the dispersed oil in water concentration exceeding the 58ppb threshold will not all be impacted at the same time. In the blowout scenario, oil will be continually released for a period of 81 days and it will gradually spread out under the influence of wind and sea currents. This gradual process will allow a proportion of adult fish the opportunity to detect the hydrocarbons and move away from affected areas. Although adult fish have the ability to move away from affected areas, juveniles and larvae have limited ability. Considering that these are focused in shallow depths and areas near islands, populations of juveniles may be at higher risk. Coupled with the extensive area impacted by the oil spill, particularly along the coastline, and the duration of contamination there will likely be significant impacts to fish populations in the short to long-term.

Seals

If Caspian seals are within the area of a spill, or if the spill affects any resting or haul out sites, there could be irreversible impacts from a hydrocarbon spill through coating, inhalation and ingestion.

A comprehensive description on the current status of the the Caspian seal (*Phoca caspica*), including data on population estimates, migration and scientific studies is provided in Section 5.4.6.4 of the SWAP Exploration Drilling Project ESIA. The latest evidence indicates seals may not always be present in the SWAP Contract Area, but there is evidence confirming that migrating seals still use the route passing the waters between Pirallahi Island, Chilov Island and Oily Rocks; during the Autumn (October-November) migration. Evidence of this includes seal observations recorded during the SWAP 3D seismic survey in 2015 and 2D survey in 2016. In addition to seal presence during the migration period, there is also the potential for seals that have not migrated to the Southern Caspian to be present for foraging from May to September with peak numbers coinciding with the peak kilka numbers in July. The scientific opinion is that seals are showing signs of adaptation to anthropogenic disturbances. It is understood that, following increased disturbances within the Dagestan coastal area of Russia (including reported mass poaching), seals tended to avoid coastal areas during the autumn and spring migrations and use routes located away from the coast. Thus, the latest research has shown it is not possible to assume the seals will always follow the previously defined migratory paths close to the east and west coastline and may travel through the centre of the Caspian. Recent research indicates that a significant proportion of seals remain to feed in the Central Caspian (to the north and south of the Absheron Peninsula) throughout summer and autumn.

In terms of the BHEX01 well location, based on the published scientific data as described in the SWAP Exploration Drilling Project ESIA, observations and knowledge from local National experts, it is considered highly unlikely that Caspian seals will be present within the vicinity of the Project location during the drilling operations. This is mainly due to lack of availability of food resources as their main prey are not abundant in this area. Furthermore, seals will tend to avoid the Baku Bay area due to anthropogenic disturbance.

With regard to a release of diesel from a Project vessel at the Project location (Scenario 1), the spill modelling confirmed that surface diesel thicknesses will be greatest near the spill location, dispersing and thinning out with distance and time. It is anticipated that there will be a very small fraction of diesel on the water surface left after 30 days (less than 0.1%). there is a reasonable probability of diesel above the 0.1 litres/m^2 threshold accumulating on the shoreline of mainland Azerbaijan, but this would be localiesd to a few kilometers of the release location. Therefore, exposure of seals to spilled diesel is possible but considered unlikely as the are not known to be commonly present with the Baku Bay area and in the event they were in the vicinity they would likely avoid the area or have limited contact with the diesel.

In the event of a blowout (Scenario 2) there will be a significant volume of oil released to the sea surface. Over time, the volume of oil on the surface will reduce through evaporation, dispersion in the water column and biodegradation. However, under worst case conditions up to 110,513 tonnes of oil may reach the shoreline with the first oil reaching shore within 12 hours of the blowout commencing. The stochastic modelling indicates that different times of year can make a difference to the amount of oil that reaches the shore with blowout start times of February - May likely to result in larger volumes of oil arriving on shore than at other times of the year. For a spill commencing between October and December, the likely amounts of oil reaching shore are far lower. The probability of oil reaching the Azerbaijan coastline varies from 5 - 100% with oil most likely to come ashore around the Absheron Peninsula, Pirallahi Island, Chilov Island and from the Kura Delta to the border with Iran.

Caspian seals are an International Union for Conservation of Nature (IUCN) endangered species and are under pressure from various natural and anthropogenic stressors. Seals are known to be highly sensitive to oiling and are most vulnerable during the breeding season (December to February) and feeding periods (May to November). Therefore, even small-medium scale exposure to toxic effects of diesel, within sensitive areas for seals, could result in a potentially significant impact. The anticipated larger volume of a major spill (i.e. blowout) and relative larger size of slick would increase the potential for contact with seals in the offshore waters and along the coastline meaning a significant impact to seals is highly likely in the event of a blowout.

Protected Areas of Sites of Ornithological Importance

As described in Chapter 3: Section 3.5 the Project location is not located within an Important Bird Area (IBA), with the nearest IBA (Red Lake) located over 10km from the BHEX01 well location. Although not a designated site of importance, the islands of Gum Zira, Dash Zira, Boyuk Zira, Tava and Khanlar island located near the entrance of Baku Bay (approximately 4.5km southeast of the proposed BHEX01 well location) are recognised as key areas for nesting/breeding birds. In a wider context, there are a number of Protected Areas (IUCN Categories II and IV), IBAs, and Key Biodiversity Areas (KBAs) located along the coastline of Azerbaijan. Further details on the locations and reasons for designation of these sites of ornithological importance is provided in Section 5.5 of the SWAP Exploration Drilling Project ESIA.

The shoreline oiling probabilities predicted by modelling in the event of a diesel spill from a Project supply vessel at the Project exploration well location (Scenario 1) or a well blowout (Scenario 2) for each of the areas of ornithological importance are summarised in Table 5.5. In the event of a diesel spill (Scenario 1) diesel is more likely to impact areas of ornithological importance during summer conditions: there is a low probability (10-30%) of diesel, above a threshold of 100ml/m^2, reaching the Red Lake, up to 20% probability of it reaching Sahil Settlement and up to 10% probability of it reaching Sangachal Bay. In the event the diesel does reach these sites there will only be very light deposition (<0.1mm) of diesel and any impacts would be limited in duration and extent.

However, in the event of a blowout (Scenario 2), each of the important ornithological sites listed in Table 5.5 have at least a 40% probability of being impacted by shoreline oiling. For all other sites the probability is 90-100%. Deposition levels at the sites vary from light (0.1-1mm) to heavy (>10mm). Due to the short distance between the BHEX01 well and the islands of Gum Zira, Dash Zira, Boyuk Zira, Tava and Khanlar island these areas are highly likely to experience heavy deposits of oil (>10mm) on their shoreline in the event of a blowout.

The recovery of different coastal and marine habitats from an oil spill varies but for hydrocarbons such as crude oil the recovery typically takes place within a few seasonal cycles for most habitats within one to three years although the recovery in more sheltered areas may take up to five years (Ref.44). Based on this medium to long term recovery and considering international conservation status and ecological importance of these areas, the potential impacts are assumed to be significant.

Table 5.5: Shoreline Oiling Probabilities for Designated Areas along the Absheron to Gobustan Coastline

Sites of Ornithological Importance	Designation	Probability of Shoreline Oiling (Above a threshold of $100ml/m^2$)			
		Diesel loss (Scenario 1)		Blowout (Scenario 2)	
		Summer	Winter	Summer	Winter
Absheron National Park (including Shahdili spit and Pirallahi Island)[5]	KBA[1]/IBA[2] IUCNII[3]	None	None	40 – 70%	90 – 100%
Red Lake	KBA/IBA	10 – 30%	10 – 20%	90 – 100%	
Sahil Settlement – 'Shelf Factory	KBA/IBA	1 – 20%	1 – 10%	90 – 100%	
Sangachal Bay	KBA/IBA	1 – 10%	None	90 – 100%	
Gil Island (or Glynanyi Island) State Nature Sanctuary	KBA/IBA IUCN IV[4]	None		90 – 100%	
Pirsagat Islands and Loc Island	KBA/IBA	None		90 – 100%	
Bandovan (or Byandovan) State Nature Sanctuary	IUCN IV	None		80 – 100%	
Shirvan National Park	KBA/ IBA/ IUCN II	None		60 – 100%	

Birds and Important Bird and Biodiversity Areas

The Caspian region supports a high diversity of bird species, with a large number of endemic and protected species present. There are 15 birds on the IUCN Red List or in the Azerbaijan Red Data Book (AzRDB) known to be present along the Absheron to Neftchala coastline. The Azerbaijan coastline of the Caspian Sea from the Absheron region moving south is an area of international and regional importance providing habitat for breeding, nesting, migratory and overwintering birds, which is reflected in the designation of a number of IBAs.

The distribution and abundance of birds in the coastal region changes significantly during the migration and overwintering periods. A large number of overwintering and migrating birds will be present offshore and along the Central and Southern Caspian coastline within a number of IBAs identified as areas at risk of potential impact from an oil spill (Table 5.6 above). Bird species that spend most of their time on water are most at risk, including a number of overwintering birds (i.e. ducks) which dive in shallow waters to feed on small fish/ benthic invertebrates.

There are some key periods and areas along the coastline of higher sensitivity. Ducks and coots are overwintering from December to February and the presence of migrating species peaks in March and November. The IBAs are the key habitats for these groups of birds, particularly for nesting and breeding, with the Shahdili Spit being particularly important for a wide variety of nesting species. As described above, the the islands of Gum Zira, Dash Zira, Boyuk Zira, Tava and Khanlar island are also important bird nesting areas. The bird nesting season begins at the end of April/beginning May and continues until mid-July. Limited information is available regarding the offshore distribution and abundance of birds in the Southern Caspian; however it is anticipated that there may be small numbers of gulls and birds such as terns that plunge dive to feed and species.

An accidental release of hydrocarbons, particularly crude oil, can impact birds n the nearshore / coastal areas and offshore. The oiling of their plumage is the most obvious impact. When this occurs, the important layer of insulation is disrupted, which results in the skin coming into direct contact with the seawater. In this condition birds lose buoyancy and the ability to take off in search of food and/or escape predation. Smothered plumage also leads to loss of body heat putting the birds at risk of hypothermia as fat reserves beneath the skin are depleted during attempts to keep warm. Ultimately, birds that suffer from cold, exhaustion and loss of buoyancy, may drown (Ref.42).

Should the birds return to a nest, this can transfer the oil to live young or hatching eggs, which can then suffer eggshell thinning, failure of the egg to hatch and developmental abnormalities. Ingestion of oil can lead to congested lungs, intestinal or lung haemorrhages, pneumonia and liver and kidney damage. Birds are likely to ingest oil whilst attempting to clean their plumage.

A small spill during breeding seasons could prove more catastrophic for birds than a larger spill at a different time of the year. The modelling indicates a blowout starting in February to May is likely to result in much larger volumes of oil arriving on shore than at other times of the year, including areas with IBA status. In some locations the oil is likely to persist for a number of months exposing birds and their habitats to the impacts of oil for an extended period.

It is considered that the impacts to birds and IBAs from a release of diesel from the vessel (Scenario 1) will be minor as the spill is mostly limited to Baku Bay with most areas of coastline predicted to have a low probability of diesel reaching the shoreline and only a very light deposition of diesel is expected to in the areas impacted as the diesel evaporates and disperses relatively quickly. In the event of a blowout (Scenario 2), it is considered that the impact of a crude oil spill on birds at sea and the IBAs and KBAs could be significant for the reasons described above and the impacts could be excarbated further if the spill was to occur during the most sensitive time of year for nesting birds in the region.

Fisheries and Other Marine Users

Due to the proximity of the well location to Baku Bay a number of socio-economic receptors such as fisheries, residents of Baku and other coastal communities, divers and coastal tourism could be exposed to the risk from an accidental spill.

As described above, for Scenario 1, the modelled maximum exposure of the water surface to diesel is generally limited to 30 days, and water column exposure to diesel concentrations exceeding the 58ppb threshold is not expected to exceed 11 days. The probability of oil from a blowout (Scenario 2) reaching coastal areas or commercial fishing grounds within Azerbaijan is 90-100% for areas around Baku Bay and further south near Neftchala and Lankaran (refer to Appendix 4B). Although a large percentage of the oil will evaporate, biodegrade or disperse within the water column it is anticipated that up to 86 tonnes of diesel (during winter conditions) and 110,513 tonnes of oil (during winter conditions) could reach the shoreline following a blowout. Areas of the Azerbaijan coastline that are predicted to receive moderate (1-10mm) or heavy (>10mm) depositions of oil include Chilov Island, Absheron Peninsula, Baku Bay, along the coast between Alat and Neftchala as well as the coast of Lankaran (refer to Figure 5.15 and Appendix 4B). A blowout of oil will also result in a significant amount of oil on the sea surface which would slowly reduce over several months (blowout). The concentration of oil in the water column is expected to remain above the 58ppb threshold for greater than 120 days for a blowout in some areas impacted by the spill as illustrated in Figure 5.13.

In the unlikely event of a large spill such as a blowout, in addition to the significant effect on the marine and coastal receptors the negative public perception and media attention can have reputational implications. There is potential for residents and tourist and recreational businesses located within the spill area along the coast to be affected. While the oil at sea will largely evaporate, disperse and biodegrade, any oil reaching the coastline may remain stranded for months on the affected beaches, hence potentially having impacts on the residents and businesses within the affected area. In Baku Bay itself, the spilled oil is initially confined by the artificial surfaces and shorelines in Baku Bay (e.g. the boulevard sea walls) and by projections from the nearby coastline and islands, which along with lower currents and winds near the shore, means the oil is on the surface for a large fraction of the time allowing oil to evaporate. This means that within Baku Bay high levels of evaporation could cause air quality issues onshore if there is a southerly wind direction.

Section 5.6.3 of the SWAP Exploration Drilling Project ESIA provides a comprehensive description of commercial fisheries in Azerbaijan. Commercial fishing is primarily undertaken in relatively shallow water of the Caspian up to 50m water depth. Due to gradual decline of fishing stocks (particularly of anchovy kilka), fishing vessels have adjusted their methods to catch fish at shallower depths. However, there is the potential that a worst case spill from a blowout could have much wider impacts on fishing including to important commercial fishing grounds such as Oil Rocks and the Makarov Bank and smaller scale fishing areas (with fishing taking place within 2-3 nautical miles from the coastline) and landing sites located along the Azerbaijan coastline. The closest commercial fishing ground to the BHEX01 well location is the Makarov Bank (located approximately 28km away) while one commercial fishing vessel is understood to operate out of Bibiheybat port of Baku City. Areas along the coastline between the Absheron Peninsula and Gobustan where the majority of licences have been issued for small-scale fishing include Zira, Hovsan, Shikh, Bayil, Zygh and Sangachal-Gobustan. It is understood that the high season for commercial fishing is during March to April whereas the peak fishing period for small scale fishing occurs in March-April and September-November, although fishing takes place throughout the year.

The impact on fisheries would reflect the impact on fish and the presence of juvenile stages at the time of a spill as they are more susceptible to relatively low levels of oil within the water column and are less likely to be able to move away. Any impact on juvenile stages could impact short to medium term recruitment to future stocks. Despite the susceptibility of fish larvae and juveniles to relatively low concentrations of hydrocarbons in the water column, adult free swimming fish and wild stocks of commercially important species are likely to detect and avoid hydrocarbon contaminated areas. Following a release, the reproductive success of unaffected fish, as well as the influx of larvae from unaffected areas should lead to the recovery of stock numbers. Given that many marine species produce vast numbers of eggs that are widely distributed by sea currents this means that species can recover from small mortality events relatively quickly.

However, fish can become tainted and contaminated with hydrocarbons. If there are signs of fish oil tainting or contamination, in the event of a hydrocarbon spill, any resultant imposed authority restrictions on fishing activities could result in detrimental financial impact upon local fisheries. Equally, a lack of timely restrictions, or illegal fishing, can create a risk to human health from contaminated product consumption. A release of diesel (Scenario 1) is unlikely to have an impact on small scale fishing although in the event of a blowout (Scenario 2) the impact from oil reaching the shoreline in areas of small scale fishing is likely to be significant as fishing represents the primary source of household income for the majority of fishermen. Commercial fishing can also be impacted in the event of a hydrocarbon spill but in the case of a diesel release it is highly unlikely that the spill will impact important commercial fishing grounds. However, in the event of a blowout (Scenario 2) there is high probability that the spilled oil will result in the concentration of oil in the water column exceeding the 58ppb threshold at important commercial fishing grounds such as Oil Rocks, Makarov Bank and Kornilov-Pavlov Bank for a period of time leading to the potential for toxic effects to fish and indirectly on human health that could trigger a temporary fishing ban. Therefore, the impact to the commercial fishing industry in the unlikely event of a blowout is considered to be potentially significant.

In the longer term, fishery products that consumers associate with areas affected by a large spill would become less marketable. This is only likely to occur for more substantial spills that endure over a long period and that receive broad media attention. In an extreme case where there are enduring concerns about food safety there could be restrictions placed by national regulators on all commercial fishing across an affected area.

Summary of Hydrocarbon Spill Impacts

Considering the spill scenarios assessed, the following conclusions can be drawn with regard to the impact of hydrocarbon spills on the marine and coastal environment:

- A spill of diesel from a vessel located at the Project location will have a limited impact to the marine environment as the majority of spilled diesel evaporates, disperses or biodegrades relatively quickly. Although in an absolute worst case 86 tonnes of spilled diesel may reach the shoreline the 50th percentile value[16] predicted is 13 tonnes. It is anticipated that the spilled diesel will reach a wide area of the coastline at very light deposition levels with the exception of some limited areas of coastline in and around Baku Bay which will likely experience moderate deposition. The probability of the spilled diesel reaching the coastline at levels above the threshold of 100ml/m^2 is low and is unlikely to directly impact designated areas with the exception of Red Lake (up to 30% probability of diesel reaching shore), Sahil Settlement (up to 20% probability of diesel reaching shore) and Sangachal Bay (up to 10% probability of diesel reaching shore).
- A major spill from a well blowout has the greatest potential for impact in terms of the volume of hydrocarbons discharged into the marine environment. In the event of a blowout, species in the immediate vicinity of the spill that cannot actively avoid the oil such as plankton, benthic invertebrates, birds and seals are likely to suffer the greatest impacts. Highly mobile species such as fish are anticipated to avoid the spilled oil in most areas. Species which inhabit in and

[16] Means that in 50% of scenarios modelled, this value or less would result.

around Baku Bay will likely suffer the greatest impacts as the spilled oil is initially confined by the artificial surfaces and shorelines in Baku Bay and by projections from the nearby coastline and islands, which along with lower currents and winds near the shore, means the oil is present for a greater period of time compared to other areas. Due to the proximity of the BHEX01 well to Baku Bay a number of socio-economic receptors such as fisheries, residents of Baku and other coastal communities and coastal tourism are also likely to suffer direct and indirect impacts from oil spilled as a result of a blowout.

- The modelling of the blowout predicts that a number of IBAs and KBAs, and associated bird species may be exposed to elevated hydrocarbon concentrations as a result of surface or dispersed / dissolved oil beaching on the shoreline following a blowout. Given the persistence and volume of oil predicted to beach in some IBAs and KBAs and the islands of Gum Zira, Dash Zira, Boyuk Zira, Tava and Khanlar island the potential impact on these areas (and the birds present there) could have a potentially significant impact, especially if the release occurs during the bird nesting period (April to July). The blowout scenario may also affect small scale fishing grounds along the coast, and commercial fishing.

5.3.4 Spill Prevention and Response Planning

The same approach to spill prevention and response planning which is described in Section 7.3.4 of the SWAP Exploration Drilling Project ESIA will be implemented throughout the BHEX01 drilling programme. Please refer to Section 7.3.4 of the SWAP Exploration Drilling Project ESIA for information relating to the Offshore Facilities Oil Spill Contingency Plan (OSCP) to be developed for the SWAP Contract Area exploration activities, Capping and Containment (C&C) Plan and bp AGT Region spill reporting procedures.

6 Environmental and Social Management

6.1 Overview of Environmental and Social Management

Under the Shallow Water Absheron Peninsula (SWAP) Contract Area Production Sharing Agreement (PSA), bp as Operator, is responsible for the environmental and social management to ensure that Project commitments are implemented, and conform to applicable environmental and social legal, regulatory and corporate standards and requirements.

This Chapter should be read in conjunction with Chapter 8 (Environmental and Social Management) of the SWAP Exploration Drilling Project ESIA, which presents an overview of the bp Operating Management System (OMS); the implementation of the Project management system and the overarching Environmental and Social Management Framework to be implemented. These same processes and procedures are also applicable to the BHEX01 well and have not been duplicated in this ESIA Addendum.

The focus of this chapter is to present a summary of key design controls, mitigation measures, monitoring and reporting requirements specific to the BHEX01 well. A summary of the key design controls and mitigation are presented in Tables 6.1 to 6.3; information regarding the source, including the SWAP Exploration Drilling Project ESIA is included in the the table.

Table 6.1: Summary of Key Design Controls, Mitigation Measures, Monitoring and Reporting Requirements for Environmental Management and Pollution Prevention

Reference to BHEX01 Addendum Section	Reference to SWAP Exploration Drilling Project ESIA Section	Summary of Key Measures Outlined in ESIA	Applicable to Jack-Up Rig and/or Support Vessels	Execution Stage[1]
Chapter 2 Summary of BHEX01 Drilling Activities, Section 2.3 Logistics, Supply and Equipment	Chapter 4 Project Description, Section 4.5.1 Jack-Up Rig Positioning	A mandatory 500 metre (m) exclusion zone will be established (for non-project related vessels) around the rig while drilling is in progress.	Jack-Up Rig	DD
Chapter 4 Impact Assessment, Section 4.4.1 Mitigation	Chapter 4 Project Description, Section 4.5.2 Logistics and Utilities, Table 4.2 Summary of Rig and Vessel Utilities	• Grey water will either be sent to the vessel sewage treatment plant with the black water or discharged directly to sea without treatment as long as no floating matter or visible sheen is observable. • Under routine conditions black water will be treated within the sewage treatment system to MARPOL 73/78 Annex IV: Prevention of Pollution by Sewage from Ships standards. No chlorination of the effluent will be required under routine conditions, however when chlorine is used for disinfectant purposes, it is planned to maintain the concentration of residual chlorine in the effluent below 0.5mg/l and discharge to sea. In the event it is not practicable to achieve this concentration, the effluent will be contained and shipped to shore. • When vessels' sewage treatment system is not available, black water will be contained and shipped to shore. • Sewage sludge will be shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures. • Oily and non-oily drainage and wash water will be segregated. Drainage (including deck drainage and wash-down water) will be discharged directly to sea, provided no visible sheen is observable. • Oily water will be shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.	Support Vessels	DD
		• Under routine conditions, grey water will be contained onboard the jack-up rig and sent to the vessel holding tank. • Black water will routinely be sent to the treatment system onboard the jack-up rig, designed to treat sewage to MARPOL 73/78 Annex IV MEPC. 159 (55) standards[2]. • Grey water and treated black water will be contained and transferred to a vessel holding tank, whereby it will be discharged >12 nautical miles from shore in accordance with MARPOL Annex IV (MEPC.157(55))[3] or shipped to shore for disposal in licensed facility. • Rig floor runoff, including WBM spills, collected via rig floor drains will be recycled to mud system with no discharge of drill cuttings or drilling fluids. • Non oily drainage (deck drainage and wash water) may be discharged to sea as long as no visible sheen is observable. • Sewage sludge will be shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.	Jack-Up Rig	DD
Chapter 2 Summary of BHEX01 Drilling Activities, Section 2.3 Logistics, Supply and Equipment[4]	Chapter 4 Project Description, Section 4.5.2 Logistics and Utilities	Consumables such as drilling mud and diesel will be provided to the jack-up rig by vessels from the existing onshore facilities previously used during Azeri, Chirag and Gunashli (ACG) and Shah Deniz (SD) pre-drilling programmes.	Both	DD

Reference to BHEX01 Addendum Section	Reference to SWAP Exploration Drilling Project ESIA Section	Summary of Key Measures Outlined in ESIA	Applicable to Jack-Up Rig and/or Support Vessels	Execution Stage[1]
Chapter 2 Summary of BHEX01 Drilling Activities, Section 2.4 Drilling Operations and Discharges[4]	Chapter 4 Project Description, Section 4.6.3 Drilling Fluids and Cutting Generation	Measures to avoid discharges to the marine environment during mud transfers include: • Appropriate design of the mud pumping system and connections between the jack-up rig and supply vessels; • Preventative maintenance of transfer equipment; and • Appropriate procedures will be used; • Conduct appropriate training/ awareness sessions for the relevant personnel, where required.	Both	DD
Chapter 2 Summary of BHEX01 Drilling Activities, Section 2.8.2 Summary of Discharges to Sea	Chapter 4 Project Description, Section 4.11.2 Summary of Discharges to Sea	There will be no planned discharges to sea of drilling muds and cuttings, BOP fluids, chemicals (including pipe dope) or cement during drilling of the Project exploration well.	Both	DD
Chapter 4 Impact Assessment, Section 4.3.1 Mitigation	Chapter 6 Environmental & Socio-Economic Impact Assessment, Mitigation and Management, Section 6.3.1 Mitigation	Existing controls associated with emissions to atmosphere from jack-up rig power generation and support vessel operations include: • Jack-up rig diesel generators and engines and support vessel engines will be maintained in accordance with written procedures based on the manufacturers' guidelines or applicable industry code or engineering standards to ensure efficient and reliable operation; and • Planned use of good quality, low sulphur fuel.	Both	DD
Chapter 4 Impact Assessment, Section 4.4.1 Mitigation	Chapter 6 Environmental & Socio-Economic Impact Assessment, Mitigation and Management, Section 6.4.1 Mitigation	Vessels will not intentionally approach seals for the purposes of casual (recreational) marine mammal viewing which may result in disturbance;	Support Vessels	Pre-D, DD, PD
		Support vessels are subject to periodical performance review, which includes environmental performance. Corrective actions will be undertaken to address any performance gaps.	Support Vessels	Pre-D, DD
Chapter 4 Environmental & Socio-Economic Impact Assessment, Section 4.4.3.2 Receptor Sensitivity	Chapter 6 Environmental & Socio-Economic Impact Assessment, Mitigation and Management, Section 6.4.3.2 Receptor Sensitivity	Cooling Water Intake - the intake will be fitted with a screen prevent fish entering the seawater system	Jack-Up Rig	DD
Chapter 5 Cumulative and Transboundary Impacts and Accidental Events Section 5.3.2 Release of Chemicals / Waste	Chapter 7 Cumulative and Transboundary Impacts and Accidental Events Section 7.3.2 Release of Chemicals / Waste	All chemicals on the vessels will be labelled and stored appropriately in areas with secondary containment.	Both	Pre-D, DD, PD
Chapter 5 Cumulative and Transboundary Impacts and Accidental Events Section 5.3.4 Spill Prevention and Response Planning[4]	Chapter 7: Cumulative and Transboundary Impacts and Accidental Events Section 7.3.4.1 Oil Spill Contingency Planning - Azerbaijan Offshore	A standalone Offshore Facilities Oil Spill Contingency Plan (OSCP) will be developed for the SWAP Contract Area exploration activities.	Both	Pre-D

Reference to BHEX01 Addendum Section	Reference to SWAP Exploration Drilling Project ESIA Section	Summary of Key Measures Outlined in ESIA	Applicable to Jack-Up Rig and/or Support Vessels	Execution Stage[1]
Chapter 6 Environmental and Social Management, Section 6.1 Overview of Environmental and Social Management[4]	Chapter 8: Section 8.2.1 HSSE Bridging Document	Vessel activities will be managed in accordance with the existing relevant bp AGT Region HSE MS requirements as part of bp OMS.	Support Vessels	Pre-D, DD, PD
		Alignment of the plans, procedures and reporting requirements of the Drilling Contractors' HSE MS and the bp AGT Region's HSE MS will be achieved through the implementation of the Health, Safety, Security and Environment (HSSE) Bridging Document developed by bp and aligned with the Drilling Contractors' HSE MS.	Jack-Up Rig	Pre-D
		The HSSE Bridging Document is a live document and will be reviewed on a regular basis.	Jack-Up Rig	Pre-D, DD, PD
	Chapter 8: Section 8.2.2 Roles and Responsibilities	The Drilling Contractor will be responsible for performing the Project activities under their own HSE MS, the bp AGT Region HSE MS (through the implementation of the HSSE Bridging Document) and in accordance with the requirements of this ESIA.	Jack-Up Rig	DD
	Chapter 8: Section 8.2.3 Training	All training material under both the bp and the Drilling Contractor's HSE MS will be reviewed by bp and any gaps specific to the Project will be ascertained. Should any gaps in training be identified, bp will ensure additional training is provided to raise the environmental and social awareness of the Drilling Contractor's personnel in areas such ecological and social sensitivities, waste management, hazardous materials management handling, spill prevention and recording and reporting requirements.	Jack-Up Rig	Pre-D
	Chapter 8: Environmental and Social Management Section 8.2.5 Monitoring and Reporting	Monitoring and reporting will be undertaken in accordance with the requirements as set out within the environmental management plans developed for the Project. These plans will be developed in alignment with the bp MODU Environmental Operating Procedure (applicable to CDC rigs) which details the method and frequency of reporting for the following categories: • Deck drainage and wash water, garbage disposal unit effluent, black water sewage treatment plant discharge, grey water discharge, oily water and fuel usage records; • Volume of drilling fluids and cuttings discharged; • Wastes shipped to shore; • Drilling/cementing/testing chemicals; • Mud sampling; • Rig chemical inventory; • Use of new or substituted chemicals not included on an approved list; • Seabed Remotely Operated Underwater Vehicle (ROV) monitoring; • Material release reporting; and • Environmental drilling report.	Jack-Up Rig	DD,PD
		It will be the responsibility of bp to report any material release to the Ministry of Ecology and Natural Resources (MENR). Other external reporting requirements and responsibilities will be set out within the management plans.	Jack-Up Rig	Pre-D, DD, PD
	Chapter 8: Section 8.3.1.1 Environmental Management Plan	A Project specific Environmental Management Plan will be developed and will set out the necessary measures (presented in this ESIA) to prevent pollution and limit impacts to the marine environment.	Jack-Up Rig	Pre-D

Reference to BHEX01 Addendum Section	Reference to SWAP Exploration Drilling Project ESIA Section	Summary of Key Measures Outlined in ESIA	Applicable to Jack-Up Rig and/or Support Vessels	Execution Stage[1]
	Chapter 8: Section 8.3.1.2 Pollution Prevention Management Plan	A Pollution Prevention Management Plan will cover issues such as sewage treatment and disposal, chemical selection management, spill response and notification procedures and monitoring and reporting and will include the measures outlined in Chapters 6 and 7 of the ESIA.	Jack-Up Rig	Pre-D, DD
Chapter 4 Impact Assessment, Section 4.2 Scoping, Table 4.1 Key "Scoped Out" Project Activities	-	Appropriate lighting design during night-time works will be implemented, including use of directed illumination, screens, shades, timers, etc. as required. Skyward and seaward light projection will be eliminated as far as safe and practicable, by removing unnecessary illumination, reduction of light intensity and shielding of light sources during the night.	Jack-Up Rig	DD

Notes:
1. Pre-Drilling (Pre-D), During Drilling (DD) and Post Drilling (PD).
2. Five day BOD ≤25mg/l, COD ≤125mg/l, total suspended solids ≤35mg/l, pH between 6 and 8.5 and thermotolerant coliform 100MPN per 100ml. Where chlorine is added, residual chlorine in the effluent to achieve below 0.5mg/l (for STP plants installed after January 2010).
3. Discharged at a distance of more than 12 nautical miles from the nearest land when the ship is en route and proceeding at not less than 4 knots.
4. Italicised text indicates section in the BHEX01 Addendum which references where the relevant key measures can be found in the SWAP Exploration Drilling Project ESIA.

Table 6.2: Summary of Key Design Controls, Mitigation Measures, Monitoring and Reporting Requirements for Waste Management

Reference to BHEX01 Addendum Section	Reference to SWAP Exploration Drilling Project ESIA Section	Summary of Key Measures Outlined in ESIA	Applicable to Jack-Up Rig and/or Support Vessels	Execution Stage[1]
Chapter 4 Impact Assessment, Mitigation and Management, Section 4.4.1 Mitigation	Chapter 4 Project Description, Section 4.5.2 Logistics and Utilities, Table 4.2 Summary of the Rig and Vessel Utilities	Galley waste will be contained and shipped to shore for disposal in accordance with the existing bp AGT waste management plans and procedures.	Jack-Up Rig	DD
		Depending on the availability of the vessel system, galley food waste will either be: • Sent to 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 prior to discharge[2]; or • Contained and shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.	Support Vessels	DD
Chapter 2 Summary of BHEX01 Drilling Activities, Section 2.3 Logistics, Supply and Equipment[3]	Chapter 4 Project Description, Section 4.5.2 Logistics and Utilities, Table 4.2 Summary of the Rig and Vessel Utilities	• In the event of a spill, the main jack-up rig deck drainage will be diverted to the hazardous drainage tank designed to contain spills including synthetic oil based mud (SOBM) / low toxicity material oil based mud (LTMOBM), oil/diesel/cement and oily water. The contents of the hazardous waste tank will be shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures. • Onboard the rig, waste oil collected from the drainage system will be contained and shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.	Jack-Up Rig	DD

Reference to BHEX01 Addendum Section	Reference to SWAP Exploration Drilling Project ESIA Section	Summary of Key Measures Outlined in ESIA	Applicable to Jack-Up Rig and/or Support Vessels	Execution Stage[1]
Chapter 2 Summary of BHEX01 Drilling Activities, Section 2.4.1 Well Design, Table 2.2 BHEX01 Exploration Well Design[3] Chapter 2 Summary of BHEX01 Drilling Activities, Section 2.4.2, Summary of Mud and Cuttings, Table 2.5 Estimated Well Cuttings and Mud Volumes Per Hole Section	Chapter 4 Project Description, Section 4.6 Drilling Operations and Discharges, Table 4.3: Summary of Drilling Discharge Types Chapter 4 Project Description, Section 4.6.1 Well Design and Drilling Fluid Types, Table 4.4: NKX01 Well Design Chapter 4 Project Description, Section 4.6.3.1 Conductor Section Chapter 4 Project Description, Section 4.6.4 Summary of Mud and Cuttings, Table 4.7: Estimated Well Cuttings and Mud Volumes Per Hole Section	SOBM / Low Toxicity Oil Based Mud (LTOBM), Water Based Mud (WBM) and cuttings will be returned to the jack-up rig. Muds will be separated from the cuttings on-board of the rig. Recovered muds and cuttings will be contained and shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.	Jack-Up Rig	DD
Chapter 2 Summary of BHEX01 Drilling Activities, Section 2.4.3 Casing and Cementing	Chapter 4 Project Description, Section 4.6 Drilling Operations and Discharges, Table 4.3: Summary of Drilling Discharge Types Chapter 4 Project Description, Section 4.6.5 Casing and Cementing	Any excess cement generated during the cement placing activities will be circulated out from the well and returned to the jack-up rig and contained in the Drill Cutting Boxes (DCB) for transportation to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.	Jack-Up Rig	DD
Chapter 2 Summary of BHEX01 Drilling Activities, Section 2.4 Drilling Operations and Discharges[3]	Chapter 4 Project Description, Section 4.6.3 Drilling Fluids and Cutting Generation	Mud transferred to the dedicated mud tanks onboard the supply vessel will be transported to shore for further transportation and disposal as waste in accordance with existing bp AGT Region waste management plans and procedures	Support Vessels	DD

Reference to BHEX01 Addendum Section	Reference to SWAP Exploration Drilling Project ESIA Section	Summary of Key Measures Outlined in ESIA	Applicable to Jack-Up Rig and/or Support Vessels	Execution Stage[1]
Chapter 2 Summary of BHEX01 Drilling Activities, Section 2.4.4 Drilling Hazards and Contingency Chemicals	Chapter 4 Project Description, Section 4.6.6 Drilling Hazards and Contingency Chemicals	Along with SOBM / LTOBM and cuttings, unused contingency chemicals remaining in the mud system will be returned to the jack-up rig and shipped to shore for disposal in accordance with the existing bp AGT Region waste management plans and procedures.	Jack-Up Rig	DD
Chapter 4 Impact Assessment, Section 4.2 Scoping, Table 4.1 Key "Scoped Out" Project Activities[3]	Chapter 6 Environmental & Socio-Economic Impact Assessment, Mitigation and Management, Section 6.2 Scoping, Table 6.1 Key "Scoped Out" Project Activities	In relation to waste generation onboard vessels and jack-up rig: • Waste onboard the jack-up rig and support/supply vessels will be segregated at source, stored and transported in fit for purpose containers. • State licensed and approved waste management facilities will be used for disposal of waste during the drilling programme. • Waste generated during the Project will be managed in accordance with the existing bp Azerbaijan Georgia Turkey (AGT) Region management plans and procedures. • Waste management plans will be established for the jack-up rig and support/supply vessels (operated in accordance with the MARPOL 73/78 Annex IV: Prevention of Pollution requirements) in accordance with the existing bp AGT Region management plans and all waste transfers will be controlled and documented.	Both	Pre-D, DD DD Pre-D, DD, PD Pre-D, DD, PD
Chapter 6 Environmental and Social Management, Section 6.1 Overview of Environmental and Social Management[3]	Chapter 8: Environmental and Social Management Section 8.2.4.3 Waste Management Plan of the SWAP Exploration Drilling Project ESIA	The Waste Management Plan (aligned to applicable national regulatory requirements, good international industry practices, existing bp AGT Region management plans and the existing Drilling Contractors' HSE MS and the associated HSSE Bridging Document) will address the anticipated waste streams, likely quantities, disposal routes and any special handling requirements. Key aspects of the Plan include the following points: • Waste will only be routed to authorised waste disposal facilities that have been approved for use by the bp AGT Region. • Non-hazardous waste generated offshore will be segregated, compacted and stored on-board the jack-up rig and vessels, and then transferred to shore to authorised waste management facilities for disposal or recycling. • Hazardous waste streams will be segregated and stored separately to prevent contact between incompatible waste streams. Hazardous waste generated offshore will be stored on board the jack-up rig and vessels in fit for purpose containers and in designated areas and transferred onshore to authorised waste facilities for treatment and disposal. • All waste generated offshore will be tracked and controlled. Waste Transfer Notes (WTNs) will be completed for every waste shipment to shore from the jack-up rig and vessels. The WTNs will detail the waste type, quantity, waste generator, consignee, consignor (if different from the generator) and, in the case of hazardous wastes, both Waste Passports and, where required, Material Safety Data Sheet (MSDS) documentation. A final visual inspection of all waste consignments will be made prior to sign-off and uplift. All parties involved in transporting wastes will retain a copy of the waste transfer documentation.	Both	Pre-D, DD

Notes:
1. Pre-Drilling (Pre-D), During Drilling (DD) and Post Drilling (PD).
2. Designed to produce a slurry of food particles and water that washes easily through the required 25 mm screen.
3. Italicised text indicates section in the BHEX01 Addendum which references where the relevant key measures can be found in the SWAP Exploration Drilling Project ESIA.

Table 6.3: Summary of Key Design Controls, Mitigation Measures, Monitoring and Reporting Requirements for Communication

Reference to BHEX01 Addendum Section	Reference to SWAP Exploration Drilling Project ESIA Section	Summary of Key Measures Outlined in ESIA	Applicable to Jack-Up Rig and/or Support Vessels	Execution Stage[1]
Chapter 2 Summary of BHEX01 Drilling Activities, Section 2.9 Management of Change Process	Chapter 4 Project Description, Section 4.12 Management of Change Process	During the detailed planning and execution stages of the Project programme, there may be a need to change a design element or a process. A formal process will be implemented 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.	Both	Pre-D, DD, PD
		Changes which do not significantly 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.	Both	Pre-D, DD, PD
		If internal review and assessment indicates that a new or significantly increased impact may occur, the following process will be applied: • Categorization 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.	Both	Pre-D, DD, PD
		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 Project ESIA; • Increase the quantity discharged as detailed in the Project ESIA by more than 20%;[2,3] or • Result in the discharge of a chemical not referenced in the Project ESIA and not currently approved by the MENR for use in the same application by existing bp AGT Region operations.	Both	Pre-D, DD, PD
		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 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.	Both	Pre-D, DD, PD
Chapter 4 Impact Assessment, Section 4.2 Scoping, Table 4.1 Key “Scoped Out” Project Activities	Chapter 6 Environmental & Socio-Economic Impact Assessment, Mitigation and Management, Section 6.2 Scoping, Table 6.1 Key	Maritime businesses (including diving companies) will be consulted and informed of the Project drilling activities and the planned schedule.	Both	Pre-D, DD
		Notifications regarding the drilling programme will be issued to the relevant maritime and port authorities, as well as directly communicated with sea users where necessary, in advance of the Project drilling programme.		Pre-D

Reference to BHEX01 Addendum Section	Reference to SWAP Exploration Drilling Project ESIA Section	Summary of Key Measures Outlined in ESIA	Applicable to Jack-Up Rig and/or Support Vessels	Execution Stage[1]
	"Scoped Out" Project Activities	All vessels will operate in compliance with national and international maritime regulations for avoiding collisions at sea, including the use of signals and lights.	Support Vessels	DD
Chapter 4 Impact Assessment, Section 4.3.2.3 Impact Significance	Chapter 6 Environmental & Socio-Economic Impact Assessment, Mitigation and Management, Section 6.3.2.3 Impact Significance	Monitoring and reporting requirements associated with emissions to the atmosphere during jack-up rig drilling activities include: • Jack-up rig diesel usage will be recorded on a daily basis; • Environmental management system audits of drilling operations including jack-up rig drilling will be undertaken periodically; and • The following will be provided to the MENR within the Environmental Report: - Volume of fuel used by the jack-up rig (recorded daily in tonnes and reported monthly); and - Estimated volumes of emissions generated as a result of fuel used (calculated using emission factors).	Jack-Up Rig	DD, PD
Chapter 4 Impact Assessment, Section 4.4.4.3 Impact Significance[4]	Chapter 6 Environmental & Socio-Economic Impact Assessment, Mitigation and Management, Section 6.4.4.3 Impact Significance	Black Water: • During periods when the vessel Sewage Treatment Plant (STP) is in use, sewage samples will be taken from the sewage discharge outlet and analysed monthly for relevant parameters to confirm compliance with the applicable MARPOL 73/78 Annex IV or MARPOL 73/78 Annex IV MEPC. 159 (55)4 standards; • Support vessel sewage sampling analysis results, recorded floating solids observations and estimated volumes of treated black water discharged daily (based on a generation rate of 0.1m^3 per person per day) will be reported to the MENR upon completion of the Project. Grey Water • Daily visual checks undertaken when discharging from support/supply vessels to confirm no visible sheen is observable; • Daily estimated volumes of grey water discharged from support/supply vessels will be recorded monthly and reported to the MENR on an annual basis. Estimates will be based on generation rates of 0.22m^3 per person per day (grey water).	Support Vessels	Pre-D, DD, PD
Chapter 5, Transboundary Impacts and Accidental Events, Section 5.3.4 Spill Prevention and Response Planning[4]	Chapter 7 Cumulative and Transboundary Impacts and Accidental Events, Section 7.3.4.3 Reporting	Under the bp AGT Region spill reporting procedures, all accidental and non-authorised releases (liquids, gases or solids), including releases exceeding approved limits or specified conditions during all phases of the Project, will be internally reported and investigated.	Both	Pre-D, DD, PD
		Existing external notification requirements agreed with the Ministry of Ecology and Natural Resources (MENR) will be adopted for the Project which are: • For liquid releases to the environment exceeding a volume of 50 litres, 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 50 litres, 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.	Both	Pre-D, DD, PD

Reference to BHEX01 Addendum Section	Reference to SWAP Exploration Drilling Project ESIA Section	Summary of Key Measures Outlined in ESIA	Applicable to Jack-Up Rig and/or Support Vessels	Execution Stage[1]
		It will be the responsibility of the contractors to report to bp any spills that occur from vessels used for Project related activities. bp will then proceed through their notification process to the MENR to report any unplanned releases.	Both	Pre-D, DD, PD

Notes:
1. Pre-Drilling (Pre-D), During Drilling (DD) and Post Drilling (PD).
2. 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).
3. Unless increase is deemed to have no material effect on the associated impact(s).
4. Italicised text indicates section in the BHEX01 Addendum which references where the relevant key measures can be found in the SWAP Exploration Drilling Project ESIA.

7 Residual Impacts and Conclusions

7.1 Introduction

This Chapter summarises the residual impacts and conclusions of the Shallow Water Absheron Peninsula (SWAP) Exploration Drilling Project ESIA – BHEX01 Addendum.

7.2 Residual Impacts

Table 7.1 outlines the residual environmental impacts for the activities associated with the Project. As outlined in Chapter 4, no social impacts are anticipated as a result of the Project.

Table 7.1 Summary of Residual Environmental Impacts for Project Exploration Drilling Activities

	Event/Activity	Significance Rating		
		Event Magnitude	Receptor Sensitivity	Impact Significance
Atmosphere	Jack-up Power Generation	Medium	Medium	Moderate Negative
	Support Vessel Engines	Medium	Medium	Moderate Negative
Marine Environment	Generation of underwater sound from jack-up Rig Positioning / Demobilisation	Medium	Low	Minor Negative
	Generation of underwater sound from drilling (excluding conductor driving)	Medium	Low	Minor Negative
	Generation of underwater sound from use of support vessels	Medium	Low	Minor Negative
	Generation of underwater sound from conductor Driving	Medium	Low	Minor Negative
	Generation of underwater sound from VSP Airgun Operations	Medium	Low	Minor Negative
	Jack-up Rig Cooling Water Intake and Discharge to Sea	Medium	Low	Minor Negative (fish and plankton)
	Jack-up Rig Cooling Water Intake and Discharge to Sea	Medium	Medium	Moderate Negative (benthic communities)
	Drainage Water Discharge	Low	Medium	Minor Negative
	Support Vessel Treated Black Water Discharge	Medium	Medium	Moderate Negative
	Support Vessel Grey Water Discharge	Medium	Medium	Moderate Negative
	Support Vessel Galley Waste Discharge	Low	Medium	Minor Negative
	Seabed disturbance due to positioning of the jack-up rig	Medium	Medium	Moderate Negative

Emissions (non greenhouse gas (GHG)) to the atmosphere associated with jack-up rig power generation and support vessel engines were assessed. Air quality dispersion modelling results demonstrated that, during routine drilling activities at the Project location, the predicted concentrations at onshore receptors are expected to be well below the short term limit value of 200µg/m^3 for nitrogen dioxide (NO_2), the main atmospheric pollutant of concern and its potential to impact upon human health and the environment. For vessels, emissions are expected to disperse rapidly and are not expected to result in measurable increases in NO_2 concentrations at onshore locations and additional mitigation was not required.

The BHEX01 well location is not considered to be sensitive to the Caspian seal as it is understood that they are unlikely to use the waters in this area (due to turbidity, lack of food resources and anthropogenic disturbance) and hence impact to seals from the generation of underwater sound is considered unlikely. Fish species understood to be present in Baku Bay are not considered to be rare, unique or endangered species. This was confirmed from analysis of a drop down video during the BHEX01 Environmental Baseline Survey (EBS). The potential impact to fish from the generation of underwater sound was based on underwater sound modelling undertaken for the NKX01 well location (presented in the SWAP Exploration Drilling Project ESIA) to understand the extent of the impact. It was concluded that underwater sound generated from the jack-up rig positioning; support vessel movements; drilling (excluding conductor driving); conductor driving; and VSP airgun operations was expected to have a minor negative impact to seals and fish for all activities.

Modelling of the cooling water which will be discharged from the jack-up rig during drilling operations showed that the temperature difference between the discharge plume and ambient conditions will return to zero well within 100m of the discharge location with an increase of 0.2-0.5°C occurring within the first few metres of the discharge point for both summer and winter conditions. The modelling results also indicates that cooling water discharge plume will not reach the sea surface, however due to the very shallow water and the depth of discharge the plume is predicted to reach the seabed and be in contact with the benthos for a very short period, although the change in temperature is very small. The assessment concluded that a minor negative impact was expected to fish, zooplankton and phytoplankton are predicted from cooling water discharge. Due to the presence of the, *Dreissena caspia bivalve*, the impact to the benthic community is expected to be moderate negative, however it is recognised the change in temperature is very limited and benthos is unlikely to be affected. It is considered that impacts from the discharge of cooling water are minimised as far as practicable.

The remaining discharges to sea from vessels (ballast water, treated black water, grey water and deck drainage) are all small in volume 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 negative impact upon biological receptors in the water column, while a moderate negative impact is predicted for the benthic community, which includes the species *D. caspia*.

Seabed disturbance from the positioning of the jack-up rig is expected to be short term and localised, occupying an area less than 500m^2 for the duration of the drilling programme (approximately 3 to 4 months). 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. However, as stated above the bivalve *D. caspia* is also expected to be present. While the impact to the benthic community from physical disturbance would be considered of minor negative significance, the presence of *D. caspia* increases the significance to Moderate Negative although it should be noted that this species is low in abundance at the BHEX01 well location (accounting for ~2% of individuals recorded) and the area of seabed impacted is minimal, with rapid recovery and reestablishment expected. Given the overall area of the jack-up rig footprint is limited as far as possible, no additional mitigation is required.

No discharges of drilling muds and fluids will occur as a result of the exploration drilling activities. This is in accordance with the Production Sharing Agreement for the Contract Area.

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

7.3 Cumulative, Transboundary Impacts and Accidental Events

In general, potential Project impacts are expected to be both of a short duration and concentrated to mostly within a few hundred metres to several kilometres of the BHEX01 well location. Due to the localised nature of the Project's impacts and the absence of other development projects in the area, no cumulative or synergistic impacts are expected.

With regard to emissions to atmosphere, the most significant air quality pollutant in terms of health impacts is NO_2. The estimated GHG emissions associated with BHEX01 well drilling programme represent approximately 0.6.% of the annual operational GHG emissions from bp's upstream activities in Azerbaijan based on GHG emissions data from 2019.

To support the assessment of unplanned events, modelling of potential hydrocarbon spill scenarios using Stiftelsen for Industriell og Teknisk Forskning (SINTEF)'s Oil Spill Contingency and Response

(OSCAR) modelling software was undertaken to predict the behaviour of the spilled hydrocarbon in the water column and on the sea surface and to estimate where and how much spilled hydrocarbon may come ashore. It must be noted that modelling has not taken into account any response mitigation measures such as dispersant application, containment or recovery, meaning that the results should only be interpreted as indication of theoretical spill consequences without implementation of the oil pollution prevention strategy.

The key accidental event scenarios modelled and assessed included:

- Scenario 1: Supply vessel inventory loss of 600m^3 of diesel; and
- Scenario 2: A blowout of crude oil (957,402 m^3) over 81 days duration.

The modelling indicated that following the release of 600m^3 of diesel, initially the majority of the diesel was predicted to be present on the sea surface. Over the first two days around 50% of the volume was predicted to evaporate while in the second half of the first day following the release there is a rapid accumulation of diesel on shore. Dispersion and dissolution into the upper water column is expected to take place very close to the release point. The diesel is predicted to travel less than 60km from the point of release in both summer and winter conditions before it drops below the lowest recognised visible thickness under ideal viewing conditions of 0.04 micrometres (μm). During the summer, the spill will be localised and largely confined near Baku Bay by coastal projections and islands. In winter, the diesel takes a different path and is slightly more persistent due to the lower temperature, resulting in shoreline deposition over a larger area.

Modelling for the blowout event was based on a worst case estimate that the release would continue for an estimated 81 days, which is the time that would be required to mobilise a drilling rig and to drill a relief well. During this time, it was estimated that approximately 957,402m^3 of crude oil would be released. The modelling indicated that the majority of the oil would initially be present on the sea surface following the release. The modelling simulation found that a significant fraction of the oil evaporated, reaching 46% of the total spilled oil volume by the end of the simulation period (120 days). This is due in part to the fact a large fraction of the shoreline in Baku Bay is artificial and is formed of marine walls and structures, which can retain less oil than a sandy shoreline. Furthermore, the projections from the nearby coastline and islands act to confine the oil, and since there are lower currents and winds at the shore, the oil is on the surface for a large fraction of the time allowing evaporation to occur. Ultimately the modelling predicts 46% of the oil evaporates, 26% is biodegraded, <1% remains in the water column, 23% is deposited in sediments with approximately 4.6% reaching the shoreline. No oil is predicted to remain on the sea surface by the end of the modelling period (120 days). The crude oil on the sea surface was predicted to travel around 400-500km before it drops below the lowest recognised visible thickness under ideal viewing conditions. Although the precise movement of the surface oil is dependent on the exact metocean conditions at the time, the analysis of over 100 different sets of metocean data suggest that the most likely locations to receive oil on shore are Azerbaijan and northern Iran.

The modelling predicts that a blowout under winter conditions could result is a worst case of 110,513 tonnes of oil reaching the coastline and that this would mainly impact the coastline of Azerbaijan, particularly around the Absheron Peninsula, Pirallahi Island, Chilov Island and from the Kura Delta to the border with Iran, and northern Iran. The modelling under summer conditions also predicts oil reaching the Russian coast. The eastern coastline of the Caspian Sea is at much lower risk of oiling. A mixture of areas of very light (<0.1mm), light (0.1-1mm), moderate (1-10mm) and heavy (>10mm) oil deposition are predicted in these areas. The maximum level of deposition on the artificial shorelines in Baku Bay is predicted to be moderate, as these shorelines are comprised of marine walls and structures which retain less oil than other shoreline types such as sand.

In the event of a blowout, species in the immediate vicinity of the spill that cannot actively avoid the oil such as plankton, benthic invertebrates, birds and seals are likely to suffer the greatest impacts. Highly mobile species such as fish are anticipated to largely avoid the spilled oil areas although the risk to fish potentially increases near the BHEX01 well due to its location within shallow water (approximately 4m water depth) at the entrance to Baku Bay. The modelling of the blowout shows that a number of Important Bird Areas (IBAs) and Key Biodiversity Areas (KBAs), and associated bird species as well as the islands of Gum Zira, Dash Zira, Boyuk Zira, Tava and Khanlar which are important nesting sites, may be exposed to elevated hydrocarbon concentrations as a result of surface or dispersed / dissolved oil beaching on the shoreline. Given the persistence and volume of oil predicted to beach in some IBAs and KBAs and the islands mentioned above the potential impact on IBAs and KBAs (and the birds present there) could be potentially significant, especially if the release occurs during the bird nesting period (April to July).

Species which inhabit in and around Baku Bay will likely suffer the greatest impacts as the spilled oil is initially confined by the artificial surfaces and shorelines in Baku Bay and by projections from the nearby coastline and islands, which along with lower currents and winds near the shore, means the oil is present for a greater period of time compared to other areas. The recovery of different coastal and marine habitats from an oil spill varies but for hydrocarbons such as crude oil the recovery typically takes place within a few seasonal cycles for most habitats within one to three years although the recovery in more sheltered areas may take up to five years.

Due to the proximity of the BHEX01 well to Baku Bay a number of socio-economic receptors such as residents of Baku and other coastal communities and coastal tourism are also likely to suffer direct and indirect impacts from oil spilled as a result of a blowout. The blowout scenario may also affect small scale fishing grounds along the coast, and commercial fishing. The AGT Region Offshore Facilities Oil Spill Contingency Plan (OSCP) provides guidance and actions to be taken during a hydrocarbon spill incident associated with all Azeri Chirag Gunashli (ACG) and Shah Deniz (SD) 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. This plan will be updated to include activities within the SWAP Contract Area.

7.4 Environmental and Social Management

bp will have overall responsibility for managing the Project activities and will be monitoring and verifying the implementation of environmental and socio-economic mitigation measures detailed in this ESIA Addendum.

The Project specific environmental and social management plans will be developed by bp as part of the overall SWAP Exploration Drilling Project, before drilling commences (starting with the NKX01 well described in the SWAP Exploration Drilling Project ESIA). The plans, procedures and reporting requirements for the Jack-Up Rig and those relevant to drilling activities will be aligned to the existing bp and Operator's Health Safety and Environmental (HSE) Management System (MS), the Health Safety, Security and Environment (HSSE) Bridging Document and the bp Environmental Operating Procedure and associated Environmental Monitoring & Reporting Forms.

The plans will cover the following topics:

- Environmental Management;
- Pollution Prevention Management;
- Waste Management; and
- Communication Management.

The plans will identify key criteria (e.g. waste volumes, discharge parameters, marine mammal observations, communication frequency, etc.) that will be used to measure environmental and social performance.

bp will verify that mitigation measures and commitments set out in this ESIA Addendum are implemented. This will be achieved through periodical environmental checks and reviews, the results of which will be documented within "Site Inspection Reports". An action-tracking system will be maintained to monitor close-out actions and the effectiveness of actions taken in response to findings.

7.5 Conclusions

The assessment of activities associated with the Project exploration drilling demonstrated that with implementation of existing design control and mitigation measures the residual environmental and socio-economic impacts will be of minor negative significance for underwater sound generation and cooling water intake and discharge for fish and plankton. Due to the proximity of the BHEX01 well to residential receptors, a moderate negative impact is anticipated from emissions from support vessel engines and the jack up power generation. This impact will be short term only.

Discharges (including cooling water from the jack-up rig and support vessel discharges) and seabed disturbance are anticipated to have a moderate negative impact on the benthic community due to the presence of the bivalve *D. caspia,* which has IUCN critically endangered status. Activities affecting the benthic community are considered to have been mitigated as far as possible.

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APPENDIX 2A

Cement Chemicals

Additive	Hazard Category[2]	Equipment Commisioning Mix Trial		24 in Liner		20" Casing		16 in Liner		13-3/8" Casing		9-5/8" Liner		P&A plugs x 2 (original and sidetrack)		Plug Across Shallowest DPZ and Environmental Plug		End of Well Possible Disposal	
		Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) **
Class C Cement (D903)	E			20.40	10.20					125.00	62.50	0.00	0.00	0.00	0.00	0.00	0.00		
D174-Expanding Agent LT	E			1.20	0.60														
D195-HP Lite Extender	E			4.80	2.40					12.00	6.00								
D163 - Microfine cement *	E			3.60	1.80					25.00	12.50								
Cement Class G D907	E	13.00	13.00	11.00	5.50	111.75	55.87	154.89	77.45	230.61	115.30	70.58	35.29	215.42	107.71	95.74	47.87	50.00	50.00
Antifoam Agent D206	Gold	0.10	0.10	0.33	0.15	0.51	0.25	0.63	0.32	0.79	0.39	0.43	0.21	1.23	0.61	0.76	0.38		
Silicate Additive D75	E																		
Weighting Agent Hematite D076	E																		
Accelerator D077	E			1.00	0.40	2.64	1.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.79	0.90		
SALTBOND II Dispersant D080A	Not currently listed in UK OCNS Lists of Notified and Ranked Products (former B)													1.25	0.62				
Low Temperature Retarder D081	E			0.68	0.34	1.35	0.67	0.00	0.00	0.00	0.00	2.31	1.15	0.00	0.00	0.51	0.26		
Cemnet D095 LCM	E			0.20	0.10	0.43	0.22	0.73	0.36	1.13	0.57	0.27	0.14	0.82	0.41	0.00	0.00		
Liquid Extender B038	E			0.39	0.18	4.41	2.20	9.72	4.86	15.91	7.95	2.87	1.43	8.51	4.25	4.71	2.35		
Dispersant D145A	Gold																		
Mid Temperature Retarder D177	Not currently listed in UK OCNS Lists of Notified and Ranked Products					1.35	0.67	3.30	1.65	4.38	2.19	2.31	1.15	5.91	2.95	0.51	0.26		
Low Temp Dispersant D230	Gold			0.41	0.18	0.64	0.32	0.65	0.33	0.81	0.41	0.48	0.24	1.25	0.62	0.77	0.39		
Accelerator D186 Low Temperature Set	Gold																		
Solid Extender D188	E																		
Fluid Loss Agent D193	Gold																		

Additive	Hazard Category[2]	Equipment Commisioning Mix Trial		24 in Liner		20" Casing		16 in Liner		13-3/8" Casing		9-5/8" Liner		P&A plugs x 2 (original and sidetrack)		Plug Across Shallowest DPZ and Environmental Plug		End of Well Possible Disposal	
		Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) *	Estimated Use per Hole (tonnes)	Worst Case Discharged (tonnes) **
AccuSET D197	Gold																		
Losseal D097	Gold			0.15	0.08	0.43	0.22	0.73	0.36	1.13	0.57	0.27	0.14	0.82	0.41	0.00	0.00		
GASBLOK* LT D500	Gold			1.50	0.55	3.68	1.84	7.34	3.67	11.80	5.90	3.49	1.75	3.74	1.87	0.00	0.00		
D620 GASBLOK-Gas-Migration Control Additive	Gold											6.98	3.49	17.35	8.68				
Mid-Temp Retarder-L D801	E											2.31	1.15	5.91	2.95				
MUDPUSH* II Spacer D182	Gold			0.52	0.52	0.52	0.52	0.68	0.68	0.54	0.54	0.63	0.63	2.67	2.67	1.31	1.31		
Ezeflo* F103 Surfactant	Gold			1.60	1.60	1.53	1.53	1.95	1.95	1.60	1.60	1.81	1.81	7.31	7.31	3.76	3.76		
Mutual Solvent U67	Not currently listed in UK OCNS Lists of Notified and Ranked Products			1.60	1.60	1.55	1.55	1.98	1.98	1.62	1.62	1.83	1.83	7.41	7.41	3.81	3.81		
D231 Solvent	Gold			1.60	1.60														
D232 Surfactant	Gold			1.60	1.60														
D259 Spacer additive fiber	Gold					0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.21	0.00	0.00	0.00	0.00		
D195S-HP Lite Extender ***	E			4.80	2.40					12.00	6.00								
D035-LITEPOZ Extender	E									19.00	9.50								
D168-Fluid Loss Additive	Gold											3.49	1.75	11.19	5.59	4.71	2.36		

APPENDIX 4A

Atmospheric Emissions Estimate

Offshore BHEX01 Well Drilling Air Quality Modelling Assessment

SWAP Exploration Drilling Project

1. Table of Contents

2. Figures

3. Tables

3.1 Units and Abbreviations

Unit	Description
°C	Degrees Celsius
g/s	Grams per Second
K	Degrees Kelvin
kg/hr	Kilograms per Hour
km	Kilometre
lb/MMBTu	Pounds per Million British Thermal Units
m	Meters
m/s	Meters per Second
m^3	Cubic Metres
m^3/day	Cubic Metres per Day
mg/Nm^3	Micrograms per Standardised Meter Cubed of Air
MMscfd	Million Standard Cubic Feet per Day
MW	Mega Watts

Abbreviation/ Acronym	Description
ADMS	Atmospheric Dispersal Modelling System
CO	Carbon monoxide
ESD	Emergency Shutdown Depressurisation
EU	European Union
GHG	Greenhouse Gas
IFC	International Finance Corporation
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_X	Oxides of nitrogen
PM	Particulate matter
SO_2	Sulphur dioxide
UK	United Kingdom
US	United States
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
WHO	World Health Organisation

4. Executive Summary

An air dispersion modelling study for the offshore drilling activities associated with the Shallow Water Absheron Peninsula (SWAP) Exploration Drilling Project, BHEX01 exploration well located within the West Prospective Area for the purpose of the project Environmental and Social Impact Assessment (ESIA) has been undertaken.

The scope of the modelling study was to estimate any changes in ambient atmospheric pollutant concentrations attributed to the offshore drilling activities. Pollutant species and corresponding averaging periods have been based on the applicable ambient air quality limit values, set for the protection of human health, and modelled at discrete onshore receptors.

The assessment considered the following emissions sources:

- Main Power 5 x Caterpillar 3516C (3125 kVA each)
- Energy Power 1 x Caterpillar 3516 C (3125 kVA)

The assessment considered a scenario of all sources in operation for the whole year. Although the drilling of the BHEX01 well is expected to commence in Q4 of 2021 and continue for up to 3 months, the assessment has modelled for the whole year to assess the worst-case scenario. The conclusions from this worst-case scenario will remain valid even if the drilling is undertaken in other months or prolonged to a longer period.

Atmospheric dispersion modelling was completed for pollutant species nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur dioxide (SO_2) and particulate matter measuring 10 microns (µm) or less in diameter (PM_{10}). Results have been presented as modelled contributions and in combination with anticipated background concentrations, presented at the closest onshore receptor locations; Absheron Peninsula, Baku, Sangachal and other towns.

This assessment has used the height of release 28 metres above the surface of the Caspian Sea.

The maximum ground level annual average NO_2 contribution was predicted to be less than 2 micrograms per cubic metre (µg/m^3) in Baku. The maximum predicted ground level short term NO_2 contribution was predicted to be less than 50 µg/m^3, also in Baku. The maximum predicted ground level short term SO_2 contribution was predicted to be 0.5 µg/m^3 at 24-hour scale, and 3.0 µg/m^3 at 1-hour scale, both in Baku.

The maximum modelled annual average PM_{10} contribution, at the worst-affected receptor, was predicted to be less than 0.1µg/m^3. The maximum short term PM_{10} contribution was predicted to be 0.1µg/m^3. The modelled contributions were not predicted to lead to any discernible impact on air quality concentrations onshore.

When taking account of the existing background concentrations the predicted concentrations comply with the air quality limit values, with the exception of PM_{10}. This can be attributed to the natural occurrence of particulate matter in the local environment reflecting the high particulate concentrations associated with dry arid region (for example soil particles becoming airborne through wind entrainment). The contribution of SWAP offshore activities to increases in PM_{10} concentrations at onshore receptors is insignificant.

In summary, it is not expected that SWAP offshore drilling activities will cause the applicable air quality limit values to be exceeded at onshore locations where concentrations currently comply with the limit values, and the contribution of SWAP offshore drilling emissions to concentrations of pollutant at onshore receptors is estimated to be very small and likely to be indiscernible.

5. Introduction

The Production Sharing Agreement (PSA) to jointly explore and develop potential prospects in the SWAP Contract Area was signed between BP and the State Oil Company of Azerbaijan Republic (SOCAR) in December 2014. BP Absheron Limited holds a 50% participating interest in the PSA, with the remaining 50% held by SOCAR Oil Affiliate.

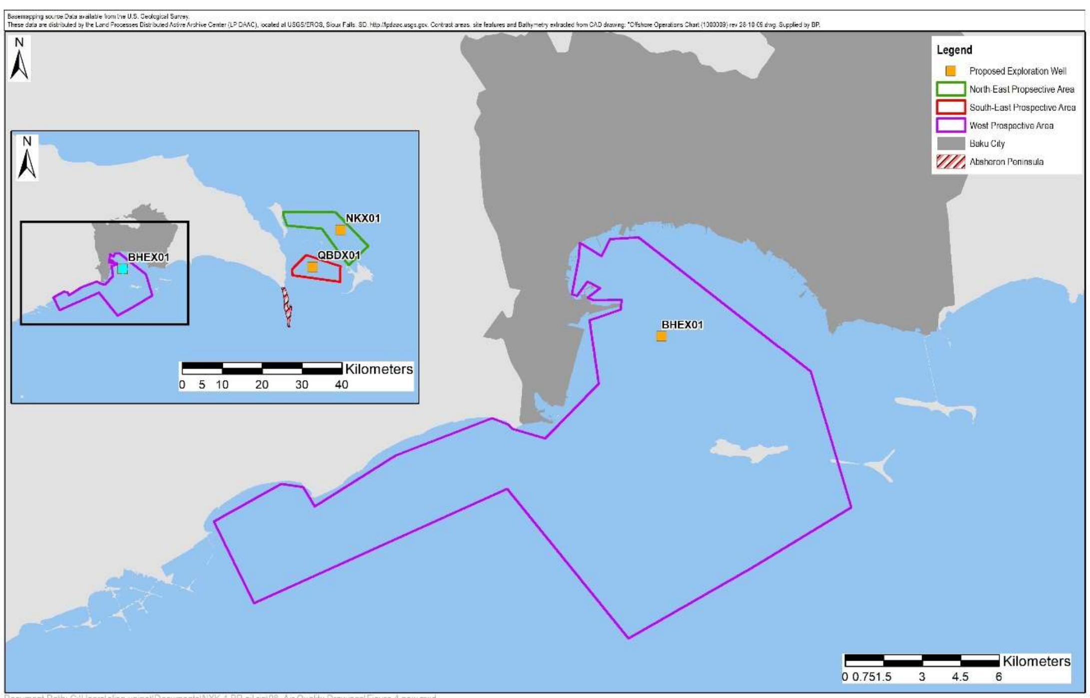
This Environmental and Socio-Economic Impact Assessment (ESIA) has been prepared for the Shallow Water Absheron Peninsula (SWAP) Exploration Drilling Project. The SWAP Contract Area comprises three Prospective Areas.

The BHEX01 exploration well is located within the West Prospective Area as shown within Figure 1, approximately 4km from the the city of Baku in a water depth of approximately 4m. It is proposed to commence drilling of the BHEX01 exploration well in Q4 2021.

The BHEX01 well is planned to target hydrocarbons approximately 2,500m below the seabed surface and drilling activities are expected to take up to 90 days to complete. During this period, assistance to the drilling rig will be provided by support vessels. Drilling of the BHEX01 well will be carried out, taking into account applicable national and international legal requirements and in accordance with the requirements of the SWAP PSA.

The key objective of drilling the BHEX01 well is to confirm well integrity and flow conditions in this part of the reservoir prior to the potential future development of the Contract Area

Figure 1. SWAP: North East Prospective Area and Proposed BHEX01 Exploration Well Location



6. Purpose and Scope

The purpose of this report is to present the air dispersion modelling study for the offshore drilling activities associated with the BHEX01 drilling project. The scope of the modelling study is to estimate any changes in ambient atmospheric pollutant concentrations attributed to the drilling activities. The results are presented as modelled contribution isopleths across the offshore domain and at selected onshore locations. Pollutant species and averaging periods have been based on the applicable ambient air quality limit values, set for the protection of human health.

7. Methodology

The following steps have been followed to undertake the assessment:

1. Define applicable air quality limit values and associated averaging periods;
2. Select a suitable atmospheric dispersion model;
3. Define the modelling scenarios;
4. Determine the model input parameters,
5. Define dimensions of modelling grid and location of sensitive onshore receptors;
6. Define background pollutant concentrations at onshore receptors;
7. Undertake the air dispersion modelling for the defined scenarios; and
8. Compare the modelled pollutant concentrations (including background concentrations) against the applicable air quality limit values to identify potential air quality impacts.

7.1 Air Quality Limits

Ambient air quality limit values are defined with the aim of avoiding, preventing or reducing harmful effects to human health and/or the environment as a whole.

Each limit value is presented for a given averaging period, based on scientific knowledge of known toxicity to human health. Certain limit values are allowed a certain number of exceedances per calendar year, which corresponds to a particular 'percentile'.

Table 1 summarises the ambient air quality limits and averaging periods as provided by:

- World Health Organisation (WHO) Guidelines (Ref. 1);
- International Finance Corporation (IFC) General Environmental, Health and Safety (EHS) Guidelines (Ref. 2);
- World Bank Pollution, Prevention and Abatement Handbook (now superseded by IFC Guidelines) (Ref. 3);
- European Union (EU) Guidelines on Air Quality (Ref. 4), and
- Traditional Azeri air quality limit.

The limits that have been adopted by the SWAP Project are shaded in grey.

Table 1. Ambient Air Quality Limit Values

Pollutant	Averaging period	Ambient Air Quality Limit Values (µg/m³)				
		WHO	IFC	Former World Bank	EU	Azeri Limit
NO_2	1 hour	200	200	400	200 (99.8th %ile)	85+
	8 hour	-	-	-	-	-
	24 hour	-	-	150	-	40
	Annual	40	40	100	40	-
CO	1 hour	-	-	-	-	5,000[b]
	8 hour	-	-	-	10,000 (100th %ile)	-
	24 hour	-	-	-	-	3,000
SO_2	10 minute	500	500	-	-	500[b]
	1 hour	-	-	350	350 (99.7th %ile)	-
	24 hour	125[a]	125[a]	125	125 (99.2%ile)	50
	Annual	-	-	50	-	-
PM_{10}	1 hour	-	-	-	-	500[b]
	24 hour	50 (99th %ile)	50 (99th %ile)	125	50 (90.4th %ile)	150
	Annual	20	20	50	40	-

Notes:
[a] Interim target
[b] Maximum Permissible Concentration, taken to be for a 1 hour averaging period (except for SO_2 where a 10 minute averaging period is used by WHO and IFC)

These limit values apply to locations where members of the public are expected to be normally present (e.g. residential areas, schools, hospitals). They do not apply to work premises such as the offshore platforms, which are subject to less stringent workplace limits. Occupational, workplace exposure is not assessed within this report.

The study pollutants are described, as follows:

- **Nitrogen dioxide:** Oxides of nitrogen (NO_X) are formed as a by-product of the high temperature combustion of fossil fuels (such as natural gas) by the oxidation of nitrogen in the air. NO_X primarily comprises of nitrogen oxide (NO), but also contains NO_2; once emitted the former can be oxidised in the atmosphere to produce further NO_2. It is the NO_2 that is associated with the health impacts; at high concentrations it can affect lung function and airway responsiveness, and enhances asthma and mortality. The rate of conversion of NO_X to NO_2 in the atmosphere is discussed in Section 3.3.2 of this report;

- **Sulphur dioxide:** SO_2 is a colourless gas that is readily soluble in water. It is formed through the combustion of sulphur containing fossil fuels and is a major air pollutant in many parts of the world. Excessive exposure to SO_2 (above the limit values) may cause discomfort in the eye, lung and throat.

- **Particulate matter**: Health based assessment criteria focuses on the fine 'PM_{10}' size fractions, which are predominately generated through the combustion of fossil fuels. PM_{10} is defined as particulate matter with an aerodynamic diameter of less than 10 microns. Exposure to increased levels are consistently associated with respiratory and cardiovascular illness and mortality;

- **Carbon monoxide:** CO is formed by the incomplete combustion of carbon containing fuels such as natural gas. Exposure to high concentrations causes carboxyhaemoglobin, which substantially reduces the capacity of the blood to carry oxygen.

The modelling results are therefore presented for against the following pollutants and averaging periods:

- NO_2 1 hour peak (project limit value)
- NO_2 annual average (project limit value)
- SO_2 24 hour average (project & Azeri limit value)
- SO_2 1 hour peak (project limit value)
- PM_{10} annual average (project limit value)
- PM_{10} 24 hour average (project & Azeri limit value)

Additional, Azeri limit values are presented in Annex A, but not discussed within the details of this report:

- NO_2 24 hour average (Azeri limit value)
- PM_{10} 1 hour peak (Azeri limit value)
- CO 1 hour peak (Azeri limit value)
- CO 24 hour average (Azeri limit value)

7.2 Model Selection

A range of models are available for atmospheric dispersion modelling including 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).

This assessment has been undertaken using the UK Atmospheric Dispersion Modelling System, ADMS5.

ADMS 5 (and previous) versions have been extensively validated for industrial sources by the model developers Cambridge Environmental Research Consultants (CERC). Details on model validity are available from their library of validation reports available at http://www.cerc.co.uk/environmental-software/model-validation.html

The resources available at this website also explain in detail the approach used to model the dispersion of emissions to the atmosphere in three dimensions and the manner in which surface parameters are taken into account.

Reasons for selection of ADMS5 are given as follows:

- Many regulatory authorities explicitly endorse or accept the use of ADMS 5. In the UK the Environment Agency (EA) does not formally "approve" any model. However, ADMS is routinely used and approved by the EA, Scottish Environmental Protection Agency, and the Department of the Environment in Northern Ireland. ADMS is also routinely used on behalf of Defra, the UK Government Department for the Environment;

- ADMS is included in the United States Environmental Protection Agency's (US EPA) List of Alternative Models, and is also approved for all types of environmental impact assessment in China. ADMS is also an approved model in France, Italy, the Netherlands, Ireland, the Baltic States, South Africa, Hungary and Thailand and was used by the California Department of Health. The models are also used in Spain, Portugal, Sweden, Cyprus, Austria, United Arab Emirates, Sudan, Saudi Arabia, Tunisia, Slovenia, Poland, New Zealand, Korea, Japan, India, Canada and Australia;

- ADMS has been rigorously validated by its developers (CERC) against existing monitoring data and alternative models that are available. For the validation studies that applied simple terrain (which is considered to be the most similar to offshore conditions), ADMS outperformed other models (such as the US regulatory model AERMOD) and demonstrated a model accuracy of within ±10% of the actual monitoring findings;

- ADMS 5 incorporates a superior basis for dispersion modelling, based on the Monin-Obhukov length parameter, rather than the Pasquill stability classes/Gaussian profiles which was used in earlier models such as OCD, NRPB-91 and ISCST. The systems in practice give similar results for stable and neutral atmospheric stability conditions, however, under unstable conditions, the predictions of models incorporating the Monin-Obhukov length are regarded as superior; and

- The ADMS 5 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, which incorporates the integrated plume rise approach but lacks a Monin-Obhukov based dispersion model.

7.3 Model Scenario

It is planned to use a jack-up rig for the drilling of the BHEX01 well with the main emissions sources comprising:

- Main Power 5 x Caterpillar 3516C (3125 kVA each)
- Energy Power 1 x Caterpillar 3516 C (3125 kVA)

The model has considered a single scenario based on all engines operating at full load for the duration of the drilling schedule.

7.3.1 Model Input Parameters

The parameters required by the ADMS5 model to calculate the predicted concentrations associated with the emissions are presented in Table 2.

Table 2. Emissions Parameters

Parameter	Main Power	Mechanical Power
Model	CAT 3516C	CAT 3516C
Fuel Type	Diesel	Diesel
No. units/Flues	5	1
Power output (kW)	2500 ekW x 5	2500 ekW
Height of release point above sea level (m)[1)]	28	28
Fuel mass flux rate (kg/h)	554.6 x 5	554.6
Internal stack diameter per unit (m)	0.575	0.575
Exit gas temperature (°C)	492.2	492.2
Exit gas flow rate per unit (m^3/s)	9.29	9.29
Maximum NO_X emission rate per unit (g/s)	9.378	9.378
Maximum CO emission rate per unit (g/s)	1.193	1.193
Maximum SO_2 emission rate per unit (g/s)[2)]	0.2900	0.2900
Maximum PM_{10} emission rate per unit (g/s)	0.06700	0.06700

[1)] Three heights (13m, 18m and 28m) were initially modelled for a possible Mercury or Neptune jack-up rig (Ref. 5). It was later confirmed the air-gap between the jack-up rig and the sea surface would be 20 m, hence the height would be 28 m.
[2)] Assuming that the fuel contains 0.1% hydrogen sulphide (H_2S) by weight.

7.3.2 Conversion of NOx to NO_2

At the point of release (from a combustion activity) NO_X emissions predominantly comprise nitrous oxide (NO). However, NO converts to NO_2 in the free troposphere under influences of other gases such as ozone (O_3) and hydroxyl (OH) compounds in the presence of UV radiation (sunlight). This process can be significant in locations over 5km downwind of large combustion sources.

Since the focus of human health criteria is on NO_2 rather than NO_X, it is important to determine a rate of conversion in the atmosphere, in order to calculate the ground level impact of NO_2.

The EA's Horizontal Guidance Note (H1) on Assessment and Appraisal Best Available Technology (Ref. 6) presents preferred conversion rates for NO_X to NO_2. It assumes, conservatively, that 100% of NO_X converts to NO_2 in the long term (i.e. annual average), and 50% NO_X for short term averaging periods (such as 1 hour and 24 hour).

Similarly, the US EPA recommends (in the absence of accurate monitoring data) a tiered approach for modelling NO_2 impacts (Ref. 7). The second tier uses the 'Ambient Ratio Method (ARM)', which assumes that 75% of NO_X is converted to NO_2 for the long term averaging period.

The ADMS 5 model includes an atmospheric chemistry module to calculate the rate of NO_X to NO_2 conversion. However, it requires accurate hourly background NO_2 and O_3 concentrations in order to produce reliable results.

In the absence of background monitoring data for O_3, and only limited data for NO_2, the most conservative assumption mentioned above has been applied to the model output i.e. 100% of NO_X converts to NO_2 for long term averages, and 50% for the short term.

7.3.3 Meteorology

The dispersion of emissions from a point source is largely dependent on atmospheric stability and turbulent mixing in the atmosphere, which, in turn, are dependent on wind speed and direction, ambient temperature, cloud cover and the friction created by local terrain.

Meteorological parameters are recorded at offshore ACG locations since 2005. Sea surface temperature and cloud cover, required for offshore modelling, are however not recorded at these locations. Previous air quality modelling (Chirag Oil Project) used a dataset from an ACG location, which is more than 10 years old, and may not reflect up-to-date meteorological conditions.

To provide a complete set of data required for the dispersion modelling, recent metrological data was sourced from World Meteorological Observation (WMO) station 'HEYDAR ALIYEV' airport, located on the Absheron Peninsula. Data was acquired for the latest years (2015 – 2017).

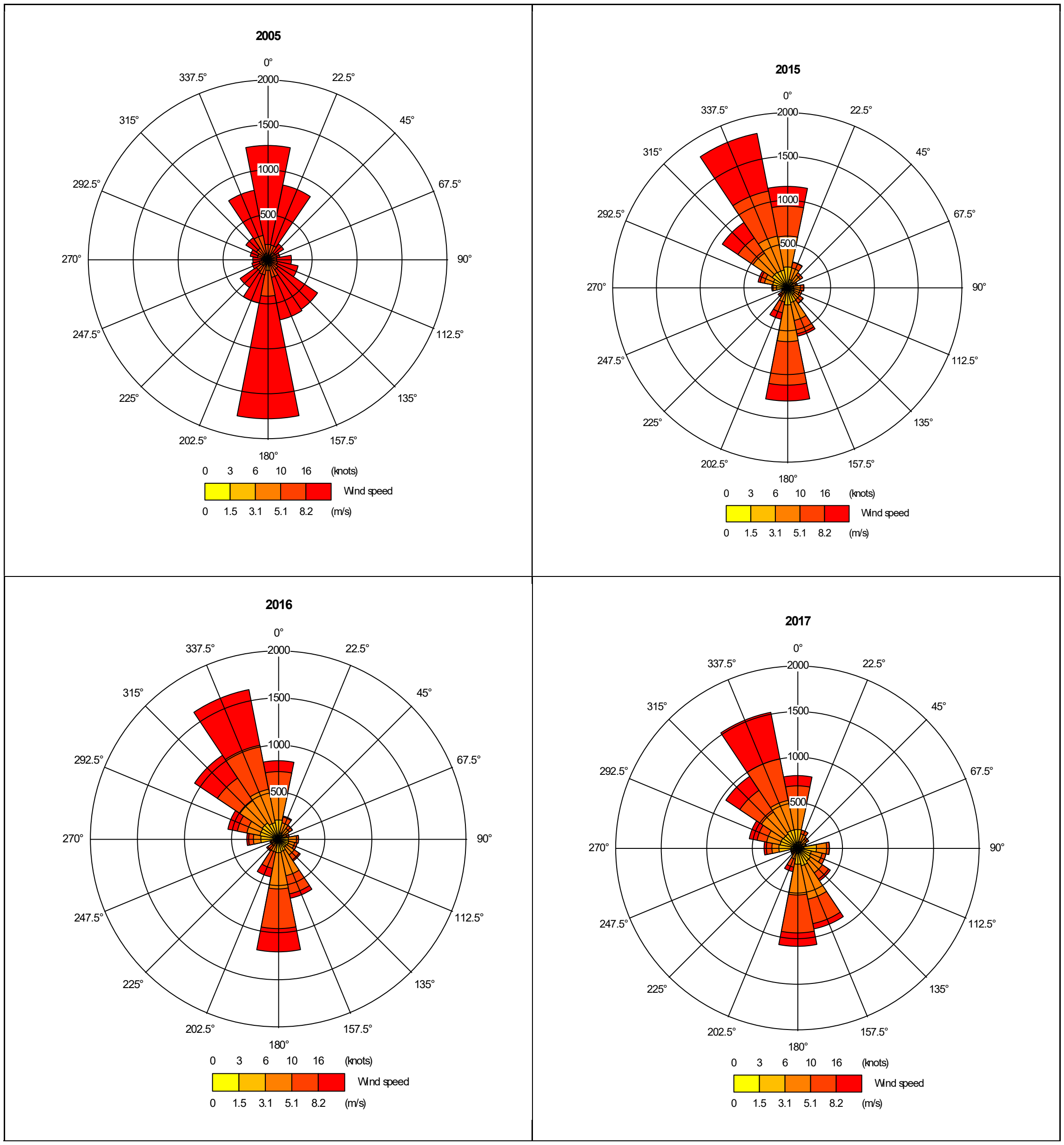
The WMO location records the key modelling parameter of 'cloud cover', although as the location is coastal and not offshore, sea surface temperature is not recorded. Without sea surface temperature the coastline option in ADMS5, which accounts for land/sea diurnal stability changes, cannot be used; the marine boundary option in the model cannot be used either. Because of this lack of sea surface temperature the 2015-2017 WMO data cannot be used with confidence without comparison sensitivity testing. For consistency, the marine boundary option wasn't used for 2005 either.

Testing of the meteorological data was carried out, with unchanged emission sources, to find the worst case meteorological dataset. The 2015-2017 and 2005 dataset from the offshore ACG facilities (which includes sea surface temperature) were compared. Figure 2 presents the wind roses for the meteorological datasets used in the ADMS5 model comparative testing.

The 2005 data set included a marine boundary layer file which assumes a default Charnock parameter[1] of 0.018 and that the boundary layer is not neutral. The 2015-2017 data was set to include the surface roughness for the sea set to the default 'sea' value of 0.0001m for the dispersion site, while the recorded location site was set to 'open grassland' which has a roughness of 0.02m. It can also be observed that the wind is more north-west to south-east from the onshore WMO station (2015, 2016, 2017) in comparison to a very north-south bearing for the 2005 offshore data. The highest modelled contributions were predicted using different years of meteorological data, depending upon which pollutant is studies on which average time scale. As such, the results presented in section 9.1 are all from the model run using different meteorological data.

[1] Used for calculating aerodynamic roughness length over the sea, accounting for increased roughness as wave heights grow due to increased surface stress.

Figure 2. Wind-roses used in sensitivity testing, 2005, 2015, 2016, 2017.



7.4 Model Domain and Specified Receptors

The Central Caspian region was modelled using a two dimensional Cartesian grid system based on the 'Pulkovo 1942' coordinate system using the 'Krasovsky 1940 spheroid'. The modelling used a 200km by 200km grid, centred on the SWAP Contract Area with spacing set at maximum resolution, resulting in a modelled concentration every 2km.

It is acknowledged that ADMS5 specialises in short range dispersion modelling and is considered to be reliable only up to 60km downwind of the source (but still provides useful, indicative information up to 100km downwind of the source). Sensitivity testing however, demonstrated that modelled concentrations were not noticeably different between 100km and 200km from the source (though this may have been a function of the relatively small concentrations being calculated by the model at these distances).

In addition to the grid domain, specified receptor points can be chosen in the model at which ground level pollutant concentrations are then calculated. Air quality limit values do not apply to workplaces, and there are not expected to be members of the public offshore.

Modelled specified receptors are presented in Table 5.

Table 3. Modelled Receptors

Receptors	Northing	Easting
Bibiheybat	399292	4464357
Baku Centre	405115	4474580
Baku Neftçilər Prospekti (Baku 2)	403127	4471793
Baku Nobel Avenue (Baku 3)	404486	4472148

8. Background Ambient Concentrations

Ambient air quality monitoring of SO_2, benzene, VOC and NO_2 has been undertaken around the Terminal since 1997. The monitoring locations, parameters recorded and analytical methodology used has varied across the monitoring surveys. The most recent air quality monitoring survey results available are from 2014. While specific background data is not available for the southern coastline of the Abershon Peninsula, it has been considered representative to use the background concentrations recorded in 2014 at Sangachal as the environments are similar in terms of the mix of local sources (e.g. industrial facilities, roads etc). Within Baku, there are a number of air quality monitoring stations across the city. The results from these stations were made publically available within the Draft National Strategy on AQAM (Ref. 8).

Surveys have not been completed for CO and therefore a typical, rural background concentration was used based on satellite monitoring data.

In the absence of a large hourly dataset it is not possible to derive accurate short term baseline concentrations; therefore a multiple of the annual average background concentration has instead been used. The approach suggested by EA's Horizontal Guidance Note (H1) is to double the annual average background concentration. This approach has been adopted for short-term averaging periods assessed in this report.

The background concentrations used for the purposes of modelling and assessment presented in Table 4 are considered to represent typical background concentrations for the onshore receptors.

Table 4. Average Background Concentrations

Pollutant	Averaging Period	Limit Value	Average Background Concentration (Sangachal & other areas outside of Baku)[1] ($\mu g/m^3$)	Average Background Concentration (Baku)[2] ($\mu g/m^3$)
NO_2	1 hour	200	22	76
NO_2	Annual	40	11	38
CO	1 hour	5,000	200[3]	200[3]
CO	24 hour	3,000	200[3]	200[3]
SO_2	10 minute	500	2	22
SO_2	1 hour	350	2	22
SO_2	24 hour	125	2	22
SO_2	Annual	50	1	11
PM_{10}	24 hour	50	184	480
PM_{10}	Annual	20	92	240

1. Based on 2014 Sangachal Terminal air quality survey (Ref. 9). In the absence of data and given the rural nature of the location the same concentrations are assumed for the Absheron Peninsula

2. Baku concentration taken from: MWH, 2014, Air Quality Governance in the ENPI East Countries National Pilot Project – Azerbaijan "Improvement of Legislation on Assessment and Management of Ambient Air" - Draft National Strategy on AQAM, report funded by the European Union (Ref. 8)

3. CO included to assess modelled concentrations against Azeri limit values (Ref. 10)

9. Modelled Contributions

This section presents the modelling results as modelled contribution for pollutants NO_2, SO_2 and PM_{10}.

Results are presented in terms of:

- Modelled Contribution: The model output predicted at ground level, considering the specified modelled sources only.
- Predicted Concentration: The model output predicted at ground level, taking into account background concentrations (refer to Section 4).
- Predicted Concentration as Percentage of Limit Value: the Predicted Concentration expressed as a percentage of the ambient limit values.

9.1 Results

Table 5 and Table 7 present the modelled contributions for NO_2, SO_2 and PM_{10}., expressed as a percentage of limit value and overall predicted concentrations at receptors.

Table 5. Modelled NO_2 Contributions

Receptor Name	NO_2 Annual Average ($\mu g/m^3$)				NO_2 1 Hour Peak ($\mu g/m^3$)			
	Limit Value	Modelled Contribution	Predicted Concentration	Predicted Concentration as % Limit Value	Limit Value	Modelled Contribution	Predicted Concentration	Predicted Concentration as % Limit Value
Bibiheybat	40	0.2	11.2	28%	200	39.1	61.1	31%
Baku Centre	40	1.3	39.3	98%	200	36.1	112.1	56%
Baku 2	40	1.3	39.3	98%	200	49.1	125.1	63%
Baku 3	40	1.6	39.6	99%	200	37.0	113.0	57%
**Note Assumed conversion of NOx to NO_2, 100% for Annual Average and 50% for 1 Hour Peak.*								

Table 6. Modelled SO_2 Contribution

Receptor Name	SO_2 24 Hour Peak ($\mu g/m^3$)				SO_2 1 Hour Peak ($\mu g/m^3$)			
	Limit Value	Modelled Contribution	Predicted Concentration	Predicted Concentration as % Limit Value	Limit Value	Modelled Contribution	Predicted Concentration	Predicted Concentration as % Limit Value
Bibiheybat	125	0.2	2.2	2%	350	2.4	4.4	1%
Baku Centre	125	0.4	22.4	18%	350	2.2	24.2	7%
Baku 2	125	0.5	22.5	18%	350	3.0	25.0	7%
Baku 3	125	0.4	22.4	18%	350	2.3	24.3	7%

Table 7. Modelled PM_{10} Contribution

Receptor Name	PM_{10} Annual Average ($\mu g/m^3$)				PM_{10} 24 Hour Peak ($\mu g/m^3$)			
	Limit Value	Modelled Contribution	Predicted Concentration	Predicted Concentration as % Limit Value	Limit Value	Modelled Contribution	Predicted Concentration	Predicted Concentration as % Limit Value
Bibiheybat	20	0.0	92.0	460%	50	0.0	184.0	368%
Baku Centre	20	0.0	240.0	1200%	50	0.1	480.1	960%
Baku 2	20	0.0	240.0	1200%	50	0.1	480.1	960%
Baku 3	20	0.0	240.0	1200%	50	0.1	480.1	960%

The modelled maximum ground level annual average NO_2 contribution, at the worst-affected receptor, is predicted to be less than 2 $\mu g/m^3$. The maximum predicted ground level 1-hour (short term) NO_2 contribution is predicted to be less than 50 $\mu g/m^3$. The maximum predicted ground level short term SO_2 contribution was predicted to be 0.5 $\mu g/m^3$ at 24-hour scale, and 3.0 $\mu g/m^3$ at 1-hour scale. All maximum impacts will take place in Baku.

The maximum modelled annual average PM_{10} contribution, at the worst-affected receptor, is predicted to be less than 0.1$\mu g/m^3$. The maximum 24-hour (short term) PM_{10} contribution is predicted to be no more than 0.1$\mu g/m^3$.

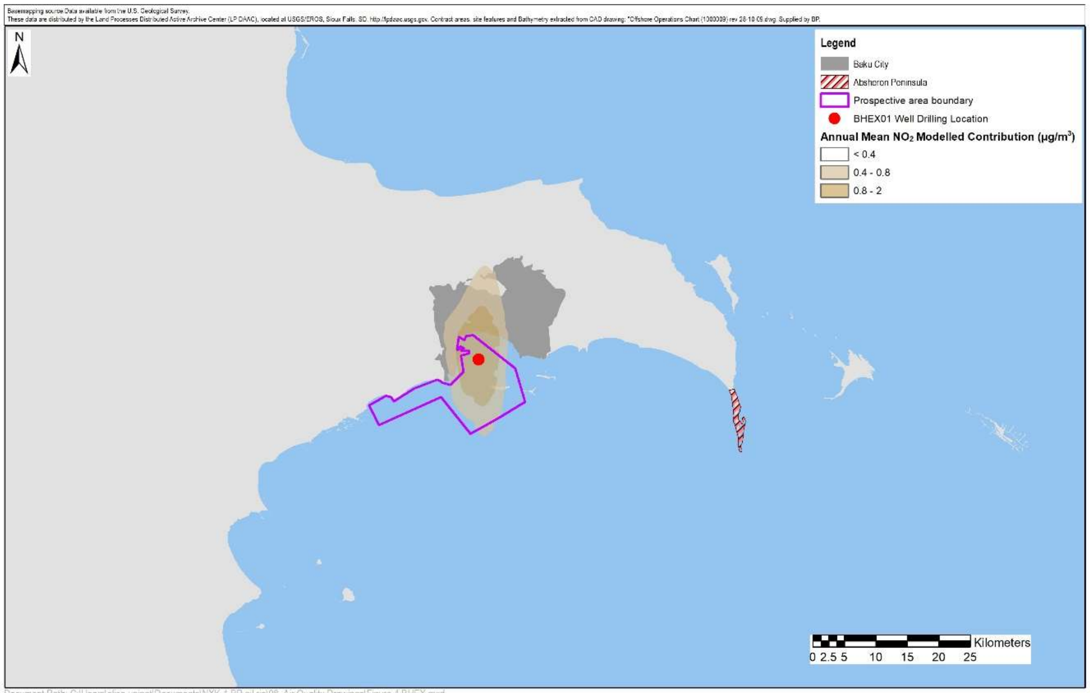
Considering the existing baseline concentrations the modelling predicts that all NO_2 air quality limit values are predicted to be met at all the modelled receptors. For PM_{10}, the mean annual and short term background concentrations already exceed limit values. This can be attributed to the natural occurrence of particulate matter in the local environment reflecting the high particulate concentrations associated with dry arid region (for example soil particles becoming airborne through wind entrainment). The contribution of SWAP offshore drilling activities to increases in PM_{10} concentrations at onshore receptors is insignificant.

Figure 3 to Figure 6 present the modelled contributions (without background concentrations) as isopleths for NO_2 and PM_{10} over long and short term averaging periods. Additional modelled contributions for Azeri limit values are provided in Annex A of this report.

The figures show that maximum offshore contributions of NO_2 for the annual average and 1 hour averaging periods at receptors are predicted to be less than 2 $\mu g/m^3$ and 40$\mu g/m^3$, respectively.

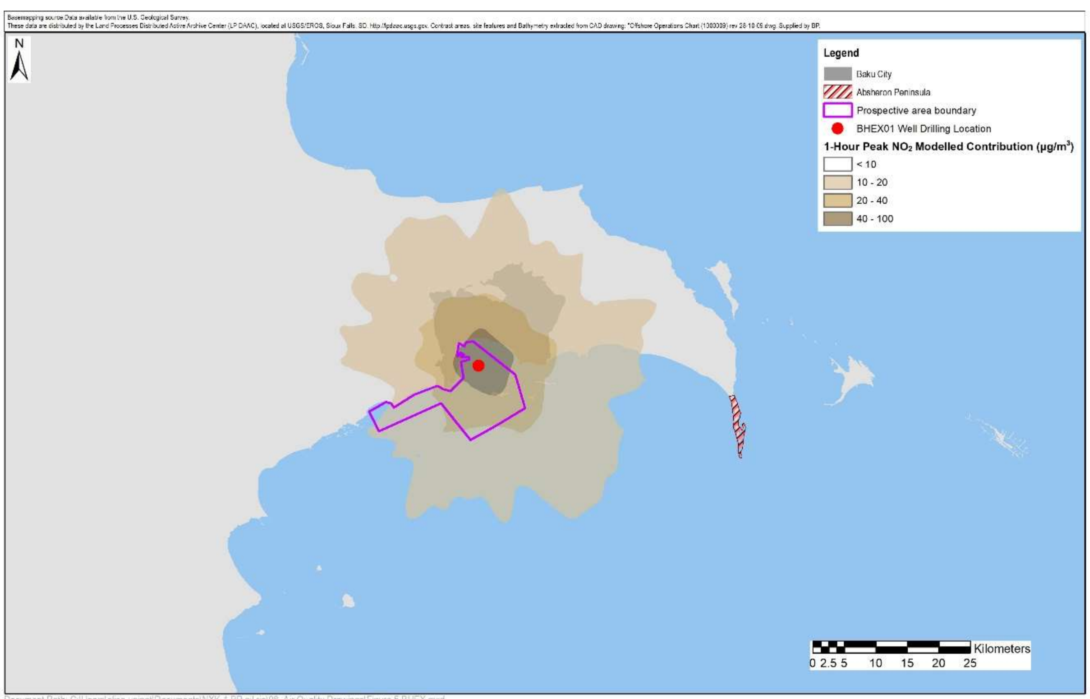
With respect to PM_{10} emissions; the maximum offshore contributions for the annual average and 24 hour averaging periods at receptors are predicted to be less than 0.01$\mu g/m^3$ and 0.1 $\mu g/m^3$, respectively.

Figure 3. Modelled Mean Annual NO_2 Contribution



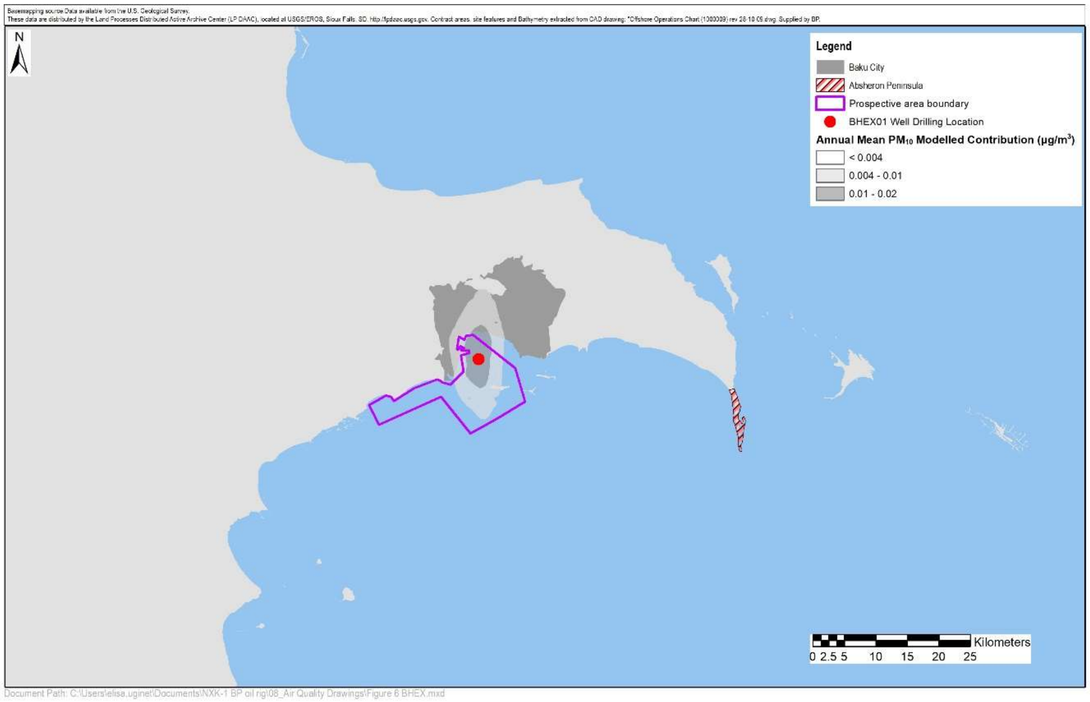
This worst case is the result of 28 m stacks using 2005 meteorological data.

Figure 4. Modelled 1 Hour Maximum NO_2 Contribution



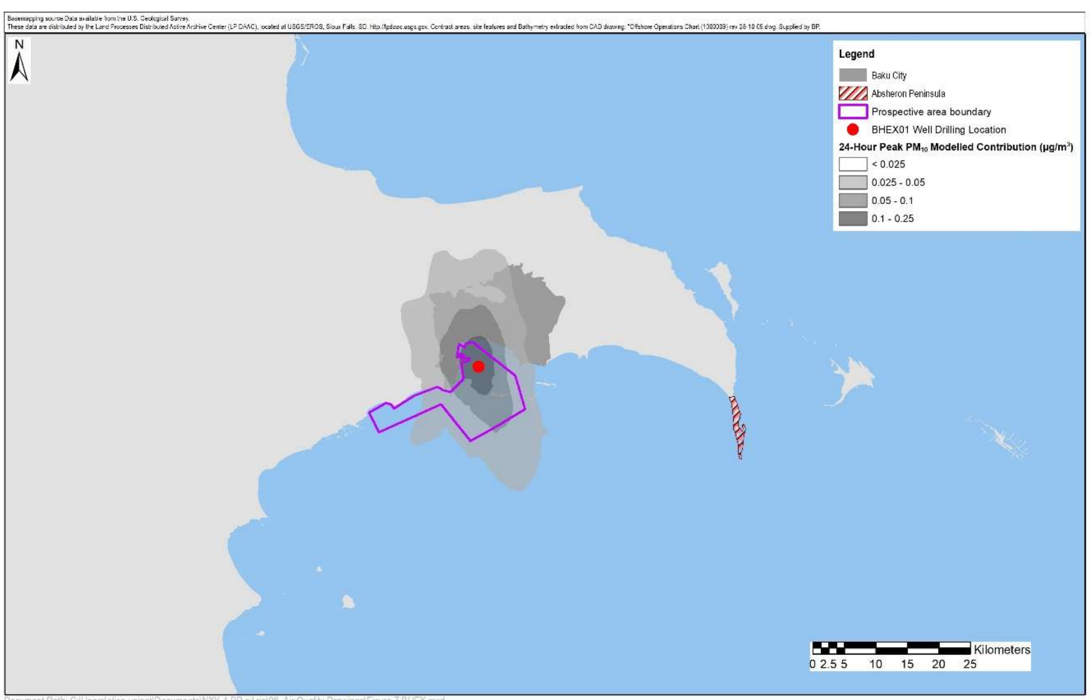
This worst case is the result of 28 m stacks using 2016 meteorological data.

Figure 5. Modelled Annual Average PM_{10} Contribution



This worst case is the result of 28 m stacks using 2005 meteorological data.

Figure 6. Modelled 24 Hour Maximum PM_{10} Contribution



This worst case is the result of 28 m stacks using 2015 meteorological data.

9.2 Conclusion

Atmospheric dispersion modelling was completed for pollutant species NO_2, SO_2 and PM_{10} with the results presented at the closest onshore receptor locations for comparison to applicable air quality limits.

The modelled contributions associated with the drilling emissions are not predicted to lead to any discernible impact on air quality concentrations onshore.

When taking account of the existing background concentrations the predicted concentrations easily comply with the air quality limit values, with the exception of PM_{10}. This can be attributed to the natural occurrence of particulate matter in the local environment reflecting the high particulate concentrations associated with dry arid region (for example soil particles becoming airborne through wind entrainment). The contribution of SWAP offshore drilling activities to increases in PM_{10} concentrations at onshore receptors is insignificant.

In summary, it is not expected that SWAP offshore drilling activities will cause the applicable air quality limit values to be exceeded at onshore locations, where concentrations currently comply with the limit values.

10. References

Ref. 1 World Health Organisation (2005); Air quality guidelines - global update 2005 Guidelines

Ref. 2 International Finance Corporation (2007); General Environmental, Health and Safety (EHS) Guidelines

Ref. 3 World Bank (1998); Pollution, Prevention and Abatement Handbook. http://smap.ew.eea.europa.eu/test1/fol083237/poll_abatement_hanbook.pdf/

Ref. 4 European Parliament and of the Council (2008); Directive 2008/50/EC on ambient air quality and cleaner air for Europe

Ref. 5 EDC (2017); Jack-up rigs. http://www.eurasiadrilling.com/operations/offshore/jack-up-rigs/.

Ref. 6 Environment Agency (2010); Horizontal Guidance Note H1 – Environmental Risk Assessment for Permits. http://www.environment-agency.gov.uk/business/topics/permitting/36414.aspx

Ref. 7 United States Environmental Protection Agency (US EPA) Applicability of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard. http://www.epa.gov/ttn/scram/ClarificationMemo_AppendixW_Hourly-NO2-NAAQS_FINAL_06-28-2010.pdf

Ref. 8 MWH (2014); Air Quality Governance in the ENPI East Countries, National Pilot Project – Azerbaijan, "Improvement of Legislation on Assessment and Management of Ambient Air", Draft National Strategy on AQAM.

Ref. 9 Sangachal Ambient Air Quality Monitoring Programme 2010, Final Report, AmC Report 10709-R1

Ref. 10 Worden, H. M, Deeter, M. N, Edwards, D.P. Gille, J.C., Drummond, J.R and Nedelec, P. 'Observations of near surface carbon monoxide from space using MOPITT multispectral retrievals, J. Geophys. Re., 115, D18314, doi:10.1029/2010JD14242, 2010

Appendix A Modelled Contributions (Azeri Limit Values)

a) Tabulated Results

Receptor Name	NO_2 1 Hour Peak (µg/m^3)				NO_2 24 Hour Peak (µg/m^3)			
	Limit Value	Modelled Contribution	Predicted Concentration	Predicted Concentration as % Limit Value	Limit Value	Modelled Contribution	Predicted Concentration	Predicted Concentration as % Limit Value
Bibiheybat	85	39.1	61.1	72%	40	3.0	25.0	62%
Baku Centre	85	36.1	112.1	132%	40	6.7	82.7	207%
Baku 2	85	49.1	125.1	147%	40	8.0	84.0	210%
Baku 3	85	37.0	113.0	133%	40	6.5	82.5	206%
**Note Assumed conversion of NOx to NO_2, 50% for 24 Hour Peak and 1 Hour Peak.*								

Receptor Name	PM_{10} 24 Hour Peak (µg/m^3)				PM_{10} 1 Hour Peak (µg/m^3)			
	Limit Value	Modelled Contribution	Predicted Concentration	Predicted Concentration as % Limit Value	Limit Value	Modelled Contribution	Predicted Concentration	Predicted Concentration as % Limit Value
Bibiheybat	150	0.0	184.0	123%	500	0.6	184.6	37%
Baku Centre	150	0.1	480.1	320%	500	0.5	480.5	96%
Baku 2	150	0.1	480.1	320%	500	0.7	480.7	96%
Baku 3	150	0.1	480.1	320%	500	0.5	480.5	96%

Receptor Name	CO 24 Hour Peak (µg/m^3)				CO 1 Hour Peak (µg/m^3)			
	Limit Value	Modelled Contribution	Predicted Concentration	Predicted Concentration as % Limit Value	Limit Value	Modelled Contribution	Predicted Concentration	Predicted Concentration as % Limit Value
Bibiheybat	3,000	0.8	200.8	7%	5,000	10.0	210.0	4%
Baku Centre	3,000	1.7	201.7	7%	5,000	9.2	209.2	4%
Baku 2	3,000	2.0	202.0	7%	5,000	12.5	212.5	4%
Baku 3	3,000	1.6	201.6	7%	5,000	9.4	209.4	4%

APPENDIX 4B

Marine Discharge and Oil Spill Modelling Report

AECOM

BHEX01 Oil Spill and Discharge Modelling

June 2020

A Report Produced By

More Energy Ltd

Figures & Tables

Figures

Tables

Abbreviations

Abbreviation	Definition
2D	Two-dimensional
3D	Three-dimensional
BHEX01	Bibiheybat Exploration Well 1
GEBCO	General Bathymetry Chart of the Oceans
ITOPF	International Tank Owners Pollution Federation
LC50	Lethal concentration for fifty percent of a population
MEMW	Marine Environmental Modelling Workbench
OSCAR	Oil Spill Contingency and Response
P10, P50, P90	A value which would not be exceeded in 10%, 50% or 90 % of scenarios
PLUME3D	Near-field plume sub-model
ppb	Parts per billion
SINTEF	Stiftelsen for industriell og teknisk forskning (Foundation for Scientific and Industrial Research)
SWAP	South West Absheron Peninsula

1 Introduction

1.1 The project

AECOM has commissioned More Energy Ltd on behalf of BP Exploration (Caspian Sea) Ltd to undertake a spill and cooling water discharge modelling study to establish the expected extent of the impacts associated with the following releases to sea. These are the worst-case releases that could be associated with the drilling of the proposed Bibiheybat exploration well (BHEX01) in the Caspian Sea. The proposed exploration well location lies approximately 1.5 kilometres (km) from the Azerbaijani mainland in a water depth of approximately 4 metres (m). The BHEX01 well will be the second of three exploration wells planned for the Shallow Water Absheron Peninsula (SWAP) Contract Area. The SWAP Contract Area comprises three Prospective Areas as shown in Figure 1. The BHEX01 well is located in the West Prospective Area.

The objective of the modelling was firstly to establish the expected extent of the impacts associated with a release of hydrocarbons by establishing:

- Where hydrocarbons are likely to travel;
- How the oil and diesel is likely to disperse over time (both on the sea surface and in the water column);
- Expected behaviour of oil and diesel sheens on the surface;
- The extent to which oil is likely to arrive on the shoreline; and
- Where hydrocarbon concentrations could exceed certain thresholds in the water column.

Secondly, the modelling was conducted to establish the expected effect of the discharge of cooling water from the jack up drilling rig.

The scenarios modelled have been identified in conjunction with the BP project team.

This report presents the results of work undertaken to model these releases and determine their extent.

The OSCAR (Oil Spill Contingency and Response) model from SINTEF (Stiftelsen for industriell og teknisk forskning) was used to model the crude oil and marine diesel release scenarios. OSCAR computes surface and subsurface transport, behaviour, weathering and fate of oil using a Lagrangian (particle tracking) approach, enabling explicit tracking of each particle's location and behaviour through time. The Dose-Related Risk and Effect Assessment Model (DREAM) published by SINTEF (v9.01 and v11.0.1) was used to model cooling water discharges. DREAM consists of a dispersion model based on 2D wind and 3D current data which was used to examine the mixing of the cooling water with ambient waters.

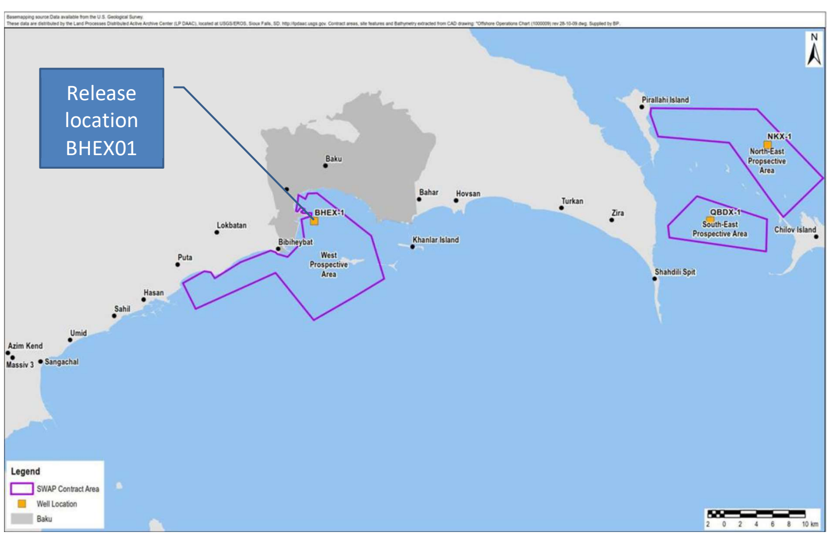


Figure 1: SWAP Prospective Areas and Proposed Exploration Well Locations

1.2 Scope of work

1.2.1 Oil spill modelling

The scope of work was to model oil releases resulting from the drilling of exploration well BHEX01 and to determine their extent.

Modelling is undertaken using the oil weathering and dispersion model OSCAR 11.0 developed by SINTEF. Inputs to the models included 3D metocean data and discharge parameters provided by BP that are specific to the Caspian Sea operations. Agreed scenarios have been modelled relating to different release scenarios for:

- Scenario 1: Diesel release; and
- Scenario 2: Blowout of crude oil.

Stochastic modelling of Scenario 1 and 2 is undertaken to demonstrate how the trajectory and fate of the oil changes under variable metocean conditions representative of summer and winter conditions. The outputs from stochastic modelling are summarised as follows.

Stochastic analysis of >100 runs:

- Probability of predicted visible oil slick above threshold;
- Profile of beaching times;
- Profile of the mass of accumulated oil onshore;
- Averaged mass balance statistics over model duration;
- Maximum exposure times of oil on surface and in the water column; and
- Minimum arrival times of oil on surface and on the shoreline.

For the worst case scenarios of amount of hydrocarbons reaching the shoreline in summer and winter periods, deterministic modelling is undertaken to predict the mass balance fate of the oil over time, the development and appearance of the surface oil slick and the behaviour of oil in the water column.

Deterministic model for worst case beaching (largest volume):

- Maximum extent and thickness of the visible oil slick on the surface;
- Distribution and density of oil reaching the shore;
- Maximum oil concentrations in the water column over time;
- Mass balance versus time profile for surface oil, oil in the water column, shoreline oil, evaporation and biodegradation;
- Areas of the water surface and volumes of the water column affected over time by certain oil concentrations or dilutions; and
- Deposition pattern and concentration of oil in sediments.

Thickness thresholds for oil on the sea surface and oil on the shoreline as well as oil concentrations in the water column based on good international industry practice were agreed with BP.

1.2.2 Cooling water discharge modelling

Cooling water discharges were modelled using the dispersion model DREAM by SINTEF.

DREAM uses its near-field sub-model PLUME3D to predict initial turbulent dispersion and advection, followed by wider-scale dispersion once momentum and buoyancy effects have subsided. Outputs are provided in temperature change relative to the ambient water column temperature profile. The nature of thermal dispersion is rapid, and the model is focussed on a short period of time at a high resolution to provide a detailed representation of the plume. This gives a clear indication of the extent of the initial mixing zone to allow comparison with international standards. This approach means it is limited in showing a time-series of results in dynamic conditions, so representative high and low current conditions are chosen for modelling by observing the current records for summer and winter conditions separately.

2 Modelling software used

2.1 The Oil Spill Contingency and Response Model (OSCAR) model

2.1.1 Description

The SINTEF OSCAR software is a sophisticated multifunction model that incorporates models of plume behaviour, oceanic dispersion, wind forcing, wave turbulence, oil weathering and behaviour including physical and chemical processes, environmental interaction, ecological impact and spill response. The model has been developed over 30 years and is the subject of verification and calibration by numerous field experiments on surface spills and subsea releases and by calibration against actual events e.g. as described in Reed *et al.* (1999), Johansen *et al.* (2001) and Susanne *et al.* (2015). It shares dispersion mathematics with sister models DREAM and ParTrack which have also been validated e.g. Niu and Lee (2013 and 2016) and Durell *et al.* (2006). The weathering of oil and its physical state are computed using the embedded Oil Weathering Model developed by the SINTEF oil weathering laboratories in Trondheim, supported by decades of research into oil chemistry and behaviour.

The model calculates and records the transport and distribution of a contaminant in three-dimensional space and time, on the water surface, along shorelines, in the water column, and in sediments, along with losses by evaporation and biodegradation. For subsurface releases the near field part of the simulation is conducted with a multi-component integral plume model that is embedded in OSCAR. The near field model accounts for buoyancy effects of oil and gas, as well as effects of ambient stratification and cross flow on the dilution and rise time of the plume.

Single oil spill scenarios can be completed for a specified meteorological period (deterministic modelling), or multiple scenarios with varying start times can be compiled to calculate statistics such as the probability of some event e.g. oil reaching shore or the fastest time of arrival (stochastic modelling). These releases can be set as single static, multiple or moving sites.

Relevant parameters are chosen based on recommendations from SINTEF via the model documentation, training courses and dialogue. Outputs are generated by collating particle properties over a grid, set to capture the main areas of interest as the plume develops and disperses. Various model parameters can affect the quality of outputs including the metocean data used, the number of particles chosen and the size of the grid applied and a balance is struck between model complexity, the output required and practical run times. All such inherent uncertainties require conclusions to be drawn carefully and using experience.

The model is capable of evaluating the effectiveness of oil spill response strategies and allows the assignment of specific operational tactics for simulated containment, storage, booming, skimming and dispersant operations. This can be coupled with biological impacts on plankton and fish to support net environmental benefit analysis.

2.1.2 Types of analysis

For each hydrocarbon release scenario, the following analyses were undertaken. OSCAR is an extremely capable model that can offer many different statistics on any particular spill, and the analyses given below are judged to be the most useful in understanding potential environmental impact.

<u>Stochastic simulation:</u>

- Probability of oil on surface at any time;
- Minimum arrival time of oil;
- Probability of oil on shoreline at any time;
- Maximum mass of oil on shoreline (and distribution of outcomes);
- Minimum arrival time of oil on shoreline (and distribution of outcomes); and
- Density of oil on shoreline.

From the stochastic analysis, a 'worst case' of metocean conditions is identified that causes the maximum amount of oil to reach shorelines.

To reflect differences in sea temperature profiles between summer and winter, separate summer and winter stochastic simulations are undertaken.

Deterministic simulation:

- Mass balance plot for evaporation, dissolved, dispersed, sediment, shoreline, biodegraded and outside grid; and
- 'Swept area' of individual spill on surface and water column.

A deterministic simulation is run for the cases that result in the most oil on shore in summer and winter conditions.

2.1.3 Modelling domain

Since the Caspian Sea is a closed waterbody, the model boundary never extends beyond the physical shoreline (see Figure 2). Metocean data is also available for the whole area. Consequently, the size of the model boundary can be as large as necessary to encompass the entire dispersion of the release within the modelling period.

3D current data and 2D wind data was obtained for the period 2006 - 2009 covering this area and imported into the model. Using this area, all oil is accounted for.

In some circumstances it is not practical to extend the model domain to capture all oil particles indefinitely as some may persist for many months and become insignificant; however since the Caspian is a closed sea, the model grids chosen do contain 100% of the model particles for the durations modelled. Model accuracy decreases, however, as distance increases as uncertainties accumulate and any wider scale results should be treated as being more indicative further from the source. Potential impacts can be assessed from this information and may be compared with background levels of oil in the environment.

Figure 2: Modelling regions used for oil release modelling

2.1.4 Environmental thresholds (hydrocarbon)

Sophisticated models such as OSCAR are capable of tracking the fate of oil in increasingly smaller and smaller concentrations and masses, beyond the point at which oil presents a significant risk or is even detectable against background levels. In order to ensure the model outputs reflect the risks, while still retaining a precautionary approach, thresholds are normally applied to thicknesses of surface oil, concentrations in the water column and densities of shoreline oiling.

The thresholds adopted in this study are described in Table 1 for:

- Shoreline oiling;
- Thickness of surface sheen; and
- Total oil in the water column.

Table 1: Thresholds for oil significance adopted

Category	Threshold	Justification
Shorelines	100 ml/m^2 (approx. equal to 87 g/m^2).	The International Tank Owners Pollution Federation (ITOPF) guidelines for the recognition of oil on shorelines (ITOPF, 2011) include shoreline oil density. The definition for 'light oiling' is selected as the most appropriate threshold and is described in the guidelines as equivalent to a volume threshold of 0.1 litre/m^2, or less than 0.2 litres of oil per metre strip along a 2m deep beach which is assumed in the model. The 0.1 litre/m^2 threshold (considered a 'stain' or 'film') is assumed as the lethal threshold for invertebrates on hard substrates and sediments (mud, silt, sand, gravel) in intertidal habitats based on Owens & Sergy (1994) and French-McCay (2009). This would be enough to coat the animal and likely impact its survival and reproductive capacity, while stain <0.1 litre/m^2) would be less likely to have an effect (French-McCay, 2009). Values have also been adopted for 'Moderate oiling' of 1 litre/m^2, and 'Heavy oiling' of 10 litre/m^2, also derived from ITOPF.
Sea Surface	0.04 µm (microns) silvery grey - rainbow sheen	Interpretations of significance of surface oil thickness vary widely. The presence of a visible sheen is likely to interfere with other users of the sea such as fishing operations and a visible sheen can occur between 0.04 and 0.3 µm as identified by the Bonn Agreement Oil Appearance Code (BAOAC). This is highly dependent on weather conditions, and the lower level of 0.04 µm is only visible under ideal conditions. Tests performed by O'Hara and Morandin (2010) indicated that significant changes in feather structure did not necessarily occur at a thickness of 0.04 µm, but began to be visible at 0.1 µm. Oil spill response in the form of containment or dispersant use is normally not attempted when oil is below a thickness of 5 µm.
Water Column	58 ppb (parts per billion) (total oil)	Research completed by Statoil (2006) and Det Norsk Veritas (2008) resulted in the development of species sensitivity dose-response curves to assess the impact to organisms from different water column hydrocarbon concentrations. A 5th percentile LC_{50}[1] for total hydrocarbon concentrations was found to be 58 ppb. This value of 58 ppb is used within this modelling as the lower threshold for potential acute toxicological responses and concentrations below this threshold are not reported from OSCAR. 58 ppb is a conservative lethal exposure value for marine fauna as it is below the LC_{50} for 95% of species and is lower than the OSPAR recommended predicted no-effect concentration of 70 ppb (OSPAR, 2014). At this concentration mortality is highly unlikely however toxicological effects may be both short and long-term.
Sediments	10 mg/kg No-effect concentration (NOEC) 100 mg/kg sub-lethal effects 1,000 mg/kg acute toxic effects	Patin (2004) describes broad ecotoxicological thresholds for oil in sediments, noting that there is a wide range depending the species present. Patin recommends threshold of 10 mg oil per kg of sediment (mg.kg) as a level that would be below NOECs for most species; 10-100 mg/kg where reversible effects would be expected; 100 - 1,000 mg/kg where sublethal effects would be expected and above 1,000 mg/kg as a level where acute toxic effects would begin to be observed. Concentrations of oil in sediment are calculated assuming a mixed layer of 5 cm of surficial sediment, although this can vary between 2-10 cm (Trauth *et al.* (1997). A bulk saturated sediment specific gravity of 1.9 is assumed.

[1] Lethal Concentration 50%. The concentration of a chemical which kills 50% of a sample population

2.2 Dose-Related Risk and Effect Assessment Model (DREAM)

2.2.1 Description

Cooling water discharges have been modelled using the SINTEF DREAM model. The model predicts the fate of materials discharged to the marine environment (their dispersion and physico-chemical composition over time). Along with OSCAR, DREAM is part of the suite of models within the Marine Environmental Modelling Workbench (MEMW) developed by SINTEF and shares much of the validation experience discussed above. Additionally, the DREAM model underwent significant development in the late 1990s and 2000s including its use in the Environmental Risk Management System joint industry project. Model details and development can be found in the technical reports at www.sintef.no/erms/reports as well as papers such as Reed *et al.* (2001) and Reed and Hetland (2002). The model has been validated in field trials relating to produced water plumes including Durell (2006) and Niu and Lee (2013), which found "*The DREAM model was also compared with field data … The results indicated that DREAM predicted both the dilution and trajectory very well*". This has been confirmed in a further study *"The comparison of modelled and empirical data showed that the DREAM model can effectively predict plume behaviour. The results agreed well with the monitoring data and simulated the location of the plume as it changed continuously with the tidal currents"* (Niu *et al.*, 2016).

The model has been developed to predict the dispersion of chemical plumes in the water column along with a variety of other physico-chemical processes such as thermal effects, evaporation, biodegradation, transition from droplet to dissolved states to adsorbed into sediments, and the dynamic equilibrium of these states dependent on local environmental conditions. The calculations are based on a Lagrangian 'particle' approach using a cloud of individual particles to represent the components of the discharge, combined with a near field plume model including advection by density, thermal and momentum forces and a far-field model for subsequent horizontal and vertical dispersion of particles. The plume model takes into account effects from water stratification on the near-field mixing and geometrical configuration of the outlet. Once the plume has been trapped by the prevailing structure of the water column, dissolved particles undergo ongoing horizontal and vertical dispersion while solids or droplets can continue to fall or rise in the water column and potentially deposit on the seabed or reach the surface and, in the case of oil droplets, form a sheen. Wave turbulence driven by wind speed and fetch is also incorporated into the surface layers of the water column.

2.2.2 Modelling domain

Figure 3 shows the model domain used for cooling water discharge modelling. The area has been selected by experience and iteration to contain the nearfield plume and the area within which temperatures return to close to ambient. In this particular situation this results in a small area 200 m by 200 m around the discharge.

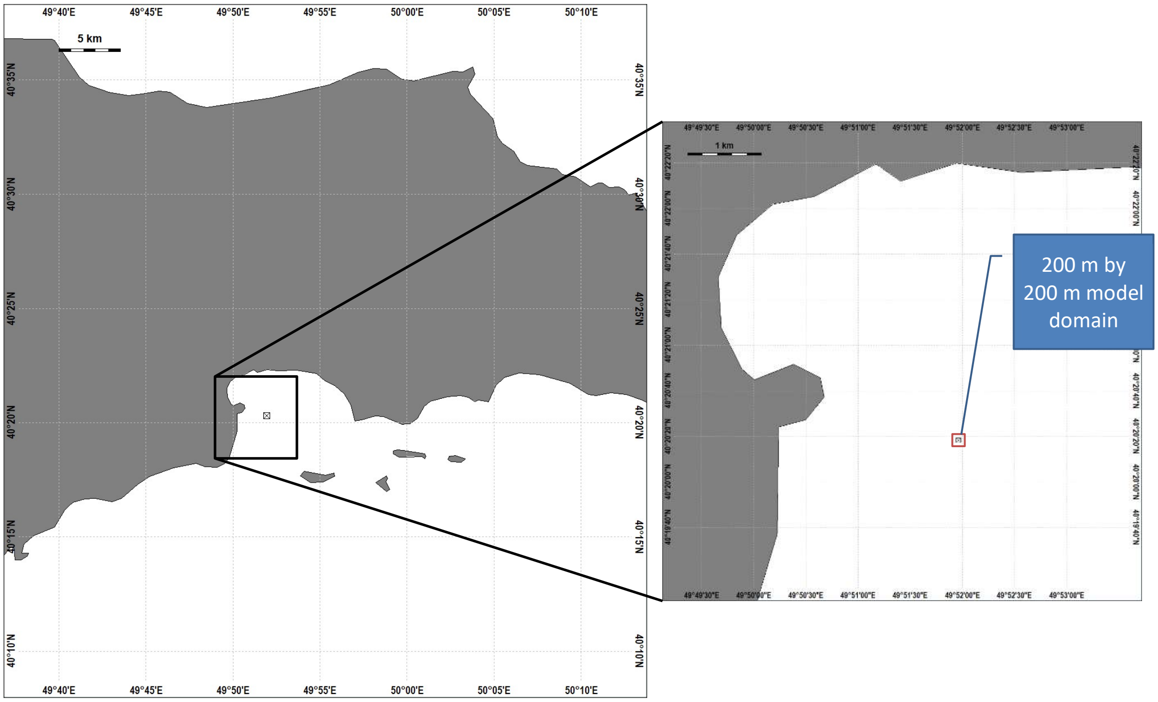


Figure 3: Modelling region used for cooling water discharge modelling

2.2.3 Environmental thresholds (thermal discharges)

There are international standards for what is normally acceptable in terms of thermal discharges such as the Environmental, Health and Safety Guidelines (International Finance Corporation and World Bank Group, 2007), which state

> *"Temperature of wastewater prior to discharge does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use and assimilative capacity among other considerations."*

Such a mixing zone is normally taken to be at the edge of the advection zone, e.g. at the edge of a 'surface boil', where the discharge rises to the surface, and where the nearfield turbulent plume collapses to give way to slower mixing processes. For marine releases, however, this behaviour does not always occur clearly, and a limit of 100 m is often used as an outer limit for acceptability, where the discharge must not cause a temperature change of more than 3°C (e.g. International Office for Water, 2008).

3 Model input data

3.1 Metocean data

Three-dimensional water column current and two-dimensional wind data were generated by the Space and Atmospheric Physics Group at Imperial College and provided by BP for a period covering 2006-2009. A snapshot of currents in the Caspian region can be seen in Figure 4 for the surface layer (which includes wind-driven currents) and a snapshot of two-dimensional winds is shown in Figure 5.

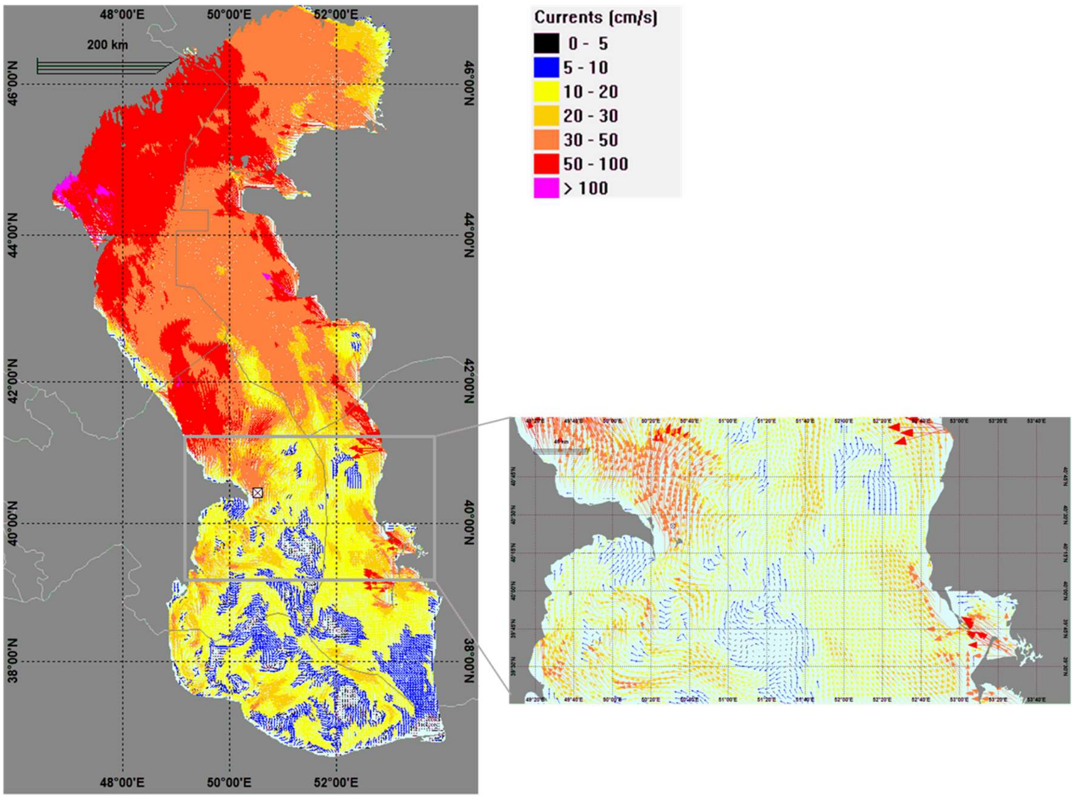


Figure 4: Example of instantaneous surface currents

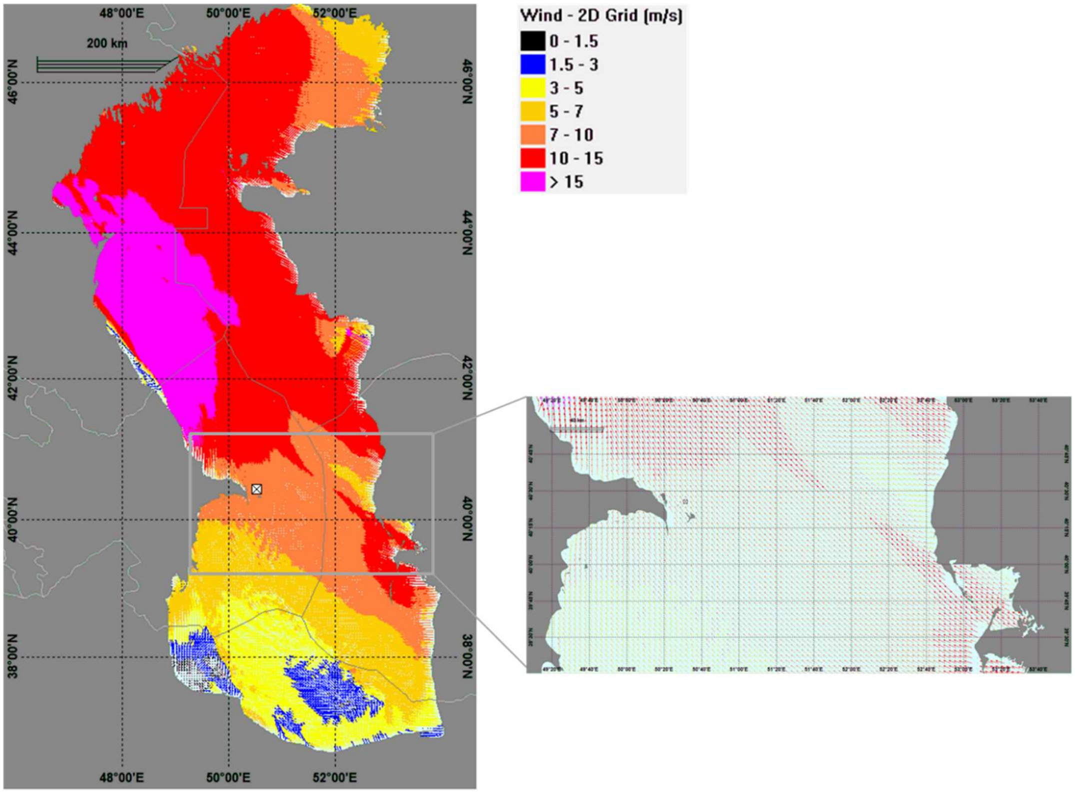


Figure 5: Example of instantaneous winds

Typical surface air temperatures and water column salinity averages were taken from Siamak *et al.* (2010) and AETC (2011) and are summarised in Table 2 .

The seawater temperature-depth profiles used in the deterministic modelling are shown in Figure 6. The values were taken from a BP Shah Deniz site survey (*per. comm.* 2013) and Kosarev (1974). For stochastic modelling, the OSCAR model adopts a simpler approach of a linear thermocline that varies through the year, and a temperature profile has been chosen that has surface temperatures (5°C winter to 25°C summer) that reflect the Caspian Sea surface temperatures closely (7°C winter to 26°C).

Table 2: Ambient conditions

Parameter	Summer	Winter
Surface air temperature (°C)	25	0
Salinity average (mg/l)	12.5	12.5

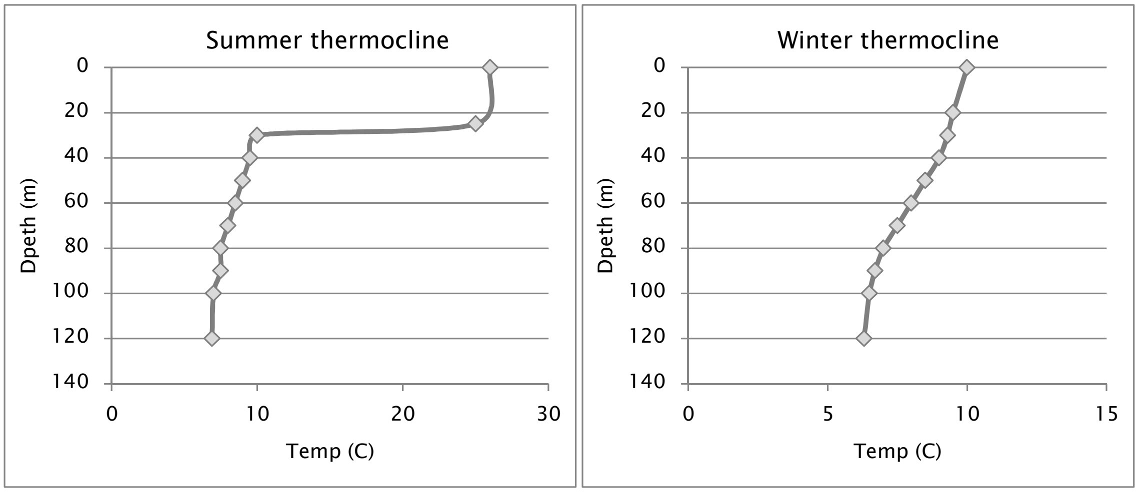


Figure 6: Summer and winter temperature-depth profiles

3.2 Bathymetry data

Bathymetry data is taken from the General Bathymetric Chart of the Oceans (GEBCO) '08' 30-arc-second grid, which has been translated into MEMW format. In turn, bathymetric grids for the Caspian Sea region were provided to GEBCO by Dr. John Hall, Geological Survey of Israel, based on bathymetric soundings digitised from Russian hydrographic charts (Hall, 2002). This differs to more recent survey data collected via ongoing projects. Currently, it is problematic to merge localised survey data with the wider GEBCO data, and changes in bathymetry would also require re-running of a hydrodynamic model to provide accurate currents. It is therefore preferable to retain the coupled bathymetry and currents even if there are some discrepancies, than attempt to merge different datasets. Oil movement largely depends on near-surface currents, which are affected little by such changes in bathymetry and the prevailing GEBCO data has been used in the model.

The bathymetry data used in the modelling is represented in Figure 7.

3.3 Shoreline data

The OSCAR model takes account of shoreline types in modelling the physics of oil interaction. The degree of adhesion of oil to shore and the rate at which oil is washed off a shore is affected by the choice of shoreline. The prevailing shoreline type in the region is that of a sandy shoreline, and this has been used as a default. However, in the vicinity of the release, a large fraction of the shoreline is artificial and is formed of marine walls and structures, which can retain less oil than a sandy shoreline. This has therefore been mapped into the OSCAR model from satellite photography as shown in Figure 8, at the two different scales used in the modelling for the diesel release and blowout respectively.

These shoreline options use default values for shoreline width and other properties. More advanced modelling of the shoreline is possible within the model, but requires detailed shoreline mapping, which is not currently available.

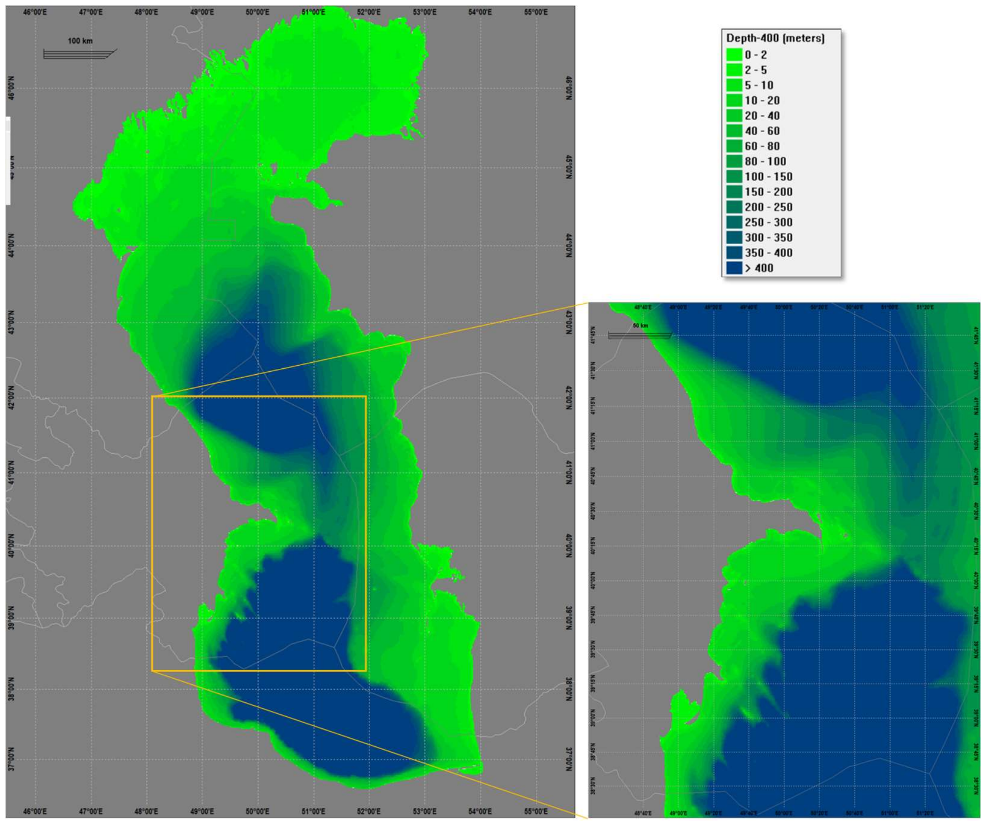


Figure 7: Regional bathymetry data used in model

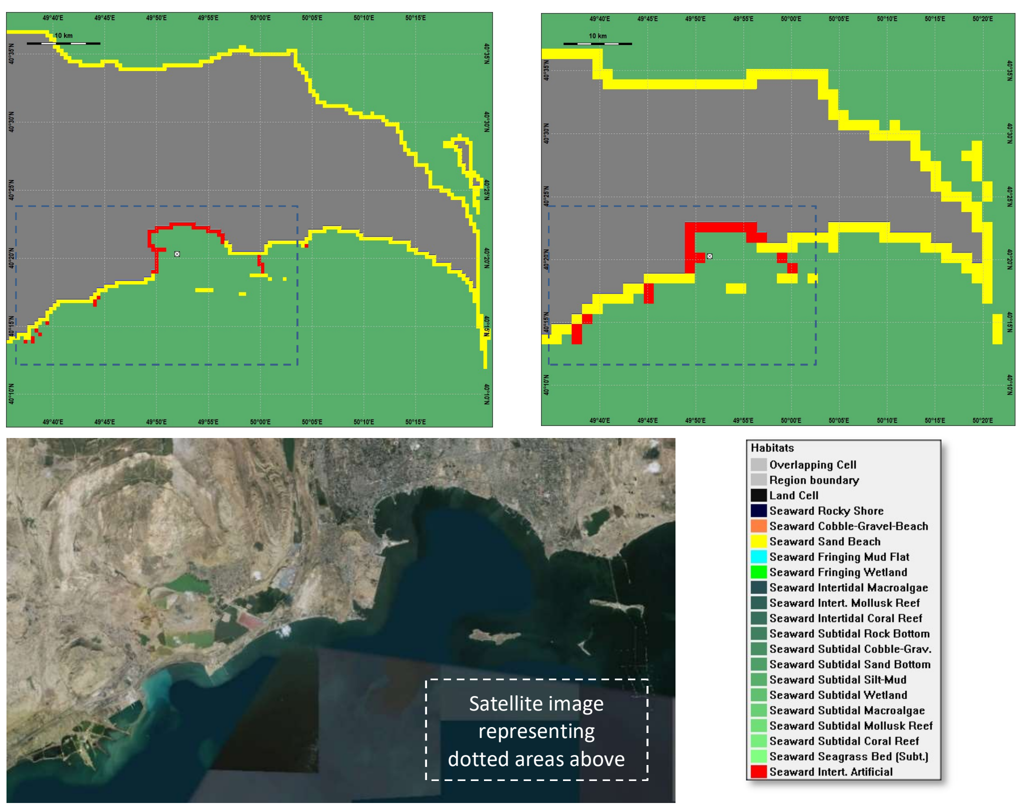


Figure 8: Enhancement of shoreline type to account for artificial shorelines (left: 500 m grid; right: 1.5 km grid)

3.4 Oil release model parameters

Key model parameters are shown in Table 3. These are chosen using experienced judgment from training received from SINTEF, the software User Guide, experience of using the model over 15 years and direct dialogue with SINTEF software developers.

3.5 Oil characterisation

The oil type used in the modelling was chosen from the OSCAR database to most closely represent the oil characteristics provided by BP of the BHEX01 well. The main oil properties are shown in Table 4. Further analysis of the oil and its weathering properties are recommended to reduce the uncertainties of the study.

Table 3: Key model settings - oil releases

Model parameter	Setting used	Notes
Grid size	Blowout: 1500 m in X and Y direction, 10 m in Z direction Diesel Spill: 500 m in X and Y direction, 5 m in Z direction	Tested to ensure results are not sensitive to changes in grid size.
Model time step	Computational time step: 15 minutes Output time step: 1.5 hours	Short enough to describe early stages of dispersion and ensure outputs maintain continuous slick features
Number of particles	Solid/Droplet particles 20,000 (stochastic) 30,000 (deterministic) Dissolved particles 10,000	Maximum recommended number of particles is 30,000 per category. Dissolved particles remain in a more homogenous pattern and fewer particles are required for equivalent accuracy.
Modelling period	Blowout: 120 days (39 days post-release) Diesel spill: 30 days (30 days post-release)	The majority of model particles have deposited or evaporated by this time. Significant environmental impacts are expected to have manifested in this time.

Table 4: Main oil properties

Property	Known value	Analogue value	Notes
Name of oil type	Bibiheybat	Norne Blend 2010, 13C	Analogue is a waxy oil analysed in 2010 by SINTEF for which good laboratory data is provided. 13C means that many tests were conducted at 13C conditions, which is close to ambient sea surface temperature.
Specific gravity	0.868 - 0.889	0.868	Analogue is in the correct range.
Pour Point	20 °C	12 °C	Pour point is reasonably close (i.e. relatively high for a crude oil) and will move between liquid and gel between summer and winter. Analogue may spread further, mix more and be less persistent on average.
Viscosity	14.8-15.1 centipoise (unspecified temperature)	53 centipoise at 13 °C	It is possible that Bibiheybat oil is more viscous than Norne and therefore could disperse more slowly.
Asphaltene content	Not known	6%	The oil is likely to form an emulsion. Although Bibiheybat asphaltene content is unknown, most oils of this density will form emulsions.
Wax content	4.2%	11.7%	Norne analogue is waxier and therefore probably more persistent.

3.6 Cooling water discharge model parameters

Key model parameters are shown in Table 5. These are chosen using experienced judgment from training received from SINTEF, the software User Guide, experience of using the model over 15 years and direct dialogue with SINTEF software developers.

Table 5: Key model settings – cooling water discharges

Model parameter	Setting used	Notes
Grid size	1 m by 1 m horizontally and 0.75 m depth	Fine cell size to capture small and rapidly dispersing plume
Model time step	1 second	Short enough to describe early stages of dispersion and ensure particles maintain a continuous plume
PLUME 3D	On, set to vertically downwards	Creates representative initial dynamic plume
Tracer properties	Neutrally buoyant, non-degradable, non-evaporative, completely soluble.	The plume is modelled using an inert tracer in the flow. It does not decay, evaporate or interact with the seabed. Dose rate 1000 ppm
Number of particles	Dissolved particles 200,000.	Greater than maximum recommended value in order to maintain a continuous plume in a fine grid and avoid false plume 'detachment' issues
Distance to nearest neighbour	Turned on	A continuous plume is expected and this feature helps to preserve plume continuity

The model is run for approximately 15 minutes. In this time, the near-field plume has stabilised in all cases allowing the potential zone of impact to be identified confidently.

4 Scenarios modelled

Table 6 and Table 7 presents the modelling scenarios which were provided by BP.

This includes the following.

1. A release of diesel from the jackup rig diesel storage, representing the largest credible spill of diesel. This is represented by the Marine Diesel oil type in the OSCAR model. A discharge duration of 10 minutes is assumed to represent a puncturing of the tank.

2. A worst case blowout. Since the jackup rig is anchored in a water depth of 4 m, a surface blowout release is modelled (rig cannot move off-site) which is usually worst case for surface and shoreline impacts. The release includes a mixture of oil and associated gas – the well is expected to be dry with no water anticipated to flow. A declining flow rate is modelled over a period of 81 days, the length of time calculated by BP to drill a relief well and arrest the blowout. In reality, it is extremely rare for blowouts to continue for this long, so the results are conservative. Since a blowout above sea surface is assumed, the associated gas is released before the oil reaches the sea and does not play a part in the modelling.

3. A release of cooling water from the rig at a continuous rate of 750 US gallons per minute (approximately 0.05 m^3/s) via an 8-inch caisson. A discharge temperature that is 5.5°C above surface ambient temperature is adopted. The release is modelled until after stable conditions are observed. A depth of 1 m has been assumed; since the water depth at this location is only 4 m, the depth of the cooling water caisson is uncertain, and this is discussed in Section 6.1.2. Note that with the resulting discharge velocity of around 1.5 m/s, if there is gas present in the caisson then gas entrainment is very likely by the plunging liquid jet, which can give rise to a surfacing plume rather than a sinking plume. Gas entrainment is not considered in the modelling, and this uncertainty is discussed in Section 6.1.3.

Table 6: Oil spill modelling scenarios

<table>
<tr><th>Scenario ID</th><th>Spill Site</th><th>Spill Event</th><th>Oil Type</th><th colspan="2">Spill Rate</th><th>Spill Duration</th><th>Total Spilled Volume</th></tr>
<tr><td>1</td><td>BHEX01 well location</td><td>Surface release of diesel fuel from diesel storage tank</td><td>Diesel</td><td colspan="2">3600 m³/hr</td><td>10 minutes</td><td>600 m³</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">BHEX01 well location</td><td rowspan="3">Surface blowout release - worst case, declining release rate</td><td rowspan="3">Norne Blend 2010</td><td rowspan="3">Oil[1,2]</td><td>Rate 1: 76,881 bbl/day</td><td rowspan="3">81 days (time to drill relief well)</td><td rowspan="3">957,402 m³</td></tr>
<tr><td>Rate 2: 73,945 bbl/day</td></tr>
<tr><td>Rate 3: 71,449 bbl/day</td></tr>
</table>

Note 1: Rate 1 for 30 days, Rate 2 for 30 days, Rate 3 for 21 days.

Note 2: Blowout rates reflect an initial rate of 78,300 bbl/day dropping to 90% of this value by the end of the blowout period.

Table 7: Cooling water discharge modelling scenarios

<table>
<tr><th>Scenario ID</th><th>Discharge flowrate (m3/s)</th><th>Pipe internal diameter (mm)</th><th>Discharge depth (m)</th><th>Season</th><th>Discharge Temperature °C</th><th>Ambient Temperature at release point °C</th><th>Current velocity[1] (m/s)</th></tr>
<tr><td rowspan="4">3</td><td rowspan="4">0.05</td><td rowspan="4">203</td><td rowspan="4">1</td><td rowspan="2">Summer</td><td rowspan="2">31.5</td><td rowspan="2">25</td><td>0.12</td></tr>
<tr><td>0.68</td></tr>
<tr><td rowspan="2">Winter</td><td rowspan="2">15.5</td><td rowspan="2">10</td><td>0.16</td></tr>
<tr><td>1.10</td></tr>
</table>

Note 1: Given the shallow water depth, currents vary significantly through the water depth, so these values are approximate and relate to near-seabed conditions where the plume stabilises.

5 Results

This section presents the results of the modelling studies. The results of the oil spill modelling are presented in Section 5.1 and 5.2 and Section 5.3 presents the cooling water release results.

For the hydrocarbon releases, key outputs from the deterministic modelling are shown in Table 6. Following the stochastic modelling (presented below), selected deterministic runs were conducted in both 'summer' and 'winter' with an overview of the results shown in Table 8 and discussed in Section 5.1 and 5.2. Note that the 'summer' scenario releases begin and end between April - September inclusive, and the 'winter' scenario releases begin and end between October - March inclusive. This captures the release with worst-case shoreline oiling, which occurs in summer for the blowout scenario.

Table 8: Deterministic results summary for hydrocarbon release scenarios

Scenario	Release location	Maximum surface extent of sheen above 0.04 µm (km)		Minimum time to beaching (days)[1]		Time until water column concentration[1] <58 ppb (days)[2]		Maximum mass onshore (tonnes)	
		Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
1. Diesel	BHEX01 well	39	59	0.1	0.1	8	11	31	86
2. Blowout	BHEX01 well	523	390	0.1	0.1	> 120	> 120	86,996	110,513

Notes: 1. Dissolved and dispersed oil in water column.

2. Time from start of release.

5.1 Scenario 1 - Diesel release results

5.1.1 Overall description of diesel behaviour from stochastic and deterministic modelling

The OSCAR model tracks the fate of diesel through the simulation as shown in Figure 9, which represents the winter conditions, but which is generally representative of the fate of diesel released at any point in the year.

Initially the majority of the diesel is present on the sea surface, and over the first two days around 50% evaporates and in the second half of day 1, there is a rapid accumulation of diesel on shore. Dispersion and dissolution into the upper water column takes place close to the release point. Biodegradation also progresses relatively quickly and along with continuing evaporation, a very small fraction of diesel on the water surface is left after 30 days (less than 0.1%). Ultimately 61% evaporates, 22% is biodegraded, 1% is in the water column, 14% comes ashore and 2% is deposited in sediments. Diesel can reach the shore approximately 2.25 hours after the initial release.

The resultant slick is relatively small and short-lived. An important feature of this release location is the relatively confined area with low currents and presence of islands and obstructions protruding from the coast and in the nearby sea area. This means that shoreline oiling in Baku Bay is relatively limited by the capacity of the artificial surfaces to retain hydrocarbons, and it means that the diesel spends some time in Baku Bay in relatively warm water with little mixing, where a large fraction can evaporate. This could give rise to air quality issues if winds are onshore.

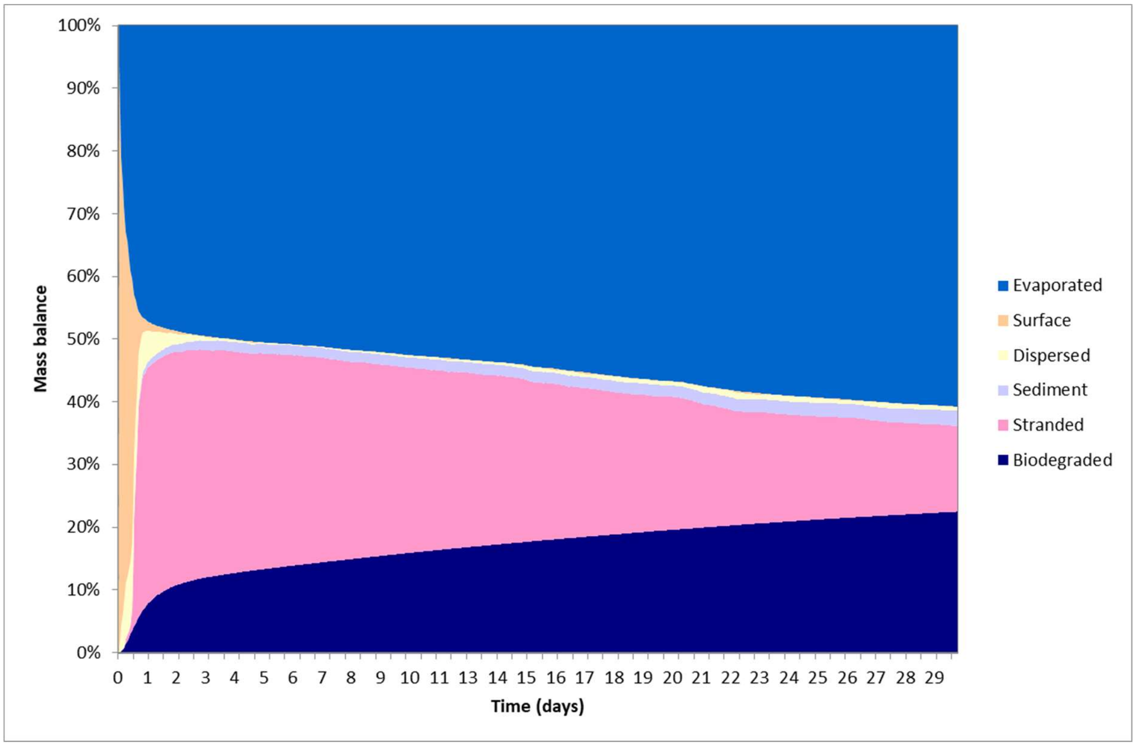


Figure 9: Diesel spill: Fate of oil during modelling period - winter

5.1.2 Stochastic modelling

Stochastic simulations in summer and winter conditions were generated encompassing over three years of year-round varying metocean data for the 600 m^3 diesel spill scenario using 102 model runs evenly spaced through the three years' data. From these results, the worst weather periods were chosen to run deterministic scenarios under summer and winter conditions.

Table 9 summarises the key statistics for minimum beaching time and mass of shoreline diesel, and Figure 10 summarises the results in terms of simulation start date for each of these simulations. Figure 10 indicates there is low seasonal bias to the results, showing the quantity of diesel reaching shore is not particularly correlated to the season in which the release occurs, although the higher beaching masses occur in the second half of the year. On release into the sea, diesel persists for relatively short periods of time and is not therefore exposed over longer periods to prevailing metocean conditions.

Table 9: Stochastic results summary

Scenario	Percentile[1]	Minimum time to beaching (days)	Mass of hydrocarbon accumulated onshore (tonnes)[2]
Diesel release	P10	0.13	5
	P50	0.38	13
	P90	1.25	21
	Worst	0.09	86

Notes:

1. P90 means that in 90 % of scenarios modelled, this value or less would result.
2. Mass of oil onshore excludes associated water, but since diesel is not expected to form an emulsion, the figures do not require further explanation.

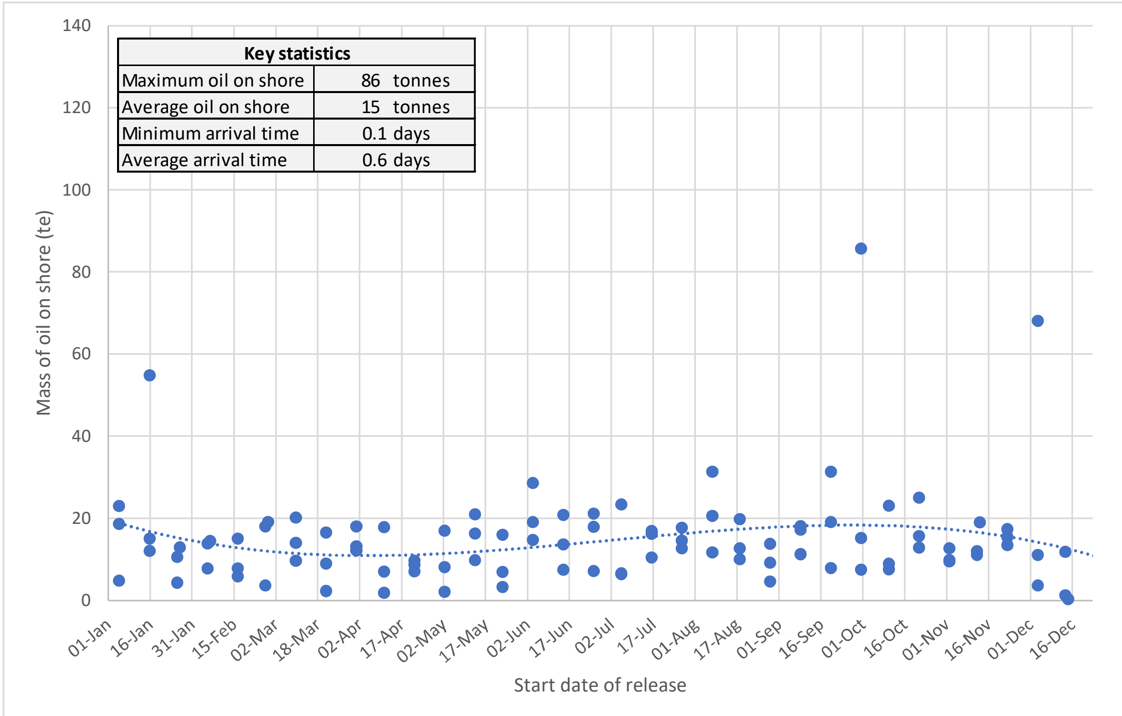


Figure 10: Distribution of oil (diesel) on shore from summer and winter stochastic analyses

Note: the average oil on shore (15 tonnes) differs slightly to the P50 (median) mass which is 13 tonnes, since the data is not linearly distributed. This data is shown in a distribution curve in Figure 11, along with minimum times of arrival ashore.

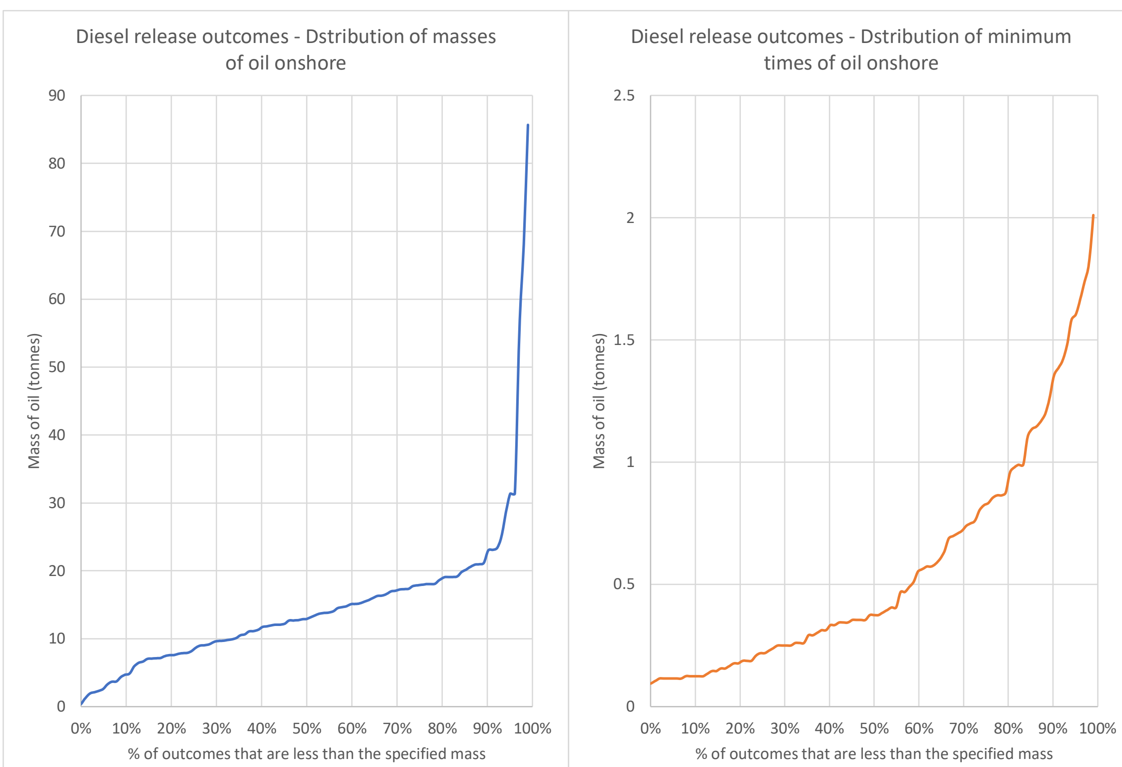


Figure 11: Statistical distribution of shoreline oil and minimum arrival times from summer and winter stochastic analyses (diesel release)

OSCAR statistical outputs are shown as follows:

- Probability of oil on the surface above the threshold of 0.04 μm (Figure 12 and Figure 13);
- Minimum arrival time of oil on the surface (no threshold) (Figure 14 and Figure 15);
- Probability of oil on the shoreline above the threshold of 100 ml/m² (Figure 16 and Figure 17);
- Minimum arrival time of oil on the shoreline (no threshold) (Figure 18 and Figure 19); and
- Probability of oil in the water column above the threshold of 58 ppb (Figure 20 and Figure 21).

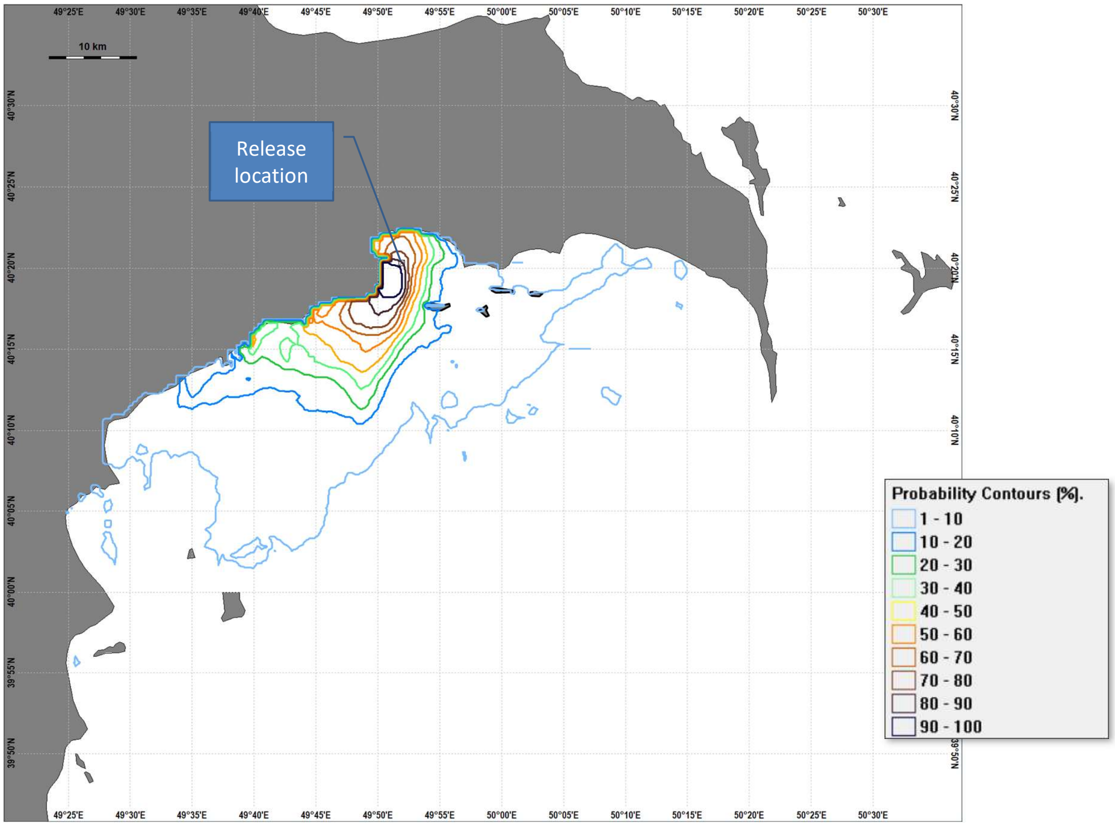


Figure 12: Diesel spill: Probability of surface oil above threshold of 0.04 µm (summer)

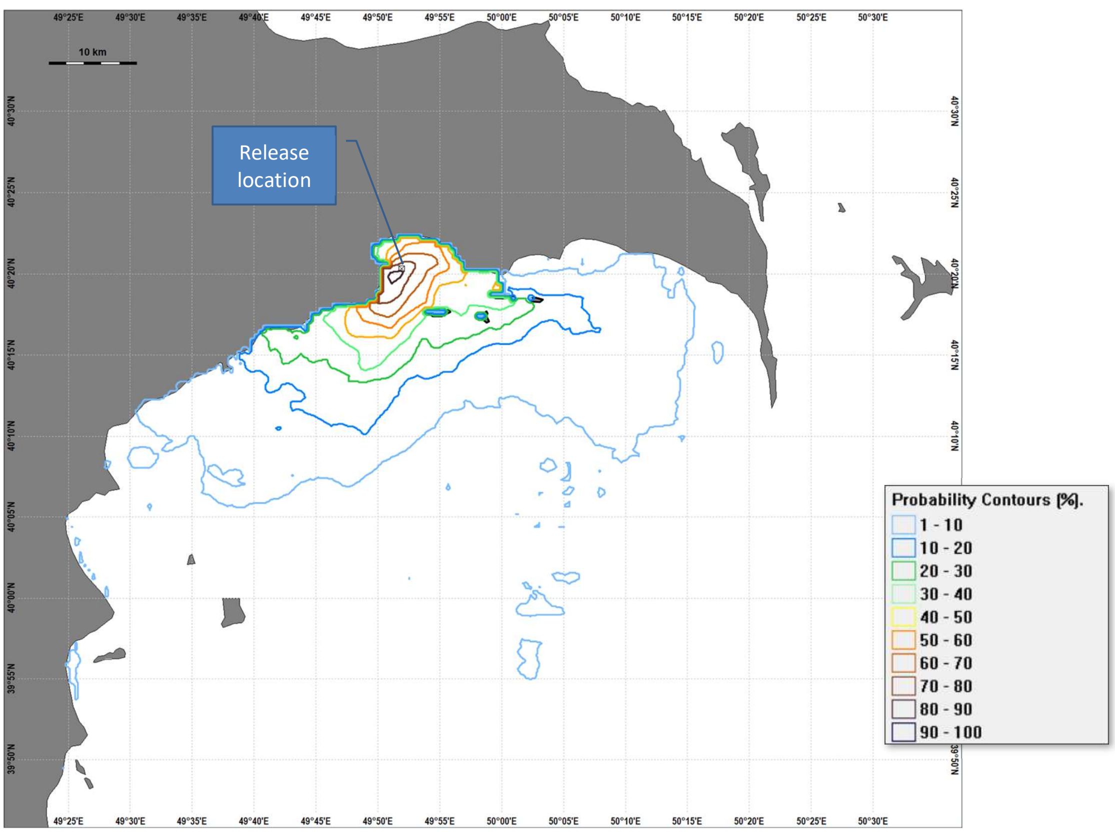


Figure 13: Diesel spill: Probability of surface oil above threshold of 0.04 µm (winter)

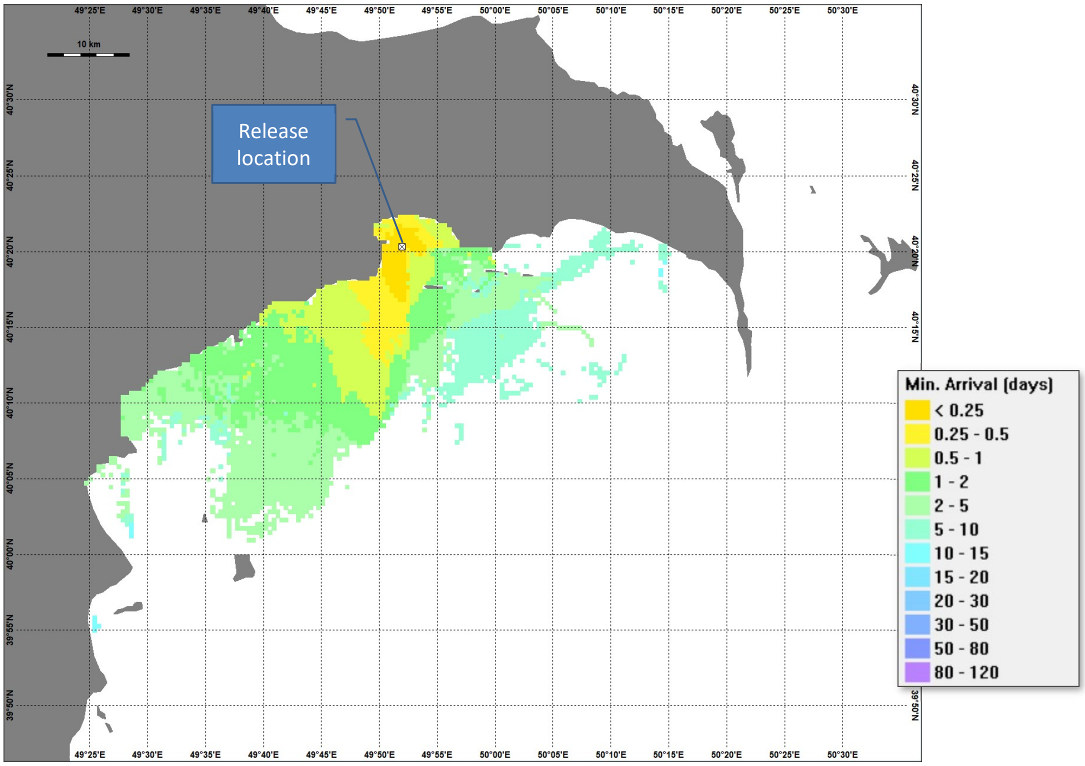


Figure 14: Diesel spill: Minimum arrival time of oil on surface (summer)

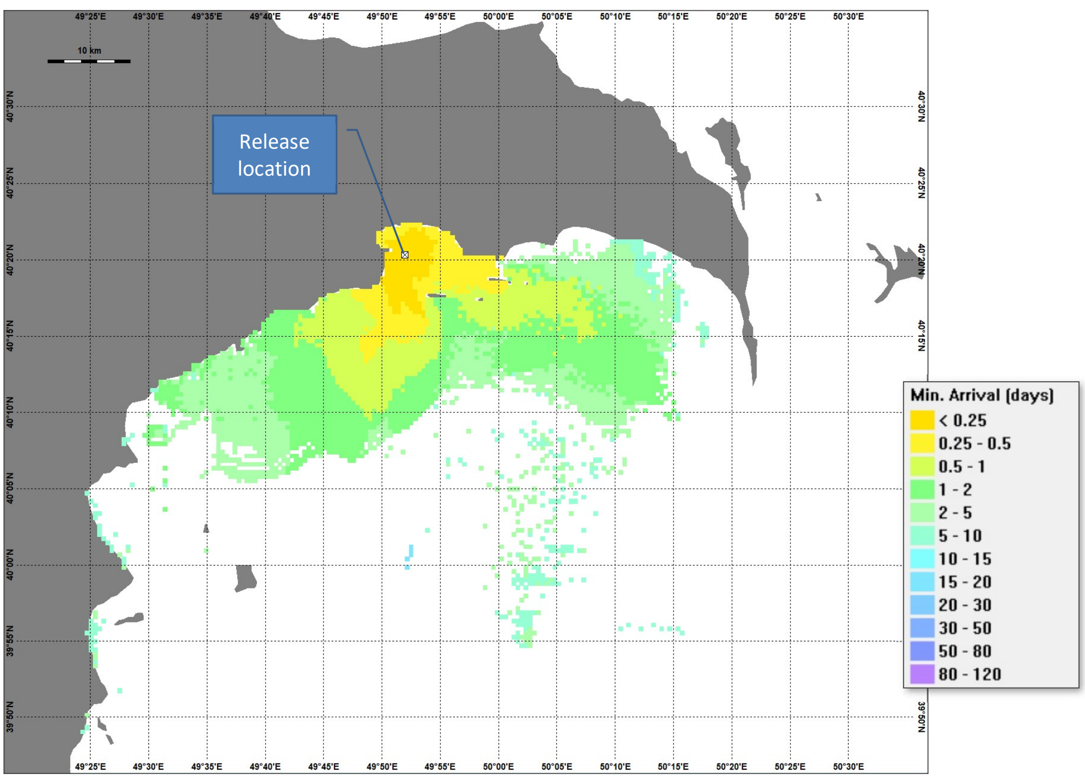


Figure 15: Diesel spill: Minimum arrival time of oil on surface (winter)

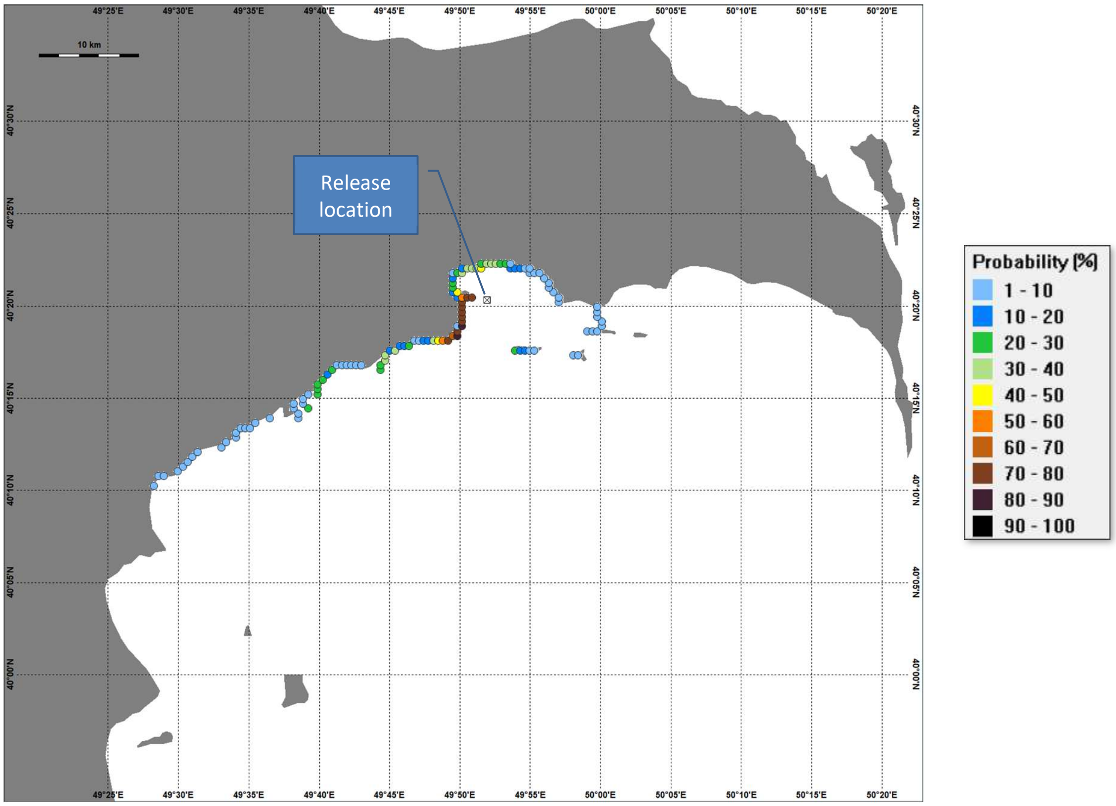


Figure 16: Diesel spill: Probability of oil on shoreline above threshold of 100 ml/m² (summer)

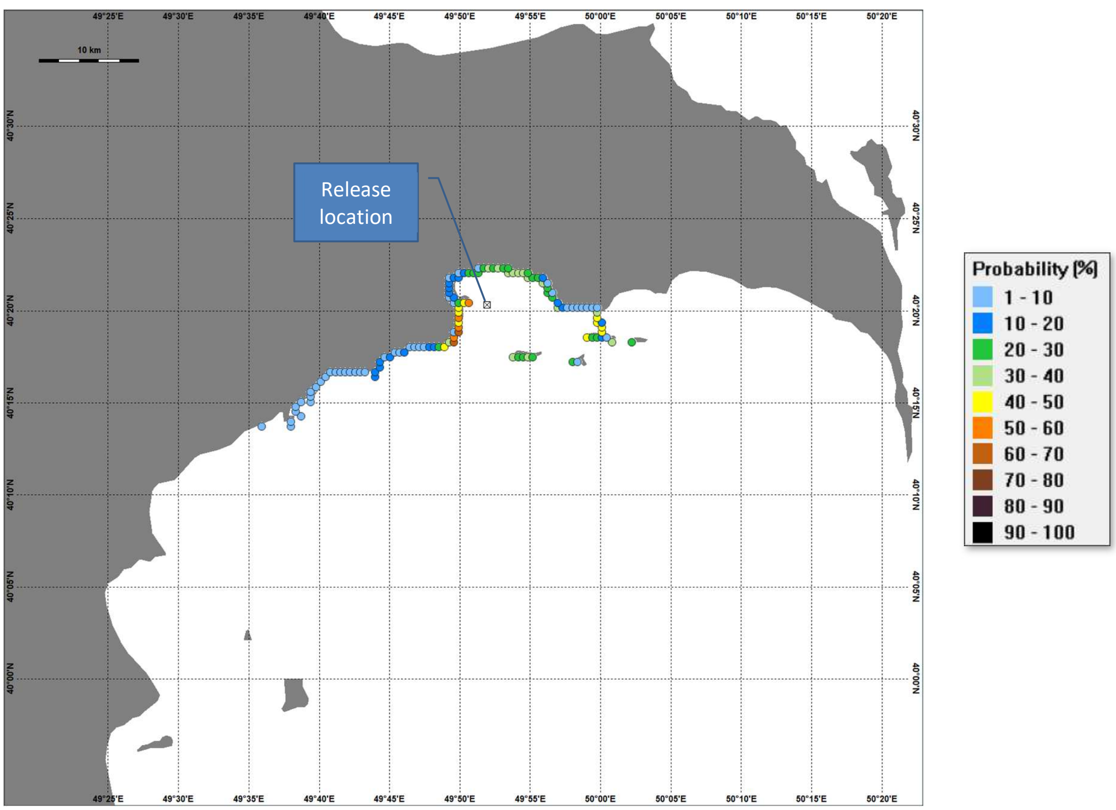


Figure 17: Diesel spill: Probability of oil on shoreline above threshold of 100 ml/m² (winter)

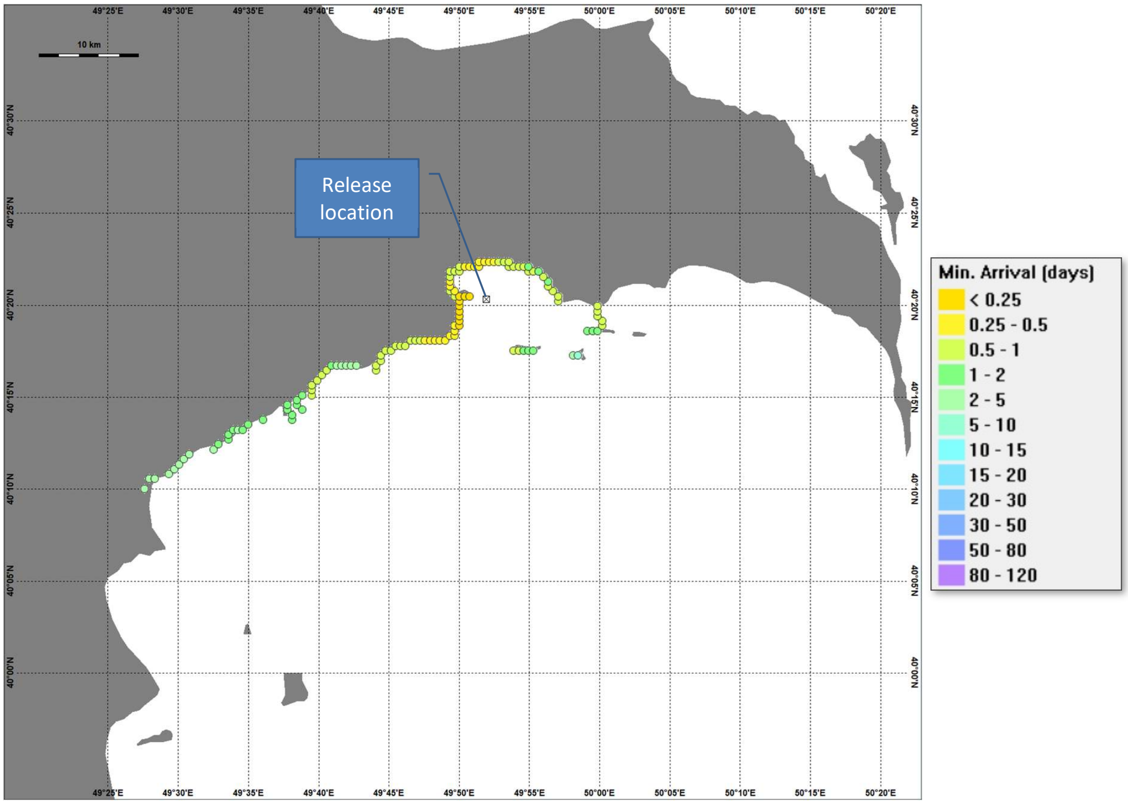


Figure 18: Diesel spill: Minimum arrival time of oil on the shoreline (summer)

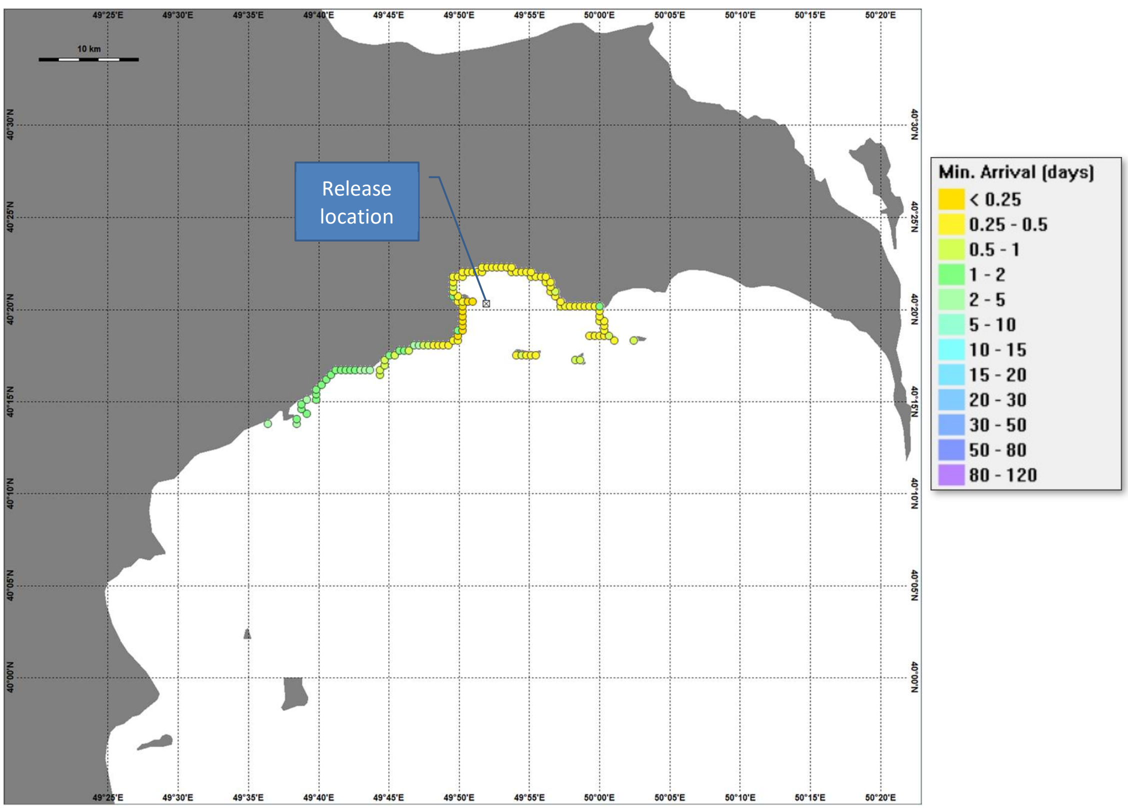


Figure 19: Diesel spill: Minimum arrival time of oil on the shoreline (winter)

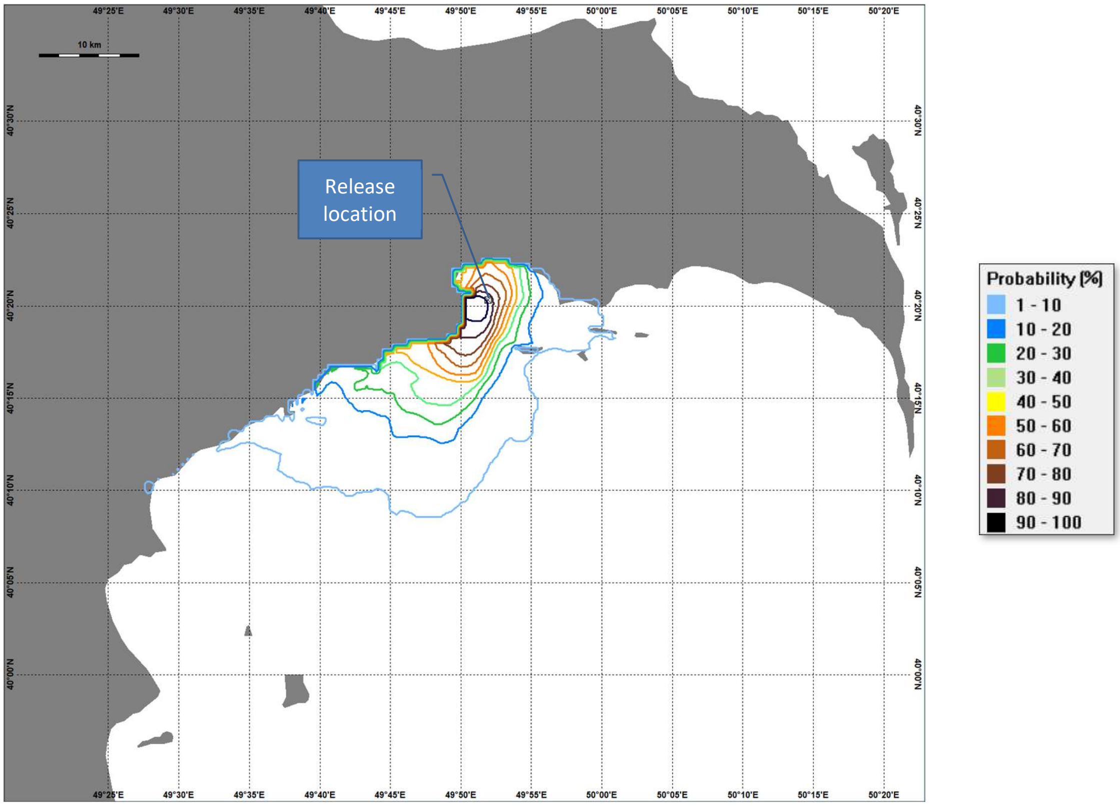


Figure 20: Diesel spill: Probability of oil in water column above threshold of 58 ppb (summer)

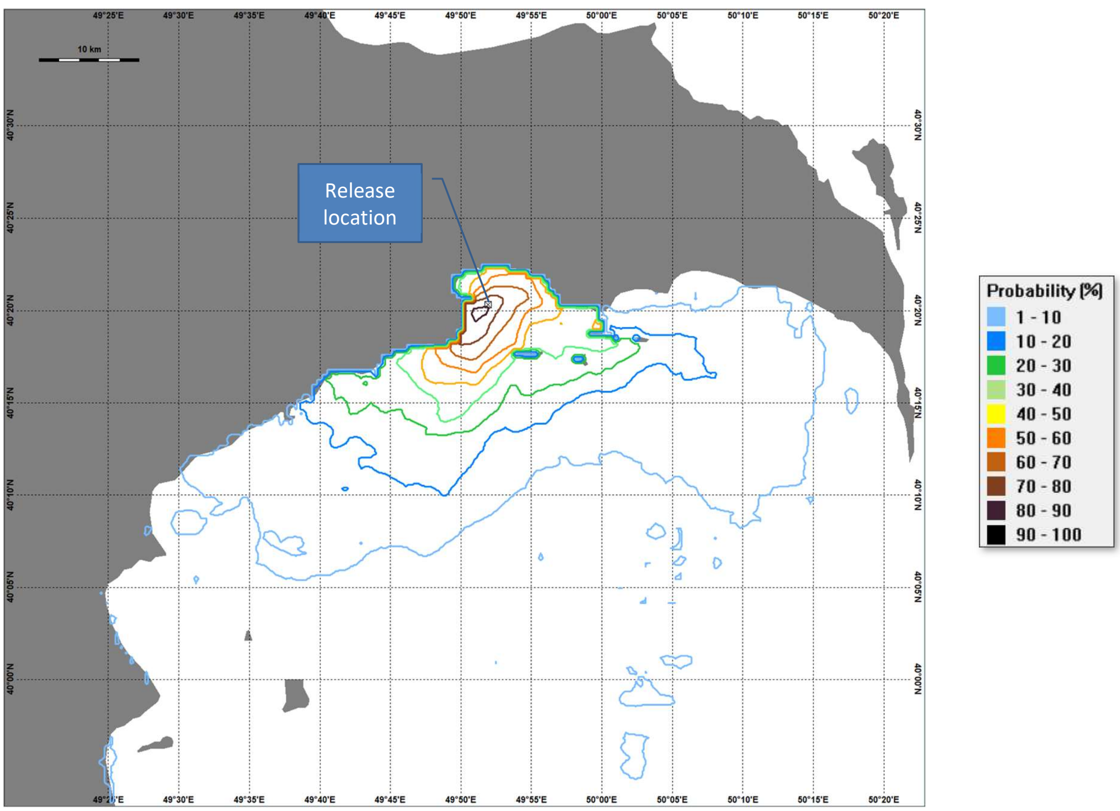


Figure 21: Diesel spill: Probability of oil in water column above threshold of 58 ppb (winter)

5.1.3 Deterministic modelling

Key outputs from the deterministic modelling are shown in Table 10.

Table 10: Deterministic results summary for diesel spill scenario

Scenario	Release location	Maximum surface extent of sheen above 0.04 µm (km)		Time until water column concentration[1] <58 ppb (days)[2]	
		Summer	Winter	Summer	Winter
Diesel spill 600 m^3	BHEX01 well	39	59	8	11

Notes: 1. Dissolved and dispersed oil in water column.

2. Time from start of release

The timing of the summer and winter deterministic scenarios is chosen to match the cases with the maximum mass of diesel reaching shore in each season.

5.1.3.1 Diesel on surface

Diesel on the sea surface is predicted to travel less than 60 km in these two sets of conditions before it drops below the lowest recognised visible thickness under ideal viewing conditions (Figure 22 and Figure 23). There are some breaks between areas of sheen that are a result of changes in wind and wave conditions that disperse the diesel briefly and then allow it to re-emerge later and form a new sheen separate to the first area.

Thicker areas of diesel that are more likely to be associated with environmental impacts are restricted to a small radius around the spill location in the Baku Bay area.

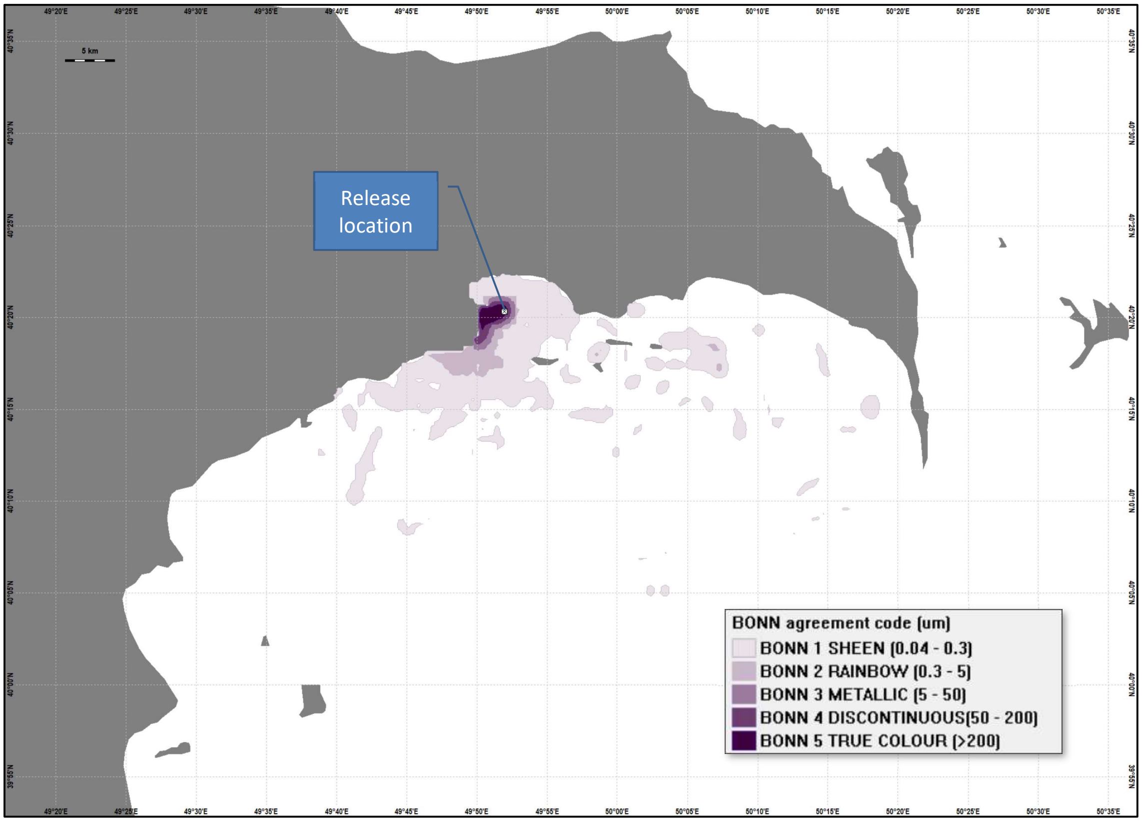


Figure 22: Diesel spill: Cumulative area of surface sheen - summer

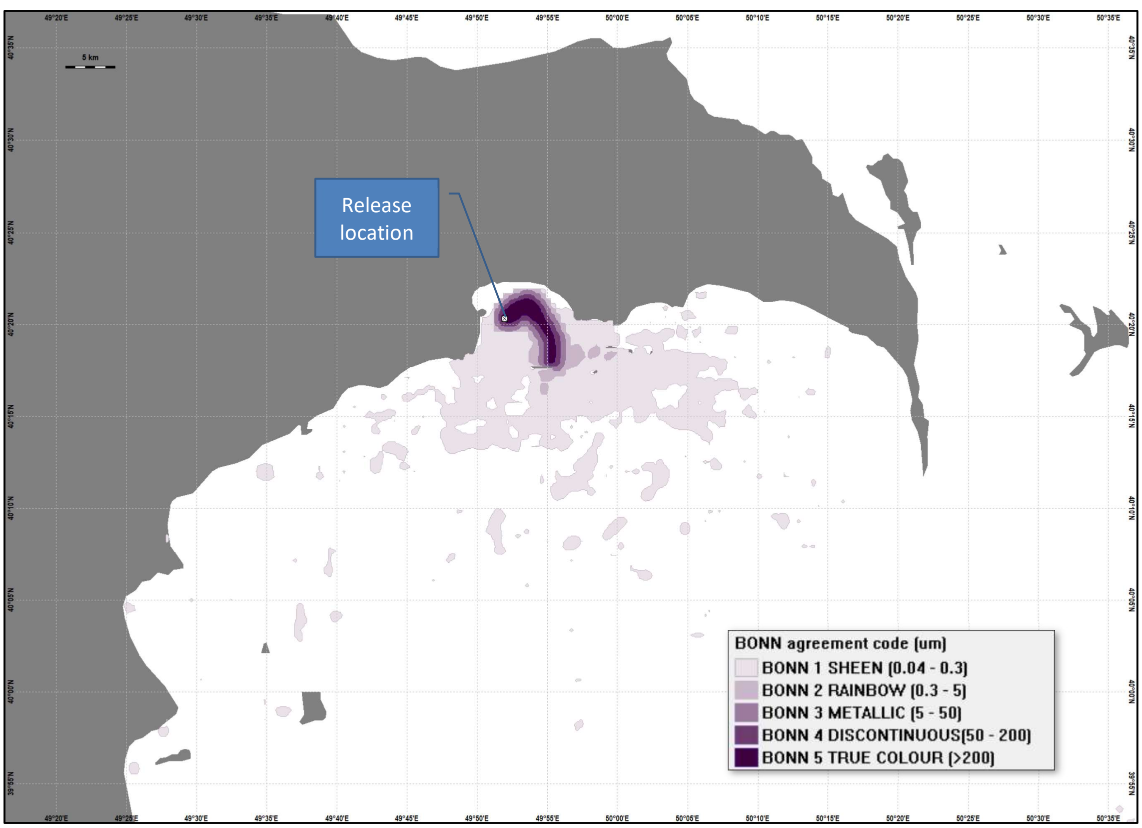


Figure 23: Diesel spill: Cumulative area of surface sheen - winter

5.1.3.2 Diesel on shore

Diesel accumulation on shore for the summer deterministic case is shown in Figure 24 and the winter deterministic case is shown in Figure 25. These represent the deposition of oil on the shore at the end of the simulation when the maximum length of coastline is affected. This distribution is very similar to the distribution at which the maximum mass of shoreline deposition occurs, and so this is not shown in addition.The summer case results in diesel reaching shoreline along the Azerbaijan coast. The case presented for summer is relatively localised and relates to the confinement of the release near Baku Bay by coastal projections and islands. In winter, the diesel takes a different path and is slightly more persistent due to the temperature, resulting in shoreline deposition over a larger area. However, the areas that are 'light' oiling or above are small and are localised to within a few kilometres of the release location. A mixture of areas of very light, light and moderate deposition are present.

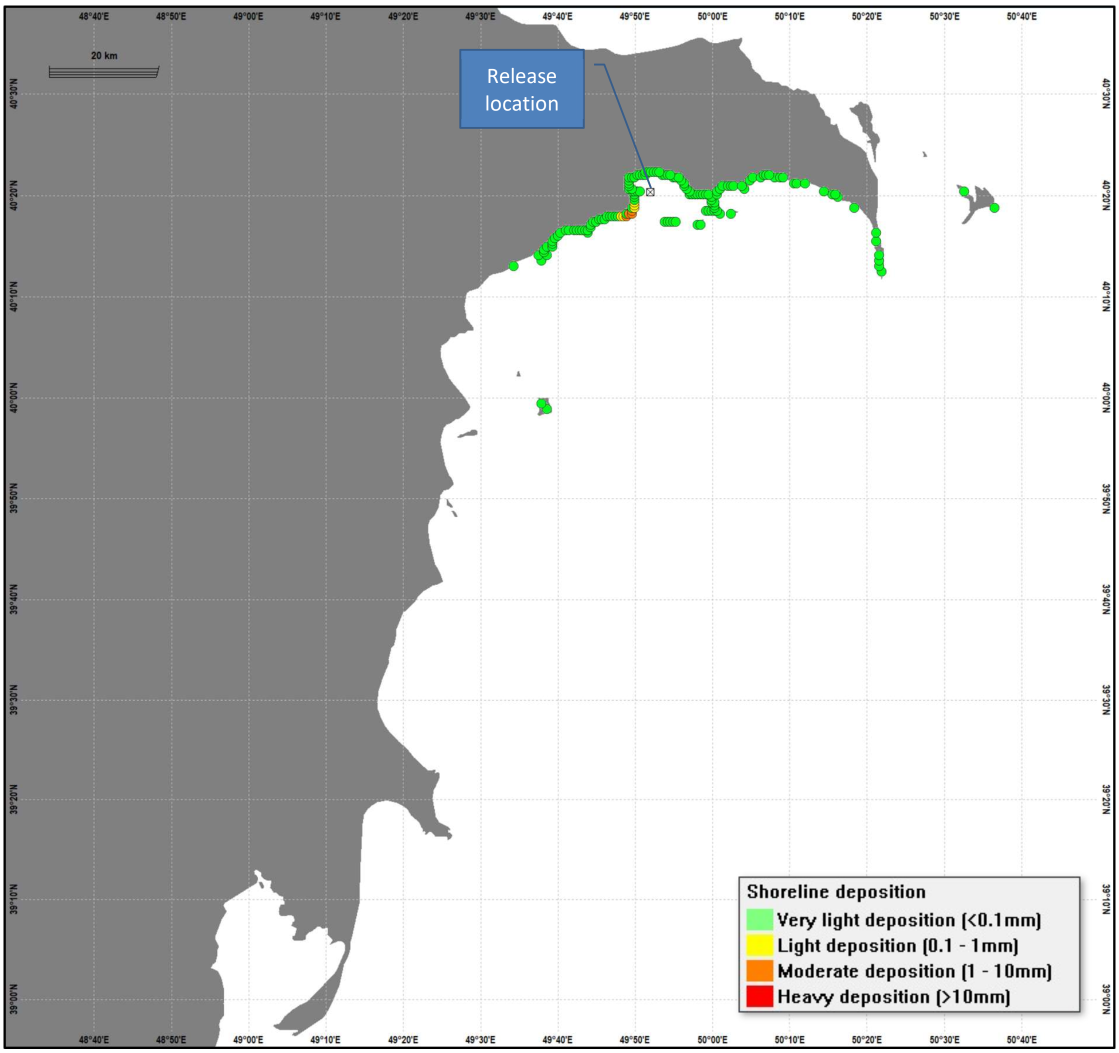


Figure 24: Diesel on shore- summer

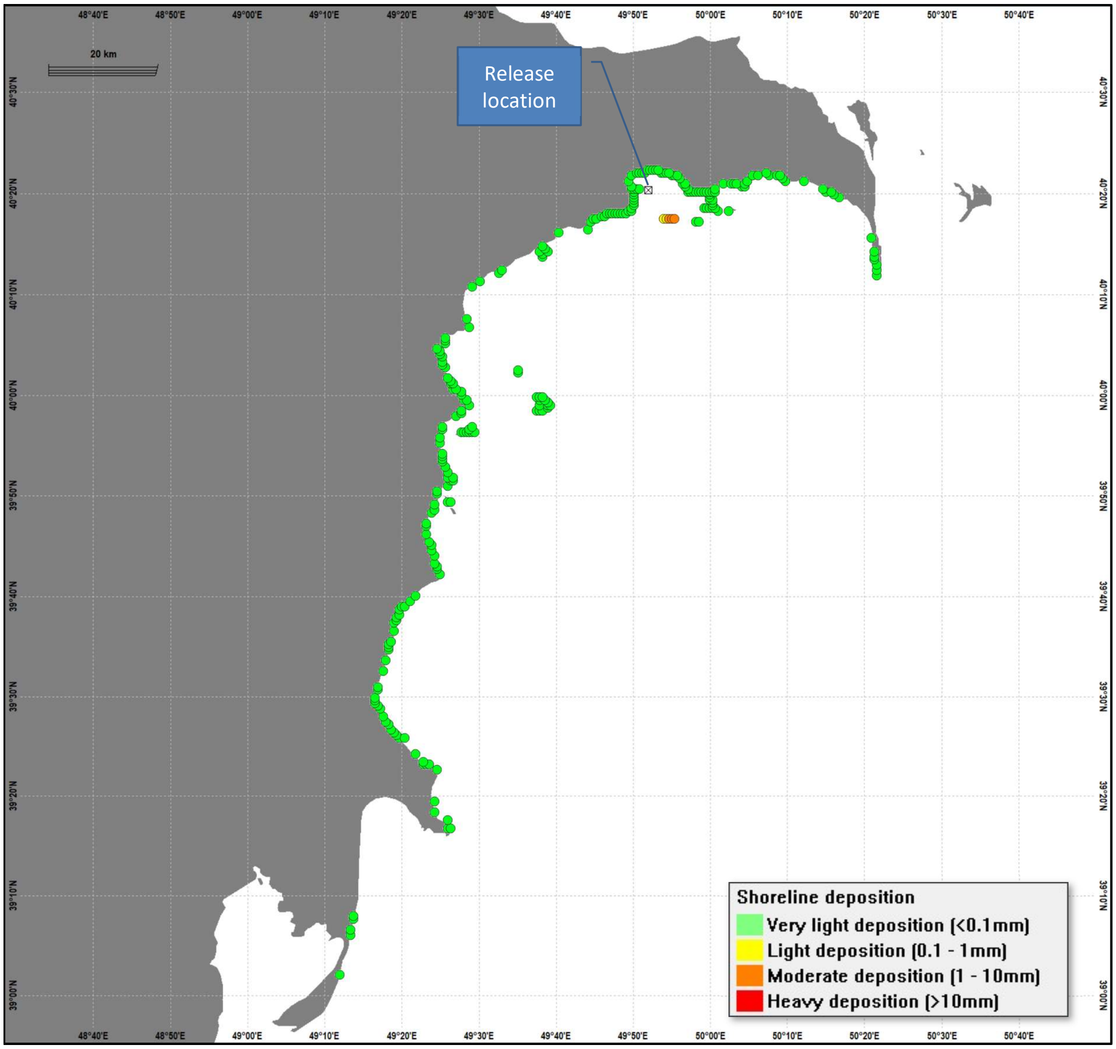


Figure 25: Diesel on shore- winter

5.1.3.3 Diesel in the water column

The extent of diesel in the water column is confined to 30 km from the release and tracks the path of the surface release. The area is affected for up to 11 days after the release before the oil disperses below the threshold levels, as shown in Figure 26 and Figure 27 representing the deterministic cases run in summer and winter including both dissolved and dispersed oil in the water column. In each figure, the output is the total area the diesel has covered as it has moved away from the release location. The cross section through the water column shows that the release remains in the upper sections of the water column.

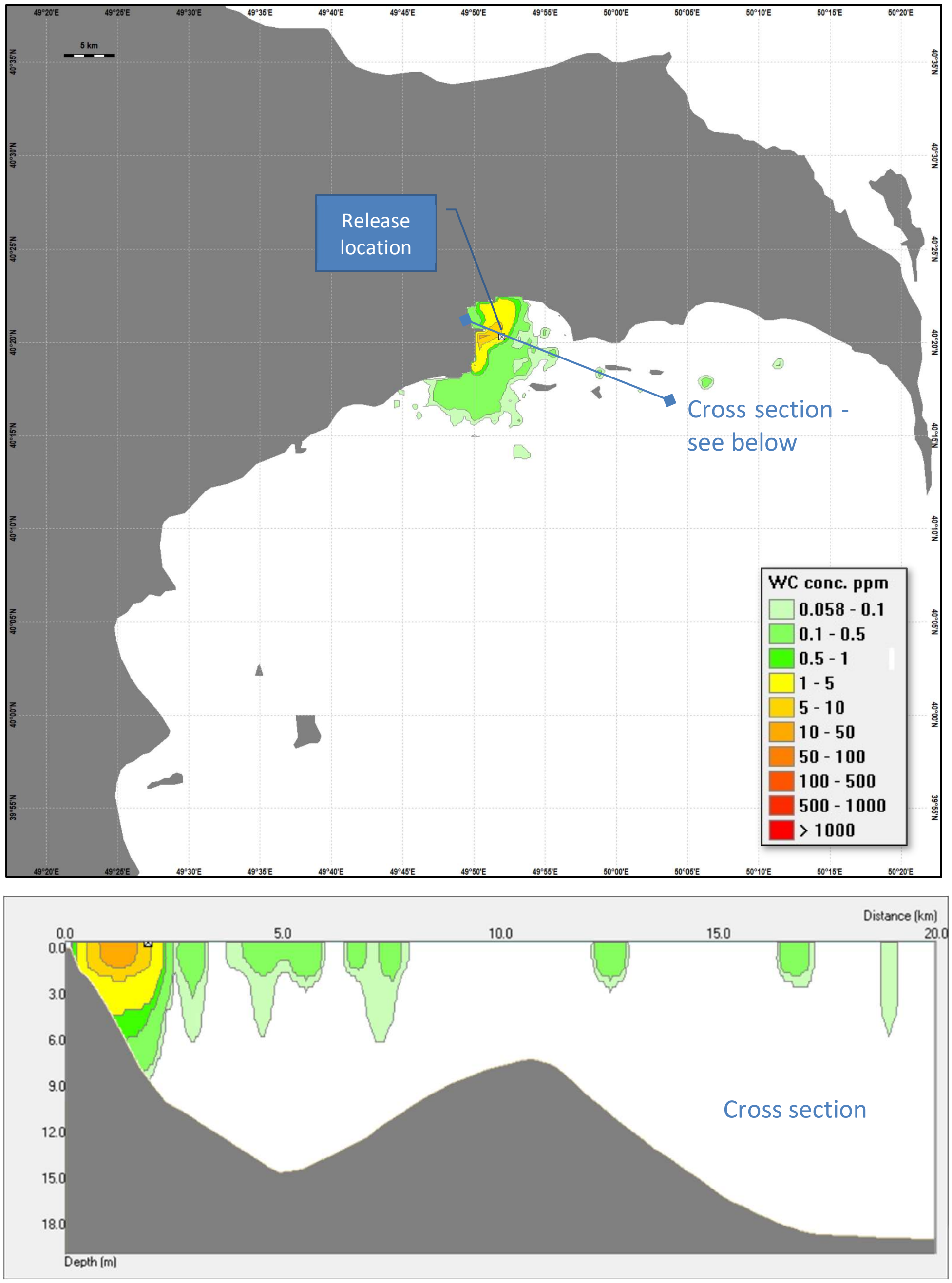


Figure 26: Diesel spill: maximum affected area of water column during simulation - summer

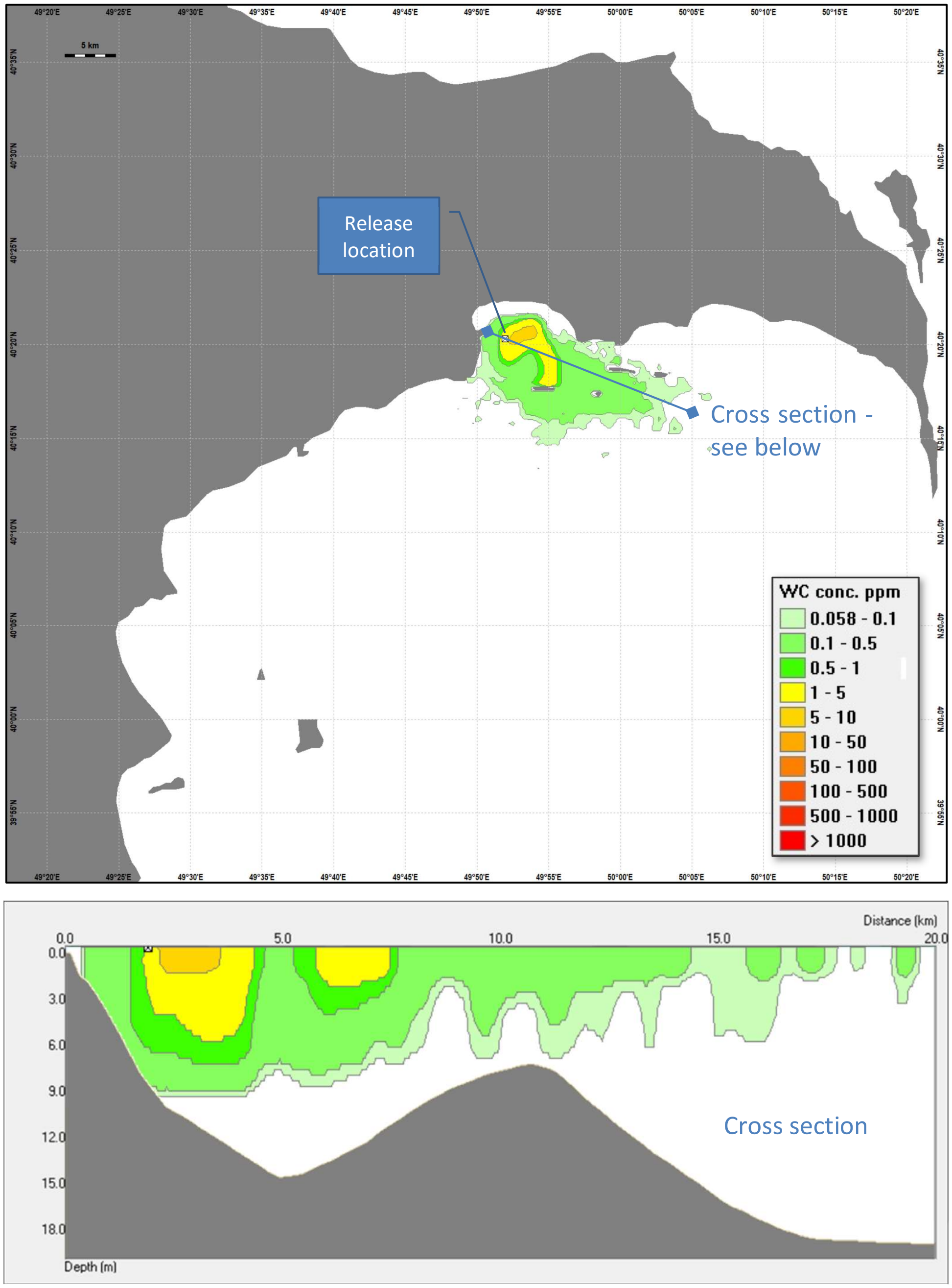


Figure 27: Diesel spill: maximum affected area of water column during simulation - winter

5.1.3.4 Diesel in sediments

By the end of the scenario, around 17% of the diesel is predicted to have deposited in sediments, predominantly in the adjacent shallow waters of the Absheron peninsula. In winter conditions, no areas of seabed deposition above the NOEC threshold of 10 mg/kg are predicted. In summer, the deposition pattern shown in Figure 28 shows that a small area around 4 km by 1 km is predicted to be above the 10 mg/kg thresholds close to the shoreline in Baku Bay, where diesel first reaches the shoreline. This is likely to have a short term and localised effect. The potential impact of oil in sediments is discussed in more detail in section 5.2.3.4.

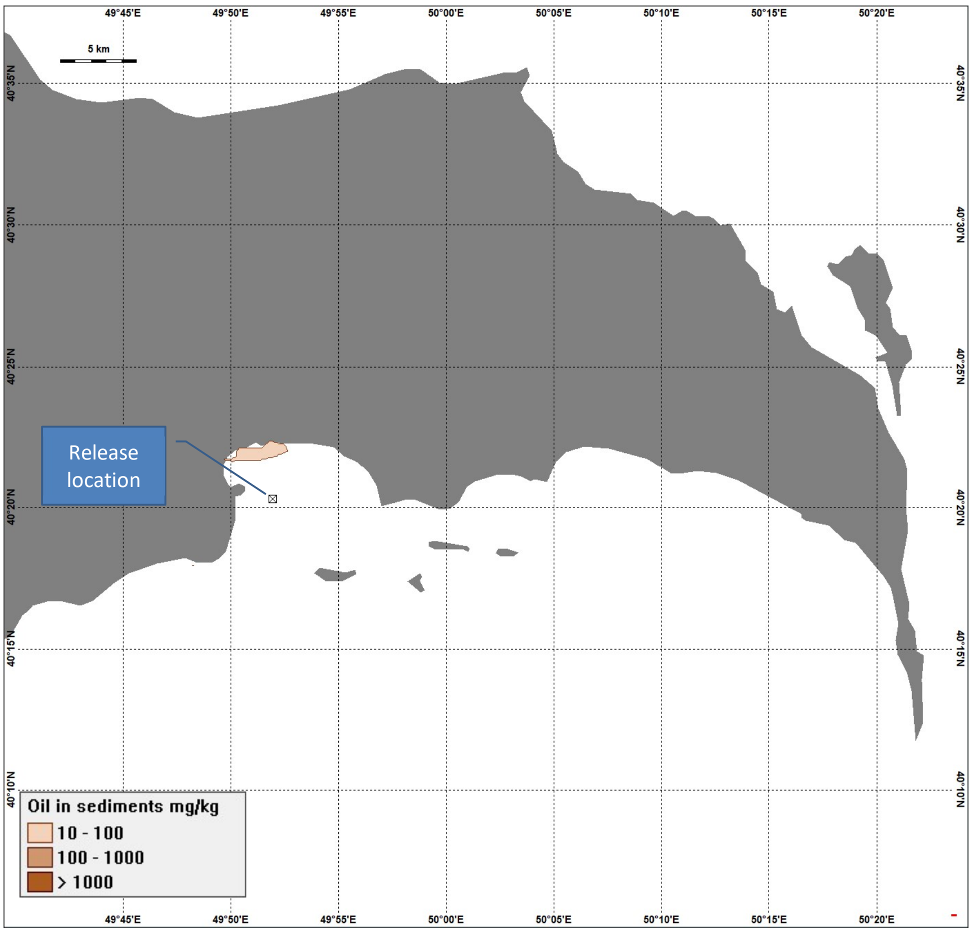


Figure 28: Worst case blowout: maximum mass of diesel deposited in sediments (summer)

5.2 Scenario 2 – Worst case blowout results

5.2.1 Overall description of oil behaviour from stochastic and deterministic modelling

The OSCAR model tracks the fate of oil through the simulation as shown in Figure 29, which represents the winter conditions, but which is generally representative of the fate of oil released at any point in the year.

Initially the majority of the oil is present on the sea surface. During the modelled period, a significant fraction of the oil evaporates, reaching 46% of the total spilled oil volume by the end of the simulation period (120 days). Partly, this is a function of the oil initially being confined by the artificial surfaces in Baku Bay and by projections from the nearby coastline and islands, and along with lower currents and winds at the shore, the oil is on the surface for a large fraction of the time allowing oil to evaporate. During the blowout period of 81 days, oil is continually supplied to the sea surface, and oil on the surface remains significant until after the end of this period. Dependent on the wind and waves, oil can be mixed into the water column and some oil can subsequently re-surface during calmer periods. After around half a day, oil begins to deposit in sediments, eventually accounting for around 23% of the oil at the end of the simulation. In this example, oil reaches the shore after approximately 0.5 days, and quickly accounts for 10% of the oil fate although the fraction reduces over time as evaporation and biodegradation continue, and oil on shore is 4.6% at the end of the simulation, with 26% biodegraded and < 1% remaining in the water column.

The high levels of evaporation could cause air quality issues onshore if there is a southerly wind direction.

Much of the oil behaviour is determined by prevailing winds, and when the wind is southerly, oil is pushed against the coastline and moves very little east or west of the release location since there are obstructions and bays along the coastline. There can be very high accumulations of oil against the coastline with a southerly wind. In these examples it can take around 9 days for the oil to move around the tip of the Absheron peninsula.

Due to the confining effect of the Absheron peninsula, the sea and shores of Azerbaijan and northern Iran, i.e. to the south of the peninsula, are far more likely to be affected than those to the north. The eastern shores of the Caspian Sea are at a much lower risk of oiling and oil would take at least 20-30 days to arrive.

The area of water column affected tends to track the surface oil location and is predominantly mixed within the upper 30 m of the water depth over the course of the simulation. As oil moves into deeper water, it tends to be more dispersed and weathered.

Given the proximity to shore, oil reaches the shore in substantial amounts and does so quickly, with the 50th percentile values for initial shoreline oiling being 20 hours and 54,299 tonnes, and a maximum shoreline oiling value of 91,218 tonnes. This would be higher if the coastlines were natural beaches, but the artificial surfaces around Baku Bay retain less oil. It should be noted that the mass of oil that aggregates at the shoreline will, at times, be higher than the mass attached to the shoreline which is reported here as 'shoreline oil', where the oil will have saturated the shoreline substrate.

The oil is predicted to emulsify to a water content of 60% within 6 hours of release and remain in a stable emulsion state for a long period thereafter. Therefore, in term of masses of emulsion at the shoreline, the results should be interpreted as being 2.5 times the mass of oil.

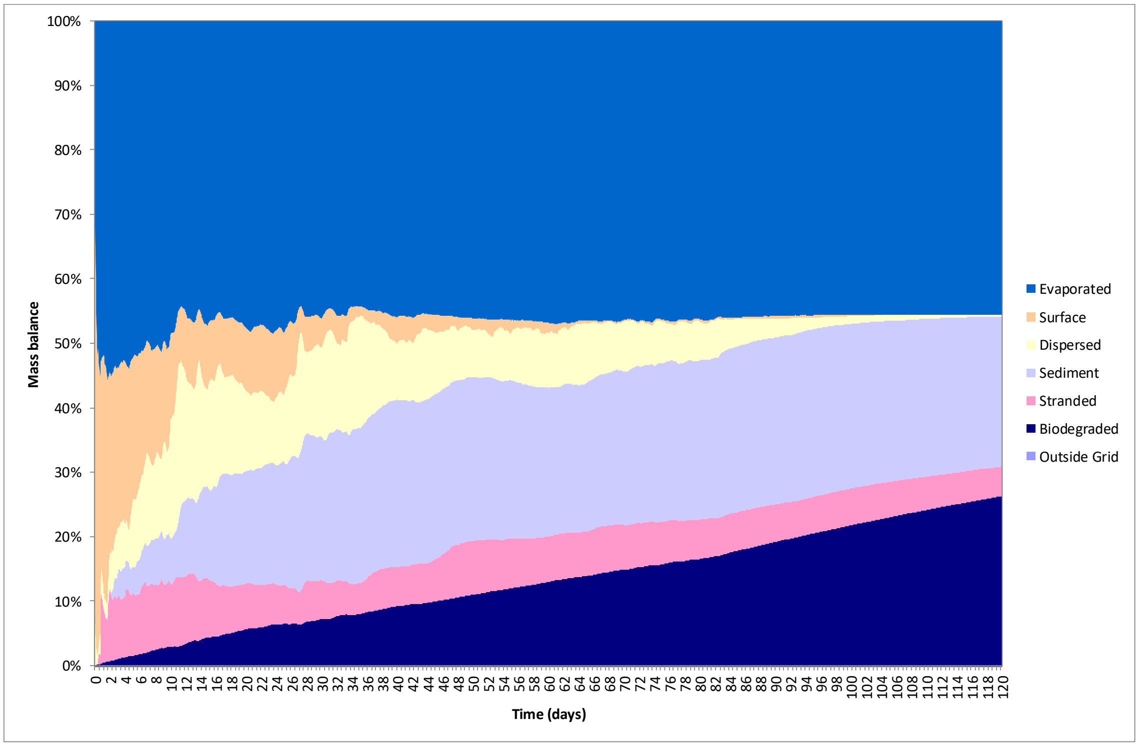


Figure 29: Worst case blowout: Fate of oil during modelling period - winter

5.2.2 Stochastic modelling

Stochastic simulations were generated encompassing year-round varying metocean data for the worst-case blowout scenario of 957,402 m^3 of crude oil using 102 model runs evenly spaced through the three years' data. From these results, the worst weather periods were chosen to run deterministic scenarios under summer and winter conditions.

The results for shoreline oiling for each of these simulations are represented in Figure 30 and statistics summarised in Table 11. There is a small seasonal bias to the results, showing blowout start times of February - May are likely to result in much larger volumes of oil arriving on shore than at other times of the year. Between October and December, the likely amounts of oil reaching shore are far lower.

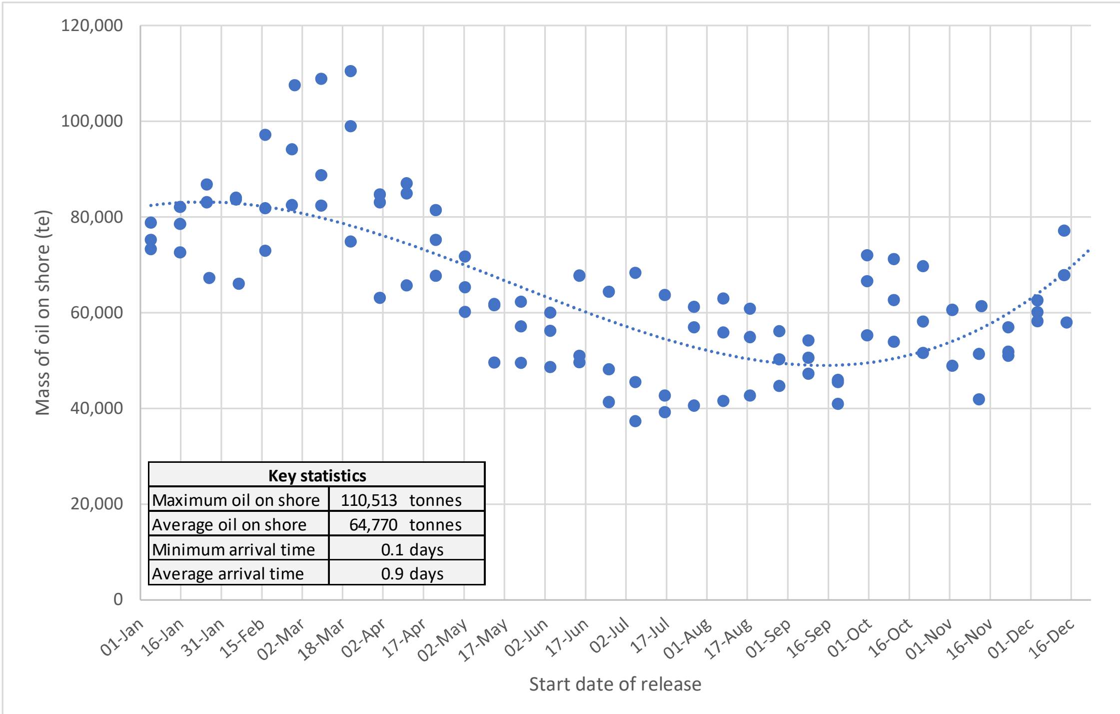


Figure 30: Seasonal distribution of oil on shore from stochastic analysis

Notes:

1. The average oil on shore (64,770 tonnes) differs slightly to the P50 (median) mass given below.
2. Mass of oil onshore excludes associated water. Crude oil is predicted to be present in an emulsion, and the mass of emulsion is expected to be around 2.5 times the mass of oil.

Table 11: Stochastic results summary

Scenario	Percentile[1]	Minimum time to beaching (days)	Mass of emulsion accumulated onshore (tonnes)[2]
Worst case blowout	P10	0.28	45,502
	P50	0.72	62,425
	P90	1.78	84,633
	Worst	0.10	110,513

Notes:

1. P90 means that in 90 % of scenarios modelled, this value or less would result.
2. Mass of oil onshore excludes associated water. Crude oil is predicted to be present in an emulsion, and the mass of emulsion is expected to be around 2.5 times the mass of oil.

OSCAR statistical outputs are shown as follows:

- Probability of oil on the surface above the threshold of 0.04 µm (Figure 31 and Figure 32);
- Minimum arrival time of oil on the surface (no threshold) (Figure 33 and Figure 34);
- Probability of oil on the shoreline above the threshold of 100 g/m^2 (Figure 35, Figure 36, Figure 37, Figure 38, Figure 39 and Figure 40);
- Minimum arrival time of oil on the shoreline (no threshold) (Figure 41, Figure 42, Figure 43, Figure 44, Figure 45 and Figure 46); and
- Probability of oil in the water column above the threshold of 58 ppb (Figure 47 and Figure 48).

Note that the arrival time of oil at the shoreline above the threshold may be different to the arrival time on the adjacent sea surface above threshold, although any differences are usually small.

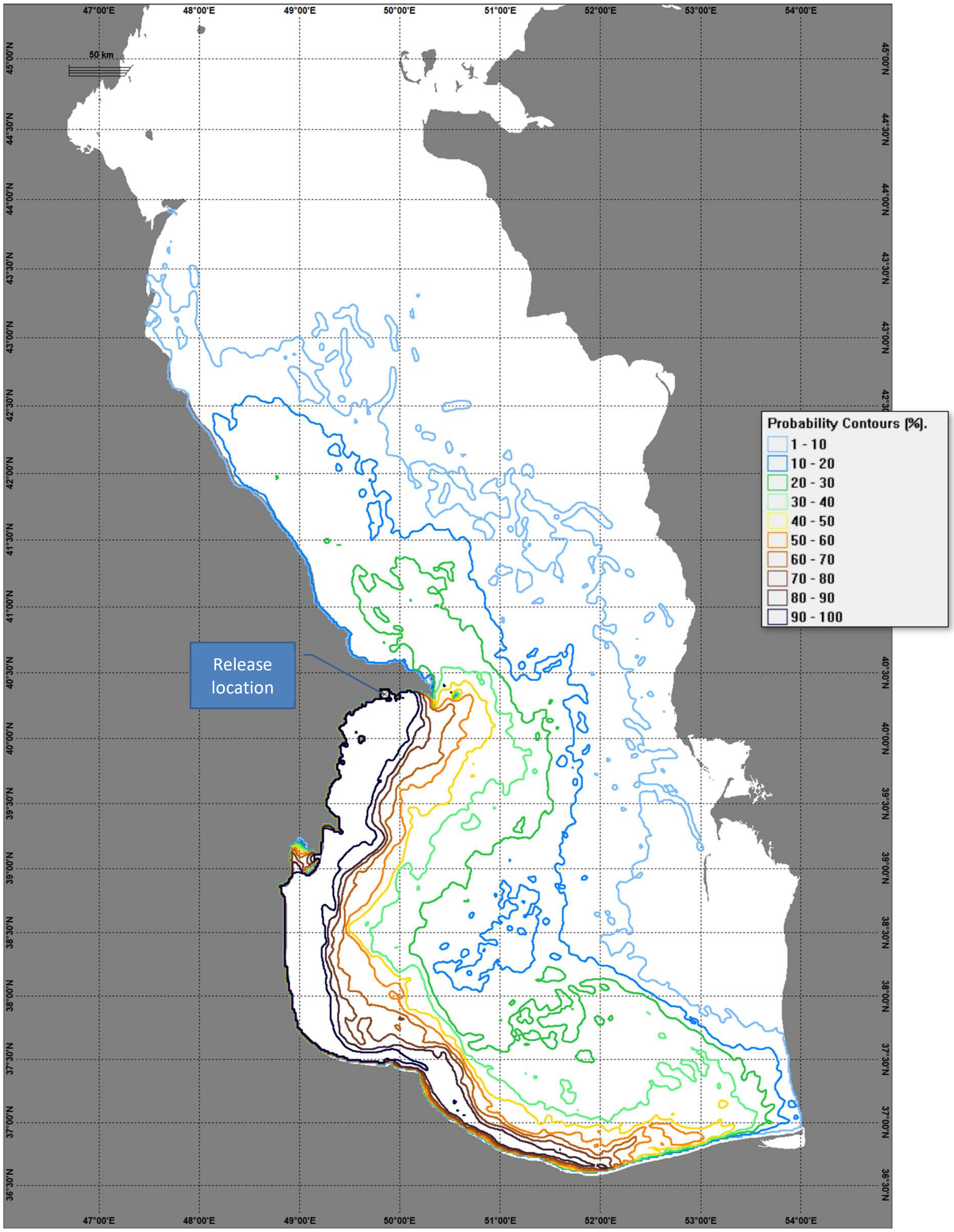


Figure 31: Worst case blowout: Probability of surface oil above threshold of 0.04 μm (summer)

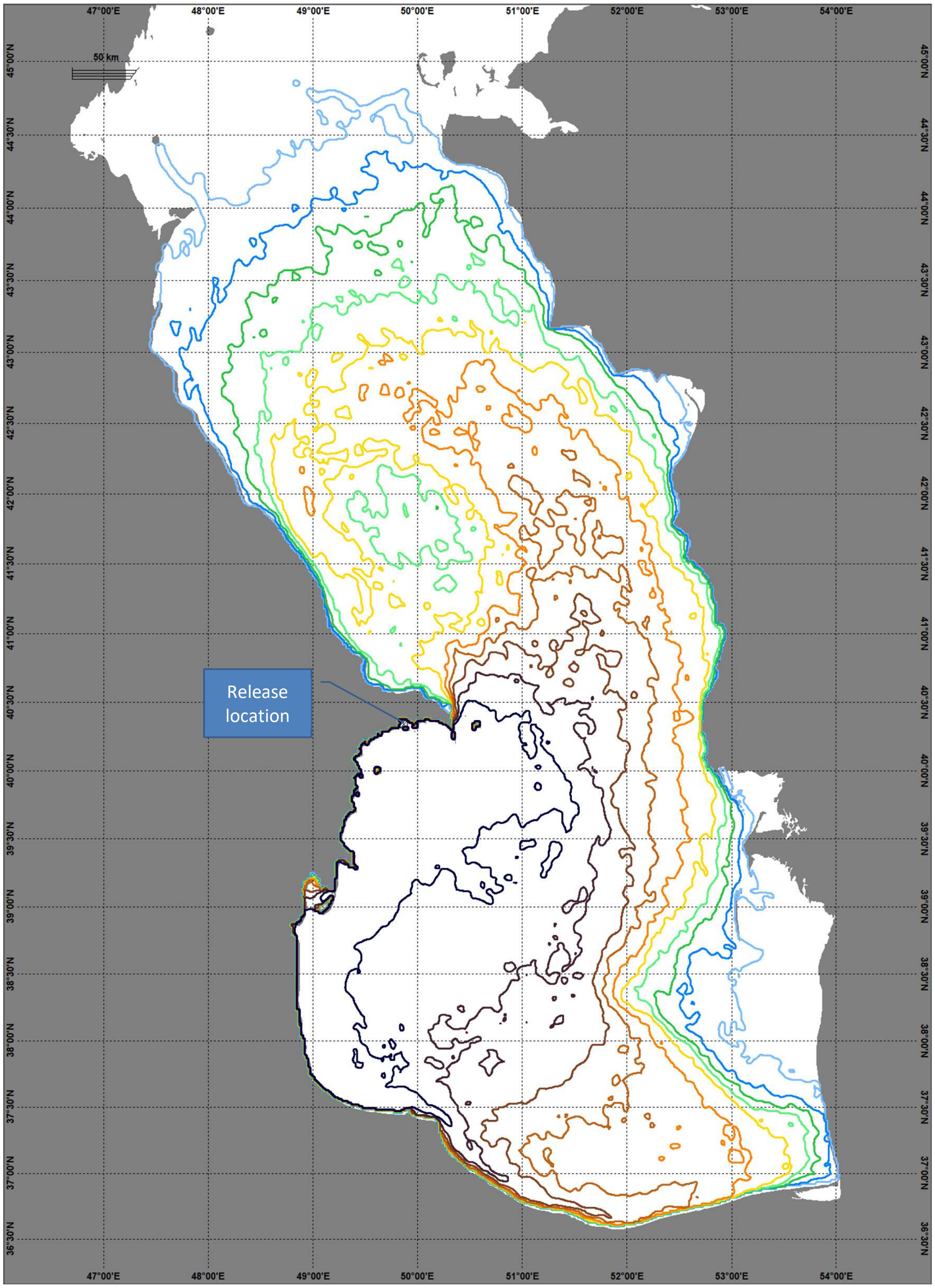


Figure 32: Worst case blowout: Probability of surface oil above threshold of 0.04 µm (winter)

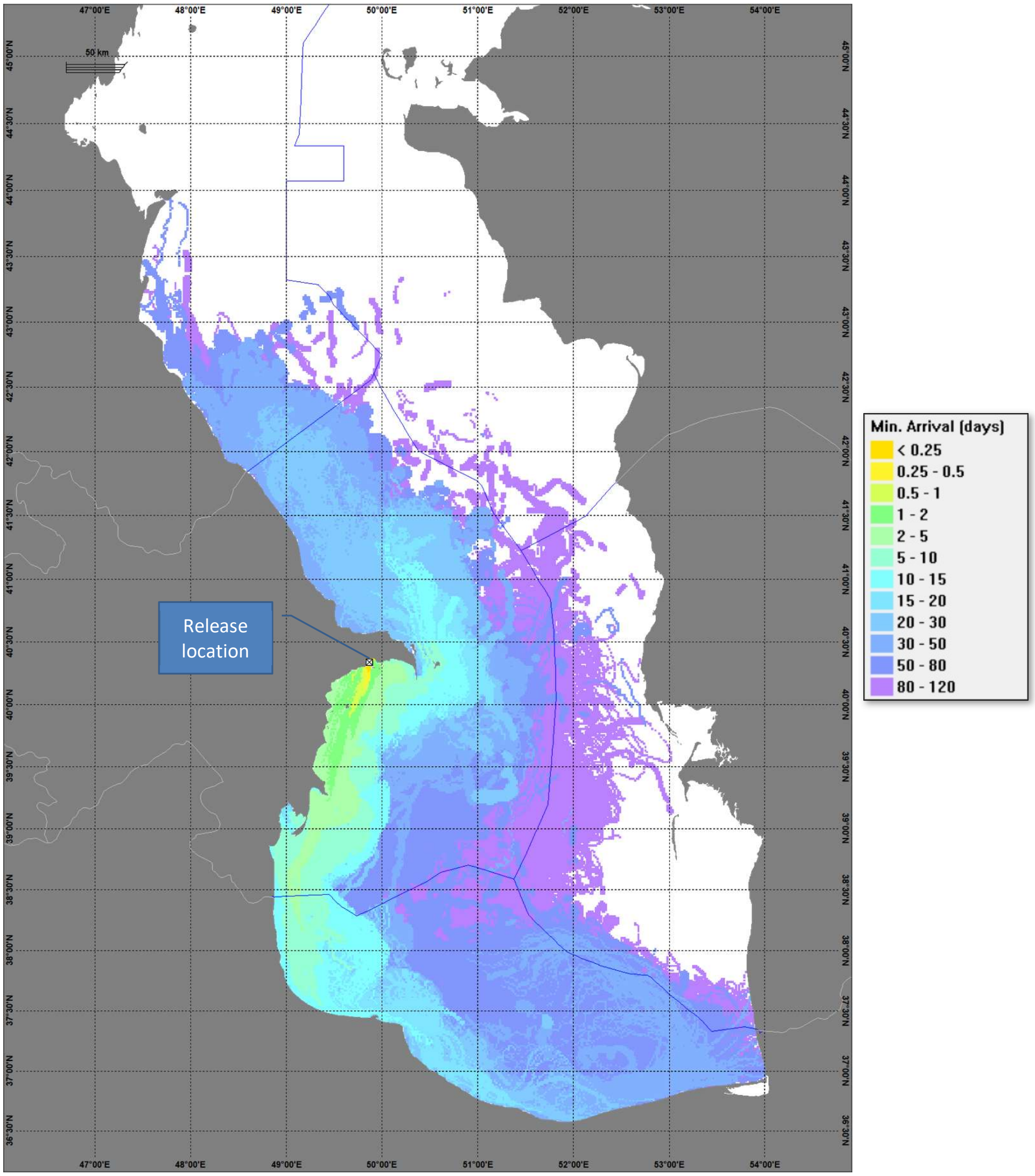


Figure 33: Worst case blowout: Minimum arrival time of oil on surface (summer)

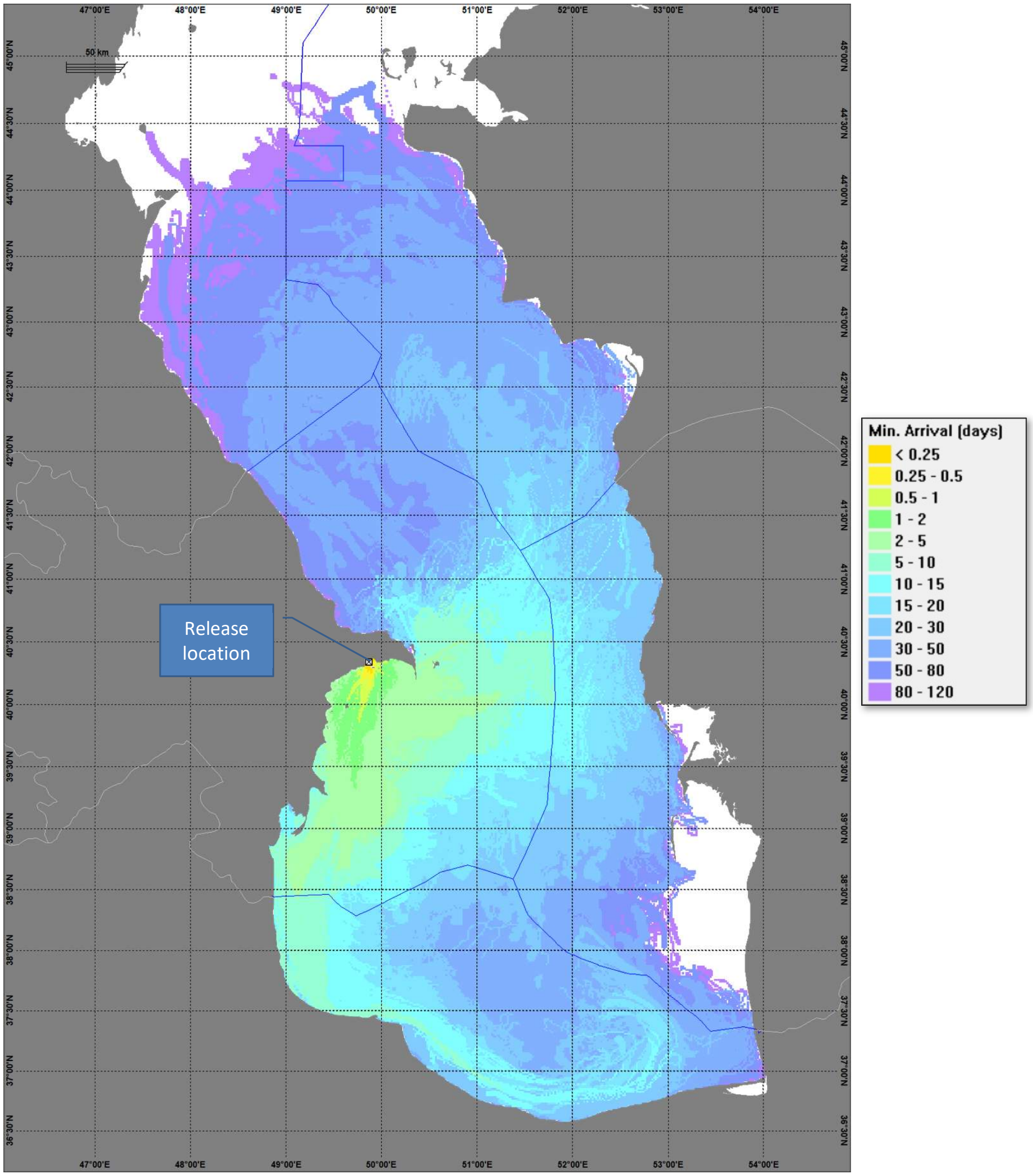


Figure 34: Worst case blowout: Minimum arrival time of oil on surface (winter)

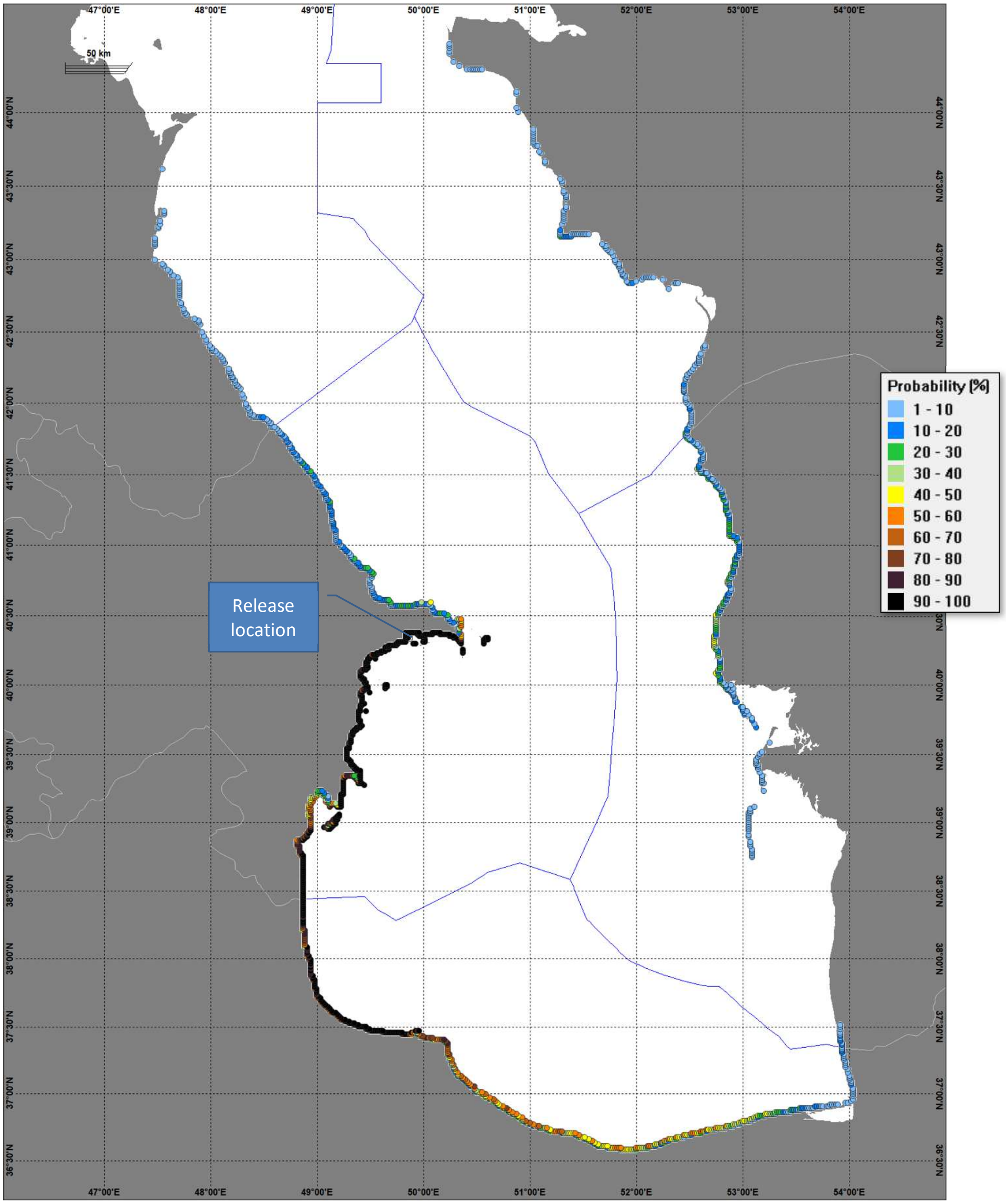


Figure 35: Worst case blowout: Probability of oil on shoreline above threshold of 100 ml/m² - Caspian Sea (summer)

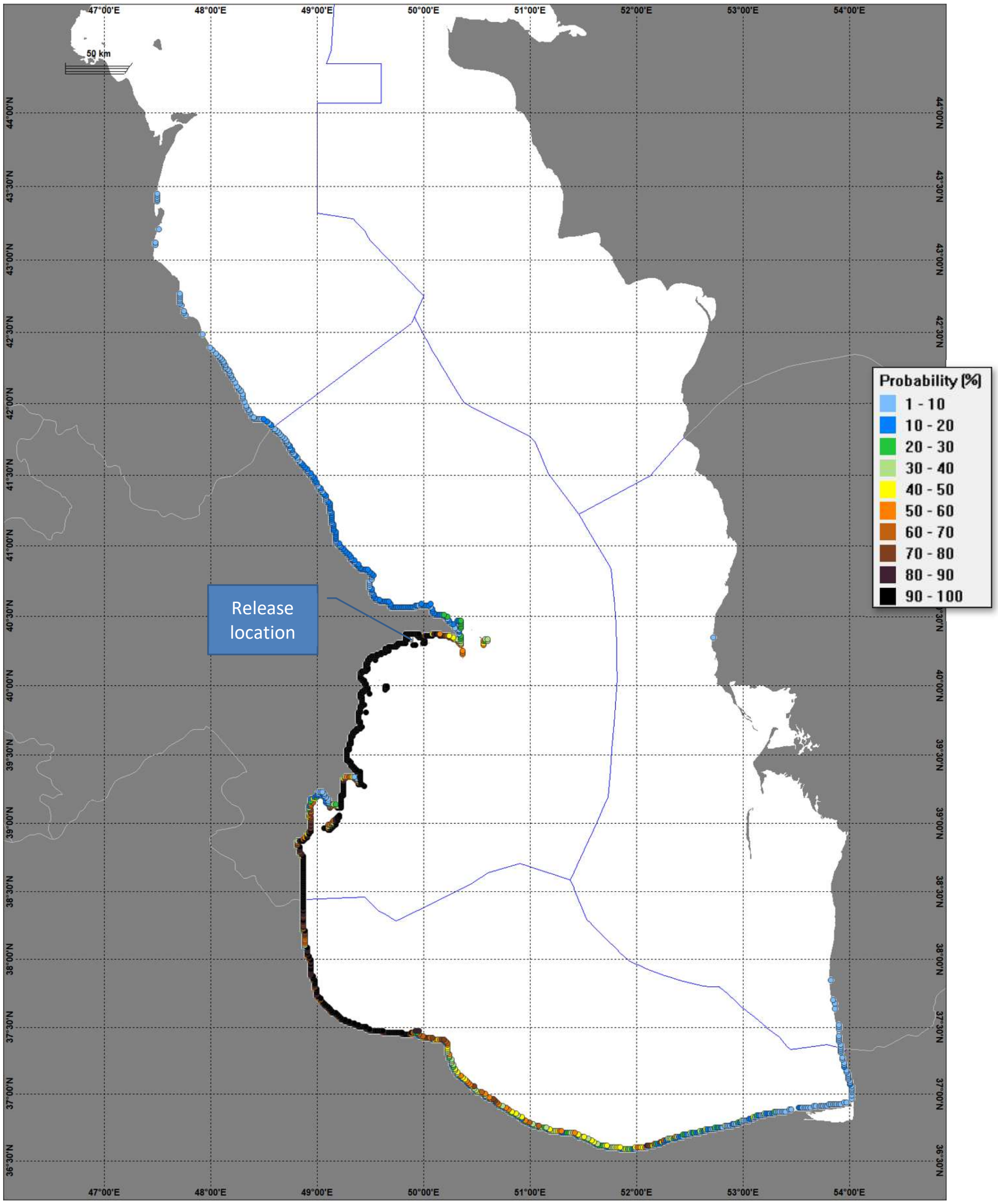


Figure 36: Worst case blowout: Probability of oil on shoreline above threshold of 100 ml/m² - Caspian Sea (winter)

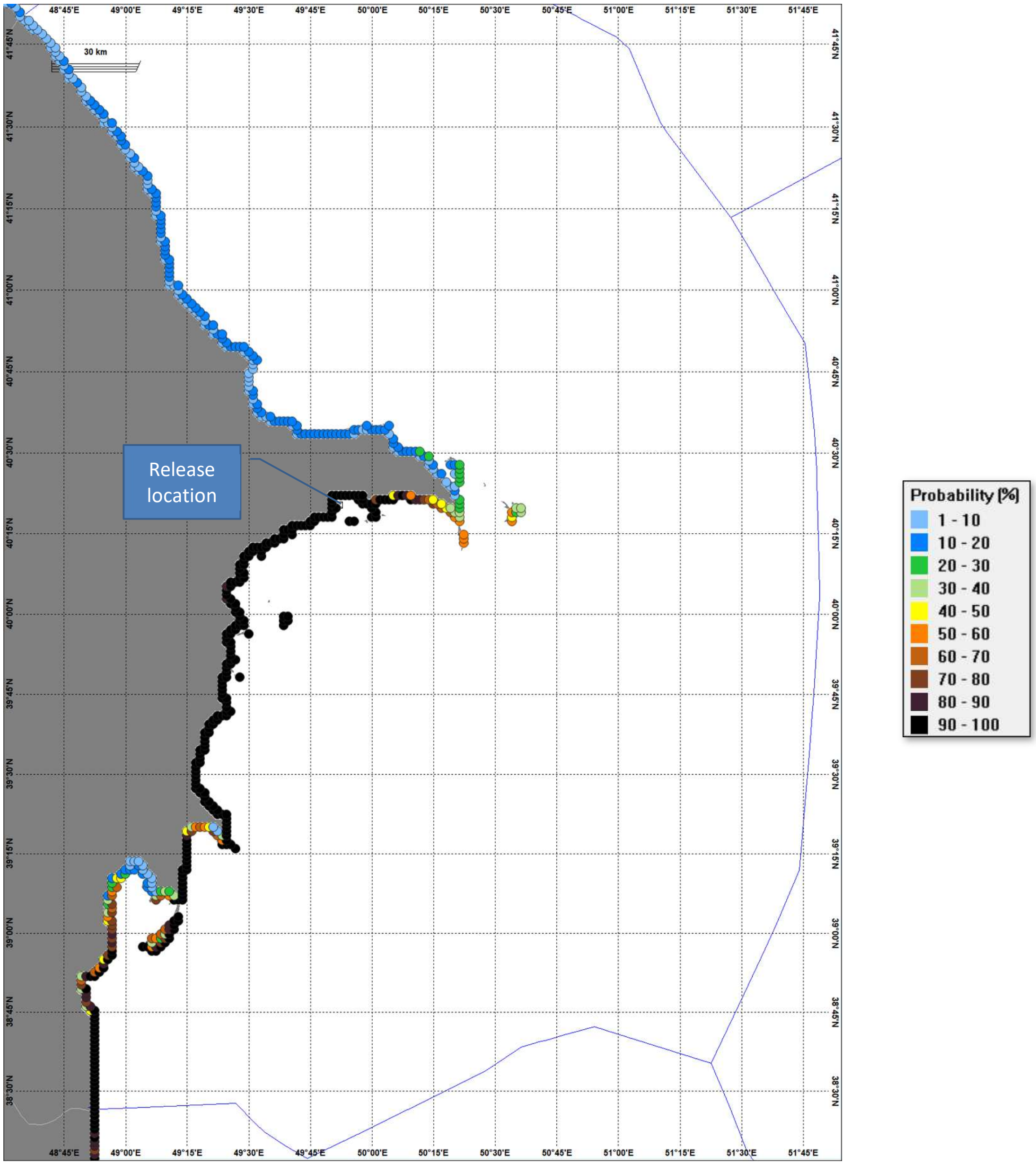


Figure 37: Worst case blowout: Probability of oil on shoreline above threshold of 100 ml/m² - Azerbaijan area (summer)

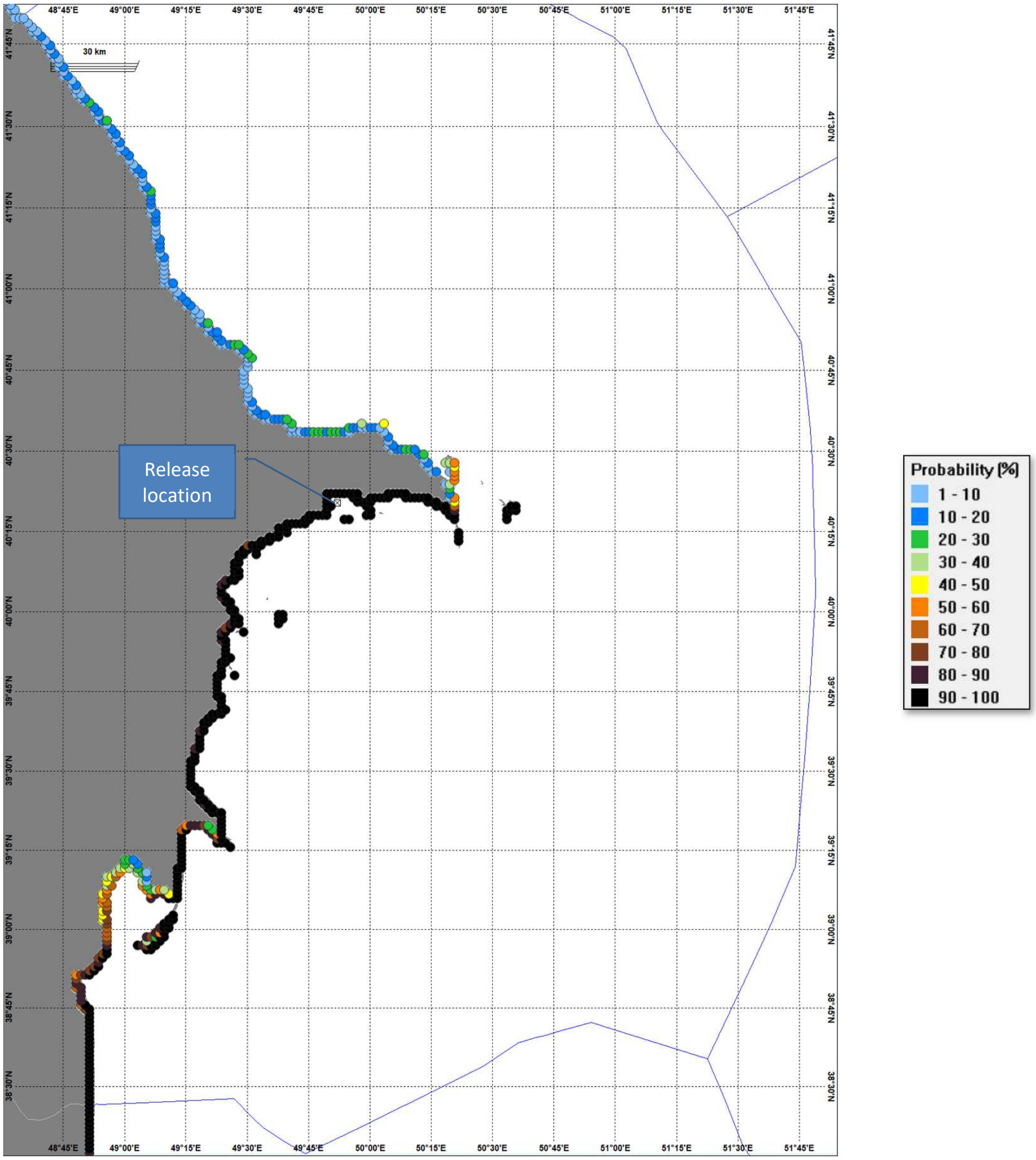


Figure 38: Worst case blowout: Probability of oil on shoreline above threshold of 100 ml/m² - Azerbaijan area (winter)

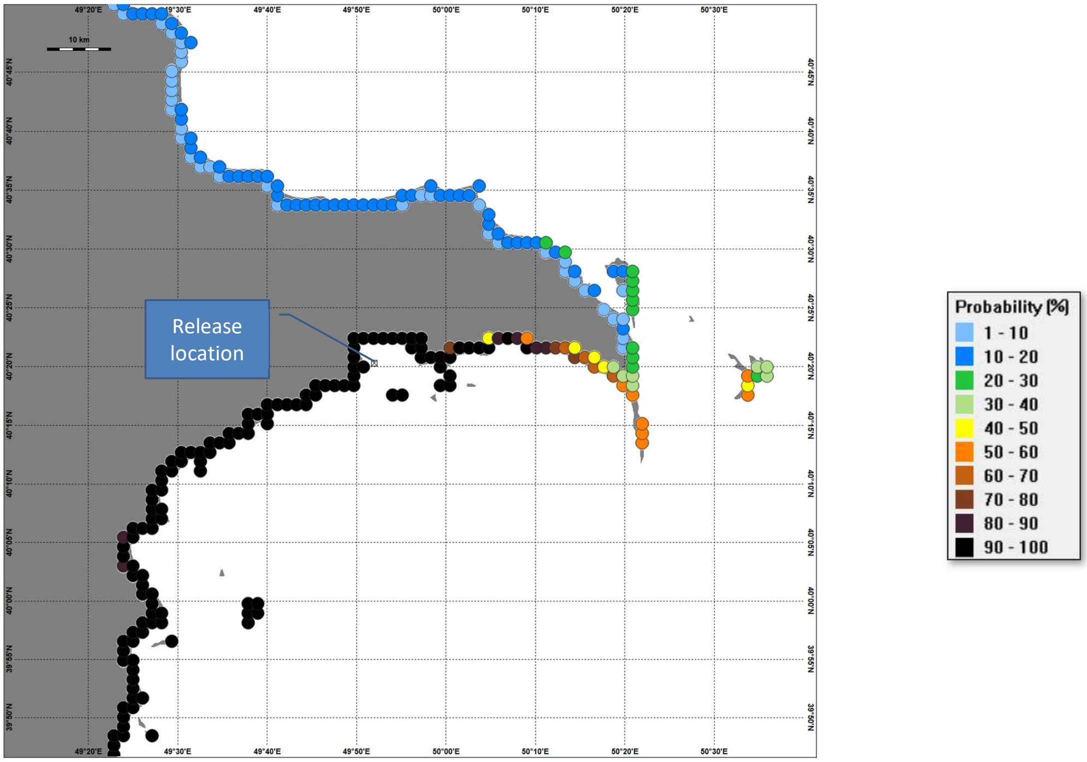


Figure 39: Worst case blowout: Probability of oil on shoreline above threshold of 100 ml/m² - Absheron peninsula (summer)

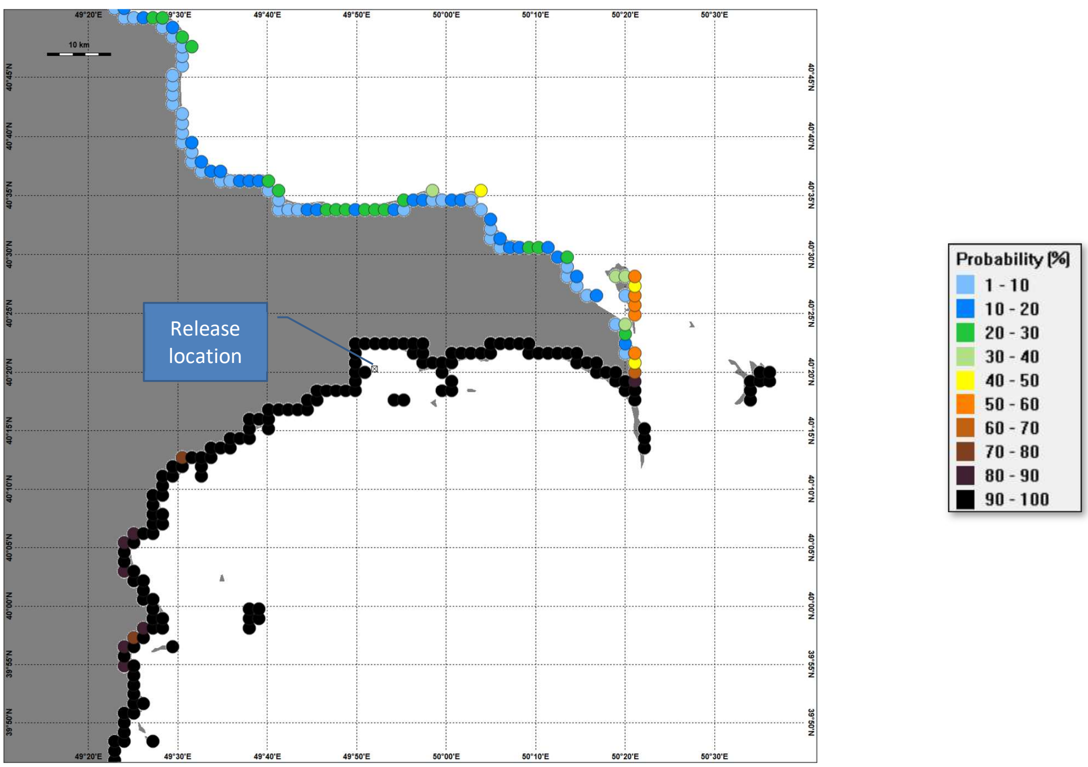


Figure 40: Worst case blowout: Probability of oil on shoreline above threshold of 100 ml/m² - Absheron peninsula (winter)

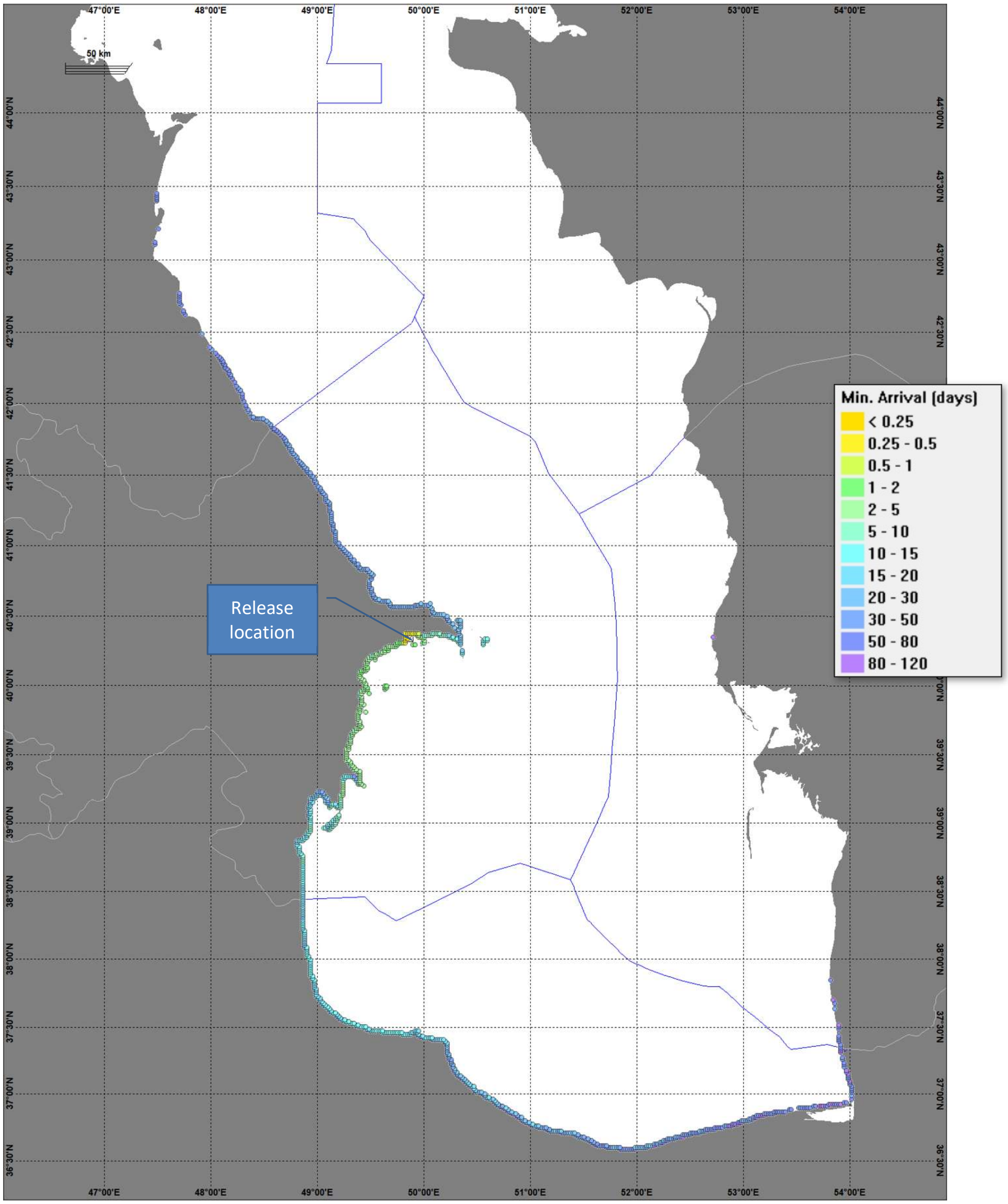


Figure 41: Worst case blowout: Minimum arrival time of oil on shoreline - Caspian Sea (summer)

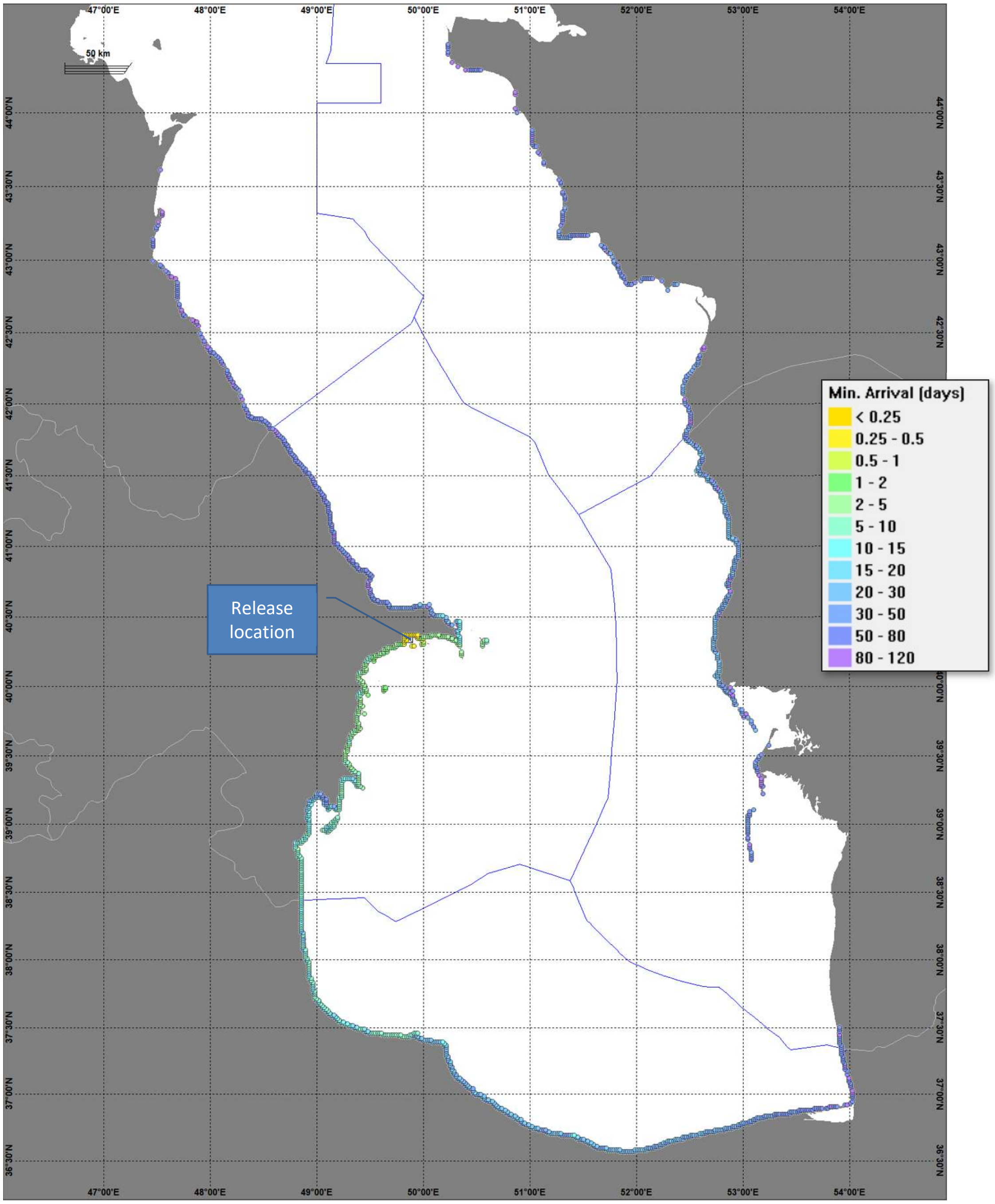


Figure 42: Worst case blowout: Minimum arrival time of oil on shoreline - Caspian Sea (winter)

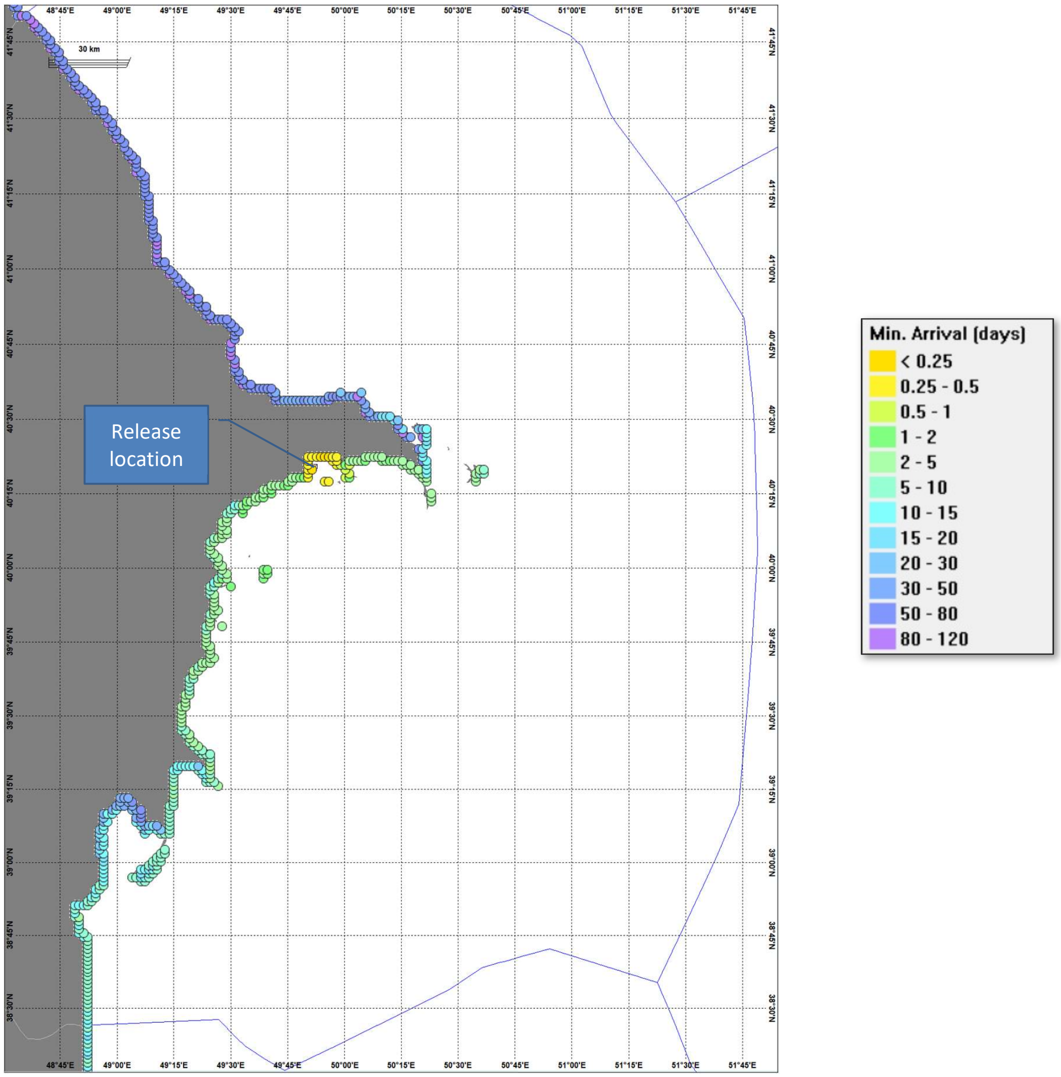


Figure 43: Worst case blowout: Minimum arrival time of oil on shoreline - Azerbaijan area (summer)

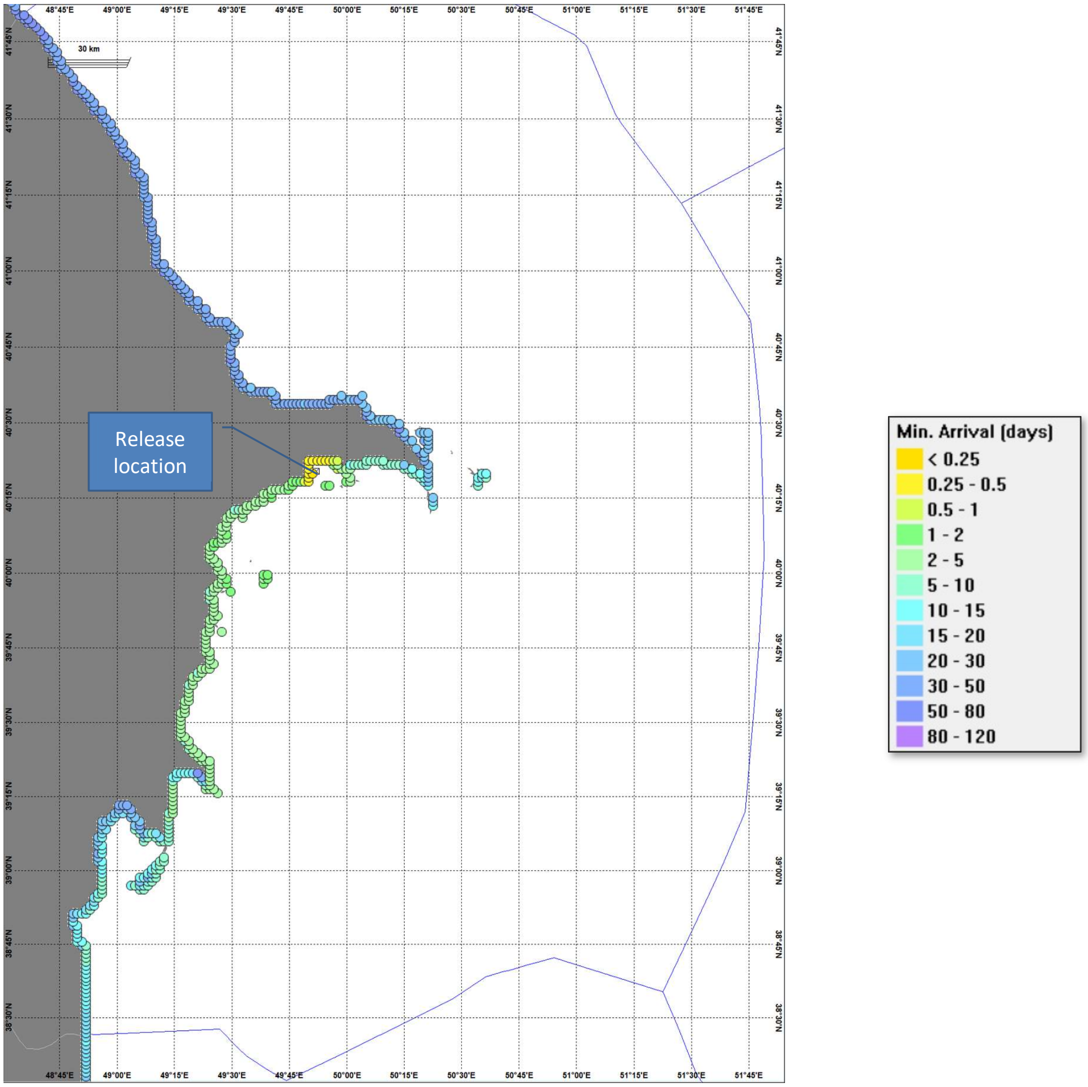


Figure 44: Worst case blowout: Minimum arrival time of oil on shoreline - Absheron peninsula (winter)

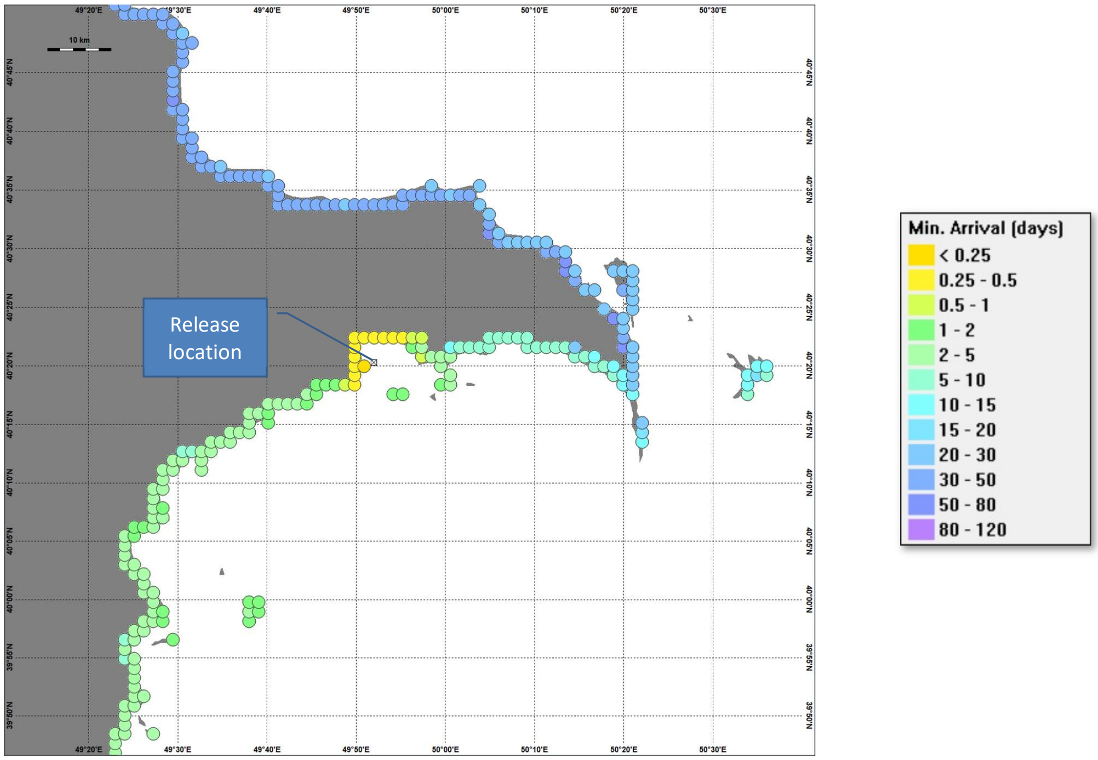


Figure 45: Worst case blowout: Minimum arrival time of oil on shoreline - Absheron peninsula (summer)

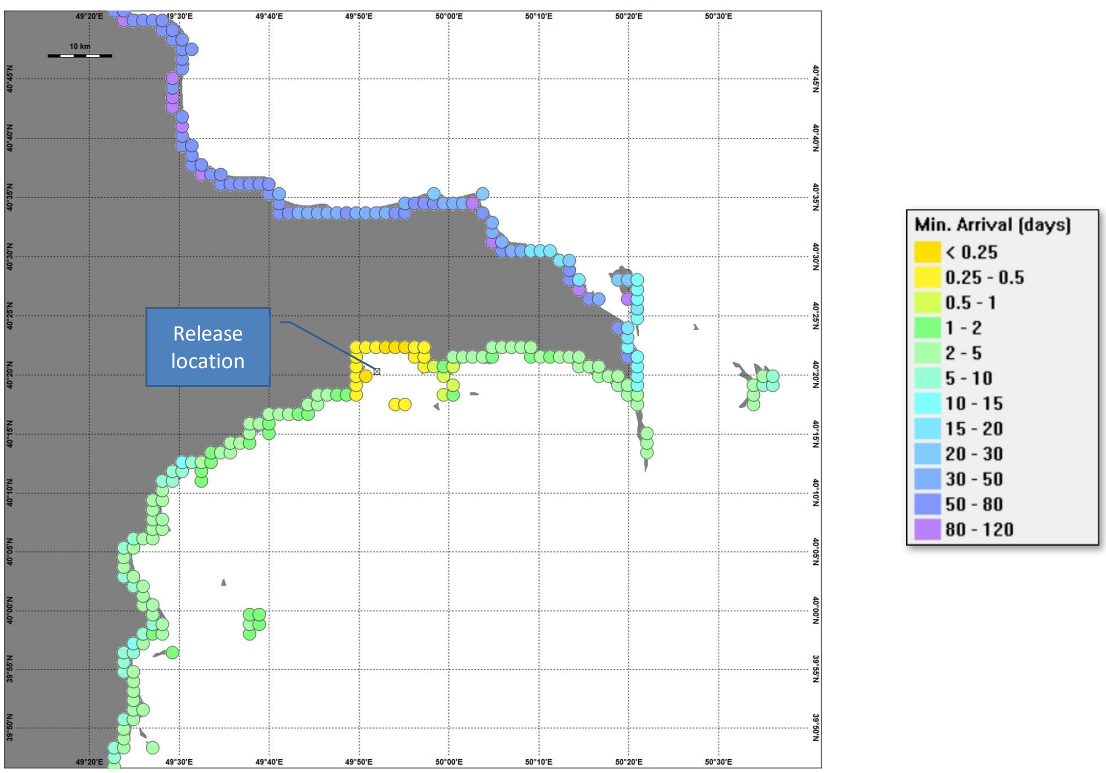


Figure 46: Worst case blowout: Minimum arrival time of oil on shoreline - Absheron peninsula (winter)

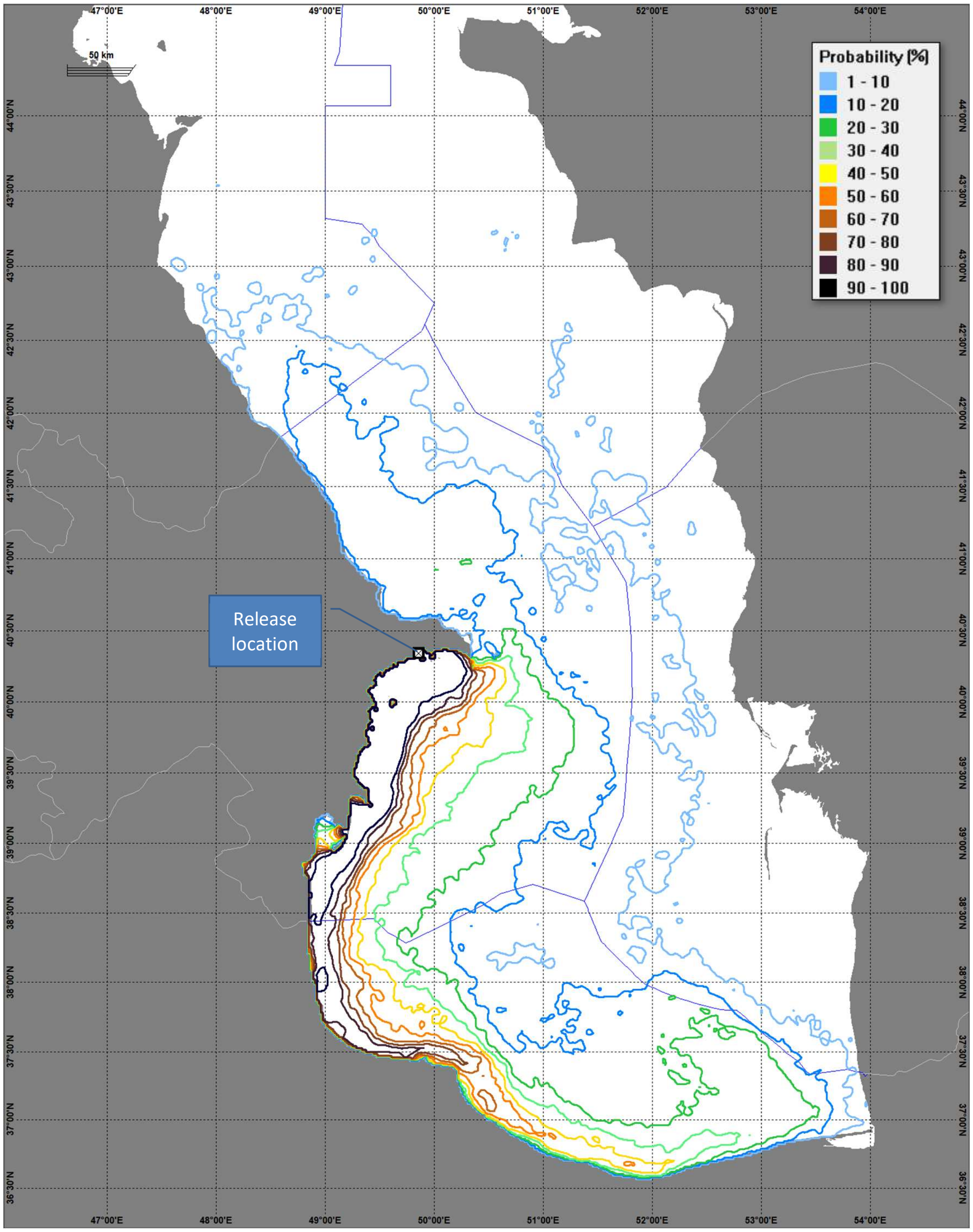


Figure 47: Worst case blowout: Probability of oil in water column above threshold of 58 ppb (summer)

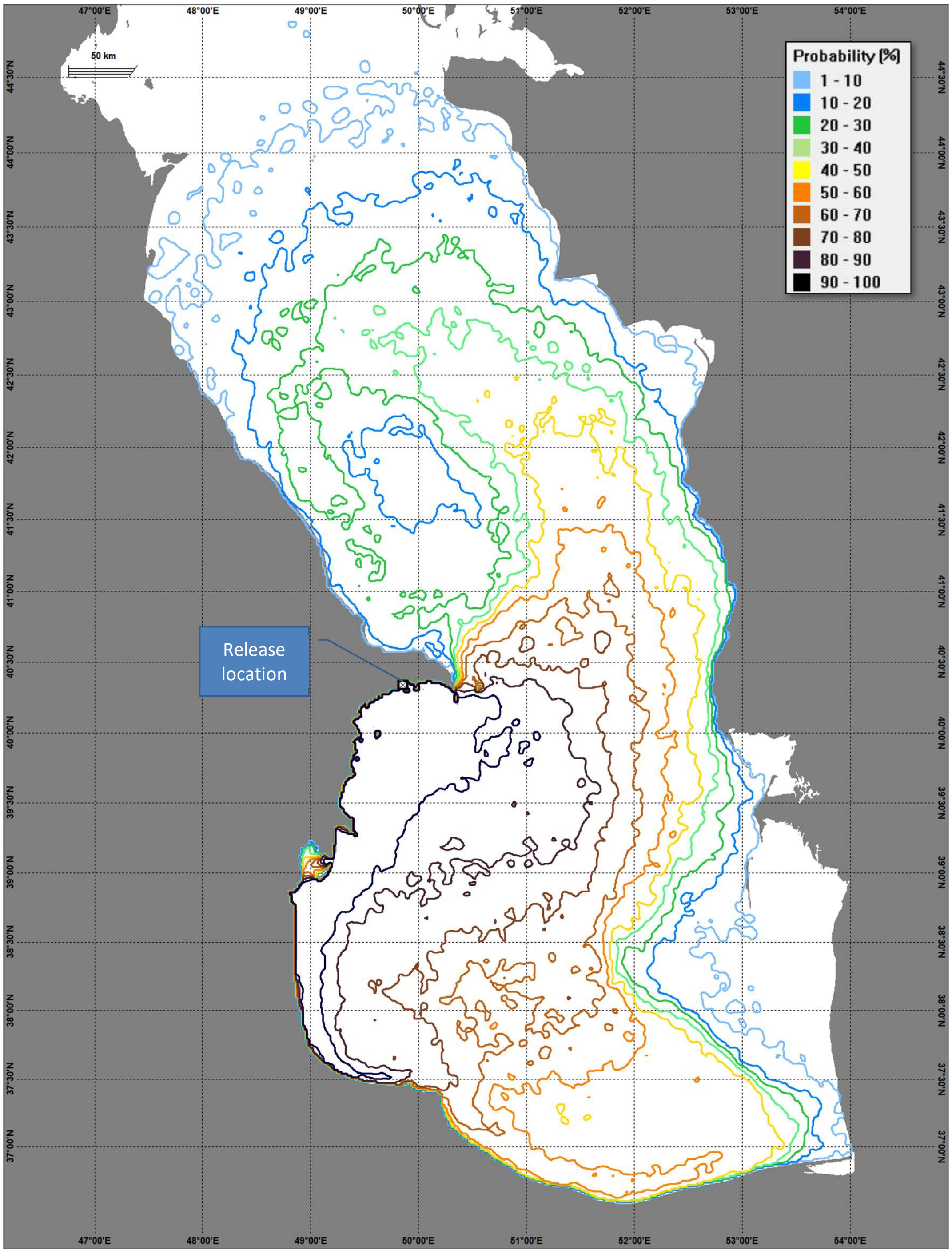


Figure 48: Worst case blowout: Probability of oil in water column above threshold of 58 ppb (winter)

5.2.3 Deterministic modelling

Key outputs from the deterministic modelling are shown in Table 12.

Table 12: Deterministic results summary for worst case blowout

Scenario	Release location	Maximum surface extent of sheen above 0.04 µm (km)		Time until water column concentration[1] <58 ppb (days)[2]	
		Summer	Winter	Summer	Winter
Worst case blowout 957,402 m^3	BHEX01 well	523	390	> 120	> 120

Notes: 1. Dissolved and dispersed oil in water column.

2. Time from start of release

The timing of the summer and winter deterministic scenarios is chosen to match the cases with the maximum mass of oil reaching shore in each season.

5.2.3.1 Oil on surface

Crude oil on the sea surface is predicted to travel around 400-500 km in these two sets of conditions before it drops below the lowest recognised visible thickness under ideal viewing conditions (Figure 49 and Figure 50). There is a distinct difference in oil movement between summer and winter as shown in the figures. In the summer, oil is more likely to remain closer to the coast and travel north and south, while in the winter it is more likely to spread further distance from the coast towards the east.

The thickest areas of oil on the surface (> 0.2 mm) are predicted to cover similar areas during winter and summer. These areas are likely to be associated with the most significant environmental impacts for animals and birds using the sea surface.

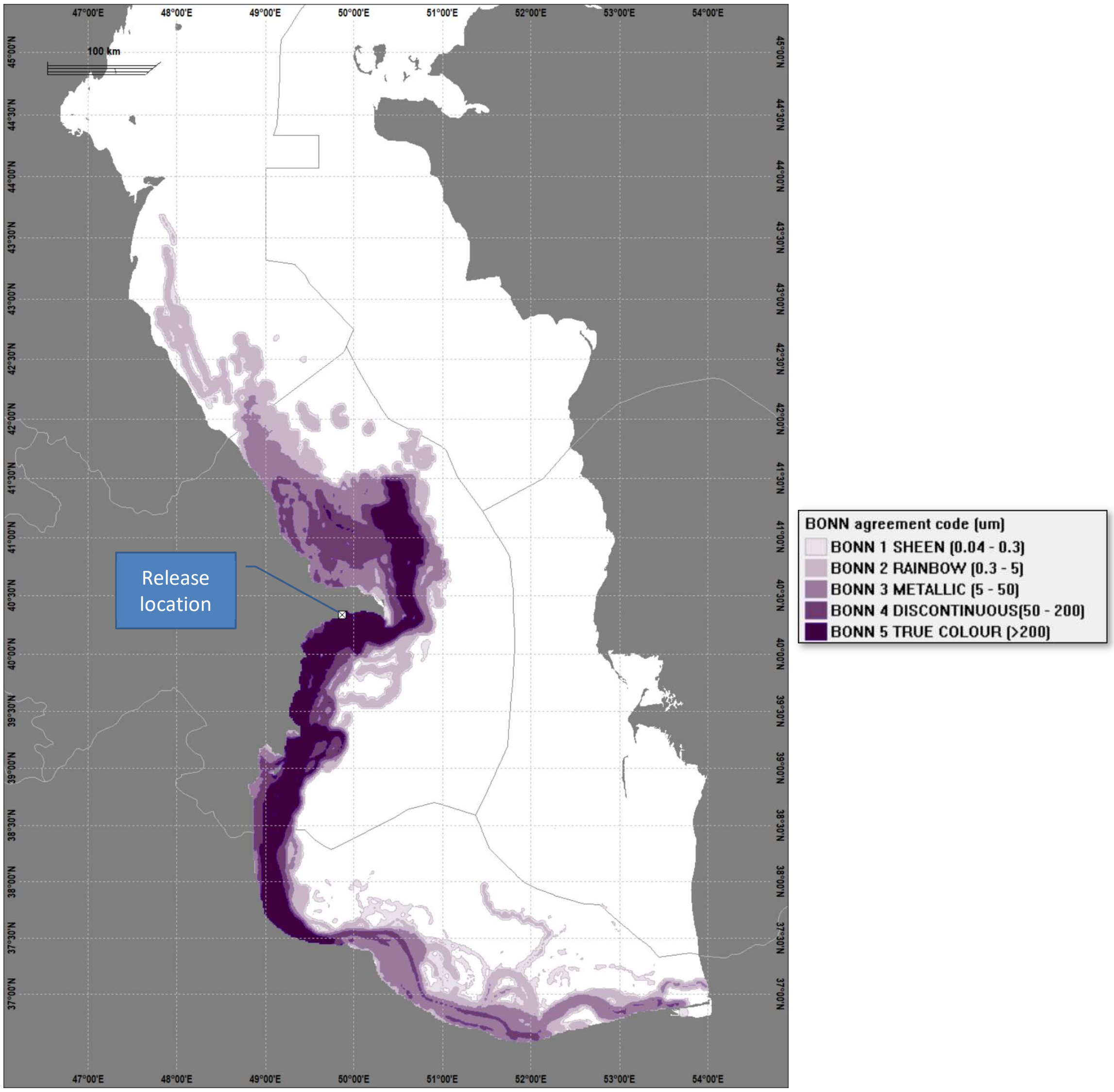


Figure 49: Worst case blowout: Cumulative area of surface sheen - summer

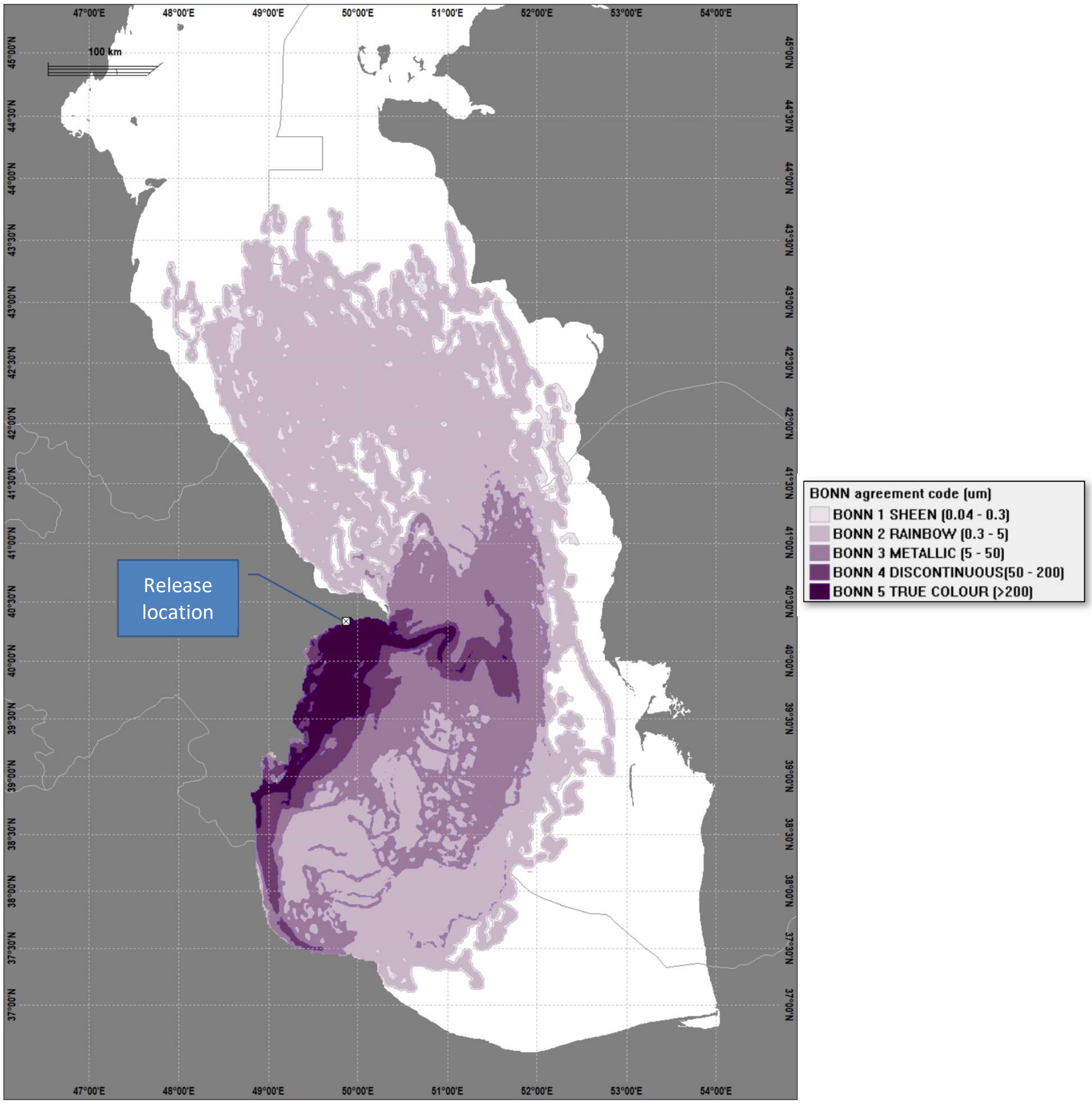


Figure 50: Worst case blowout: Cumulative area of surface sheen - winter

5.2.3.2 Oil on shore

Oil accumulation on shore for the summer deterministic case is shown in Figure 51 and the winter deterministic case is shown in Figure 53. These represent the deposition of oil on the shore at the end of the simulation when the maximum length of coastline is affected. Given the length of the release and the widespread dispersion after 80 days, this distribution is very similar to the distribution at which the maximum mass of shoreline deposition occurs, and so this is not shown in addition.

Both cases result in oil reaching southern Azerbaijan, northern Iran and the Absheron peninsula. The summer case presented results in oil also reaching the Russian coast. The eastern coastline of the Caspian Sea is unaffected, although the stochastic analysis indicates that it is possible for scenarios to reach the eastern coastline in some metocean conditions. A mixture of areas of very light, light, moderate and heavy oil deposition are present. Note that the maximum level of deposition on the artificial shorelines in Baku Bay is 'Moderate' - these shorelines will be saturated with oil but are modelled as having a smaller surface area available to oil compared with a sandy beach and so this would not exceed an equivalent of 10 mm thickness in the model outputs.

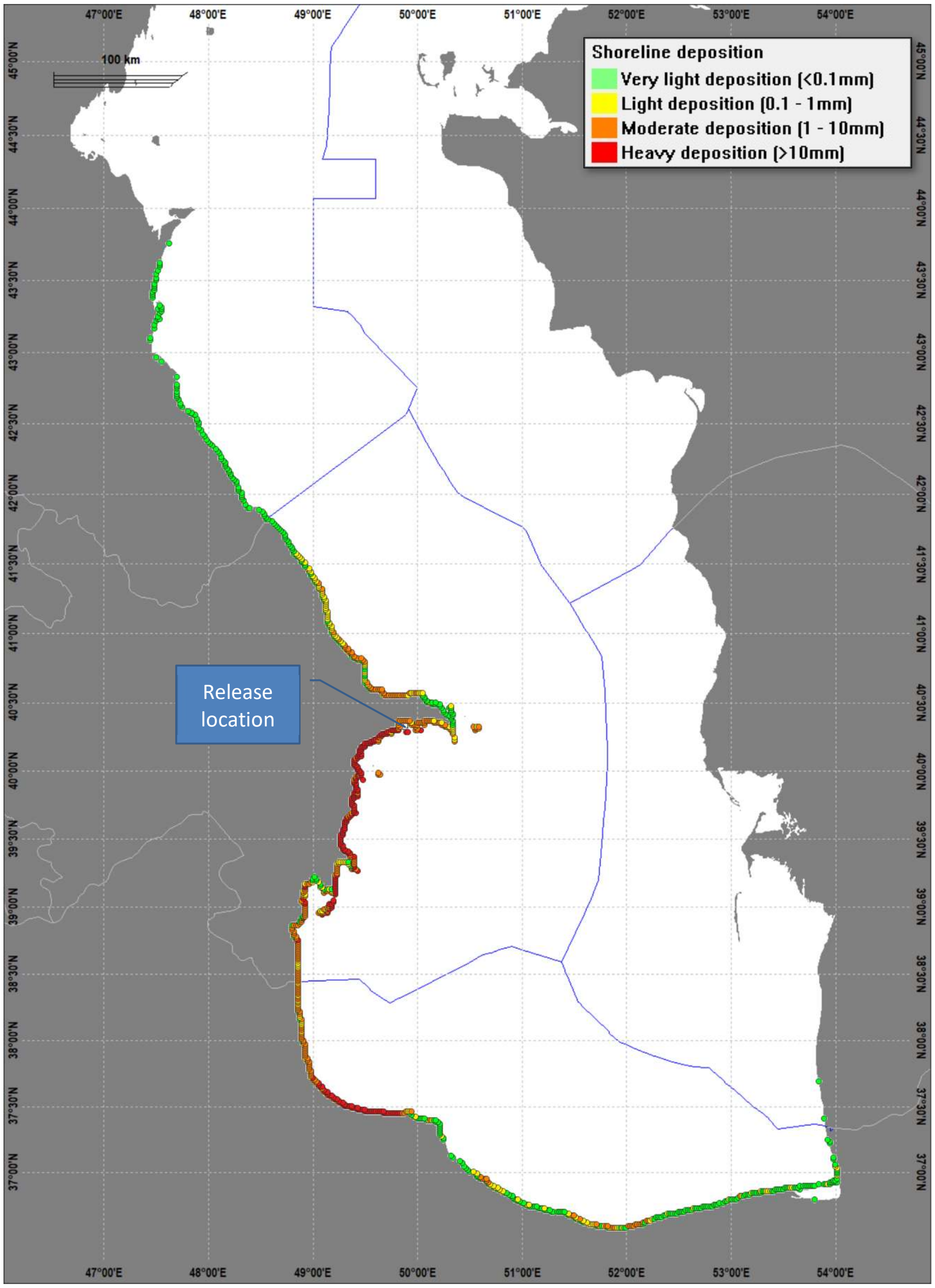


Figure 51: Worst case blowout: Oil on shore - summer - Caspian Sea

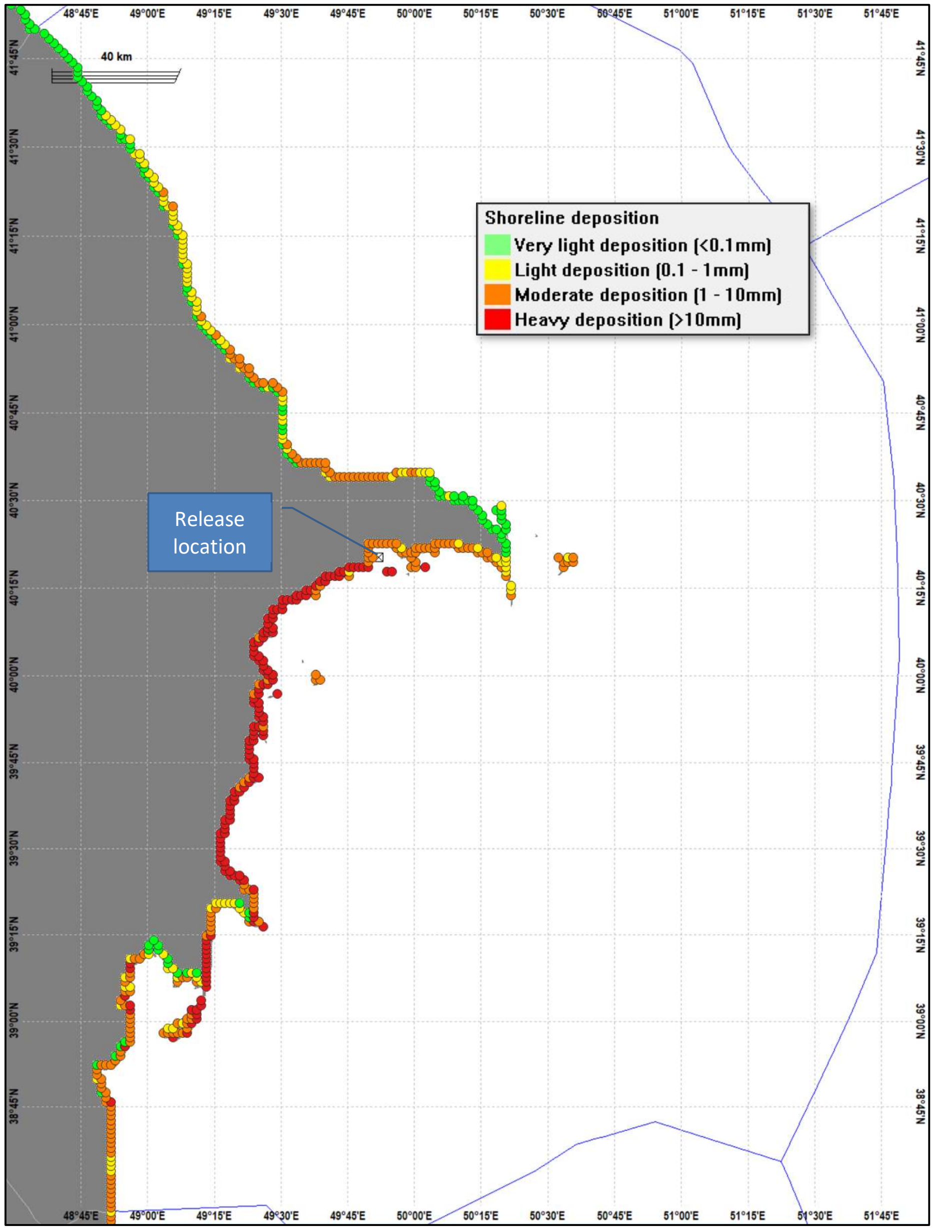


Figure 52: Worst case blowout: Oil on shore - summer - Azerbaijan Area

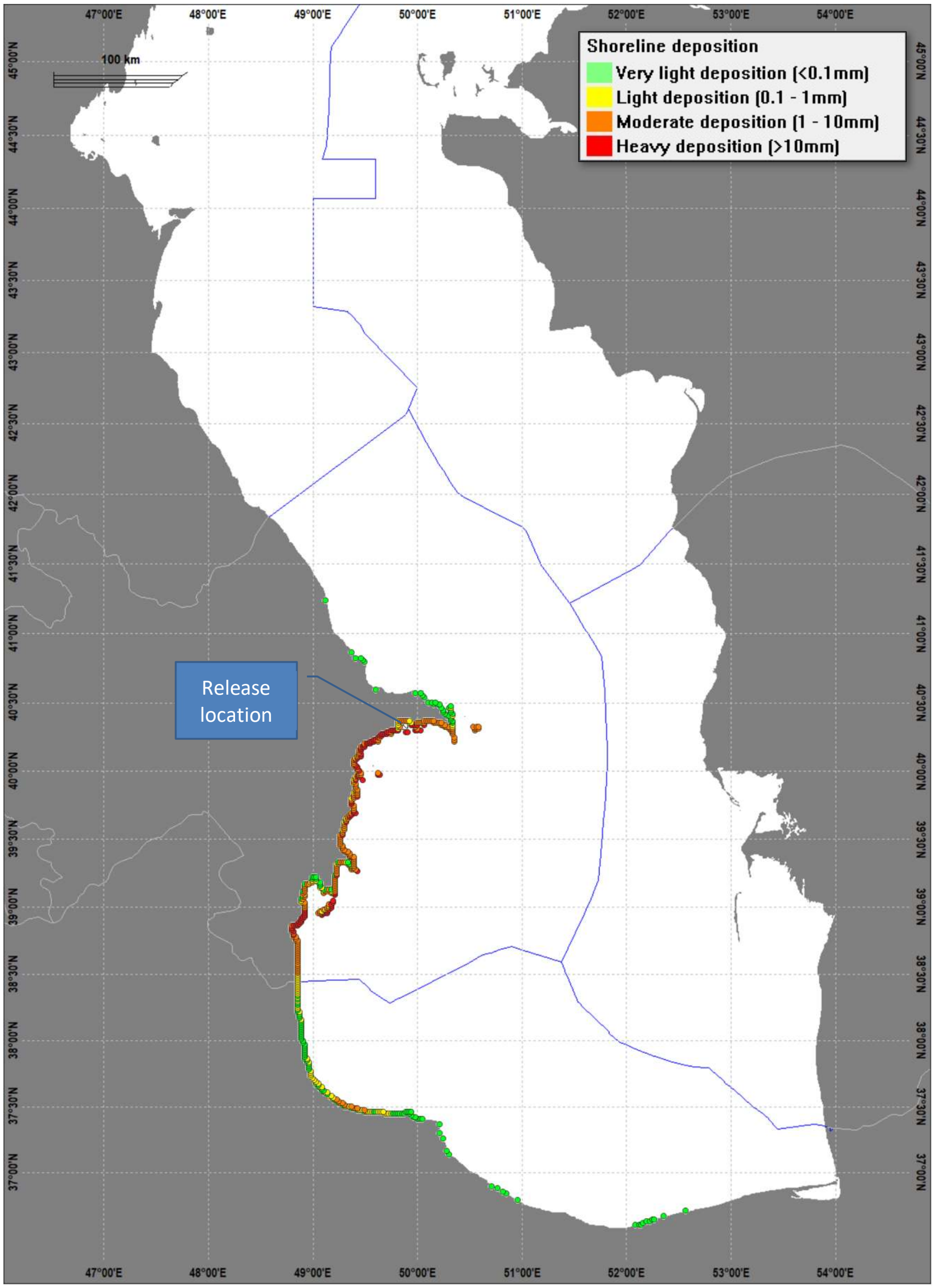


Figure 53: Worst case blowout: Oil on shore - winter

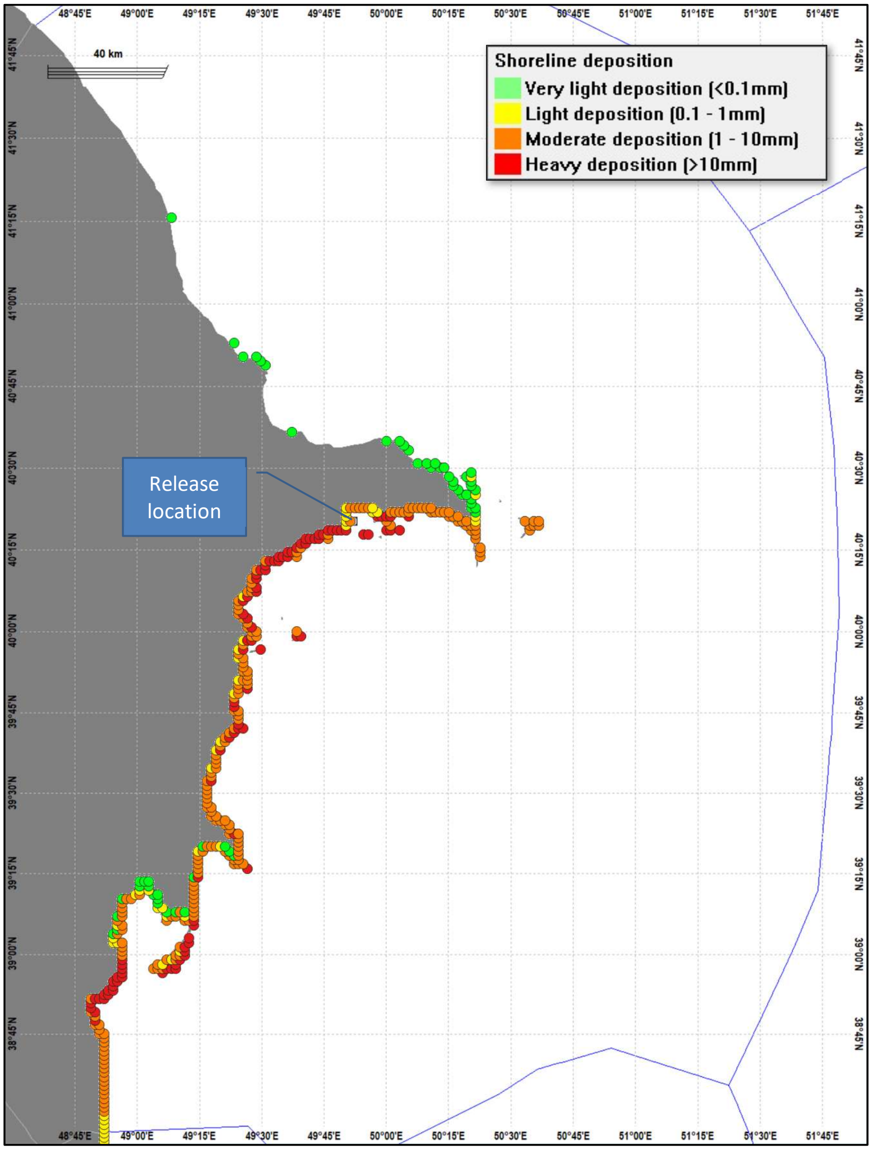


Figure 54: Worst case blowout: Oil on shore - winter - Azerbaijan Area

5.2.3.3 Oil in the water column

The extent of oil in the water column above the 58 ppb threshold tracks the path of the surface release and can extend 390-530 km from the source as shown in Figure 55 and Figure 56 representing the deterministic cases run in summer and winter, where (for each season respectively) the maximum oil reaches the shore. These outputs represent both dissolved and dispersed oil in the water column. In each figure, the output is the total area the oil has covered as it has moved away from the release location.

The oil moves outwards and disperses via the action of circulation currents, winds and waves and its presence in the water column is dominated by the presence of surface slick. Some of the surface oil dissolves into the upper water column and some disperses in droplet form during stronger wind and wave conditions and can then re-appear on the surface in calmer conditions. Wave mixing and diffusion of the dissolved components gives rise to appreciable concentrations in the upper 20 m of the water column, and occasionally deeper to around 50 m depth, although the maximum concentrations remain immediately below the surface oil which is persistent.

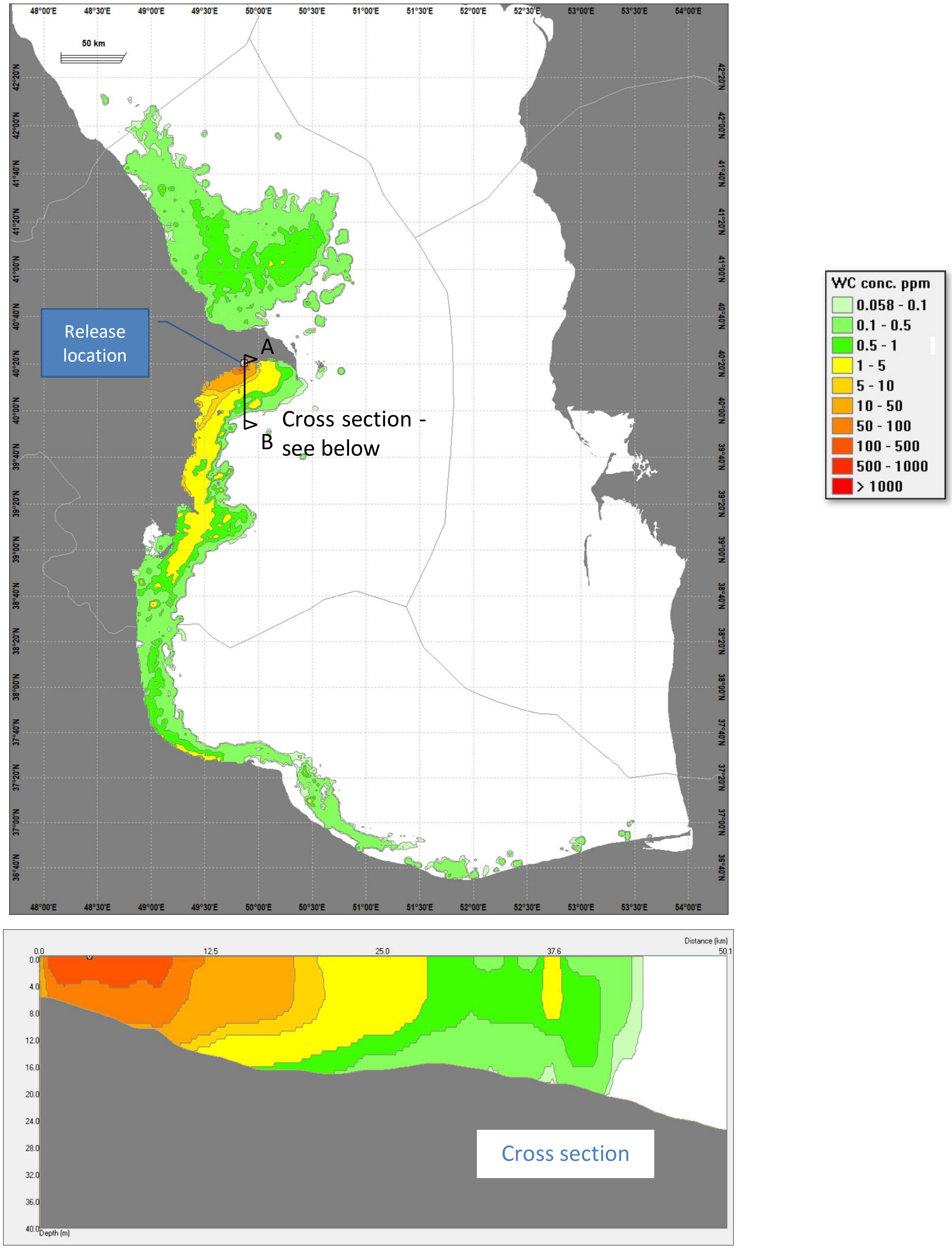
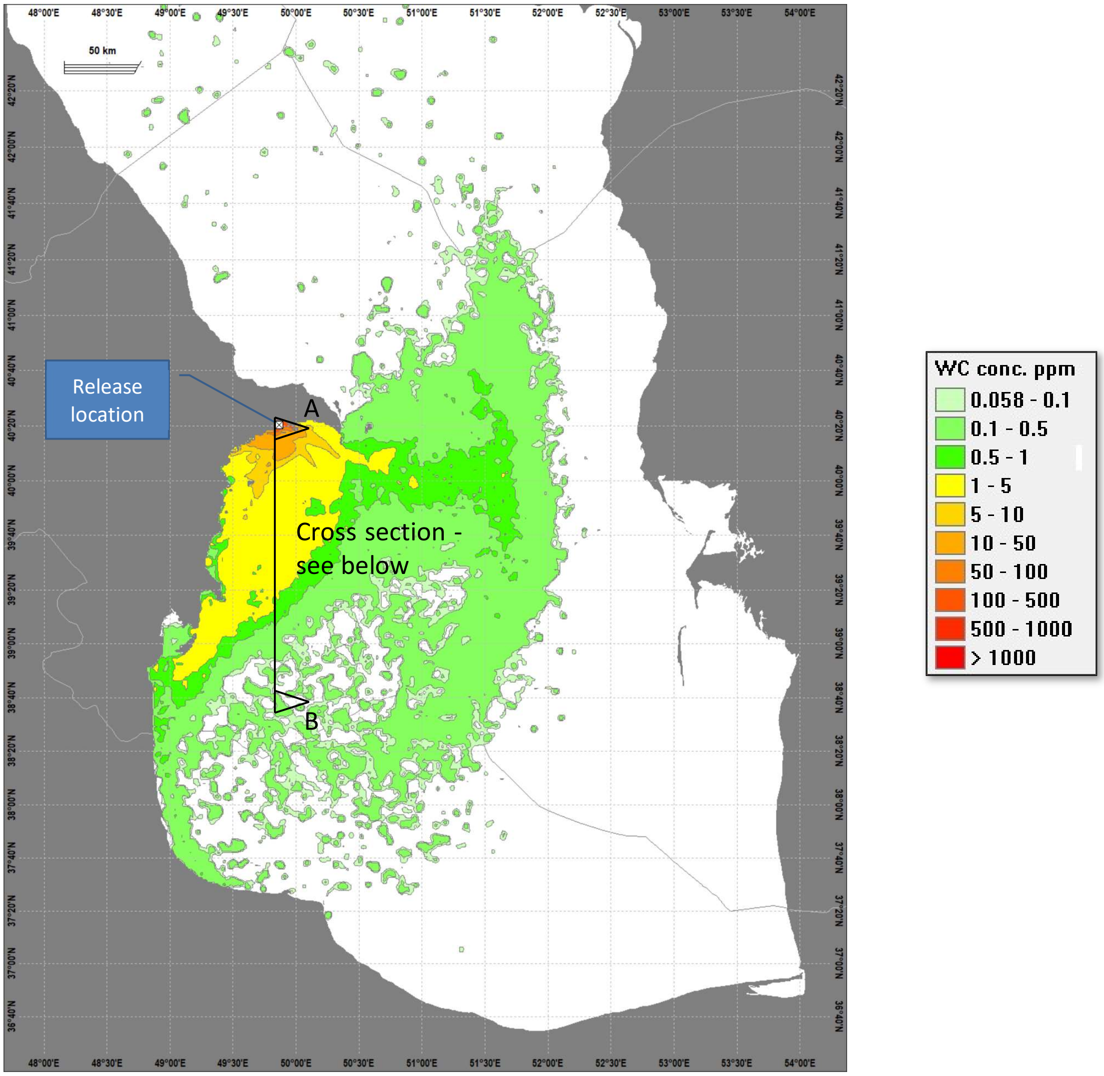


Figure 55: Worst case blowout: maximum affected area of water column during simulation - summer



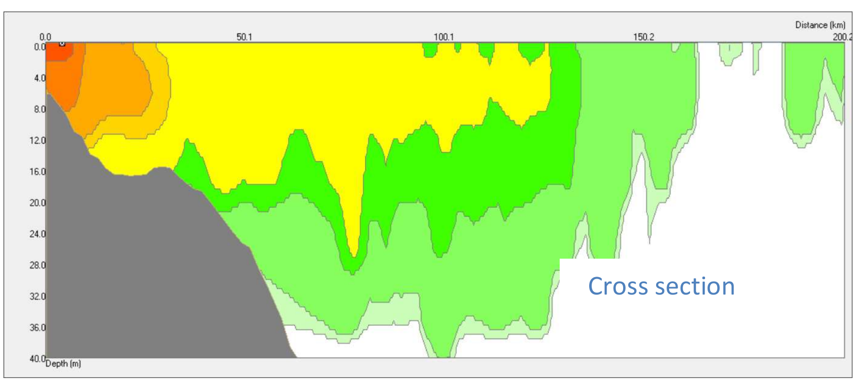


Figure 56: Worst case blowout: maximum affected area of water column during simulation – winter

5.2.3.4 Oil in sediments

By the end of the scenario, around 23% of the oil is predicted to have deposited in sediments, predominantly in the shallow waters around the Absheron peninsula. The deposition pattern for summer conditions at the end of the simulation (the point of maximum oil in sediments) is shown in Figure 57. This may take a period of months or years to decline substantially. Based on experiences elsewhere in the world, effects on macrofauna are typically greatest amongst mollusc and crustacean communities due to their habitation of the benthos and their limited ability to metabolise oil components. Higher animals are more mobile and typically have wider food sources and greater ability to metabolise oil, although demersal fish could exhibit sub-lethal or toxic effects in the short term and taint in their flesh. Using the thresholds set out, significant effects would be unlikely below the 10 mg/kg contour; between 10-100 mg/kg sub-lethal effects could be expected (such as narcosis and lower reproductive success); while above 1,000 mg/kg acute toxic effects would be expected in multiple species. Given the historic oil-producing nature of the area, background oil levels may already be elevated or tolerated; nevertheless acute toxic effects would be expected mainly within 42 km of the well based on these thresholds and sub-lethal effects potentially at a distance of 120 km.

In winter, the deposition pattern shown in Figure 58 is less extensive near the coast with a greater level of deposition offshore, reflecting the different metocean conditions.

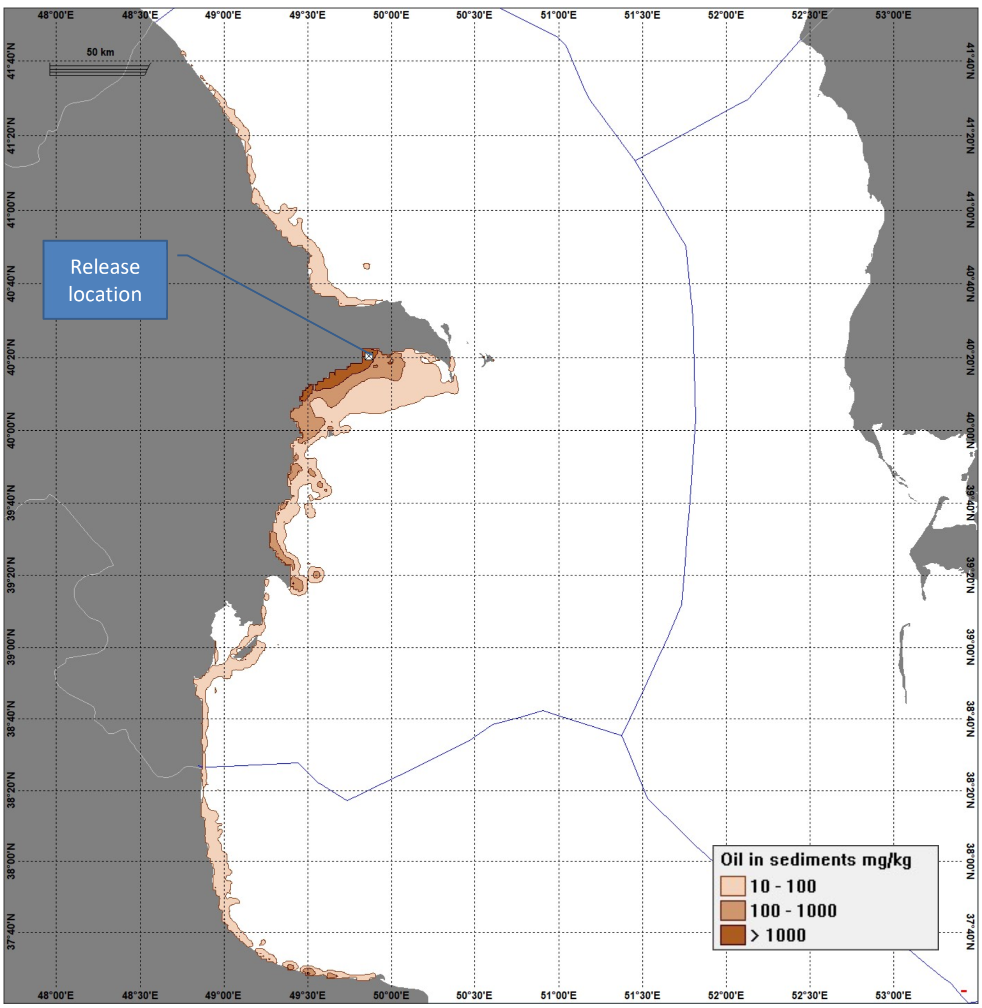


Figure 57: Worst case blowout: maximum mass of oil deposited in sediments (summer)

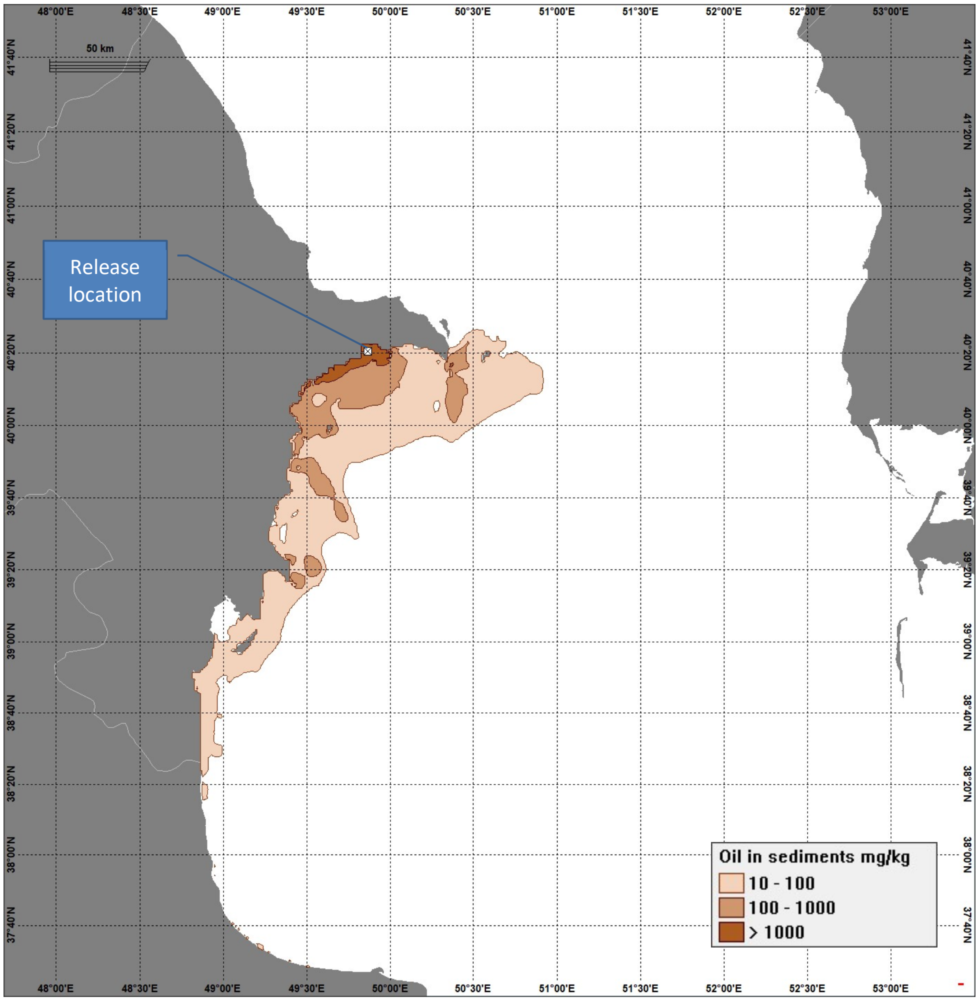


Figure 58: Worst case blowout: maximum mass of oil deposited in sediments (winter)

5.3 Scenario 3 – Cooling water discharge results

As previously described, the prevailing water column temperature profile varies significantly between summer and winter, although in this shallow water depth, temperature will vary little between the top and bottom of the water column. Circulation currents vary throughout each day, therefore a low and a high current velocity case has been examined for summer and winter conditions, producing four scenarios. For early February and early July (winter and summer respectively), the current data has been examined to find low and high current conditions that are typical of the month. This produces four extremes of plume behaviour, and through each day and season the plume behaviour is expected to vary within the envelope of these scenarios. Under different metocean conditions the orientation of the plume will vary. Overall, currents in Baku Bay can be around 50% lower than those in the offshore environment.

The cooling water release results are presented in the following Figures 40-43 which show the plumes after 15 minutes having reached stable conditions in the near field mixing zone. Given the small (8") diameter of the discharge caisson, there is high turbulence and the majority of the heat loss takes place within a few metres of the discharge, often within the initial turbulent plume section. There is some difference between high and low current conditions, which will occur on a daily basis; during slack currents, a stable plume forms which descends downwards through momentum but which then rises upwards slightly due to the residual thermal buoyancy. In higher current conditions, the stable plume does not have a chance to form and both the momentum and thermal advection are overcome by the rapid horizontal current to form an elongated plume at a fairly constant depth.

The water depth is very shallow and the plume is predicted to reach the seabed and be in contact with the benthos, although the change in temperature is very small and the benthos is unlikely to be affected.

In all scenarios, the temperature difference between the discharge plume and ambient conditions has returned to zero within 100 m of the discharge location with differences of 0.2-0.5°C occurring within the first few metres of the discharge point in all scenarios modelled. Therefore it is concluded that the 3°C criterion is not exceeded at the edge of a scientifically established mixing zone under any conditions.

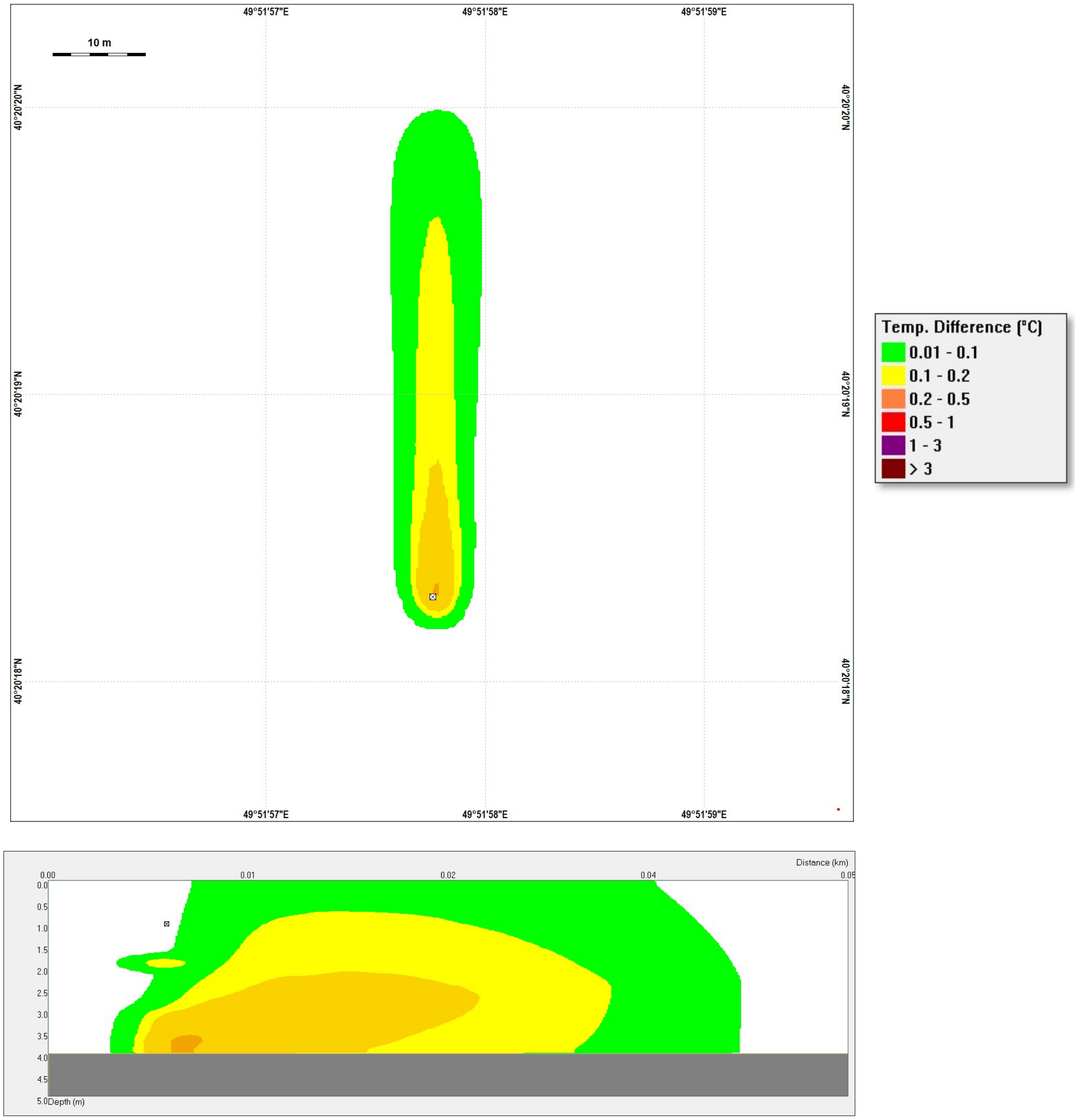


Figure 59: Stable thermal plume, summer, high current conditions (~0.105 m/s)

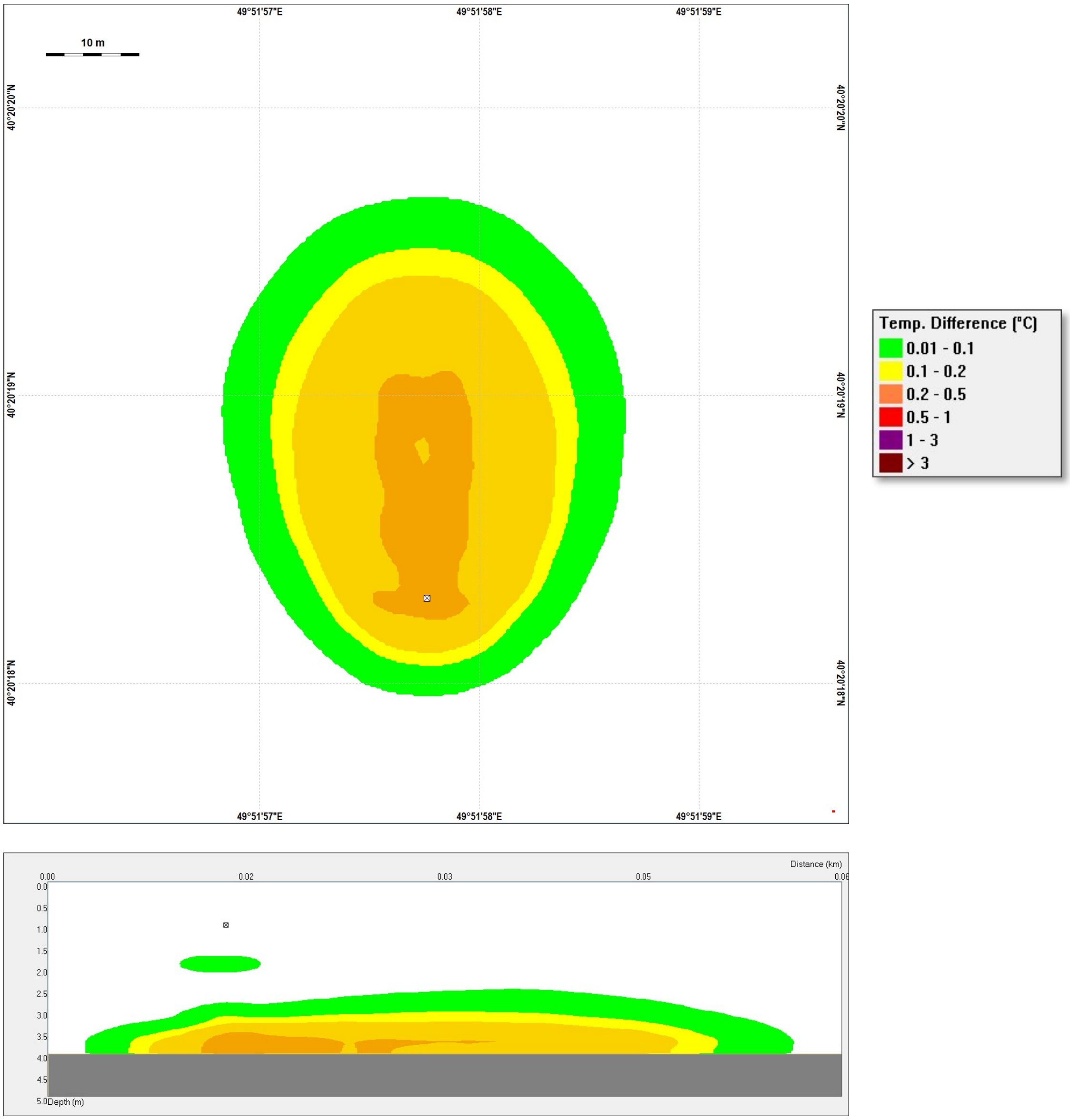


Figure 60: Stable thermal plume, summer, low current conditions (~0.020 m/s)

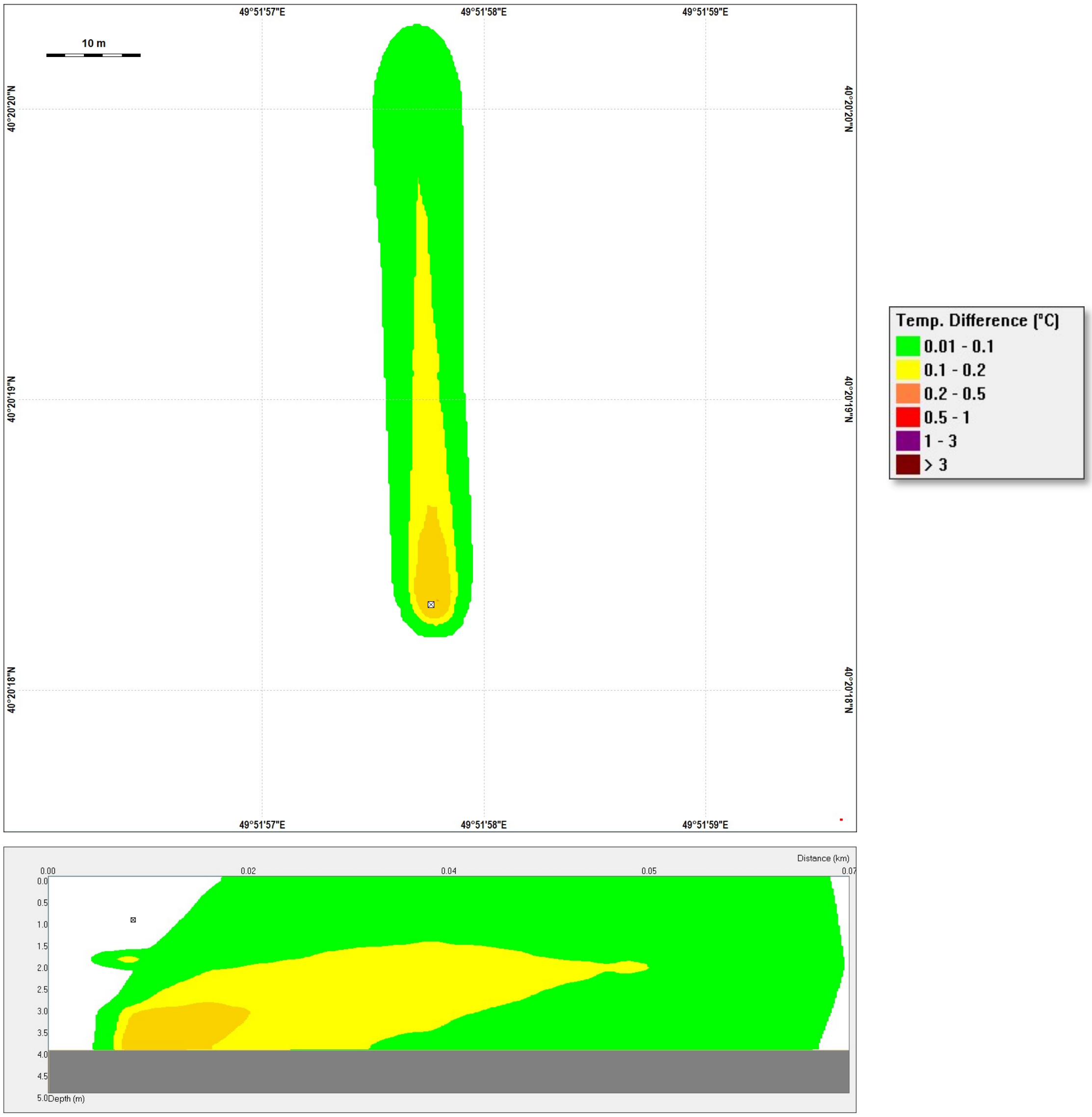


Figure 61: Stable thermal plume, winter, high current conditions (~0.107 m/s)

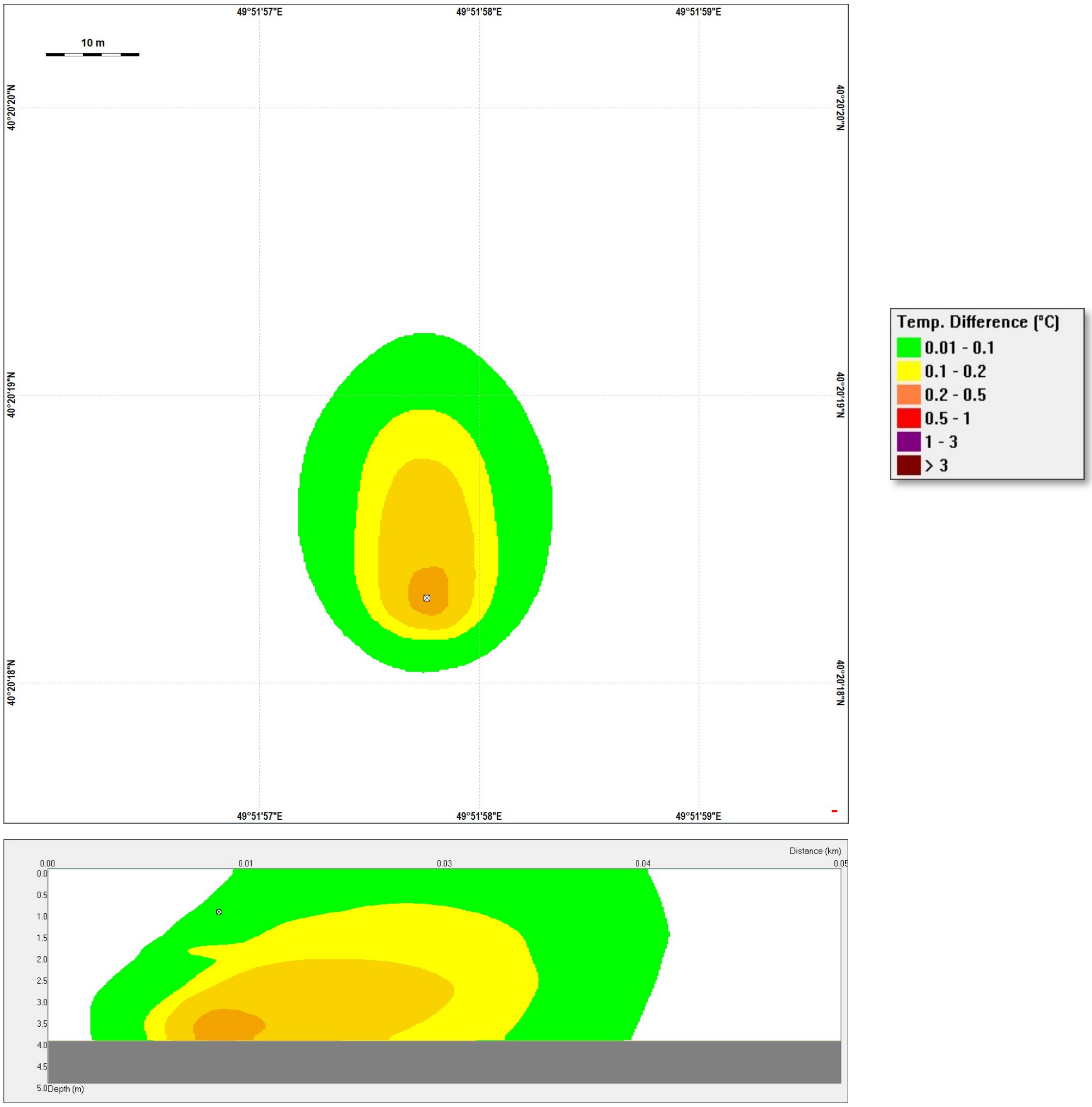


Figure 62: Stable thermal plume, winter, low current conditions (~0.014 m/s)

6 Uncertainties

6.1 Characterisation of the release

6.1.1 Release volumes

Diesel volumes are based on known tank sizes and are well defined. Release rates depend on the means of discharge e.g. a perforation. Assuming that this volume leaks in ten minutes is a reasonably conservative estimate that gives rise to a thick sheen and is a small proportion of the time taken for the release to disappear from the surface subsequently.

Estimates were provided by BP for the maximum declining rate of a blowout from well BHEX01. It is recommended that these are reviewed following well testing.

The duration of blowouts, should they occur, can be very variable and ultimately depend on a maximum realistic time to drill a relief well to arrest the flow. A value of 81 days has been estimated and is within typical timescales for this operation worldwide. Again, data obtained from drilling the exploration well may allow a more accurate estimate to be made.

6.1.2 Spill response

The modelling has been undertaken without applying any oil spill tactical response methods such as surface mechanical recovery or chemical dispersant application. In reality, spill mitigation measures such as oil spill containment, recovery and shoreline protection measures would be implemented in the event of a spill to reduce adverse effects to marine and coastal resources, thereby mitigating the full impact of a spill.

6.1.3 Release geometry

The release geometry for diesel is onto the water surface. An underwater release would reduce the diesel on the surface and increase the diesel in the water column, by a small margin. A smaller release would result in a thinner sheen that would evaporate more quickly.

The release geometry for the worst-case blowout has been assumed to be a topsides release given that a fixed jackup rig is being used. There are many other potential geometries of the release, including a subsea blowout, however for this well, sea-surface release from the rig is considered to be the worst case as oil on the surface typically reaches shorelines more quickly and in greater volumes. A subsea release may affect water quality more significantly but reduce surface and shoreline impacts. The time to arrest the blowout by a relief well remains the same, independent of the geometry of the release.

The depth and diameter of the cooling water caisson discharge point are uncertain given the very shallow water depth in this location. A depth of 1 m is assumed and a diameter of 203 mm. In the event that a discharge above the sea surface is adopted, this would have the effect of presenting a wider release diameter at the sea surface and a downward momentum. A sensitivity test has therefore been conducted on one of the scenarios to compare the temperature difference outputs, using a diameter of 1 m and a depth of 0.2 m for a discharge above the sea surface. The results are compared in Figure 63, which shows that the simulated discharge above sea surface results in a slightly smaller zone of effect than the original discharge modelled at a depth of 1 m, with the plume residing in the upper water column rather than the lower water column as there is less downward momentum. The results presented are therefore adequate for assessment purposes.

A further uncertainty for the cooling water discharge is the phenomenon of air entrainment if there is air inside the caisson, given the flow velocity through the caisson of approximately 1.5 m/s. This is not represented in the modelling, and if air is present then entrainment is very likely and it would tend to make the plume rise and will to some extent counteract or overcome the downward momentum. In this scenario, the modelled plume without gas entrainment descends through the water column, and in some cases is restricted by the seabed. With gas entrainment, it is likely that the plume will either occupy more of the water column, which will reduce modelled temperature difference, or it will rise and be restricted by the sea surface. Broadly, the effect of restriction at the surface will be similar to restriction by the seabed and therefore the modelled results are indicative of the area affected. The modelled temperature differences are all much less than 3°C and this effect is not believed to alter the conclusions.

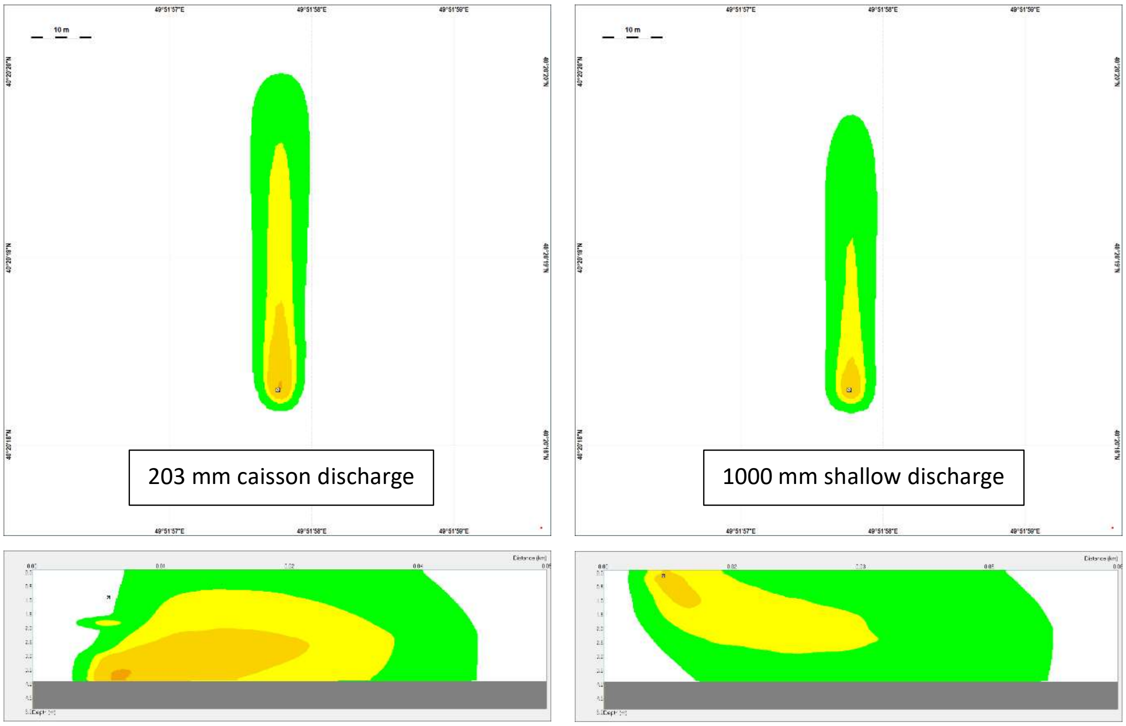


Figure 63: Comparison of cooling water discharge with a simulated case discharging above sea level

6.1.4 Oil properties

The oil properties are not well understood given the exploratory nature of the project and the uncertainties associated with this could be reduced significantly via an oil weathering study on samples of fluid obtained during the exploration drilling. An analogue oil type was chosen from the OSCAR database to align with the crude oil properties provided by BP for the fluids anticipated from the well. The pour point provided for the target crude oil is relatively high and the analogue chosen has a higher wax content but a lower pour point. A large fraction of evaporation is predicted for the analogue crude which is partly due to the confined and relatively calm conditions, but it is possible the target oil would exhibit less evaporation. The crude oil properties are probably the largest uncertainty in the analysis and this uncertainty has a high level of management attached once oil samples have been analysed at a weathering laboratory.

6.2 Metocean data

Seasonal variations in temperature occur, mainly in top tens of metres of the water column. Seasonal variations in salinity are not expected.

The main uncertainty arising is that of differences between actual bathymetry data and that observed through recent surveys, which can be 10-15% offshore and higher than this near the coast. This will have some effect on the hydrodynamic data drawn into the model although variability in the results is not expected to be as high as 10-15% as the changes are spread over wide areas. The decision has been taken to retain the GEBCO bathymetry data in the model as the most representative, uniform source, rather than try to load in small patches of new data, which would create anomalies in the seabed and mean that releases were not depth-proportional to the profile of currents. It is unlikely that overall regional circulation is altered by improved bathymetry data, but local effects may be noticeably changed. The effects on oil movement are limited since oil is buoyant and quickly reaches the sea surface layers.

In the vicinity of the Absheron peninsula there are some anomalies in the underlying current data due to the grid size used in the hydrodynamic model leading to some inaccuracy in oil movement very close to the coast. While the impact of this is expected to be limited for a worst case blow out given its scale and the likelihood for all nearby coastlines to be affected, for operational response planning greater model resolution is recommended or specific trajectories could be miscalculated.

6.3 Model capabilities

The OSCAR model has a long pedigree of development coupled with testing that gives confidence in surface and water column outputs. Validation by BP has also given confidence to shoreline statistics (de Susanne *et al.,* 2015). Predictions for sediment, however, are based on very simple partitioning calculations, and may have a large margin of variability. Additionally, while artificial shorelines around Baku Bay have been mapped, natural shoreline types have been mapped as sandy beach, and precise local shorelines will show a greater or lesser affinity for oil.

7 Conclusions

The modelling of hydrocarbon release and rig cooling water discharges associated with the BHEX01 well predicted the following key outcomes. Note that comments are restricted to the behaviour of the modelled fluids rather than interpretation of impacts.

1. Diesel release. A diesel release of 600 m^3 would create a sheen that would occupy a relatively small area of the Caspian Sea centred on Baku Bay for a period of up to 11 days, after which it would be relatively insubstantial. Diesel can reach the shoreline in approximately 2.2 hours with up to 86 tonnes predicted to be on the shoreline (13 tonnes typically (50^{th} percentile value)). The majority of the diesel would be lost to the atmosphere through evaporation and/or biodegraded, with a residual component in the water column.

2. Well blowout. A worst case well blowout at the sea surface would create a thick oil slick extending up to 530 km at its maximum, although for a number of days after being released, the oil is relatively confined in its movement by the geography of Baku Bay and coastal obstructions and nearby islands. During the blowout period of 81 days, oil is continually supplied to the sea surface, and oil on the surface remains significant until after the end of the 120-day model period. Oil could reach shore within 12 hours of the release commencing. The thickest areas of oil on the surface (> 0.2 mm) are predicted to remain close to the shore. The most likely locations to receive oil on shore are Azerbaijan and northern Iran and up to 110,513 tonnes are predicted to beach on the shoreline (62,425 tonnes typically (50^{th} percentile value)) with the majority deposited in sediments or biodegraded but with a significant proportion remaining on the sea surface. The oil emulsifies rapidly and the masses of emulsion at the shoreline are predicted to be 2.5 times the mass of oil reported equating to a maximum value of shoreline emulsion of around 276,000 tonnes (50th percentile value around 156,000 tonnes). In terms of oil spill response, there would be floating, recoverable oil for a long period with limited initial movement, so booming and recovery may have a relatively high efficiency.

3. Rig cooling water discharge. Predictions of the thermal plume from rig cooling water discharges show that temperature changes are reduced to negligible levels within a few metres of the discharge point in a representative range of conditions. Assuming that the cooling water is discharged via a submerged caisson, the plume travels quickly to the seabed, but remains within the accepted temperature difference.

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